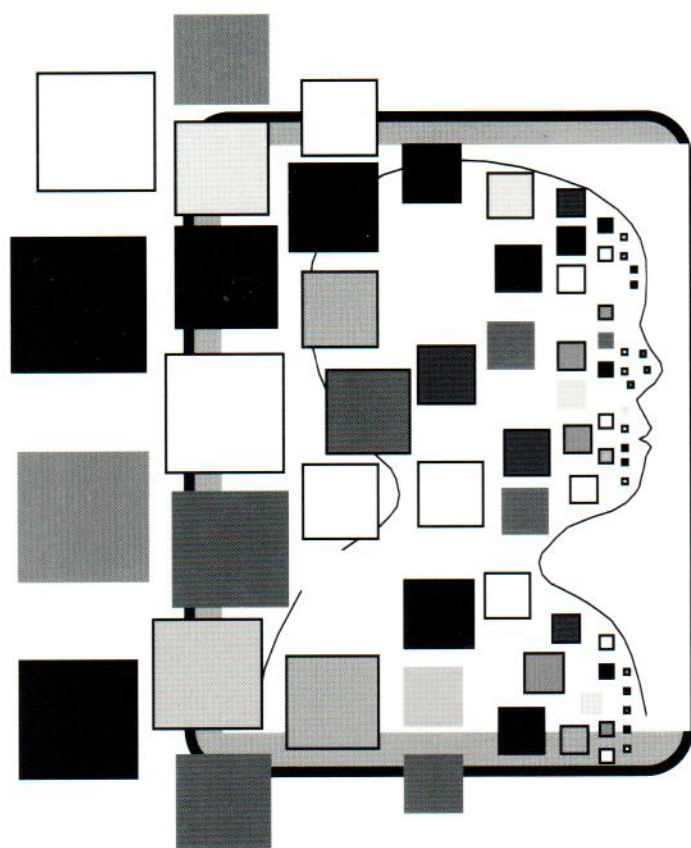


Diagnostic Imaging and Child Abuse: Technologies, Practices, and Guidelines



Medical Technology and Practice Patterns Institute
Washington, DC

**DIAGNOSTIC IMAGING AND CHILD
ABUSE: TECHNOLOGIES, PRACTICES,
AND GUIDELINES**

**Medical Technology and Practice Patterns Institute
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Foreword

Child abuse is a national issue, both shocking and poignant. The abuse documented is often very brutal, the victims are young and helpless. But the irrational act of inflicting intentional injury on a child is really only part of the story.

National statistics reveal that more than a million children suffer maltreatment every year and that thousands die from those injuries. Beyond the immediate medical and societal costs associated with such trauma lie the costs of future lost productivity – estimated in one study to be as much as \$1.3 billion – and the uncounted cost to society of resultant violent and criminal behavior and other psychological impairment of victims.

While images of child abuse document a significant problem in this country and are painful to look at, they are also key elements in treating the problem. As the authors of this monograph point out, careful diagnosis and documentation of abuse can help prevent its recurrence.

The inspiration for this monograph grew out of discussions with people involved in the effort to prevent and treat child abuse, many of whom are familiar with the various imaging technologies used in detecting, diagnosing, and documenting abuse. They suggested that a paper reviewing the literature of imaging applied to child abuse could provide thoughtful insights into the best technologies and practices to use in addressing issues surrounding the prevention and treatment of child abuse.

Subsequently, the Medical Technology and Practice Patterns Institute commissioned the authors to conduct a thorough review of the literature on imaging of child abuse, from its earliest applications more than 100 years ago to the present day, when new electronic technologies provide unforeseen opportunities and challenges to those engaged in the effort to end child maltreatment.

The monograph's annotated bibliography provides those concerned with child welfare with ample sources of research into the imaging technologies used to detect, diagnose, and document child abuse injuries, and guidelines and issues concerning their application.

The image on the cover represents the various imaging technologies – photographic, medical, digital – discussed in this monograph. The squares represent the dots – in digital images, the pixels – of which all printed images consist. But they also represent the pieces of the puzzle that is a case of suspected child abuse – of which imaging is only one piece. Since many of the other pieces of the puzzle are non-images (a school nurse's report, the child's medical history, family circumstances, etc.), the squares continue beyond the image, suggesting that additional pieces of the puzzle lie outside the image but are directly and integrally connected to it. Finally, child abuse is not a 'pretty picture' so it is appropriate that the cover image is not a piece of pretty art.

We wish to thank Dr. Carole Jenny of the Department of Pediatrics of the University of Colorado, and her colleagues, Mr. Richard J. Taylor of the School of Medicine of the University of Colorado and Ms. Monika Cooper of the Denver University School of Law, for their work in producing this monograph.

We also wish to thank the many people who participated in the discussions with us and the people who reviewed this document.

On behalf of all of them and us, this monograph is offered in the hope that it might inspire renewed efforts to provide an abuse-free environment for children.

Dennis J. Cotter
Executive Director

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National Center for Prosecution of Child Abuse

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National Center for Missing and Exploited Children

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National Victim Center



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Executive Summary

Child abuse is a significant problem in the United States. The most recent statistics from the National Center on Child Abuse and Neglect show that more than a million children are known to be victims of maltreatment. Yet, the medical recognition of child abuse as a syndrome is relatively recent, with most advances in detection and diagnosis occurring in the latter half of this century.

For secondary prevention, careful diagnosis and documentation of abuse inhibits the re-abuse of children and helps to protect siblings. The type of imaging studies useful in the diagnosis, prevention, and treatment of child abuse is broad, ranging from simple photography of injuries to the most complex digitally-generated images such as subtraction magnetic resonance angiography. A growing body of literature indicates that the use of various imaging technologies is increasingly well understood and validated.

This monograph reviews that literature supporting the use of imaging technology in the protection of children. The review presents the current consensus about imaging in child abuse. It then evaluates the quality of the work that has been done to date and raises important questions about the future uses of imaging technology and the costs and benefits of this technology for child protection.

The review begins by looking at a number of societal problems that researchers have associated with child abuse, including adolescent suicide, substance abuse, criminality and violence, various kinds of psychiatric illnesses, and teen pregnancy and sexual violence. Then it discusses the response of the child protection system to incidents of abuse. The monograph notes that many jurisdictions require a medical evaluation for signs of abuse and that physicians are often asked to testify as expert witnesses in abuse cases.

A wide array of imaging technologies have application to the problems of detecting and diagnosing child abuse. Photography and plain-film radiography are still the modalities most commonly used to detect and document lesions characteristic of abuse. Photography provides a permanent record of the child's injuries and can document healing of lesions over time. Distortion, however, can be a problem with photography.

Magnified colposcopic photographs are a variation on unenhanced

photography. There is a large body of literature on the usefulness of colposcopy in documenting sexual abuse of children. Another magnified photographic technique is retinal funduscopy photography, which is used to document retinal lesions in child abuse cases. A final visible-light technology used in child abuse cases is endoscopic photography, which is used to document injury to internal organs. Alternative light sources such as ultraviolet and infrared have been used to document bite marks and wound patterns, sometimes in cases of old injuries no longer visible to the eye.

Radiographs were the first diagnostic tools used to detect child abuse injuries and they remain the standard for diagnostic purposes. Plain-film radiography can detect fractures of the skull, axial skeleton, and extremities. The skeletal survey is the most commonly used screening technique for child abuse injuries. Studies of skeletal surveys in these cases have shown rates of detection of unsuspected fractures from 11 to 33 percent. The main drawback to radiography is the exposure of the patient to ionizing radiation.

Another diagnostic modality used in the detection of child abuse is high-resolution sonography (ultrasound). Abdominal injuries detected by sonography include post-traumatic pancreatitis, pancreatic pseudocysts, and retroperitoneal hematomas. Sonography is non-invasive, inexpensive, and readily available in most hospital emergency rooms. The primary problem with ultrasound has been its limited resolution. High-resolution techniques and 'real time' imaging have provided more useful results.

Computed tomography (CT) has given radiologists a new order of diagnostic ability, replacing the pneumoencephalogram for neuroimaging. CT of the head has been found to be a sensitive method for evaluating intracranial lesions in abused children. It is more sensitive than other modalities in detecting subarachnoid hemorrhage and in the diagnosis of abdominal and thoracic injuries. Although radiation exposure to the patient is much higher with CT scans than with conventional radiographs and magnetic resonance imaging (MRI) has eclipsed certain aspects of the diagnosis of cerebral injury, CT is still the cross-sectional imaging method of choice in many instances.

Magnetic resonance imaging does not use ionizing radiation and it offers greater contrast when examining soft tissues, allowing easier recognition of parenchymal brain injuries such as shearing tears and subdural hematomas. It also facilitates more precise dating of intracranial wounds. But MRI is substantially more expensive than CT,

patients often require sedation during the procedure, and motion artifact is a problem in the imaging of children.

Scintigraphy (bone scanning, radionuclide imaging) involves the injection of a radioisotope; the resulting gamma radiation can be detected in the body using digital imaging. This technique can be useful in confirming suspicious bone lesions seen on plain-film as possible fractures. Bone scans will also show new fractures not yet visible on radiographs due to lack of callus. Thus, bone scans are a more sensitive test in certain kinds of child abuse injury such as rib fractures or subtle long bone shaft fractures. However, the lack of specificity of scintigraphy for fractures limits its usefulness; it also is more expensive than radiography and exposes the child to more radiation.

Two sets of guidelines covering the imaging of child abuse injuries have been developed. The American Academy of Pediatrics' 1991 guidelines cover skeletal imaging, intracranial injury, and thoracoabdominal trauma. The American Professional Society on the Abuse of Children's 1995 guidelines describe the proper equipment and technique to use in photographing child abuse injuries. Although both sets of guidelines were developed by nationally recognized experts, neither of the guidelines were promulgated using an explicit evidence-based approach.

Among the problems facing practitioners are lack of specialized training and the cost of the technology. In addition, as new technologies are developed, such as digital photography and radiography and other computerized aids to image evaluation, bone densitometry, retinal imaging, and positron emission and single photon emission tomography, new opportunities and new challenges will arise.

In the courtroom, the status of images of child abuse injuries varies from jurisdiction to jurisdiction. Currently only 36 states expressly protect the use of unconsented images of child abuse victims, although most judges will admit them into evidence. Because many people will not report suspected abuse for fear of reprisal, states have granted immunity from potential civil or criminal liability to people who report suspected cases of child abuse. Most states provide general immunity but some states provide additional immunity from reprisal for the taking of photographs, tests, and/or radiographs related to cases of suspected child abuse.



Introduction

The maltreatment of children is a significant problem in our society. Aggregate data submitted to the National Child Abuse and Neglect Data System of the National Center on Child Abuse and Neglect from 1993 found that 1,018,692 American children are known to be victims of abuse or neglect. These were cases reported to social service agencies and substantiated. The incidence of children harmed was estimated at 15 per 1,000 children under the age of 18 years per year. One thousand child deaths were attributed to abuse.¹ The overall incidence of child maltreatment increased 66 percent between 1980 and 1986.² This increase may represent an increase in recognition and reporting of abuse.

"Medical technology can make an important and under-emphasized contribution to child protection."

Medical recognition of the syndromes of child abuse is relatively recent.³ The latter half of this century has seen the emergence of comprehensive multidisciplinary teams which step in when child abuse is suspected.⁴ These teams work to confirm or rule out abuse, they preserve evidence and bring police and social service intervention to bear, and they try to minimize the physical and psychological consequences to the victim of abuse. The multidisciplinary approach has integrated medicine and technology into the protection of children from abuse.

Typically when one thinks of child abuse prevention, diagnosis, or treatment, mental health services are considered vital. For prevention, they provide parenting classes and psychotherapy for new parents. For diagnosis, sensitive interviewing of children. And for treatment, psychotherapy of children and adult survivors. However, medical technology can make an important and under-emphasized contribution to child protection as well. For diagnosis, radiological studies find evidence of abuse. Photography and colposcopy document injuries in physical and sexual abuse for use in the courts. For secondary prevention, careful diagnosis and documentation of abuse inhibits the

"The type of imaging studies useful in the treatment of child abuse is strikingly broad, covering everything from simple photography of injuries to the most complex digitally-generated images such as subtraction magnetic resonance angiography."

re-abuse of children, as well as the protection of siblings. Treatment involves the medical interventions that allow for a good outcome after physical injuries.

The scope of diagnostic imaging has grown markedly. New technologies have emerged, new uses for old technologies have been refined, and a national revolution in digital data processing has been applied to imaging. All of these changes affects how imaging of abuse takes place. Questions about clinical practice, its cost, and its justification quite rightly occupy much of the discussion concerning the imaging of abuse. While many questions remain unanswered, enough consensus has emerged to make this review and discussion of accepted practice needed.

The type of imaging studies useful in the diagnosis, prevention, and treatment of child abuse is strikingly broad, covering everything from simple photography of injuries to the most complex digitally-generated images such as subtraction magnetic resonance angiography. All of these have potential application in some child abuse investigations; some have application in virtually all. A growing body of literature indicates that the applications are increasingly well understood and validated.

The purpose of this monograph is to review the literature supporting the use of imaging technology in the protection of children. The review presents the current consensus about imaging in child abuse. We then evaluate the quality of the work that has been done to date and raise important questions about the future uses of imaging technology and the costs and benefits of this technology for child protection. Next, we explore the areas of imaging technology and child abuse where research has yet to be done and the important questions yet to be asked. Finally, we will discuss the difficult barriers to the application of technology to the field of child protection, including costs and limitations of diffusion of the knowledge base.

"The list of secondary effects of child maltreatment contains some of the most pressing societal issues of our time."

Child maltreatment is seen as 'root cause' of many of the worst problems facing our country. The list of secondary effects of child maltreatment contains some of the most pressing societal issues of our time:

Adolescent suicide⁵

Suicide attempters are more often sexually abused than nonattempters. Physical abuse has been found more commonly in boys who attempt suicide.⁶ Physical and sexual abuse have also been found to cause self-mutilation behaviors such as cutting or burning oneself.⁷

Drug and alcohol abuse

Women using crack cocaine report a high rate of depression and sexual abuse in childhood.⁸ Juvenile alcohol and drug abuse is much more common in teens physically abused as children.⁹

Depression

One study has shown 64 percent of sexual abuse survivors to be clinically depressed.¹⁰ Sexually abused teenage girls score significantly higher on tests measuring anxiety and depression than non-abused girls.¹¹

Borderline personality disorder

Abuse in childhood has been shown to be a major factor in the development of borderline personality disorder, a type of mental illness particularly resistant to treatment.¹²

Criminality and violence

Child sexual abuse has been strongly linked to the development of juvenile delinquency and criminal behavior.¹³ People who batter their spouses are more likely to have been abused as children than others.¹⁴

"Childhood victimization has been shown to increase a person's risk for committing violent crimes as an adult."

One study of 15 death row inmates described 13 of them as having been exposed to extraordinary levels of physical and sexual abuse as children.¹⁵ Another study of women who had murdered their children showed they all had been seriously maltreated as children themselves.¹⁶ Childhood victimization has been shown to increase a person's risk for committing violent crimes as an adult.¹⁷

Dissociation

Child sexual abuse survivors are more likely to experience dissociation than other adults.¹⁸

Eating disorders

Various studies have linked child sexual abuse with obesity,¹⁹ poor self image and bulimia.²⁰

Other medical and psychological problems

A study in the United States military showed childhood physical and/or sexual abuse survivors are less likely to be able to complete basic training than non-abused people.²¹ Sexually abused children have been shown to have heightened sexual preoccupation and behavior problems, and lower cognitive abilities and school achievement.²² Sexually abused adolescents have lower levels of self esteem, increased anxiety, and report feeling lonelier than their peers. Physically and sexually abused males are more likely to engage in "risk-taking behaviors" such as skipping school, forcing partners into sex, and committing violent crimes.²³ Sexual victimization has been shown to be a risk factor for contracting AIDS in adult women.²⁴

Homelessness

Homeless women are more likely to report abuse in childhood than others.²⁵ One study reported sexual abuse histories in 38 percent of

male teenage runaways and 73 percent of female teenage runaways.²⁶

Post-traumatic stress disorder (PTSD)

PTSD is a commonly described sequelae of physical and sexual abuse in childhood.²⁷

Psychiatric illness

A high percentage of people admitted to psychiatric hospitals have experienced physical and sexual abuse in childhood.²⁸

Psychosomatic illness and poor health

Sexual and physical abuse have been linked to several types of psychosomatic illness including chronic pelvic pain,²⁹ premenstrual syndrome,³⁰ chronic gastrointestinal diseases,³¹ paradoxical vocal cord dysfunction,³² and other somatization disorders.³³

Teen pregnancy and sexual violence

Sexual abuse histories are very common among pregnant adolescents.³⁴ On the whole, sexually victimized teenagers begin having consenting sex one year earlier than non-victimized teenagers, leading to earlier adolescent pregnancy and sexually transmitted diseases. Over half of men convicted for serial rape report sexual abuse in childhood.³⁵ One study of female sexual abusers of children showed 100 percent to have been abused themselves as children.³⁶ Prostitution is strongly linked to abuse in childhood. Most male and female prostitutes are abuse survivors.³⁷

"Sexual and physical abuse have been linked to several types of psychosomatic illnesses including chronic pelvic pain, premenstrual syndrome, chronic gastrointestinal diseases, paradoxical vocal cord dysfunction, and other somatization disorders."

Response of the Child Protection System to Allegations of Abuse and Neglect

Professionals dealing with children are "mandated reporters" of suspected abuse or neglect. Other referrals to the child protection

"Once a complaint is made to a child protection agency, the response varies widely, depending on the jurisdiction."

system come from concerned parents, neighbors, family friends, or sometimes, from children themselves.

Once a complaint is made to a child protection agency, the response varies widely, depending on the jurisdiction. Some states have a state-wide, coordinated response system. Other states organize their response by counties or other jurisdictions. Some states require every report of possible abuse or neglect to be investigated. Other states will 'triage' complaints, and investigate only complaints implying the child is at immediate risk.

In most states, child protective services will only investigate complaints of intrafamilial abuse or institutional abuse. If the abuse is perpetrated by someone outside the family, the child protective services will not become involved, but police will investigate. Some states require that each complaint be investigated by both the police and by child protective services. The police investigate possible criminal behavior that could be prosecuted, and the social services agencies assure the safety of the child from future harm.

Once a complaint of abuse or neglect is investigated, the jurisdiction involved has the right to place the child in protective custody if imminent danger exists. Different states have different mechanisms for protecting children. One or more juvenile or family court hearing is required within a certain period of time to protect the rights of the parents. At that hearing, the complaint may be dismissed, the child may be put in foster care, or the jurisdiction may take custody of the child for supervision while leaving the child in the care of his or her parents. Sometimes, parents maintain custody while agreeing to accept voluntary services from the state.

After a child is placed in foster care, the state must present a treatment plan to the juvenile or family court for eventual reunification. Except in the most egregious cases, parents are given a chance to comply with the court's recommendations for rehabilitation before parental rights

are terminated and the child is released for adoption. Many states hold the reunification of the family as their utmost goal, even over ‘the best interest of the child’.

Criminal investigation and charges for child abuse proceed separately from social services evaluation. County or district courts and county prosecuting attorneys act on information provided by law enforcement agencies to prosecute the crime of child abuse under criminal laws. In intrafamily cases, juvenile or family courts determine the child’s placement and supervision.

The medical care system interacts with these complex systems at many levels. Medical providers can report suspected abuse/neglect. After a report is made to social services, many jurisdictions require a medical evaluation for signs of abuse and neglect. When children go into foster care, their medical care becomes the responsibility of the state. The delivery of effective, continuous care to these children has often been overlooked by the systems that care for them. Physicians are often asked to interpret medical data for the courts, and to testify as ‘expert witnesses’ about medical aspects of child abuse and neglect cases.

"After a report is made to social services, many jurisdictions require a medical evaluation for signs of abuse and neglect."

Methodology

The review of literature presented here began with a search of *Medline* (National Library of Medicine) references, cross-referencing the *MeSH* categories related to diagnostic imaging with those related to child abuse. Records dating back to 1966 were searched directly. After selection of relevant articles from the search results, additional citations were added to encompass important references not indexed by the first search, including topics from the forensic science and radiology literature. Preference was given to recent articles and to articles covering issues which have scientific research documentation. In addition, certain practice standards were reviewed, comparing them to standards for evidence-based guideline development.³⁸

Diagnostic Imaging and Child Abuse: A Comparative History

Diagnostic imaging dates from the early work with photography in the mid-1800s and Roentgen's discovery of X-rays in 1895. The use of diagnostic imaging in child abuse cases is much more recent. Improvements in imaging science and technology have quickly been applied to the diagnosis of child abuse. (Table 1) Photography was first reported to be used in the diagnosis of child abuse in 1876, sixteen years after its invention. Forty nine years after Roentgen discovered X-rays, Caffey reported typical child abuse fractures. The length of time from their invention to their application in the field of child abuse for ultrasound, computerized tomography and magnetic resonance imaging respectively was eighteen years, five years, and four years. As technology develops, its application to the detection and diagnosis of child abuse appears to be 'speeded up' by modern research and communication.

Specific techniques have specific uses

A wide array of imaging techniques have application to the problems of detecting and diagnosing child abuse. Despite their venerable age, visible-light photography and plain-film radiography are still the modalities most commonly used to detect and document characteristic lesions of child abuse. Computed tomography (CT) and magnetic resonance imagery (MRI) have become more useful as they have become more available to clinicians.

Photography

Physical abuse of children often leaves visible signs such as bruises, lacerations, or deformities. Authorities recommend recording these signs with proper photographic technique.^{39,40,41,42,43,44,45,46,47} In the first case of child abuse adjudicated in the United States, the case of 'Mary Ellen', photographs of the battered victim in ragged clothing were

"As technology develops, its application to the detection and diagnosis of child abuse appears to be 'speeded up' by modern research and communication."

"A wide variety of imaging techniques have application to the problems of detecting and diagnosing child abuse."

TABLE 1 - A comparative timeline for imaging and application to medically recognized child abuse cases

	Imaging Developments	Child Abuse Landmarks
200 AD		Soranus' <i>Gynaecology</i> discusses how to recognize an infant worth rearing (Greece) ¹⁷⁶
900		Rhazes' <i>Practica Peurorum</i> discusses children injured when intentionally struck (Baghdad) ¹⁷⁷
1684		Theoph Bonet describes child abuse and failure to thrive in <i>A guide to the Practical Physician</i> (England) ¹⁷⁸
1823		M. J. Dowager Countess Mountcastell describes consequences of violent shaking of children in a book on child rearing (England) ¹⁷⁹
1850	Silver iodide photography developed	
1860		Ambrois Tardieu describes medical findings in 32 abused children (France) ¹⁸⁰
1876		"Mary Ellen" photographs displayed at the Philadelphia Centennial Exhibition ¹⁸¹
1883		English Society for the Prevention of Cruelty to Children established
1885	X-rays discovered by Roentgen	
1925	Hinselmann describes the use of colposcopy in gynecology ¹⁸²	
1944		Ingraham and Matson describe subdural hematomas in infants and note that trauma is often the cause ¹⁸³
1946	Caffey reports the association between fractures and subdural hematomas in infants ¹⁸⁴	Caffey reports the association between fractures and subdural hematomas in infants ¹⁸⁵
1952	Silverman describes bony fractures of different ages caused by trauma ¹⁸⁶	
1958	Satomura and Kaneko develop the first clinical ultrasound machine ¹⁸⁷	
1959		Kempe and Silver describe parents battering and neglecting children ¹⁸⁸
1961		Kempe presents his paper on "The Battered Child Syndrome" to the American Academy of Pediatrics ¹⁸⁹
1971	Computed tomography becomes clinically available ¹⁹⁰	

"In the first case of child abuse adjudicated in the United States, the case of 'Mary Ellen', photographs of the battered victim in ragged clothing were exhibited by the Society for the Prevention of Cruelty to Animals at the Philadelphia Centennial Exhibition in 1876."

TABLE 1 - (Continued)

	Imaging Developments	Child Abuse Landmarks
1971	Technetium-99m radionuclide introduced for bone scanning in non-malignant bone disease ¹⁹¹	
1973	Magnetic image formation described ¹⁹²	
1976		Jones <i>et al</i> report the use of CT in abused child craniocerebral trauma ¹⁹³
1980		Smith <i>et al</i> report the use of bone scanning to identify child abuse fractures ¹⁹⁴
1981		Texeira describes use of the colposcope for the diagnosis of sexual assault ¹⁹⁵
1982	Magnetic resonance imaging becomes available ¹⁹⁶	
1984		Hausdorf and Helmke describe the use of ultrasound to diagnose abusive head trauma ¹⁹⁷
1986		Kirks describes the use of ultrasound to diagnose abusive abdominal trauma ¹⁹⁸
1986		Alexander <i>et al</i> describe the use of MRI in the evaluation of child abuse head trauma ¹⁹⁹
1986		Woodling and Heger describe the use of colposcopy in the diagnosis of sexually abused children ²⁰⁰

exhibited by the Society for the Prevention of Cruelty to Animals at the Philadelphia Centennial Exhibition in 1876.⁴⁸ (Table 1) The child's plight led to the formation of the Society for the Prevention of Cruelty to Children in New York.

Photographing abused children serves three purposes. First, it permits a permanent, visible image of the state of the child as he or she presented to the clinician. This can be a crucial element in court proceedings aimed at protecting the child. Second, from a clinical perspective photographing injuries permits review of the progress of healing of lesions over time. In child death cases, autopsy photographs create a permanent image of the injuries for expert analysis.⁴⁹ Finally,

photographs of lesions allow for collection of information on series of cases for research and teaching.

Recommendations for techniques necessary for proper photography in child abuse cases have been reported. Consensus changes as the technology available to practitioners changes. Photography of the abused child is a relatively specialized application, calling for specific guidelines to preserve medical and legal significance. The guidelines promulgated by the American Professional Society on the Abuse of Children represent the most recent and comprehensive effort.⁴⁷

Although other photographic techniques, such as the use of 'instant' cameras and self-developing film, have been described,⁴³ most experts recommend the use of a high-quality 35-mm camera and appropriate flash. Slide film should be used, both for its reproducible color and for the ease of presentation in court or lectures. Lens selection is important, and issues such as rapid recycling of a flash arise because children tend to be impatient and embarrassed.⁴⁷ There is little question, however, that these simple practices can yield consistently useful images.

Photography does have its pitfalls. Lesion size and significance can be distorted in photographs.^{50,51} Any photograph of an abused child must be accompanied by proper descriptive text.^{47,51}

"In child death cases, autopsy photographs create a permanent image of the injuries for expert analysis."

Colposcopy

Magnified colposcopic photographs are a variation on unenhanced photography. These photographs are taken through the colposcope (a magnifying microscope). The resulting images have spawned a large body of literature on the usefulness of colposcopy in documenting genital and anal trauma in children and adolescents. Early reports focused on the ease of data collection and the seeming certainty of diagnosis the technique afforded.^{52,53} Since then, large studies of normal genital and anal variations in non-abused children have called

"Although colposcopy is primarily useful in the diagnosis of child sexual abuse, it also can be used in the evaluation and documentation of genital injuries from physical abuse, and in the differentiation of physical abuse from sexual abuse."

into question many of the physical findings initially reported as related to abuse.^{54,55,56,57,58} Interobserver agreement has also been studied and found to be variable, particularly in less experienced examiners.^{59,60}

Use of the colposcope has many advantages. It obviates the need for multiple examinations when findings are questioned in legal cases. It allows for the education of health care providers in recognition of sexual abuse injuries. It provides quality assurance in examinations. Overall, colposcopy is considered a valuable but not infallible tool.^{61,62,63}

Although colposcopy is primarily useful in the diagnosis of child sexual abuse, it also can be used in the evaluation and documentation of genital injuries from physical abuse, and in the differentiation of physical abuse from sexual abuse.

Another magnified photographic technique with particular application in the diagnosis of child abuse is retinal funduscopy photography. Funduscopy photography has been used to screen and to follow diabetic patients for retinopathy. Studies have shown effective images are obtained in up to 90.5 percent of cases.⁶⁴ Since Harcourt⁶⁵ and Caffey⁶⁶ noted the characteristic retinal hemorrhages of physical abuse, retinal examination has been a standard part of the evaluation of suspected child abuse. Researchers have used funduscopy photography to illustrate and demonstrate the retinal lesions in child abuse in a number of papers.^{65,67,68,69} Retinal photographs have not been routinely used to document forensic cases. With more widespread availability of the technique and equipment, retinal photography could be a potentially powerful tool in the documentation of individual child abuse cases.

One final visible-light photographic imaging technique applicable to child abuse cases is endoscopic photography. Injuries to the hollow viscera (stomach and intestine) from blunt abdominal trauma are much more common in child abuse cases than in accidental injuries.⁷⁰

Endoscopic examination with permanent photographic recording of findings is commonly available, and has been used to document child abuse injuries.⁷¹

Alternative light sources extend photographic imaging even farther. Ultraviolet (UV) and infrared (IR) light have unique photographic properties. UV photography has been used in forensic science for some time, particularly in the documentation of bite marks and wound patterns.^{72,73,74,75,76} Although the technique is controversial, some forensic experts have used reflective UV photography to demonstrate past injuries that are no longer visible to the unaided eye. One expert recommends limiting UV photography to cases where the injury is no longer apparent, but where corroboration of the presence of the injury is available.⁷⁷ No cases have been published specifically relating to its use in child abuse. The most common application of a UV light source in the evaluation of child abuse is the use of the Wood's lamp to reveal the presence of semen on the body.⁷⁸

Radiographic imaging

Since Roentgen's discovery of X-rays in 1885, radiography has been used to visualize the inside of the body. Radiographs were the first diagnostic tools used to detect child abuse, and they remain the standard for diagnostic purposes. Plain-film radiography can detect fractures of the skull, axial skeleton, and extremities. Certain types of fractures are considered to be highly suggestive of abusive injuries in children. These include metaphyseal "chip" or "bucket handle" fractures of the long bones, posterior and lateral rib fractures in infants, fractures of the acromion process and scapula, sternal fractures and spinous process fractures.⁷⁹ Fractures moderately specific for child abuse include compression fractures of the vertebrae, multiple fractures, fractures of different ages in the same child, epiphyseal separations, digital fractures, and complex skull fractures.⁷⁹ Skull and rib radiographs are superior to computerized tomography images for the diagnosis of skull and rib fractures. Fractures that lie parallel to the plane of the

"Although the technique is controversial, some forensic experts have used reflective UV photography to demonstrate past injuries that are no longer visible to the unaided eye."

"The 'skeletal survey' is the most commonly used screening technique for child abuse injuries."

tomographic section can go undetected on CT. Abusive rib fractures of infants often are not visible radiographically when acute. Repeated imaging over time will reveal callus formation, however.⁸⁰

The 'skeletal survey' is the most commonly used screening technique for child abuse injuries. A skeletal survey consists of detailed views of each bone in the body. The American Academy of Pediatrics recommends using an imaging system that uses single emulsion, high-detail film and cassettes with intensifying screens.⁸¹ Studies of skeletal surveys have shown rates of detection of unsuspected fractures in 11 to 33 percent of physically abused children.^{82,83} The yield of skeletal surveys is higher in certain age groups.⁸² Skeletal surveys are recommended by the American Academy of Pediatrics for all children under 2 years of age where child physical abuse is suspected.⁸¹ In children over 5 years of age, skeletal surveys are rarely indicated.⁸⁴ Between two and five years, skeletal surveys should be considered on a case-by-case basis.

Bony injuries can be dated on radiographs based on their stages of healing. While fracture dating is not precise, estimates of ages of fractures can be compared to histories obtained from caretakers to assess the reliability of those histories. O'Connor and Cohen⁸⁵ have reviewed the literature on the estimation of age of injury to bones based on radiographic presentation. (Table 2)

Adjuncts to unenhanced radiographs include various techniques to enhance contrast. Many of these have direct application to the evaluation of child abuse. Intravenous pyelography, for example, can quickly reveal renal blockage or failure secondary to blunt abdominal trauma. Barium contrast studies can be useful in diagnosing intra-abdominal conditions such as duodenal intramural hematoma. Arthrography (injection of contrast material into the joint space and then obtaining radiographic images of the space) has been used to visualize fractures of the distal humerus in abused infants.⁸⁶

TABLE 2 - Timetable of radiographic changes in children's fractures²⁰¹

Category*	Early	Peak	Late
Resolution of soft tissue injury	2-5 days	4-10 days	10-21 days
Periosteal new bone formation	4-10 days	10-14 days	14-21 days
Loss of fracture line definition	10-14 days	14-21 days	
Soft callus	10-14 days	14-21 days	
Hard callus	14-21 days	21-42 days	42-90 days
Remodeling	3 months	1 year	2 years to epiphyseal closure

* Repetitive injuries may prolong resolution of soft tissue injury, periosteal new bone formation, hard callus formation, and remodeling.

The main drawback to radiography is the exposure of the patient to ionizing radiation. While there is no *safe* level of exposure to radiation, the potential risk from lowdose, diagnostic radiation is thought to be minimal.⁸⁷ The average natural radiation exposure to a person living at sea level is 0.1 rad/year. A chest X-ray exposes the patient to 1.4×10^{-6} rad, roughly 1/10,000 of the yearly dose of background radiation from nature.

"Sonography is virtually non-invasive, it is inexpensive, and ultrasound machines are readily available in most emergency departments."

Sonographic imaging

Another diagnostic modality used in the detection of child abuse is high-resolution sonography. Sonography is virtually non-invasive, it is inexpensive, and ultrasound machines are readily available in most emergency departments. The primary problem with ultrasound has been its limited resolution. High-resolution techniques⁸⁸ and 'real-time' imaging at the bedside⁸⁹ have allowed more useful results.

Abdominal injuries detected by sonography include post-traumatic pancreatitis, pancreatic pseudocysts, and retroperitoneal hematomas.⁹⁰ One paper reported imaging soft-tissue brain injury after an abusive

incident.⁹¹ Even with these successes, sonographic imaging remains less useful than computerized tomography for the diagnosis of either head or abdominal injuries. Sonography is not a sensitive test for subdural fluid, and it is not useful to diagnose any cerebral pathology in children with fused fontanelles. Overall, few studies have been done on the use of sonography in child abuse cases.

Cross-sectional imaging: CT and MRI

When computed tomography came into widespread use in the late 1970s, it gave radiologists a new order of diagnostic ability. The pneumoencephalogram became outmoded for neuroimaging, replaced by the much less invasive and much safer CT scan.

The CT scan consists of many projection images acquired at many angles about the subject. Transmission measurements are digitized and stored in a computer memory where cross-sectional images are reconstructed.⁹² Current technology using a 'helical' or 'spiral' CT scan allows for more accurate, volumetric scans. The length of time required to complete a scan has markedly decreased.⁹³

"When computed tomography came into widespread use in the late 1970s, it gave radiologists a new order of diagnostic ability."

Starting in 1979, a series of papers first demonstrated the use of CT in detecting the cranial manifestations of child abuse.^{94,95,96,97} CT of the head was found to be a sensitive method for evaluating intracranial lesions in abused children that might not be evident on clinical examination.⁹⁸ It is more sensitive than other modalities in detecting subarachnoid hemorrhage.

Computed tomography also was found to be useful in the diagnosis of abdominal injuries.⁹⁹ Liver, spleen, kidney, pancreatic, adrenal, and mesenteric injury from blunt trauma from child abuse can be detected with CT.^{90,100} CT has also been shown to be an accurate method to diagnose bowel rupture in children.¹⁰¹ Child abuse abdominal injury is often undetected until late in the child's clinical course because the child's caretakers do not report the possibility of trauma when the child

"Child abuse abdominal injury is often undetected until late in the child's clinical course because the child's caretakers do not report the possibility of trauma when the child presents symptoms."

presents with symptoms. This increases the mortality rate in abusive abdominal trauma compared to non-intentional abdominal trauma.^{102,103} CT became a helpful modality in diagnosing occult injuries. It also allows for a more conservative approach to management of many abdominal injuries. Serial scanning allows for clinical 'tracking' of an injury and makes a laparotomy less likely to be done in many cases.¹⁰⁴

Chest trauma likewise came under CT scrutiny. One study showed that early use of CT in thoracic injury identified thoracic pathology significantly more often than radiography, and modified treatment for 70 percent of the patients studied.¹⁰⁵ Chest CT effectively visualizes pulmonary contusions, hemothorax, chylothorax, and pneumothorax, as well as injuries to the heart, the great vessels, and trachea.

While MR imaging has eclipsed certain aspects of the diagnosis of cerebral injury, CT is still the cross-sectional imaging method of choice in many circumstances. The cost of CT scans are lower than MRI scans. They can often be accomplished without sedation. CT scanners are more readily available than MR scanners. The radiation exposure to the patient is much higher with CT scans than with conventional radiographs, often ranging from 1 to 3 rad depending on the procedure.

The technology which has replaced CT in some clinical settings is magnetic resonance imaging (MRI). MRI does not use ionizing radiation. It uses a strong external magnetic field provided by a superconducting magnet and radiofrequency radiation to generate tomographic images. MR images are density maps of water or lipid protons and their relaxation times, while CT images depend solely on tissue X-ray attenuation. Thus, MRI offers greater contrast when examining soft tissues.¹⁰⁶ 'Ultrafast' scanning machines are now becoming available which allow for shorter procedure times, less motion artifact, less use of patient sedation, and shorter waiting times for patients.¹⁰⁷

Cranial MRI has several advantages to the clinician over CT imaging in

"Cranial MRI has several advantages to the clinician over CT imaging in abusive head injury."

abusive head injury.^{108,109} The first is that MR images soft tissue much more effectively, allowing easier recognition of parenchymal brain injuries such as shearing tears. In one study, subdural hematomas were detected in abused infants when the lesions had not been seen on CT scan.¹¹⁰ MRI also allows more precise dating of intracranial blood. This occurs because chemical alterations in the blood as it ages change the magnetic resonance of the molecules.

MRI of organs other than the brain has been somewhat less successful. MRI of the abdomen has not been useful in trauma diagnosis. Researchers have reported a case of adrenal hemorrhage diagnosed by abdominal MRI.¹⁰⁰

MRI is substantially more expensive than CT. Patients often require sedation during the procedure. Motion artifact is a difficult problem in the imaging of children.

A variation of MRI, magnetic resonance angiography (MRA) has also been shown to be useful in the evaluation of abusive head trauma. The differential diagnosis of intracranial bleeding in infants and young children includes cerebral vascular anomalies such as arteriovenous malformations and vascular aneurysms. MRA allows for the imaging of cerebral vessels from magnetic resonance data measuring the signal alterations caused by the flow of blood compared with surrounding tissues.¹¹¹ MRA has largely replaced the more invasive conventional X-ray angiography methods.

Scintigraphy

Scintigraphy (bone scans, radionuclide imaging) involves the injection of a radioisotope into the patient's body. The resulting gamma radiation can be detected in the body using digital imaging. Dynamic changes in the distribution of the radioisotope can be tracked over time. In areas of increased blood flow and metabolic activity, 'hot spots' show up on the resulting image.¹¹²

Scintigraphy can be useful to confirm suspicious bony lesions seen on plain-film as possible fractures. Bone scans will also show new fractures not yet visible on radiographs because of an indistinct fracture line or lack of callus. Thus, bone scan is a more sensitive test for certain kinds of child abuse fractures such as rib fractures or subtle long bone shaft fractures.^{113,114} The lack of specificity of scintigraphy for fractures limits its usefulness. Since the infants' and toddlers' epiphyseal regions of the long bones are quite metabolically active, these areas routinely show increased nuclide uptake. Subtle metaphyseal lesion may not be recognized in the 'shadow' of the epiphysis. One source reported a combination of scintigraphy and radiographs to be useful in diagnosing child abuse and determining placement of high risk children.¹¹⁵ Fractures identified with scintigraphy require radiographic confirmation before the final diagnosis is made.

Scintigraphy is also useful for diagnosing injuries to the liver and spleen after abdominal trauma.¹¹⁶ Since CT also assesses injuries to other organs, it is the method of choice for screening the abdomen of the abused child for injury.⁹⁰

"Bone scans will also show new fractures not yet visible on radiographs because of an indistinct fracture line or lack of callus."

Scintigraphy is more expensive than radiography, and exposes the child to more radiation. Because of the metabolic activity of the child's bone growth plates, the amount of radiation delivered to that tissue is six to eight times more than that which would be delivered to a similar portion of the adult skeleton during a bone scan.¹¹⁷ The child requires sedation for a bone scan, adding minimally to the possibility of an adverse outcome. Sedation is not required for a radiographic skeletal survey. All of these factors make the skeletal survey more useful as a screening tool for occult fractures in child abuse.⁸¹

Guidelines for Imaging in Child Abuse

With increasing concerns about the cost and quality of medical care, practice guideline and practice policy development has become

"Two organizations have produced guidelines on imaging techniques used in cases of nonaccidental trauma..."

important in guiding day-to-day clinical decision making.¹¹⁸ Traditionally, practice guidelines in child abuse have been promulgated by 'expert panels'. Essentially, groups of experts convened to reach consensus about practice based on their opinions. This approach has been superseded by a new emphasis on 'evidence-based' medical guidelines. This process involves identifying all the pertinent clinical literature, analyzing the literature in a rigorous and scientific way to document the evidence supporting the guidelines, and incorporating expert opinion into guidelines when the research is insufficient to support conclusions. Part of the process is to explicitly state how sound the research is that supports the guidelines, and to plan when the issue should be re-explored to incorporate new research.¹¹⁹ Often guidelines present clinical research in an 'evidence table'. Patient preferences and the cost of various interventions also are considered in the guidelines development process.¹²⁰

Two organizations have produced guidelines on imaging techniques used in cases of nonaccidental trauma: the American Academy of Pediatrics (AAP) statement on *Diagnostic Imaging of Child Abuse* produced by their Section on Radiology,⁸¹ released in 1991, and the American Professional Society on the Abuse of Children's (APSAC) *Photographic Documentation of Child Abuse, Practice Guidelines*,⁴⁷ released in 1995.

The APSAC guidelines describe proper equipment and technique to use for photography of child abuse cases. The guidelines are clear and well-written, with specific recommendations for equipment (35-mm camera, ring flash, particular lens combinations) and techniques calculated to produce excellent photographs of abusive injuries. The guidelines stress the need for scrupulous written documentation of injuries as well as obtaining photographs.

The APSAC guidelines reflect standard practice on how to produce "good pictures." There is, however, little data to support one photographic technique over another, especially since the outcome

measures for “good” pictures are quite vague. While the practitioner who carefully follows the guidelines is likely to produce an adequate photograph, the guidelines do not explore alternative photographic techniques nor do they discuss the alternative methods considered in reaching their conclusions.

The AAP Diagnostic Imaging statement implicitly incorporates most of the relevant medical literature available in 1991. The specific articles are not discussed or evaluated. While the conclusions are relevant, practical, and defensible, the process of reaching those conclusions is not explicitly noted. The statement covers skeletal imaging, intracranial injury, and thoracoabdominal trauma.

We have reviewed the guidelines compared to the above criterion. (Table 3) Neither of the guidelines were promulgated using an explicit, evidence based approach.¹²¹ While the resulting guidelines incorporate the best opinions of nationally recognized experts, evidence-based guidelines continue to be needed by practitioners in the field. The most likely inhibitor to developing evidence-based guidelines is the cost of the process.

"While the resulting guidelines incorporate the best opinions of nationally recognized experts, evidence-based guidelines continue to be needed by practitioners in the field."

Problems in Current Practice

Current practices in the diagnostic imaging of child abuse are difficult to analyze because of lack of objective data. Subjectively, child abuse practitioners frequently face several problems that complicate their professional assessment of abused children. An informal list of these problems follows.

1. The assessment of pediatric radiographs requires special skills and training,¹²² particularly in complicated, sensitive forensic cases. Less than 11 percent of diagnostic radiologists subspecialize,¹²³ and an even smaller number specialize in the radiologic evaluation of children and infants. Misreading of films and ‘missing’ classical signs of child abuse trauma on radiographs occur frequently.

"Many hospitals and investigative agencies take poor-quality photographs of child abuse cases, even though good photographic equipment is available at a reasonable price."

TABLE 3 - Evaluation of existing guidelines on imaging of child abuse

Criterion	AAP Diagnostic Imaging of Child Abuse ²⁰²	APSAC Practice Guidelines: Photodocumentation of Child Abuse ²⁰³
Identifies pertinent literature	No	No
Analyzes literature in a rigorous manner	No	No
Incorporates expert opinion when literature is inadequate	Yes	Yes
Level of scientific support for the guidelines is explicitly stated	No	No
Guidelines examine costs of alternative strategies	No	No
Guidelines incorporate patient preferences	No	No
Plans to revisit the issue scheduled	No	No

2. Many hospitals and investigative agencies take poor quality photographs of child abuse cases, even though good photographic equipment is available at a reasonable price.

3. With the emphasis on cost control in medicine, physicians are reluctant to obtain MRI of the head in abusive head trauma cases. CT is adequate for clinical management of head trauma in most cases, and is less expensive. MRI gives a clearer forensic evaluation in terms of delineating the scope of injuries and the age of injuries.

4. Many health care providers who take images of children are not educated in the recognition of child abuse injury.

New Techniques and Research Questions with Potential Application to Child Abuse and Imaging

Many potential research frontiers are available in child abuse research.¹²⁴ Research funding available for medical aspects of child abuse has been scarce. One study of published research from North American institutions found less than 5 percent of published studies were funded by grants or contracts.¹²⁵ A list of potential research and development questions in child abuse and imaging follows.

Digital photography

In the future, we anticipate digital photography to become more widely used in the documentation of child abuse. With current equipment, it is possible to take photographs, scan them, produce a medium-resolution digital image, and store and manipulate that image. While the opportunities for information storage, photo enhancement, and networked collaboration are exciting, new problems will accompany the widespread use of digital photography. Particularly in forensic cases, the ability to retouch a photograph to add or subtract evidence of abuse could facilitate evidence tampering.¹²⁶

"While the opportunities for information storage, photo enhancement, and networked collaboration are exciting, new problems will accompany the widespread use of digital photography."

Issues of security and reliability must be addressed before digital imaging is routinely applied to child abuse and forensic cases. The National Institute of Standards and Technology has proposed "The Digital Signature Standard" as a means of assuring accuracy of photographic images.

Digital radiography

In digital radiography, an image is divided in a two dimensional matrix array. X-rays are detected by a receptor (a film, a storage phosphor plate, or a fluorescent screen). The image is then digitized. Each square in the array (pixel) is represented by a binary code depicting the gray-

"Future radiology departments will likely use high-resolution video displays throughout a hospital connected to a large digital image archiving system..."

scale values of the area. The quality of the image is determined by the pixel size and the number of shades of gray recorded by the system.¹²⁷ Digitized images allow for *teleradiology* transmission of images.¹²⁸ Images can be manipulated to compensate for over- or under-exposure and to highlight poorly visualized structures.¹²⁹ They also obviate the need for expensive storage of radiology films. Films can be read as printed images on a traditional view box, or they can be viewed on a video screen. Currently, the expense of such systems has inhibited their widespread use. Future radiology departments will likely use high-resolution video displays throughout a hospital connected to a large digital image archiving system (a *picture archiving and communication system*, or PACS). It is estimated that by the year 2000, 50 percent of teaching hospitals will have such systems.¹³⁰ Systems will have to include safeguards to prevent image tampering in medical-legal cases.

Computerized aids to image evaluation

In mammography, computerized, objective interpretation aids have been developed to increase the radiologist's accuracy in interpreting the films.¹³⁰ The observer completes a checklist providing quantitative assessment of important features in the image. The computer then merges these assessments to estimate the likelihood of a specific diagnosis. The radiologist uses the information provided by the computer to guide the final diagnosis. Another system has been developed to use 'artificial intelligence' to analyze lung texture on chest radiographs.¹³¹ Similar methods of evaluation, particularly in interpreting skeletal surveys could be developed.

Densitometry

Bone densitometry is in common use to estimate bone mineral content.¹³² In adults and children, many endogenous and exogenous factors can decrease bone density and thus increase the fragility or fracturability of bones. These include corticosteroid therapy, hyperthyroidism, hyperparathyroidism, malabsorption syndromes,

alcoholism, rheumatoid arthritis, and paralysis, among others. The most common method of measuring bone density is dual energy X-ray absorptiometry (DXA). Using this technique, bone density can be measured in the total body, the lumber spine, the proximal femur, and the forearm. Until recently, normative values for bone density in infants and young children have not been available.^{133,134,135} As norms become available, the question -- "Do some normal children have bones that are easily fractured?" -- could be answered. Densitometry could be used to compare children with unexplained fractures with normal children to determine if their bone density is sufficient.

Retinal imaging

No data exists on the healing of retinal hemorrhages or the characteristic variations in retinal hemorrhages with various kinds of abusive and non-abusive trauma. Availability of improved retinal cameras and digital enhancement techniques could make such a study possible.

"Densitometry could be used to compare children with unexplained fractures with normal children to determine if their bone density is sufficient."

Positron emission tomography (PET) and single photon emission computed tomography (SPECT)

PET and SPECT scans represent a new frontier in neuroimaging of functional brain status. To date, most of the work in the literature addresses the use of these technologies in the diagnosis of adult brain disorders, particularly in assessing dementia, seizures, and degenerative diseases. These scans use radioisotopes to measure cerebral blood flow, cerebral metabolism, and receptor uptake.¹³⁶ They provide a functional map of brain activity. In pediatric head trauma, they could theoretically provide new information on the healing of injury and on the effectiveness of therapeutic or rehabilitation strategies.^{137,138}

Evaluating new imaging modalities and techniques

New imaging techniques are useful if they allow a trained observer to

"New imaging techniques are useful if they allow a trained observer to perform a diagnostic or patient management task more effectively or in less time."

perform a diagnostic or patient management task more effectively or in less time.¹³⁹ The best test of a new technique is whether or not it actually affects the clinical outcome of the patient. Most studies of new imaging techniques involve "side by side" comparisons of two images. If the new image is clearer than the old image, it is considered superior. In effect, the pictures speak for themselves.¹⁴⁰ A more appropriate measure would include patient survival, functioning, or comfort.

The ability of observers to increase their performance with new imaging techniques can be measured by the receiver operating curve (ROC) analysis.¹⁴¹ This method provides for performance measurement without observer bias. Measurement of improvement also depends on the selection of cases for measurement. When only very subtle or difficult cases are studied, a new imaging method may be deemed much more effective than if it is tested on routine, 'run of the mill' cases where the diagnosis is usually not subtle or difficult.¹⁴² If unusual cases are used in evaluating an imaging technique, the benefits of the technique in general clinical use may be overestimated.

A final complication involves the evaluation of image enhancement methodology (particularly digital enhancement techniques) using 'simulated degradation' of images. In these studies, images are first degraded digitally to simulate actual imaging situations where the outcome is suboptimal.¹⁴³ The degraded image is then restored and the results are displayed side-by-side or presented as the calculated mean square error between the restored and original (degraded) image.¹⁴⁴ The applicability of this model to actual clinical work is unclear. To evaluate the degraded/restored image, the original image must be made available for comparison. In practice, the original image is the one in need of enhancement, thus making technique evaluation difficult.¹⁴⁵

Legal Issues in Imaging of Child Abuse

While all states provide immunity from potential civil or criminal liability for people who report child abuse, only 36 states expressly

provide for the taking of photographs and/or radiographs in cases of suspected child abuse. Even though a state statute may not specifically provide for the taking of photographs or X-rays, courts still seem to be lenient in allowing them to be used as evidence of child abuse.

Photographs are usually admissible in child abuse cases, although the defense counsel often will argue strongly against their use. They are considered 'real or demonstrative evidence'. As such, they do not need to meet tests of reliability and acceptability under the Frye/Daubert decisions. In order to be admissible, they must be relevant to a material issue in the case and properly authenticated. The final decision about their admissibility rests with the trial judge. Once the judge determines the relevancy and authentication issues, he/she must then decide whether the probative value of the photograph substantially outweighs the danger of an unfair prejudicial effect from using the photograph. They can be admissible even if they inflame the emotions of the jury.

Radiographs are less objectionable than photographs. They are considered reliable and accurate. They can be authenticated by offering testimony about the hospital practices for taking and identifying the films.

"While all states provide immunity from potential civil or criminal liability for people who report child abuse, only 36 states expressly provide for the taking of photographs and/or radiographs in cases of suspected child abuse."

State statutes

Thirty-six states, including the District of Columbia and the Virgin Islands, expressly provide for the taking of photographs and/or X-rays in situations of suspected child abuse.¹⁴⁶ Most of the statutes vary in their specific requirements, but the express inclusion allows people to take photographs and X-rays without fear of future reprisal. These provisions allow evidence to be gathered that might otherwise be lost with the physical healing of the wounds, or, in the case of death, the burial of the body. Even though a state statute may not specifically provide for the taking of photographs and/or radiographs, courts still seem to be lenient in allowing photographs to be used as evidence of child abuse.¹⁴⁷

Not all of the statutes mention whether there needs to be express consent from the parents or guardians before taking the photographs or radiographs. While some statutes provide that there not be any parental or guardian consent,¹⁴⁸ the issue remains unclear in most statutes. Some of the statutes require notification after the action as been taken,¹⁴⁹ while only one statute requires a reasonable attempt at notification before the action.¹⁵⁰

"Not all the statutes mention whether there needs to be express consent from the parents or guardians before taking the photographs or radiographs."

Because most of the statutes are silent as to the issue of consent, there is room for statutory interpretation. The statutes can be interpreted in a variety of ways, both for and against prior consent. One interpretation, however, is that there need not be consent when the statutes provide for the taking of photographs and radiographs. If statutes provide consent for photographs and radiographs, it seems there would not need to be additional consent from a parent or guardian. In addition, the abuser is often a parent who would likely not consent to the taking of photographs, tests or radiographs.¹⁵¹ Not allowing the photographs or studies would not be in the best interests of the children, and it is the children whom the statutes are designed to protect. The requirement of consent, therefore, would defeat the purpose. It is possible that specifically stating "no consent" in the statutes is simply a precautionary measure by the states so there would be no chance for misinterpretation.

Liability for unconsented photographs, tests, and/or radiographs

Statutory immunity provisions are important, because many people will not report suspected abuse for fear of reprisal. This delay can be dangerous to children and sometimes even fatal. For this reason, every state provides immunity from potential civil or criminal liability for people who report potential child abuse.¹⁵² The only requirement is that the person act in good faith, and in many states good faith is presumed.¹⁵³ While most statutes provide for general immunity, some states specifically provide for immunity from reprisal for taking

photographs, tests and/or radiographs.¹⁵⁴ This illustrates the importance of these methods of documenting child abuse.

Admissibility of photographs and radiographs as evidence in child abuse cases

The use of photographs and radiographs in child abuse cases is extremely important, because pictures can often express what words cannot, providing a graphic account of the abuse. Some courts have even found photographs to be more descriptive and to give a clearer impression than words.¹⁵⁵

Photographs are usually admissible in child abuse cases, although the defense counsel will argue strongly against their use. Photographs and X-rays are considered real or demonstrative evidence,¹⁵⁶ and in order to be admissible they must be relevant to a material issue in the case and must be properly authenticated.¹⁵⁷ This is true both under common law and under the Federal Rules of Evidence.¹⁵⁸ The decision of whether or not to admit photographs or X-rays is within the trial judge's discretion,¹⁵⁹ and the judge's decision will not be overruled unless there was a clear abuse of discretion.¹⁶⁰ It is rare, however, for an appellate court to find that a trial court judge abused his/her discretion.¹⁶¹

The relevancy issue is a lenient one, requiring that the photograph be relevant to a specific issue at trial.¹⁶² Authenticating the photograph is also a relatively simple matter, requiring that the photograph accurately depicts what it purports to represent.¹⁶³

Once the trial judge determines the relevancy and authentication issues, she/he must decide whether the probative value of the photograph substantially outweighs the danger of an unfair prejudicial effect from using the photograph.¹⁶⁴ If the photograph is found to be unfairly prejudicial it will not be admitted as evidence, even if it is relevant and properly authenticated. Photographs are admissible to illustrate lay and expert witnesses' testimony,¹⁶⁵ illustrate the extent and nature of

"The use of photographs and radiographs in child abuse cases is extremely important, because pictures can often express what words cannot, providing a graphic account of the abuse."

injury,¹⁶⁶ show evidence of malice,¹⁶⁷ and for any other legitimate purpose.¹⁶⁸

Photographs can be admissible even if they inflame the emotions of the jury. This is important, since it would be difficult not to inflame the jury with photos of badly abused children.

“The fact that photographs are inflammatory is not sufficient reason alone to exclude them.... Inflammatory photographs are admissible in the discretion of the trial judge if they tend to shed light on any issue, enable a witness to better describe the objects portrayed, permit the jury to better understand the testimony, or corroborate testimony.”¹⁶⁹

Photographs may be admissible even where there have been changes in the object photographed between the time of the incident and the taking of the photograph. In order to be admissible, it is required that the nature of the change be explained to the jury.¹⁷⁰ The effect of the change would then go to the weight given to the photograph.¹⁷¹

"Radiographs are even less objectionable than photographs, because of their strong reliability and accuracy; the chance for deception with radiographs is very low."

Radiographs are even less objectionable than photographs, because of their strong reliability and accuracy; the chance for deception with radiographs is very low.¹⁷² In order to authenticate the X-rays, the foundation can easily be laid with testimony about “the X-ray process and hospital identification procedures.”¹⁷³ The inherent reliability of X-rays is because they are always taken under controlled conditions by a professional. The technician also develops the X-rays while the patient waits, so that they can be retaken if faulty.¹⁷⁴ X-rays also have identifying marks, allowing a radiologist to easily determine from the film whether the exposure was proper and the film diagnostic.¹⁷⁵ Overall, the courts seem to take a liberal approach in admitting photography and diagnostic imaging studies in child abuse cases.

We have identified the important developments in imaging and how

"Overall, the courts seem to take a liberal approach in admitting photography and diagnostic imaging studies in child abuse cases."

they have affected the diagnosis and treatment of child abuse. Major limitations include a substantial lack of research funding in the field and problems with diffusion of technology to practitioners in medicine and other disciplines caring for these children. As new technologies emerge, new research and development goals will be identified to put these tools to use for the protection of children.

Notes

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¹⁴⁷ See *State v. Grant*, 634 A.2d 1181, 1186 (Conn. App. Ct. 1993) (photographs of vagina taken three years after abuse are admissible); *State v. Morrison*, 437 N.W.2d 422, 428 (Minn. Ct. App. 1989) (proving age and extent of injuries is best demonstrated by photographs), *cert. denied*, 493 U.S. 858 (1989); *State v. Peters*, 780 P.2d 602, 604 (Idaho Ct. App. 1989) (photographs are generally admissible to show appearance); *State v. Prouse*, 767 P.2d 1308, 1311 (Kan. 1989) (autopsy photographs admissible, because they assisted the jury in understanding medical testimony); *Monk v. State*, 532 So. 2d 592, 602 (Miss. 1988) (photographs have probative value because showed injuries, even though victim was hooked up to life support).

¹⁴⁸ Cal. Penal Code § 11171 (West 1992); Fla. Stat. Ann. § 415.507 (West 1993); Ga. Code Ann. § 19-7-5 (Harrison 1990); Ky. Rev. Stat. Ann. § 620.050 (Michie 1990); Me. Rev. Stat. Ann. tit. 22, § 4011.2 (West 1992); Mass. Gen. Laws Ann. ch. 119, § 51A (West 1994); Mont. Code Ann. § 41-3-204 (1987 & Supp. 1992); Nev. Rev. Stat. § 432B.270 (Michie 1991); N.H. Rev. Stat. Ann. § 169-C:33 (1994 & Supp. 1994); N.D. Cent. Code Ann. § 50-25.1-03.1 (1989); S.C. Code Ann. § 20-7-530 (Law. Co-op. 1985); S.D. Codified Laws Ann. § 26-8A-16 (1992); Tenn. Code Ann. § 37-1-609 (1991); Tex. Fam. Code Ann. § 35.04 (1986); Va. Code Ann. § 63.1-248.13 (Michie 1991).

¹⁴⁹ Alaska Stat. § 47.17.064 (1990) (requires notification of the parents or guardian, but not until after the action taken); Nev. Rev. Stat. § 432B.270 (Michie 1991) (specifically states that no consent is needed, but does require notification after the fact if it would not endanger the child).

¹⁵⁰ Ill. Rev. Stat. ch. 325, pare. 5/6 (Smith-Hurd 1993) (requires that the person attempting to take the photographs and/or X-rays make a reasonable effort to notify someone responsible for the child's welfare).

¹⁵¹ Freidman, 50 Geo. Wash. L. Rev. at 263.

¹⁵² *Id.* at 262.

¹⁵³ *Id.* at 263.

¹⁵⁴ Ark. Code Ann. § 12-12-517 (Michie 1987 & Supp. 1993); Cal. Penal Code § 11172 (West 1992); Colo. Rev. Stat. Ann. § 19-3-309 (West 1990); Me. Rev. Stat. Ann. tit. 22, § 4011.2 (West 1992); Mo. Rev. Stat. § 210.135 (1983); Nev. Rev. Stat. § 432B.160 (Michie 1991); Pa. Cons. Stat. § 6318 (1991); S.D. Codified Laws Ann. § 26-8A-14 (1992); Tex. Fam. Code Ann. § 35.04 (1986); Utah Code Ann. § 62A4a-410 (Supp. 1994); Wis. Stat. Ann. § 48.981 (West 1987 & Supp. 1994).

¹⁵⁵ *State v. Healey*, 562 S.W.2d 118, 127 (Mo. Ct. App. 1978) (citing *State v. Davis*, 515 S.W.2d 181, 183 (Mo. Ct. App. 1974)).

¹⁵⁶ See Freiman, 50 Geo. Wash. L. Rev. at 263 n.171. Because photographs and X-rays are demonstrative evidence and not scientific evidence, there is no requirement to meet the Daubert test.

¹⁵⁷ Christine A. Guilshan, Note, *A Picture is Worth a Thousand Lies: Electronic Imaging and the Future of the Admissibility of Photographs into Evidence*, 18 Rutgers Computer & Tech. L.J. 365, 366 (1992).

¹⁵⁸ *Id.*

¹⁵⁹ I John E.B. Myers, *Evidence in Child Abuse and Neglect Cases*, 213 (2nd ed. 1992); Guilshan, 18 Rutgers Computer & Tech. L.J. at 367.

¹⁶⁰ Guilshan, 18 Rutgers Computer & Tech. L.J. at 367.

¹⁶¹ A trial court judge has such wide discretion, that the decision is rarely overturned on review. See I John E.B. Meyers, *Evidence in Child Abuse and Neglect Cases*, 213 (2nd ed. 1992).

¹⁶² Guilshan, 18 Rutgers Computer & Tech. L.J. at 367.

¹⁶³ *Id.* at 368.

¹⁶⁴ *Id.* at 367.

¹⁶⁵ *State v. Stevens*, 794 P.2d 38, 46 (Wash. Ct. App. 1990) (photograph admissible to aid expert's testimony); *State v. Prouse*, 767 P.2d 1308, 1311 (Kan. 1989) (autopsy photographs admissible, because they assisted the jury in understanding medical testimony); *Deviney v. State*, 685 S.W.2d 179, 182 (Ark.Ct. App. 1985) (photographs necessary to illustrate the expert witness' testimony).

¹⁶⁶ *Athey v. State*, 797 P.2d 956, 960 (Nev. 1990) (photographs admissible because they assisted the witness in explaining the victim's injuries); *Robins v. State*, 798 P.2d 558, 566 (Nev. 1990) (photographs assisted jury in understanding the nature and severity of the injuries), *cert. denied*, 499 U.S. 970 (1991); *Stevens*, 794 P.2d at 46 (photographs admissible to show unusual size of the vagina); *State v. Morrison*, 437 N.W.2d 422, 428 (Minn. Ct. App. 1989) (autopsy photographs admissible to show the nature and extent of child's internal injuries); *Monk v. State*, 532 So.2d 592, 602 (Miss. 1988) (photographs admissible to show extent of injuries); *People v. Arca*, 424 N.Y.S.2d 569, 571 (N.Y. App. Div. 1980) (photographs admissible to prove extent of injuries); *State v. Healey*, 562 S.W.2d 118, 127 (Mo. Ct. App. 1978) (photographs showed extent of injury to child); *People v. Strohm*, 523 P.2d 973, 978 (Colo. 1974) (photographs admissible to show nature and permanency of injuries to child); *State v. Austin*, 84 S.D. 405, 411, 172 N.W.2d 284, 287 (S.D. 1969) (photographs admissible as they provided greater accuracy of condition).

¹⁶⁷ See *Monk*, 532 So.2d at 602 (photographs admissible as evidence of malice); *Wetz v. State*, 503 So.2d 803, 812 (Miss. 1987) (photographs showing multiple bruises were evidence of malice).

¹⁶⁸ *Wetz*, 503 So.2d at 812 (to show condition of child immediately after accident); *State v. Holland*, 346 N.W.2d 302, 307 (S.D. 1984) ("photographs are admissible into evidence where they accurately portray anything which is competent for a witness to describe in words"); *Healey*, 562 S.W.2d at 127 (photograph goes to a material element of the case).

- ¹⁶⁹ 1 John E.B. Myers, *Evidence in Child Abuse and Neglect Cases* 214-5 (2nd ed 1992) (citing *Watson v. State*, 720 S.W.2d 310, 311 (1986)).
- ¹⁷⁰ *Seyle v. State*, 584 P.2d 1081, 1084 (Wyo. 1978) (citing *State v. Tafoya*, 454 P.2d 569, 572 (1969)).
- ¹⁷¹ *Id.* (citing *State v. Rogers*, 523 S.W.2d 344,347 (Mo. Ct. App. 1975)).
- ¹⁷² Benjamin V. Madison III, Note, *Seeing Can Be Deceiving: Photographic Evidence in a Visual Age – How Much Weight Does it Deserve?*, 25 Wm. & Mary L. Rev. 705, 736 (1984).
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- ¹⁷⁴ *Id.* 737 n.205 (citing I.C. Scott, *Photographic Evidence* § 1 (2d. ed. 1969)).
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ARTHROGRAPHY

Akbarnia BA. Silberstein MJ. Rende RJ. Graviss ER. Luisiri A. : Arthrography in the diagnosis of fractures of the distal end of the humerus in infants. *Journal of Bone & Joint Surgery - American Volume*. 68(4):599-602, 1986 Apr. (Medline ID 86168386)

Single-contrast arthrography was performed in six infants who had an injury to the elbow because the exact nature of the injury was uncertain from interpretation of the plain radiographs and clinical findings. A correct diagnosis was made in all six patients, and it significantly altered the treatment in five. Four lesions were a Salter-Harris Type-I fracture and two were a Salter-Harris Type-II fracture. Three patients had a closed reduction, two required no reduction, and one had an open reduction. Child abuse of two infants was confirmed, and it was suspected in another two.

CHILD ABUSE

Anonymous. : Non-accidental injury in children. *British Medical Journal*. 4(893):656-60, 1973 Dec 15. (Medline ID 74044664)

This practice guideline from the B.P.A. and B.A.P.S. covers the medical, social, and medicolegal aspects of the management of non-accidental injury in children. The importance of a working system and proper teamwork is stressed.

Anonymous. : American Medical Association Diagnostic and Treatment Guidelines on Child Physical Abuse and Neglect. *Archives of Family Medicine*. 1(2):187-97, 1992 Nov. (Medline ID 94084149)

Child maltreatment has been endemic for generations. It is serious and life-threatening, affecting not only children but families and society as well. Every year, approximately 2 million children in the United States are seriously abused by their parents, guardians, or others, and at least 1000 children die as a result of their injuries.

Anonymous.: *Photographic Documentation of Child Abuse. [Practice Guideline]* American Professional Society on the Abuse of Children. 1995.

Discusses current photographic recommendations by APSAC.

English PC. Grossman H. : Radiology and the history of child abuse. *Pediatric Annals*. 12(12):870-4, 1983 Dec. (Medline ID 84094683)

This overview of radiology as it relates to child abuse covers the sociological history of child abuse (dating back into history) and correlates it to the seminal work by Caffey and Kempe which uncovered the syndrome and revealed its radiologic signs.

Fukunaga T. Mizoi Y. Yamashita A. Yamada M. Yamamoto Y. Tatsuno Y. Nishi K. : Thymus of abused/neglected children. *Forensic Science International*. 53(1):69-79, 1992 Feb. (Medline ID 92234387)

Forty-six cases of child abuse/neglect autopsied during the period of 1967 to 1990 were investigated. The weight and histological findings of the thymus were compared with those of control children. In most abused and/or neglected children, the weight of the thymus decreased conspicuously. Involution correlated well to the degree and period of maltreatment. In cases without weight loss of the thymus, i.e. spasmodic abuse by a mentally deranged parent or foster parent, a short history of maltreatment was noted. On the other hand, marked involution was observed in cases of prolonged physical abuse and/or neglect. Microscopically, a decrease in the number and pyknosis of lymphocytes were observed in the involuted thymus. Atrophy of the thymus was more conspicuous in the cortex than in medulla. Immunohistochemically, CD-1a positive cells (immature thymocytes) decreased in cases with thymic involution. This involution appears to be an important index of the degree and duration of child abuse/neglect. Furthermore, thymic involution in the early stage of childhood may also be related to insufficiency of the immune system.

Hernandez R. Freeman EL. : The role of bone scintigraphy in detecting child abuse. [Review] *Seminars in Nuclear Medicine*. 23(4):321-33, 1993 Oct. (Medline ID 94078170)

This review of diagnostic imaging in cases of suspected child abuse characterizes the significant differences between bone

scintigraphy and x-ray evaluation, describes the advantages and disadvantages of each modality, postulates on the specific mechanisms of injury that produce the characteristic scintigraphic findings, and emphasizes the influences that scintigraphic studies have on the medical, social, and legal aspects of child abuse. The major advantages of bone scintigraphy are its increased sensitivity (25% to 50%) in detecting evidence of soft tissue as well as bone trauma in child abuse. Furthermore, it is postulated that the specific mechanisms of inflicting the trauma relate to the patient's size and are characterized by bone scintigraphy. During fits of anger or frustration, the perpetrator of child abuse grasps the small infant or child by the thorax during the shaking activity. This produces characteristic rib injuries. The older and heavier child is more likely to be grabbed by the extremities, which produces periosteal injuries manifested as characteristic abnormal localizations in the diaphyses of the extremities. The roentgenograms of these injuries are frequently normal. The importance of bone scintigraphy is its complementary nature in defining and characterizing the extent and severity of trauma from child abuse. Such findings have direct bearing on the medical, social, and legal outcomes for the abused child. The quality of scintigraphic imaging is important, requiring the use of magnification techniques in the infant. The interpretation of the scintigraphic images depends on an understanding of the mechanisms by which the radionuclide localizes in bone. The same traumatic incident can lead to decreased, normal, or increased localization at the trauma site. Radionuclide scintigraphy is a complementary rather than competitive imaging modality to X-ray evaluation in the diagnosis and management of physical child abuse. [References: 53]

Liao HB. Hwang RC. Chi YW. Chu ML. Chou TY. Lee SK. : [Child abuse: report of three cases]. [Chinese] *Acta Paediatrica Sinica*. 30(3):216-22, 1989 May-Jun. (Medline ID 90281885)

Child abuse, a clinical condition in young children who have received serious physical abuse, is a frequent cause of permanent injury or death. The first case is a 7-year-old boy suffering from abdominal distension and pain for 3 days. He was beaten by his mother as a result of inadequately learning his lessons. Sonogram and CT of the abdomen showed massive ascites and a pseudocyst of the pancreatic body about 3 x 3 cm in diameter. The second case is a 4-year-old girl who developed a semicomatose state after her father impulsively struck her with a chair. CT of the brain revealed subdural hematoma over the left fronto-temporal region and midline shift to the right. She expired 5 days later. The third case, a 2-year-old girl, suffered from headache, seizure, vomiting and general malaise. CT of the brain showed severe brain swelling over the right side and midline shift to the left. She expired 1 month later. Psychiatric factors are probably of prime importance in the pathogenesis of the disorder, but our knowledge of these factors is limited. Parents who inflict abuse on children do not necessarily have psychopathic or sociopathic personalities or come from borderline socioeconomic groups, although most published cases fall into one of these categories. It is clearly the responsibility of all physicians serving children to be aware of, to recognize, and to properly manage any child who has been the victim of abuse.

Merten DF. : [Role of radiography in the diagnosis of battered children]. [Review] [French] *Journal de Radiologie*. 66(8-9):485-95, 1985 Aug-Sep. (Medline ID 86143477)

Radiological imaging plays an important role in diagnosis of the child abuse syndrome. The radiologist must identify specific foci of injury and document that such injuries are the result of abuse. The capacity to identify abuse-related injuries (sensitivity) has been greatly enhanced by technological advances in radiological imaging including radionuclide scintigraphy (skeletal injury); cranial computed tomography (craniocerebral injuries); and body computed tomography/ultrasonography (abdominal injury). This increased sensitivity has resulted in a greater appreciation of the magnitude of abuse related injuries. Specificity, differentiation between accidental and non-accidental injuries, depends on knowledge of the radiologic characteristics and pattern of abuse-related trauma. Specific injuries must be viewed in light of known pathologic response of anatomic structures to mechanical forces, and determination of the chronology of trauma. [References: 33]

Miller TQ. : The role of the radiologist on the child abuse team. *Journal of the National Medical Association*. 74(7):647-51, 1982 Jul. (Medline ID 83010413)

Physicians in most jurisdictions are mandated to report all suspected cases of child abuse to the appropriate authorities. Often in a position to initially suspect child abuse, the radiologist must be aware of the roentgenographic manifestations of the various forms of child abuse. In recognition of the difficulty for an individual to maintain expertise in all aspects of child abuse, multidisciplinary teams have evolved to share responsibility in the diagnosis and treatment of child abuse as well as aid in prosecution of the perpetrator and in family therapy when applicable.

Olesen T. Egeblad M. Dige-Petersen H. Ahlgren P. Nielsen AM. Vesterdal J. : Somatic manifestations in children suspected of having been maltreated. *Acta Paediatrica Scandinavica*. 77(1):154-60, 1988 Jan. (Medline ID 88219955)

The present study revealed an incidence of maltreatment of 26.8 in 100,000 children under 15 years of age, higher than previously assumed. The sample comprises 41 children suspected of having been maltreated. A systematic examination included radiography and isotope scintigraphy of the skeletal system. In 9 cases the diagnosis was not confirmed, in 23

confirmed, and in 9 children it seemed likely. The most common form of maltreatment was physical violence with bruises. A total of 6 fractures were demonstrated. Three children had been exposed to sexual abuse. Intracranial haematoma, of long standing, was found in one child. Thirteen of the children (40%) were of short stature, their height and weight below the 25th percentile. Among 27 children examined by X-rays 16 (59%) had delayed skeletal maturation. Disturbances of growth, as well as behavioural abnormalities, were particularly striking in this group of patients. The findings suggest that even the slightest suspicion of maltreatment should lead to a general medical evaluation without delay.

O'Neill JA Jr. Meacham WF. Griffin JP. Sawyers JL. : Patterns of injury in the battered child syndrome. *Journal of Trauma*. 13(4):332-9, 1973 Apr. (Medline ID 73165773)

The authors describe experience with 110 children who were the victims of physical abuse, seen over a course of five years. This is thought to represent only a fraction of the true incidence of child battering. Most patients were less than two years of age and were injured by a member of the family. Low socioeconomic status, broken homes, illegitimacy, mothers under the age of 17, and both mental and physical defects in the child were associated factors. Signs of nutritional, hygienic, and psychological deprivation were common. The types of injuries encountered, in the order of frequency, were soft tissue injuries, fractures, and head injuries. Combined injuries were common and evidence of prior injury was the rule. History was routinely confusing or deliberately evasive, indicating that the physician must be alert in order to diagnose and initiate early and appropriate treatment of obscure injury. Typical patterns of soft tissue, skeletal, and intracranial injury are described, as well as characteristic X-ray and physical findings.

Radkowski MA. : The battered child syndrome: pitfalls in radiological diagnosis. *Pediatric Annals*. 12(12):894-903, 1983 Dec. (Medline ID 84094687)

The author discusses a variety of conditions, both congenital and acquired, that can predispose to skeletal injury or present with skeletal lesions similar to those of child abuse. The duty of all physicians who care for the victims of abuse to consider a thorough differential diagnosis is stressed. Case histories and radiographs which illustrate the discussion are included.

Rahilly PM. : The pneumographic and medical investigation of infants suffering apparent life threatening episodes. *Journal of Paediatrics & Child Health*. 27(6):349-53, 1991 Dec. (Medline ID 92096319)

Investigation of 340 babies who suffered from apparent life threatening episodes (ALTE) was performed using pneumographic studies and a variety of medical investigations. A number of medical abnormalities were demonstrated by history or investigation, including gastro-oesophageal reflux (211), airways pathology (17), evidence of fits (25), brain-stem tumour (2), hypoglycaemia (2), respiratory syncytial virus (8) and possible Munchausen by proxy (5). Pneumographic abnormalities were detected in 27 of the 340 infants. Home monitors were used for 135 infants. Future central apnoeas occurred in 20 of the 26 infants on home monitors that had had an abnormal pneumogram, compared with one of the 109 infants on home monitors after a normal pneumogram. Thus pneumograms have a sensitivity and specificity of 95% for predicting central apnoeas in babies who have already suffered an ALTE. The effect of eyeball pressure on the heart rate was measured in 65 babies and was found to cause a brisk drop in heart rate in 32 babies. Twenty-two of the 32 babies had future white apnoeas (usually associated with gastro-oesophageal reflux), compared with five of the 33 babies who had no drop in heart rate in response to eyeball pressure. Thus this test has a sensitivity of 81% and a specificity of 74% at predicting white apnoeas in babies who have already suffered an ALTE.

Ricci LR. : Photographing the physically abused child. Principles and practice. *American Journal of Diseases of Children*. 145(3):275-81, 1991 Mar. (Medline ID 91165794)

Photographic documentation of significant findings is an important part of any child abuse evaluation. High-quality photographs of significant physical findings may be important in helping courts to adjudicate whether child abuse has taken place. The physician evaluating abused children should ensure adequate photographic documentation of visible lesions. Physicians who care for abused children should be familiar with the basic principles and techniques of clinical photography. These include good equipment, adequate lighting, and planned composition. Equally important is a working knowledge of camera equipment, film procedure, and medicolegal implications. This review outlines for the practicing physician the basic concepts and techniques of photographing abused children.

Sirotnak AP. Krugman RD. : Physical abuse of children: an update. [Review] *Pediatrics in Review*. 15(10):394-9, 1994 Oct. (Medline ID 95090000)

Now, more than ever, physicians must be willing to suspect child abuse and report their concerns. New information from the past decade warns us that reports of violence against children continue to increase. We are learning that MRI imaging of the head may, in some cases, help date subdural hematomas, but long-term developmental follow-up studies of "shaken" infants are

lacking. Intentional thoracic and abdominal injuries carry a high mortality. Finally, new information in the field of child abuse--in particular, physical abuse--is slow to come. Lack of funding for basic medical child abuse research and lack of trained researchers in the field are the two most important barriers. Preventive intervention at the community and family level needs to be supported by both the pediatrician and the local and national government leaders. As the U.S. Advisory Board on Child Abuse and Neglect says, "We need to make it as easy for parents to pick up the telephone and get help before they abuse their child as it is now for their neighbor or physician to pick up the telephone and report them after it has happened." Child health practitioners may be in the best position to implement such a policy. [References: 20]

Wales JK. Herber SM. Taitz LS. : Height and body proportions in child abuse. *Archives of Disease in Childhood*. 67(5):632-5, 1992 May. (Medline ID 92286823)

Abused children are said to retain 'infantile body proportions'. The presenting height, sitting height, and leg length standard deviation scores of 91 victims have been calculated from data derived from a study of local inner city schoolchildren. In the study population 31/ 91 (34%) were significantly short and all but two of these had relatively shorter legs than backs, this limb disproportion being significant in 17. In 25 patients of the original group followed up after various social interventions there was a significant recovery of leg length. Measurement of height and proportionality, especially when compared with appropriate modern or local standards, is an important means of detecting and following up victims of child abuse.

Willner A. Ledereich PS. de Vries EJ. : Auricular injury as a presentation of child abuse. *Archives of Otolaryngology -- Head & Neck Surgery*. 118(6):634-7, 1992 Jun. (Medline ID 92344823)

Child abuse causes serious physical and emotional injury. Those abused, however, are usually unable or unwilling to gain access to agencies that might help them. The otolaryngologist, while usually not the patient's primary physician, may be in the position to detect child abuse. We describe a 3-year-old boy who sustained auricular trauma as the result of child abuse. The importance of physician recognition of an abuse case and the institution of appropriate measures are discussed.

CHILD ABUSE — ABDOMINAL INJURIES

Beauchamp JM. Belanger MA. Neitzschman HR. : The diagnosis of subcapsular hematoma of the liver by scintigraphy. *Southern Medical Journal*. 69(12):1579-81, 1976 Dec. (Medline ID 77127517)

The diagnosis of subcapsular hematoma of the liver following blunt abdominal trauma has assumed clinical importance with recent reports of improved mortality with conservative management. There is increasing use of hepatic scintigraphy in evaluation of upper abdominal trauma. Two recently observed cases are used to illustrate the typical findings in this entity.

Boysen BE. : Chylous ascites. Manifestation of the battered child syndrome. *American Journal of Diseases of Children*. 129(11):1338-9, 1975 Nov. (Medline ID 76059162)

A child had chylous ascites and other findings suggestive of child abuse. He had a spontaneous remission, with conservative therapy. A lymphangiogram showed the area of leakage into the peritoneal cavity. The discussion includes a brief review, a literature on chylous ascites.

Coant PN. Kornberg AE. Brody AS. Edwards-Holmes K. : Markers for occult liver injury in cases of physical abuse in children. *Pediatrics*. 89(2):274-8, 1992 Feb. (Medline ID 92131595)

Children suffering physical abuse are at risk for abdominal trauma. When the abdominal trauma is not evident clinically and remains occult, the child's condition can rapidly deteriorate before the diagnosis is made, and delay may occur in the activation of child protective services. The use of markers for abdominal trauma in the evaluation of cases of child physical abuse was examined. Children younger than 12 years presenting to the Emergency Department at the Children's Hospital of Buffalo from August 1989 through April 1990 for the evaluation of suspected physical abuse were prospectively entered in the project. All patients had a complete history and physical examination performed. Those patients who did not show any signs of abdominal injury had the following laboratory tests done: (1) levels of liver transaminases, lactate dehydrogenase, and alkaline phosphatase; (2) amylase level; and (3) urinalysis. Of 49 patients without clinical signs of abdominal trauma, 4 children had elevated transaminase levels. Three of these 4 patients had liver lacerations documented by subsequent abdominal computed tomographic scans. A new finding of transaminase levels as markers of occult liver injury in children suffering physical abuse is reported.

Haller JO. Bass IS. Sclafani SJ. : Imaging evaluation of traumatic hematuria in children. *Urologic Radiology*. 7(4):211-8, 1985. (Medline ID 86098347)

The 3 major causes of traumatic hematuria in children are accidents, iatrogenic damage, and child abuse. While computerized tomography plays a major role in the evaluation of accidental trauma, ultrasound and routine radiography are important in the work-up of iatrogenic hematuria and injuries caused by child abuse. This paper reviews the role of these imaging modalities in diagnosing traumatic hematuria in children.

Hernanz-Schulman M. Genieser NB. Ambrosino M. : Sonographic diagnosis of intramural duodenal hematoma. *Journal of Ultrasound in Medicine*. 8(5):273-6, 1989 May. (Medline ID 89236500)

Intramural duodenal hematoma, sometimes accompanied by retroperitoneal extension, is a frequent injury resulting from blunt abdominal trauma in childhood. In fact, it may be the first sign of child abuse identified in the young child. The typical appearance of this injury on upper gastrointestinal examination was described by Felson, although its radiographic variability has been stressed more recently. We have encountered two cases of intramural duodenal hematoma diagnosed with sonography. In the appropriate clinical setting, this diagnosis may be made with specificity using state-of-the-art equipment and technique. Computerized tomography (CT) and barium meal (UGI) studies were done in these cases and the multimodality appearance of the injury is discussed.

Kaufman RA. Babcock DS. : An approach to imaging the upper abdomen in the injured child. *Seminars in Roentgenology*. 19(4):308-20, 1984 Oct. (Medline ID 85040442)

Paper discusses available imaging modalities and evaluates their effectiveness.

Kirks DR. : Radiological evaluation of visceral injuries in the battered child syndrome. *Pediatric Annals*. 12(12):888-93, 1983 Dec. (Medline ID 84094686)

Diagnostic imaging plays an important role in the recognition, evaluation, and follow-up of visceral injuries in the battered child syndrome. Conventional radiography is important for the diagnosis of associated skeletal fractures, pulmonary parenchymal injury, gastric dilatation, and pneumoperitoneum. An upper gastrointestinal series is the examination of choice in suspected intramural duodenal hematoma. Ultrasonography is helpful in the diagnosis of retroperitoneal hematoma, acute traumatic pancreatitis, and pancreatic pseudocyst. Nuclear scintigraphy is valuable if injury is limited to the liver or spleen. CT is the imaging modality of choice for assessing generalized blunt abdominal trauma as well as evaluating the extent of injuries to the liver, spleen, pancreas, kidneys, and mesentery.

Kleinman PK. Brill PW. Winchester P. : Resolving duodenal-jejunal hematoma in abused children. *Radiology*. 160(3):747-50, 1986 Sep. (Medline ID 86288008)

Acute intramural duodenal-jejunal hematoma is a classical finding in the battered child syndrome. The radiographic findings of a large obstructing intramural mass associated with the "coiled-spring" appearance generally raise the question of child abuse in any patient without appropriate accidental injury. In this study the radiologic features of resolving duodenal-jejunal hematoma are detailed in five abused children. The results show that the coiled-spring appearance is an acute phenomenon associated with a well-localized intramural hematoma. In the resolving phase, localized mural masses in the lateral aspect of the descending duodenum and fold thickening are indications of prior intramural hemorrhage. When these radiologic features are encountered in a child with nonspecific abdominal complaints, child abuse should be suspected. Furthermore, in patients with suspected occult trauma, resolution of abdominal symptoms should not deter the radiologist from performing an upper gastrointestinal tract series, which may provide evidence of child abuse.

Mukherji SK. Siegel MJ. : Rhabdomyolysis and renal failure in child abuse. *AJR. American Journal of Roentgenology*. 148(6):1203-4, 1987 Jun. (Medline ID 87209588)

Acute renal failure secondary to rhabdomyolysis with myoglobinuria is uncommon in childhood and, when present, usually is a complication of massive crush injuries. A few reports in the medical and urologic literature have documented a rare association between rhabdomyolysis-induced renal failure and child abuse. We report an additional patient in whom the diagnosis was first suggested by the radiologic findings.

Nimkin K. Teeger S. Wallach MT. DuVally JC. Spevak MR. Kleinman PK. : Adrenal hemorrhage in abused children: imaging and postmortem findings. *AJR. American Journal of Roentgenology*. 162(3):661-3, 1994 Mar. (Medline ID 94152583)

OBJECTIVE. Adrenal hemorrhage associated with child abuse has received little attention in published reports. We review imaging studies or pathologic findings of adrenal hemorrhage in five cases of proved child abuse. SUBJECTS AND METHODS. The imaging findings in three children with adrenal hemorrhage were analyzed retrospectively. All three had abdominal CT scans and skeletal radiographs. One also had abdominal sonograms and MR images. The pathologic findings in two other abused children with adrenal hemorrhage who died of head injuries were also studied. In all five cases, a history of trauma was not initially known; child abuse was later confirmed. RESULTS. Unilateral hemorrhage in the right adrenal gland was found in all patients. Enhanced CT scans of the abdomen showed a low-attenuation, oval mass separating the limbs of the adrenal gland. Sonograms in one case showed a small, heterogeneous mass in the right adrenal gland. MR images obtained 3 weeks later showed an area of high signal intensity within the right adrenal gland on both T1- and T2-weighted images, consistent with subacute hemorrhage. In both deceased children, autopsy showed hemorrhage in the right adrenal gland, mainly within the medulla with some extension beyond the capsule in one case. All five children had associated abdominal visceral injuries or rib fractures or both, on the same side as the hemorrhage. CONCLUSION. Imaging findings of adrenal hemorrhage are similar to those previously described in patients with accidental trauma. Pathologic sections of the gland reveal predominantly medullary involvement with hemorrhage. The presence of adrenal hemorrhage in a child should prompt a search for other associated injuries and raise the possibility of unsuspected trauma.

Orel SG. Nussbaum AR. Sheth S. Yale-Loehr A. Sanders RC. : Duodenal hematoma in child abuse: sonographic detection. *AJR. American Journal of Roentgenology*. 151(1):147-9, 1988 Jul. (Medline ID 88238304)

The clinical signs and symptoms of duodenal injury caused by child abuse are often nonspecific, and external signs of trauma may be absent. In four children with unexplained gastrointestinal symptoms, sonography detected and showed the extent of a duodenal hematoma resulting from child abuse. In two of the children, sonography was also used to follow the evolution of the duodenal hematoma.

Rosenberg HK. Geftter WB. Lebowitz RL. Mahboubi S. Rosenberg H. : Prolonged dense nephrograms in battered children. Suspect rhabdomyolysis and myoglobinuria. *Urology*. 21(3):325-30, 1983 Mar. (Medline ID 83173288)

Prolonged, dense nephrograms were seen on intravenous urography in 5 cases of child abuse presenting with possible renal injury. Each child had oliguria, elevated muscle enzymes, and pigmented urine positive for blood, but without red cells on microscopic examination. These findings are suggestive of myoglobinuria. The abnormalities resolved with appropriate fluid and electrolyte management. This complication of child abuse, not previously emphasized, may be suggested by the urographic findings. Possible factors contributing to the dense nephrograms are presented.

Sachdeva RS. Jaeger A. Norton K. Raucher H. Dolgin SE. Benkov K. LeLeiko NS. : Intramural hematoma of the transverse colon in battered child syndrome. *Journal of Pediatric Gastroenterology & Nutrition*. 18(1):111-3, 1994 Jan. (Medline ID 94172506)

Major blunt trauma is a serious, though infrequent, pattern of injury in the battered child syndrome. Various types of intraabdominal visceral injuries including contusions of the liver, spleen, pancreas, and kidney have been described. Other injuries such as duodenal and jejunal hematomas, perforation of the jejunum, rectal perforation, and torn mesenteric vessels are well-documented in child abuse. We describe a 3-year-old boy with intramural hematoma of the transverse colon as a manifestation of the battered child syndrome.

Sivit CJ. Taylor GA. Eichelberger MR. : Visceral injury in battered children: a changing perspective. *Radiology*. 173(3):659-61, 1989 Dec. (Medline ID 90047648)

Abdominal or lower thoracic visceral injury was present in 14 of 69 children (20.3%) examined after suspected physical abuse. Of these, 10 were hemodynamically stable and examined with abdominal computed tomography (CT); four were hemodynamically unstable, taken directly to surgery, or died in the emergency room. In the group studied with CT, injuries to solid abdominal organs were most common (hepatic [n = 5], splenic [n = 3], renal [n = 1], adrenal [n = 1], and pancreatic [n = 1]) followed by pulmonary contusion or laceration (n = 2) and pneumoperitoneum due to duodenal transection (n = 1). No additional radiographic abnormalities were noted in five of these children. In the group not studied with CT, injuries to the intestinal tract and mesentery were most common (n = 3), followed by solid organ injury (hepatic [n = 1] and renal [n = 1]) and

pulmonary contusion (n = 1). Intestinal, mesenteric, and pancreatic injuries were associated with a poor outcome. CT should be the examination of choice in abused children with suspected intraabdominal injury.

Sivit CJ. Eichelberger MR. Taylor GA. : CT in children with rupture of the bowel caused by blunt trauma: diagnostic efficacy and comparison with hypoperfusion complex. *AJR. American Journal of Roentgenology*. 163(5):1195-8, 1994 Nov. (Medline ID 95067483)

OBJECTIVE. The purpose of this study was to determine the sensitivity and specificity of CT in diagnosing bowel rupture in children after blunt trauma and to compare CT findings in children with bowel rupture with those in children with the hypoperfusion complex. **SUBJECTS AND METHODS.** Twenty-one (1%) of 1488 children who had contrast-enhanced CT of the abdomen after blunt trauma had a bowel rupture subsequently verified at surgery or autopsy. Thirty-three additional children had a characteristic hypoperfusion complex at CT. The CT scans in all 1488 children were prospectively evaluated for the following findings: peritoneal fluid, extraluminal air, bowel wall enhancement, bowel wall thickening, and bowel dilatation. **RESULTS.** The most common CT findings in children with bowel rupture were peritoneal fluid (14, 67%) and bowel wall enhancement (13, 62%). One or more of the five studied CT findings were noted in 20 of the 21 children with bowel rupture and in 64 of the 1467 children without bowel rupture (sensitivity 95%, specificity 96%). Thirty-three children who had one or more of the CT findings and did not have bowel rupture had the hypoperfusion complex. **CONCLUSION.** Our results show that CT is accurate in the diagnosis of bowel rupture after blunt trauma in children. The most common findings are peritoneal fluid and bowel wall enhancement. CT findings in children with bowel rupture may overlap with those in children with the hypoperfusion complex.

Tolia V. Patel AS. Amundson GM. : Pancreatic fracture secondary to child abuse: the role of computed tomography in its diagnosis. *Clinical Pediatrics*. 29(11):667-8, 1990 Nov. (Medline ID 91092079)

Pancreatitis in children is relatively uncommon and usually due to trauma, viral infections, congenital anomalies, or idiopathic causes. Child abuse is a well recognized cause of traumatic pancreatitis. We present the case of an infant with a pancreatic fracture caused by child abuse, diagnosed by computed tomography (CT), which progressed to a pseudocyst and resolved with conservative medical management.

CHILD ABUSE — CHEST INJURIES

Dogruyol H. Gurpinar AN. : A foreign body in a four-day-old infant's esophagus: a case of negligence. *Turkish Journal of Pediatrics*. 31(2):163-6, 1989 Apr-Jun. (Medline ID 90142154)

A foreign body in the esophagus of a four-day-old male baby is presented. Since self-introduction of a foreign body is impossible at this age, the accident was considered to be the result of a form of neglect.

Kleinman PK. Spevak MR. Hansen M. : Mediastinal pseudocyst caused by pharyngeal perforation during child abuse. *AJR. American Journal of Roentgenology*. 158(5):1111-3, 1992 May. (Medline ID 92230586)

Pharyngeal and esophageal perforation caused by child abuse is rare. All published reports have described cervical swelling, emphysema, and fever, and in two cases of a cervical abscess there was spread to the mediastinum. We report a case of child abuse in which the patient had inspiratory stridor from a mediastinal pseudocyst. Additional studies revealed evidence of prior pharyngeal perforation and widespread skeletal injury typical of child abuse.

CHILD ABUSE — CHILD DEATH

Little GA. Brooks JG. : Accepting the unthinkable [editorial]. *Pediatrics*. 94(5):748-9, 1994 Nov. (Medline ID 95022933)

This editorial responds to the recent revelation that some children reported to have died of SIDS in an original study by Steinschneider, et. al. may actually have been murder. Discrimination between SIDS and death due to nonaccidental trauma are discussed.

Reece RM. : Fatal child abuse and sudden infant death syndrome: a critical diagnostic decision [see comments]. *Pediatrics*. 91(2):423-9, 1993 Feb. (Medline ID 93141307)

This report describes the proper management of suspected SIDS deaths, with an eye to permitting the rapid differentiation between true SIDS and fatal child abuse. Radiologic studies are specifically discussed, with another repudiation of the "babygram."

Samuels MP. Poets CF. Noyes JP. Hartmann H. Hewertson J. Southall DP. : Diagnosis and management after life threatening events in infants and young children who received cardiopulmonary resuscitation. *BMJ*. 306(6876):489-92, 1993 Feb 20. (Medline ID 93192694)

OBJECTIVE – To determine the mechanisms and thereby appropriate management for apparent life threatening events treated with cardiopulmonary resuscitation in infants and young children. DESIGN – Prospective clinical and physiological study. SETTING--Royal Brompton Hospital or in patients' homes, or both. SUBJECTS – 157 Patients referred at median age 2.8 months (range 1 week to 96 months), 111 (71%) had recurrent events, 44 were born preterm, 19 were siblings of infants who had died suddenly and unexpectedly, and 18 were over 12 months old. INTERVENTIONS – Multichannel physiological recordings, including oxygenation, in hospital (n = 150) and at home (n = 61). Additional recordings with electroencephalogram, video, or other respiratory measures were used to confirm diagnoses. Management involved monitoring of oxygen at home, additional inspired oxygen, anticonvulsant treatment, or child protection procedures. MAIN OUTCOME MEASURES – Abnormalities on recordings compared to published normal data and their correlation with clinical events; sudden death. RESULTS – 53 of 150 patients had abnormalities of oxygenation on hospital recordings, 28 of whom had an accompanying clinical event. Home recordings produced physiological data from 34 of 61 patients during subsequent clinical events. Final diagnoses were reached in 77 patients: deliberate suffocation by a parent (18), hypoxaemia induced by epileptic seizure (10), fabricated history and data (Munchausen syndrome by proxy; seven), acute hypoxaemia of probable respiratory origin (40), and changes in peripheral perfusion and skin colour without hypoxaemia (two). Four patients died: three suddenly and unexpectedly (none on home oxygen monitors) and one from pneumonia. CONCLUSIONS: Identification of mechanisms is essential to the appropriate management of infants with apparent life threatening events.

CHILD ABUSE — DIFFERENTIAL DIAGNOSIS

Berant M. Jacobs J. : A "pseudo" battered child. *Clinical Pediatrics*. 5(4):230-7, 1966 Apr. (Medline ID 66099305)

The authors report a case of a thirty-two-month-old developmentally-delayed boy who was admitted to the hospital because of tender swelling of both legs, his left shoulder and his left arm. After considering a differential diagnosis which included nonaccidental injury, the final diagnosis was found to be scurvy, due to the inadequacy of the child's preferred diet. The authors discuss the sociological aspects of the apparent neglect seen here.

Koyama T. Ogawa M. Kurata S. Komazawa M. Murakami M. : Meningeal malignant melanoma in a child: immunocytological diagnosis. *Acta Paediatrica Japonica*. 34(2):173-8, 1992 Apr. (Medline ID 92320941)

A 10-year-old boy, who was thought to have had a traumatic intracranial hemorrhage, was transferred to our Children's Medical Center. In spite of conservative treatment, he developed dysarthria, systemic convulsions, unconsciousness, quadriplegia, and consecutive paralysis of the cranial nerves. Magnetic resonance imaging scans demonstrated areas of increased signal intensity around the brain stem. The cerebrospinal fluid (CSF) contained a few large cells with abundant melanin-like granules, and numerous bizarre cells. The latter were considered to be malignant melanoma cells on immunocytological examination. Chemotherapy with dimethyltriazenoimidazole carboxamide (DTIC) and interferon beta (IFN-beta) was ineffective and he expired. Autopsy revealed diffuse infiltration of malignant melanoma cells into the meninges. We think that immunocytological examination of CSF is advisable for correct and rapid diagnosis.

CHILD ABUSE — FRACTURES

Kaye JJ. : Roentgenographic evaluation of children with acute onset of a limp. *Pediatric Annals*. 5(1):11-31, 1976 Jan. (Medline ID 76175337)

The author discusses the radiographic consideration of a new-onset limp in a child. The author describes the specific radiographic features of traumatized (battered) children.

Kleinhans E. Kentrup H. Alzen G. Skopnik H. Bull U. : [A false negative bone scintigram in a biparietal skull fracture in a case of a Battered Child Syndrome]. [German] *Nuklearmedizin*. 32(4):206-7, 1993 Aug. (Medline ID 93382811)

Kleinman PK. : Schmid-like metaphyseal chondrodysplasia simulating child abuse. *AJR. American Journal of Roentgenology*. 156(3):576-8, 1991 Mar. (Medline ID 91135611)

Schmid metaphyseal chondrodysplasia is characterized by mild to moderate flaring and irregularity of the metaphyses, a normal spine, and frequently short stature. It is rarely diagnosed in patients younger than 2 years old without a reported family history of the condition. This report describes a case of metaphyseal chondrodysplasia radiologically resembling the Schmid type in a 5-month-old patient with an apparent leg-length discrepancy. Child abuse was initially suspected radiologically, until additional radiographs of the patient and his father were obtained. Subsequently, another sibling with similar radiologic features was born.

Kleinman PK. Spevak MR. : Variations in acromial ossification simulating infant abuse in victims of sudden infant death syndrome. *Radiology*. 180(1):185-7, 1991 Jul. (Medline ID 91271544)

A variation in ossification of the acromial process of the scapula is described. Postmortem radiographs, obtained in 78 infants who died of sudden infant death syndrome, showed an ossific opacity adjacent to the acromial process in 10 infants (13%). This finding was noted bilaterally in six patients and unilaterally in four patients. No two ossicles were identical. Histologically, no growth plate cartilage was evident between the bony structure and the acromion proper; therefore, this appeared to represent a "pseudoepiphyseal." Superficially, this normal variation may appear similar to an acromial fracture resulting from infant abuse. However, a careful analysis of the findings of this normal variation should help prevent any confusion with inflicted injury.

Laor T. Jaramillo D. : Metaphyseal abnormalities in children: pathophysiology and radiologic appearance. *AJR. American Journal of Roentgenology*. 161(5):1029-36, 1993 Nov. (Medline ID 94099155)

The most active site of formation of bone in children is the metaphysis. Systemic and local diseases are reflected by alterations in the morphology of this region. In this pictorial essay, we examine several patterns of metaphyseal abnormalities seen on radiologic images and review the associated pathophysiology. Differential diagnosis may be aided by considering the pathologic mechanisms responsible for the various metaphyseal alterations.

Leonidas JC. : Skeletal trauma in the child abuse syndrome. *Pediatric Annals*. 12(12):875-81, 1983 Dec. (Medline ID 84094684)

This review paper discusses the skeletal manifestations of child abuse. It includes specific recommendations about which imaging studies should be used and discusses a variety of patterns of skeletal injury in the abused child. Scintigraphy is recommended for its sensitivity, but its lack of specificity is noted.

Leventhal JM. Thomas SA. Rosenfield NS. Markowitz RI. : Fractures in young children. Distinguishing child abuse from unintentional injuries. *American Journal of Diseases of Children*. 147(1):87-92, 1993 Jan. (Medline ID 93118606)

OBJECTIVE – To determine features of fractures in young children that would be helpful in distinguishing child abuse from unintentional injuries. DESIGN – Case series. SETTING – Pediatric Services of Yale-New Haven (Conn) Hospital (a tertiary care center). PATIENTS – Consecutive children who were less than 3 years of age and who were examined for a fracture from January 1979 through December 1983 were identified from the daily logs of the emergency department or the hospital's child abuse registry. OUTCOME MEASURE – Each case was rated, by means of predefined criteria and a consensus of two clinicians and two pediatric radiologists, on a seven-point scale from "definite child abuse" to "definite unintentional injury." A middle

rating of “unknown” was used if there was not enough information to reach a consensus. RESULTS – Of the 253 fractures in 215 children that were identified, we categorized 24.2% as abuse, 8.4% as unknown, and 67.4% as unintentional injuries. Fractures that were considered likely due to abuse were (1) fractures in children whose caretakers reported either a change in the child’s behavior, but no accidental event, or a minor fall, but the injury was more severe than expected; (2) fractures of the radius/ulna, tibia/fibula, or femur in children less than 1 year of age; or (3) midshaft or metaphyseal fractures of the humerus. Linear fractures of the parietal bone were the most common skull fractures, whether due to abuse or unintentional injuries. CONCLUSION – In young children with fractures, child abuse is common. By comparing fractures due to abuse and those due to unintentional injuries, we obtained empiric evidence to help clinicians and radiologists correctly examine children with such serious injuries.

Mellick LB. Reesor K. Demers D. Reinker KA. : Tibial fractures of young children. *Pediatric Emergency Care*. 4(2):97-101, 1988 Jun. (Medline ID 88247854)

Tibial fractures are relatively frequent injuries of young children. These fractures are occasionally the cause of a childhood gait disturbance. Additionally, tibial fractures may be the result of child abuse. Consequently, the pediatrician should have knowledge concerning these injuries. In this paper, we present a review of tibial fractures in hospitalized children and describe their associations with nonaccidental trauma (NAT). Finally, we provide suggestions for improving nomenclature clarity for isolated spiral fractures of the tibia.

Mellick LB. Reesor K. : Spiral tibial fractures of children: a commonly accidental spiral long bone fracture. *American Journal of Emergency Medicine*. 8(3):234-7, 1990 May. (Medline ID 90234058)

Pediatric training in child abuse has consistently emphasized a strong association between nonaccidental injuries and spiral fractures of long bones. Isolated spiral tibial fractures of childhood have previously been recognized by the orthopedic specialty to most frequently be accidental in etiology. The authors present evidence that supports a predominantly accidental etiology for isolated spiral tibial fractures of young children. This article presents a series in which 9 of 10 such spiral fractures were most likely the result of an accident and not child abuse or gross neglect. Additionally, almost all of these fractures presented as a gait disturbance and should be included in the differential of this complaint.

Mellick LB. : Spiral tibial fractures revisited [letter; comment]. *American Journal of Emergency Medicine*. 9(1):99, 1991 Jan. (Medline ID 91090773)

This letter discusses the specificity of spiral tibial fractures as a marker for child abuse. The author states that regardless of location, most tibial fractures are of accidental origin. A differential which includes Childhood Accidental Spiral Tibial fracture is suggested.

Merten DF. Radkowski MA. Leonidas JC. : The abused child: a radiological reappraisal. *Radiology*. 146(2):377-81, 1983 Feb. (Medline ID 83092007)

Radiological findings in 563 abused infants and children who were studied retrospectively emphasize the limitations of diagnostic imaging, specifically radiographic examination of the skeleton. Skeletal trauma was detected in less than one-third of all patients and was uncommon beyond two years of age. Fractures were rarely present without clinical evidence of physical abuse. Radiographic features considered specific for child abuse (epiphyseal-metaphyseal, rib fractures) or highly suggestive (occult, multiple/repetitive fractures) were distinctly infrequent and limited to infancy. A more efficacious approach to radiological evaluation based on clinical presentation is offered.

Merten DF. Osborne DR. Radkowski MA. Leonidas JC. : Craniocerebral trauma in the child abuse syndrome: radiological observations. *Pediatric Radiology*. 14(5):272-7, 1984. (Medline ID 84296869)

Experience with craniocerebral trauma in 712 physically abused children is reviewed. Ninety-three (13%) had evidence of head trauma (cranial and/or intracranial). Seventy-seven of these patients had computed tomography (CT) of the head, and 47 had CT evidence of intracranial injury. Extracerebral fluid collections, predominantly convexity subdural hemorrhage, were the most common acute intracranial lesions. Concurrent intracranial and skeletal trauma (cranial and/or extracranial) was present in 33 of the 47 patients (70%) with intracranial injury. A high incidence of skull fractures (45%) in those children with intracranial lesions suggest a significant role for impact head injuries (“battering”) in the pathogenesis of craniocerebral trauma in the child abuse syndrome. Greater emphasis on CT examination in evaluation of the abuse infant and child is recommended.

Pickett WJ. Faleski EJ. Chacko A. Jarrett RV. : Comparison of radiographic and radionuclide skeletal surveys in battered children. *Southern Medical Journal*. 76(2):207-12, 1983 Feb. (Medline ID 83120258)

A review of 13 cases of suspected child abuse in which radionuclide (RN) scans, radiographic skeletal surveys, and sufficient follow-up were available showed that the RN scans were insensitive, even though fractures were more than 48 hours old at the time of the scan. Frequently missed lesions included skull and extremity fractures. Furthermore, soft tissue and visceral abnormalities that were identified on radiographic examination went undetected on RN scan. We conclude that, although the RN scan may augment the radiographic examination, it should not be used alone to screen for the battered child.

Rogers LF. Poznanski AK. : Imaging of epiphyseal injuries. [Review] *Radiology*. 191(2):297-308, 1994 May. (Medline ID 94204193)

There have been many advances in the diagnosis and treatment of epiphyseal injuries in the 30 years since the publication of the landmark article by Drs Robert Salter and William Harris. They are the subject of this review. The anatomic features of the physis, epiphysis, and metaphysis are presented, and histologic studies of human and experimental physeal injuries are described. The recently recognized histologic, anatomic, and imaging characteristics of bone bridging of the physis resulting in growth disturbances are reviewed. Modification in and additions to the original Salter-Harris classification system have been proposed. The role and technique of computed tomography and magnetic resonance imaging in the assessment of the initial injury and analysis of subsequent growth disturbance are discussed. [References: 97]

CHILD ABUSE — HEAD TRAUMA

Alexander RC. Schor DP. Smith WL Jr. : Magnetic resonance imaging of intracranial injuries from child abuse. *Journal of Pediatrics*. 109(6):975-9, 1986 Dec. (Medline ID 87060361)

Magnetic resonance imaging (MRI) and computed tomography (CT) were compared in four children who had evidence of intracranial injury caused by shaking. All children had intracranial bleeding, neurologic impairment, and history or physical examination findings suggestive of child abuse. Three had bilateral retinal hemorrhages, and three had visual impairment. MRI revealed bilateral subdural hematomas in all four children, but CT showed this in only one. Skull fractures in one patient were visualized by CT alone. MRI alone demonstrated posterior fossa bleeding in one patient and intraparenchymal bleeding in another; an additional patient in whom CT showed relatively diffuse atrophy also had defined areas of focal atrophy apparent on MRI. Subarachnoid hemorrhages were equally well detected using CT or MRI. Overall, MRI was superior to CT for detection of intracranial injury caused by shaking, and may help to document milder instances of this form of child abuse.

Alexander R. Sato Y. Smith W. Bennett T. : Incidence of impact trauma with cranial injuries ascribed to shaking. *American Journal of Diseases of Children*. 144(6):724-6, 1990 Jun. (Medline ID 90266830)

Shaking as a mechanism of severe brain injury in infants has been challenged on a theoretical basis as insufficient to explain the magnitude of observed injuries. Computed tomography and magnetic resonance imaging, developed since shaken baby syndrome was first described, are helpful in establishing whether external trauma occurred for infants thought to have been shaken. We compiled data from 24 infants initially diagnosed as having shaken baby syndrome, including physical examination, roentgenograms, computed tomography or magnetic resonance imaging, and autopsy (when applicable). Half of the patients showed no evidence of direct impact, and evidence of external trauma was not predictive of a fatal outcome. These findings indicate that shaking by itself is sufficient to cause severe or fatal intracranial injury and that the shaken baby syndrome reflects a spectrum of such child abuse injuries that may include direct trauma or only shaking.

Ball WS Jr. : Nonaccidental craniocerebral trauma (child abuse): MR imaging [editorial]. *Radiology*. 173(3):609-10, 1989 Dec. (Medline ID 90047635)

This editorial addresses the issue of CT versus MR imaging as a first study in suspected child abuse. CT is recommended overall, because of its superior ability to detect subarachnoid hemorrhage, its use for evaluating the calvaria, its ease of performance in the unstable acutely injured child, and its ability to image the chest and abdomen when indicated. MR is recommended for detection of injury when CT is normal or equivocal and the clinical picture suggests cerebral injury. MR is also preferred for evaluation of subacute or chronic abuse, since CT may miss intraparenchymal injury and misinterpretation of scar tissue is possible.

Bennett HS. French JH. : Elevated intracranial pressure in whiplash-shaken infant syndrome detected with normal computerized tomography. *Clinical Pediatrics*. 19(9):633-4, 1980 Sep. (Medline ID 81002682)

This report briefly discusses the limitations of CT imaging in diagnosing elevated intracranial pressure in a single case. A fifteen-month-old child was admitted with signs of WSIS, including bilateral retinal hemorrhages, bilateral decerebrate posturing, bradycardia, hypertension, and irregular respirations. While clinical signs of elevated intracranial pressure were present and radiography of the skeleton showed old fractures, CT images remained normal on the first and fifth hospital day.

Bird CR. McMahan JR. Gilles FH. Senac MO. Apthorp JS. : Strangulation in child abuse: CT diagnosis. *Radiology*. 163(2):373-5, 1987 May. (Medline ID 87176406)

The central nervous system is commonly affected in child abuse. Between April 1985 and July 1986 three infants were identified in whom the primary mode of injury had been strangulation. In each case computed tomography (CT) demonstrated a large cerebral infarction confined to vascular territories associated with small subdural hematomas. There was no history or visible evidence of significant head trauma. Autopsy of one infant confirmed the presence of a hemispheric infarct, thin subdural hematoma, and an area of subintimal hemorrhage in the carotid artery ipsilateral to the infarct. The remaining two patients survived with residual hemiparesis. CT findings of a large cerebral infarction with an associated subdural hematoma in an infant without a history of a significant trauma should suggest the possibility of child abuse and may be the primary manifestation of abuse in some patients.

Brown JK. Minns RA. : Non-accidental head injury, with particular reference to whiplash shaking injury and medico-legal aspects. [Review] *Developmental Medicine & Child Neurology*. 35(10):849-69, 1993 Oct. (Medline ID 94009969)

This report contains a complete review of non-accidental head injury. In addition to incidence and mechanism information, the clinical picture is described in detail. The characteristics of non-accidental skull fractures are discussed. A brief discussion of confounding diseases and differential diagnosis is followed by a comprehensive set of practice recommendations.

Bruce DA. Zimmerman RA. : Shaken impact syndrome. [Review] *Pediatric Annals*. 18(8):482-4, 486-9, 492-4, 1989 Aug. (Medline ID 89366351)

The authors present a comprehensive discussion of the presentation, management, and diagnosis of shaken impact syndrome. Suspicion is urged for any child under one year of age with altered consciousness, particularly with a history of minor trauma. CT is recommended as a first imaging modality, with discussion of the characteristic features of shaken impact syndrome in this imaging modality. Management both of acute resuscitation and followup care is discussed.

Caffey J. : The whiplash shaken infant syndrome: manual shaking by the extremities with whiplash-induced intracranial and intraocular bleedings, linked with residual permanent brain damage and mental retardation. *Pediatrics*. 54(4):396-403, 1974 Oct. (Medline ID 75016801)

The theme of this report is fourfold: (1) it presents the essential clinical manifestations of the whiplash shaken infant syndrome; (2) it presents evidence which indicates that many so-called battered babies are really shaken babies; (3) it emphasizes the high vulnerability of the infantile head, brain and eyes to habitual, manual, whiplash stresses of ordinary shaking by the extremities; and (4) it supports the hypothesis that casual, habitual, manual whiplash shaking (WLS) of infants is a substantial primary, frequent cause of later mental retardation and permanent brain damage.

Carter JE. McCormick AQ. : Whiplash shaking syndrome: retinal hemorrhages and computerized axial tomography of the brain. *Child Abuse & Neglect*. 7(3):279-86, 1983. (Medline ID 84105971)

Three cases of whiplash shaking injury of infants are presented. All children presented with seizures and had minimal signs of external injury. Examination of the retina revealed extensive retinal hemorrhages. These were missed on initial examination and were only discovered after pupillary dilatation. The presence of these pale-centered retinal hemorrhages suggested the diagnosis of child abuse and skeletal surveys and thorough social histories confirmed the diagnosis. Despite extensive retinal hemorrhages, computerized axial tomography (C.T.) scan showed minimal inter-hemispheric bleeding. In contrast to the "Battered Child Syndrome," all the findings in whiplash shaking syndrome of infants are subtle and demand an awareness, an index of suspicion and a thorough examination which may include extensive retinal examination following dilatation of the

pupils. This latter examination is frequently not performed by family physicians and residents so that the syndrome may be missed. A fourth case is also discussed where shaking is admitted on initial presentation but said to be done for resuscitation. This poses an immense diagnostic dilemma to the pediatrician since in this case the child presented later with all the signs of physical abuse.

Cohen RA. Kaufman RA. Myers PA. Towbin RB. : Cranial computed tomography in the abused child with head injury. *AJR. American Journal of Roentgenology*. 146(1):97-102, 1986 Jan. (Medline ID 86073816)

Cranial computed tomographic (CT) findings are described in 37 children with head injuries resulting from physical abuse. CT findings included subarachnoid hemorrhage (27 patients), cerebral edema (24), cerebral hemorrhage (11), and subdural hematoma (nine). Intravenous contrast material was administered in 10 children in whom there were neurologic symptoms or signs but no history or physical signs of trauma or abuse. In five of these children, increased vascularity was seen in areas that later showed infarction. Eight children were studied by both CT and sonography. Sonography detected 50% fewer abnormalities than did CT. It was found that children with skull fracture had the same range of injuries as children without fracture, and they had a higher incidence of subarachnoid hemorrhage. In acutely traumatized children, cranial CT should be the method of choice to provide the most accurate diagnosis and documentation of injury. Skull radiographs should also be obtained because they sometimes show fractures not recognized by CT.

Dykes LJ. : The whiplash shaken infant syndrome: what has been learned?. [Review] *Child Abuse & Neglect*. 10(2):211-21, 1986. (Medline ID 86217371)

In 1974 John Caffey described a form of abuse in infants which he called "The Whiplash Shaken Infant Syndrome." This syndrome involves vigorous manual shaking of infants by the extremities or shoulders, with whiplash-induced intracranial and intraocular bleeding, but with no external signs of head trauma. This article reviews the literature on whiplash shaken infant syndrome since Caffey's original review. The bulk of this literature focuses on the use of cranial computed tomography in the diagnosis of head injury in infants. Many questions remain regarding the incidence of this syndrome, and the long term morbidity resulting from this type of injury in infants. Caffey's recommendations for routine, regular examinations of the ocular fundi in all babies, and for a massive public educational program on the hazards of shaking infants have yet to be carried out. [References: 65]

Ellison PH. Tsai FY. Largent JA. : Computed tomography in child abuse and cerebral contusion. *Pediatrics*. 62(2):151-4, 1978 Aug. (Medline ID 79011666)

Cerebral contusion is considered to be the lesion leading to neurological sequelae of mental retardation and cerebral palsy in abused children. This has been difficult to document other than at autopsy or craniotomy by previously available techniques. Acute contusion or hemorrhage presumably secondary to contusion is readily documented by computed tomography (CT). We are reporting the cases of four children with alleged or suspected abuse and CT evidence of cerebral contusion. The contusion has been found both with and without external evidence of head injury.

Frank Y. Zimmerman R. Leeds NM. : Neurological manifestations in abused children who have been shaken. *Developmental Medicine & Child Neurology*. 27(3):312-6, 1985 Jun. (Medline ID 85258657)

Four infants with the 'shaken infant syndrome' are described. None had skull fractures and only one had a subdural hematoma. All had extensive retinal and pre-retinal hemorrhages. Follow-up computerized tomography showed severe brain atrophy, multiple hypodense areas and ventricular enlargement. Three of the patients suffered severe, permanent brain damage, with mental retardation, spasticity and blindness. It is suggested that the underlying pathogenesis of this syndrome is acutely increased intrathoracic pressure, transmitted into the head to cause multiple venous infarctions. Retinal and pre-retinal hemorrhages are cardinal features of this syndrome and their presence should raise the suspicion of this form of battering in the absence of the 'classical' signs of battering.

Giangiaco J. Khan JA. Levine C. Thompson VM. : Sequential cranial computed tomography in infants with retinal hemorrhages. *Ophthalmology*. 95(3):295-9, 1988 Mar. (Medline ID 89015656)

Five whiplash-shaken infants presented initially with lethargy, vomiting, irritability, and intraocular hemorrhage and had sequential cranial computed tomography (CT). In three of the five infants, results of the initial CT scans of the head were either normal or demonstrated subtle abnormalities. However, significant subdural hemorrhages which were demonstrated by subdural aspiration developed subsequently in all three infants. Results of repeat CTs of the head showed progressive

ventricular dilation and symmetrical bilateral fronto-parietal subdural hematomas. The retinal hemorrhages preceded both the clinical and radiologic recognition of subdural hematoma. Results of the initial head CT of the remaining two children showed intracerebral hemorrhages, cerebral edema and subsequently subdural hematoma. The finding of unexplained retinal hemorrhages in some infants, even though the initial CT head scan may show only minimal changes, warrants monitoring of the head circumference, fundus, and repeat head CT as indicated.

Goldstein B. Kelly MM. Bruton D. Cox C. : Inflicted versus accidental head injury in critically injured children. *Critical Care Medicine*. 21(9):1328-32, 1993 Sep. (Medline ID 93380352)

OBJECTIVES: To assess the frequency of inflicted head injury in critically injured children; the severity of neurologic injury; the neurologic outcome; and the historical, socioeconomic, physical, and radiologic factors associated with inflicted head injury. DESIGN: Prospective clinical study. SETTING: Multidisciplinary pediatric intensive care unit (ICU). PATIENTS: Consecutive cases (n = 40) of severe head injury admitted to a pediatric ICU. INTERVENTIONS: None. MEASUREMENTS AND MAIN RESULTS: Fourteen (35%) of 40 cases of head injury were due to inflicted head injury. Eleven (79%) of 14 inflicted head injury cases were due to child abuse and three (21%) were due to neglect. The severity of neurologic injury, as measured by the admission Glasgow Coma Scale, was worse in cases of inflicted head injury (7.1 +/- 0.7 [SE] [inflicted] vs. 9.9 +/- 0.8 [accidental]; p = .04). Glasgow Outcome Scores were worse after inflicted head injury (2 +/- 1 inflicted) vs. 4 +/- 1 [accidental]; p = .004). In victims of child abuse, we found the combination of any two of the following three factors was associated with inflicted head injury: an inconsistent history/physical examination; retinal hemorrhages; or parental risk factors (alcohol or drug abuse, previous social service intervention within the family, or a past history of child abuse or neglect). CONCLUSIONS: This study confirms that severity of neurologic injury and neurologic outcome in cases of inflicted head injury are worse than in any other type of childhood head injury. We believe that a combination of any two of the above three risk factors may prove to be a reliable marker of inflicted head injury in children admitted to a pediatric ICU and will lead to an early and definitive diagnosis.

Hanigan WC. Peterson RA. Njus G. : Tin ear syndrome: rotational acceleration in pediatric head injuries. *Pediatrics*. 80(5):618-22, 1987 Nov. (Medline ID 88040253)

An array of signs pathognomonic of child abuse is described for three young children. The eponym "tin ear syndrome" describes distinct unilateral ear bruising, radiographic evidence of ipsilateral cerebral edema with obliteration of the basilar cisterns, and hemorrhagic retinopathy. Rotational acceleration produced by blunt trauma to the ear is shown to be a necessary and sufficient cause for the production of this syndrome. An approximate value of 4,670 radians/s² produced by a force of 309 to 347 N (70 to 80 lb) results in shear stress and tearing of the subdural veins, loss of cortical vasomotor tone, cerebral hyperemia, herniation, and death. Past history and environmental circumstances implicated child abuse in every case.

Hansen KK. : Twins and child abuse. *Archives of Pediatrics & Adolescent Medicine*. 148(12):1345-6, 1994 Dec. (Medline ID 95039518)

This case report discusses two female twins, one of which presented to the emergency department with what was diagnosed as shaken baby syndrome. Her sister, though asymptomatic, was evaluated with CT, MR, and skeletal survey and was found to have intracranial blood as well. Because MR images were the only ones on which unequivocal evidence of cranial trauma were found, the authors strongly recommend MR as the imaging modality of choice in evaluation of nonaccidental trauma.

Harwood-Nash DC. : Abuse to the pediatric central nervous system. [Review] *Ajnr: American Journal of Neuroradiology*. 13(2):569-75, 1992 Mar-Apr. (Medline ID 92230633)

This report reviews skull fractures, intracerebral hematomas (particularly parafalcial and intrafalcial hematomas), ischemic changes, and the "white cerebellum" sign, where the normal cerebellum appears bright on CT, relative to darker, globally ischemic cerebral hemispheres. CT and MR imaging are discussed, and specific recommendations for case management are made.

Jacobi G. : [Damage patterns in severe child abuse with and without fatal sequelae]. [German] *Monatsschrift Kinderheilkunde*. 134(6):307-15, 1986 Jun. (Medline ID 86310931)

In 62 battered children with involvement of the central nervous system clinically 3 patterns of impact to the skull, brain and its coverings could be distinguished: In 22 babies (mean age 6 months) the brain was damaged mainly by violent shaking. Many of those infants were in shock and epileptic status on admission. Retinal, subarachnoidal, and later subdural bleedings were

recognizable. At first, all patients survived, but later 3 of them died in a vegetative state. Retinal bleedings are prompted by subarachnoidal hemorrhage due to shearing of bridging veins and by compression of the chest which immediately is followed by raise of venous pressure in the upper half of the body and by arteriospasm, leading to endothelial damage and increase of vascular permeability (Purtscher's disease). Both mechanisms result in severe retinal hemorrhage which might intrude into the vitreous body (Terson-syndrome). The consequences of violent shaking for the child might be disastrous mental retardation, microcephaly, spasticity, and epilepsies. The child might turn blind on one or both eyes; the visual failure is due to retinal scar formation, retinal detachment and fibrous organisation within the vitreous body on the one hand, due to raised intracranial pressure on the other hand, adding further damage to the visual pathway. In 19 children whose mean age was 13 months massive impact on the skull resulted in major brain damage: acute subdural hematoma, contusional bleedings, compound, diastatic or impression fractures. Ten of them died immediately or were picked up dead from home by different emergency services. (ABSTRACT TRUNCATED AT 250 WORDS)

Jaspan T. Narborough G. Punt JA. Lowe J. : Cerebral contusional tears as a marker of child abuse--detection by cranial sonography. *Pediatric Radiology*. 22(4):237-45, 1992. (Medline ID 92396453)

A series of 6 infants subjected to child abuse is presented in whom contusional tears of subcortical white matter were detected during life by intracranial sonography. The sonographic appearances of this highly pathognomonic marker of shaking injury are described for the first time and their significance discussed. On the basis of our experience we suggest that high resolution cranial sonography is an extremely valuable part of the diagnostic work up in cases of suspected non-accidental injury.

Levin AV. Magnusson MR. Rafto SE. Zimmerman RA. : Shaken baby syndrome diagnosed by magnetic resonance imaging. [Review] *Pediatric Emergency Care*. 5(3):181-6, 1989 Sep. (Medline ID 90115504)

We report an infant with Shaken Baby syndrome (SBS) who presented with status epilepticus. The initial evaluation with computerized axial tomography (CAT scan) of the head was normal, and there was no history or physical finding consistent with physical abuse or shaking. This prompted an extensive evaluation to determine the etiology of the seizures. An ophthalmology consultation revealed the presence of severe bilateral retinal hemorrhages, which raised the possibility of SBS. Magnetic resonance imaging (MRI) showed cerebral hemorrhages, hemorrhagic contusions, and bilateral subtemporal subdural hematomas. This is the first reported case of SBS diagnosed by magnetic resonance imaging following a normal initial CAT scan. MRI may be a valuable tool in the diagnosis of brain injury in SBS and may be particularly valuable when the CAT scan of the head is normal, the etiology of neurologic injury is unclear, and the presence of retinal hemorrhages raises the suspicion of SBS. [References: 32]

McClelland CQ. ReKate H. Kaufman B. Persse L. : Cerebral injury in child abuse: a changing profile. *Childs Brain*. 7(5):225-35, 1980. (Medline ID 81137255)

This report of 21 patients with cerebral injury resultant from child abuse, identifies a broad profile of central nervous sequelae from such injuries, 6 patients were admitted with whiplash shaken infants syndrome, all with severe signs of CS dysfunction. 3 children presented with acute cerebral confusions, 2 with severe cord injuries with resultant paresis and 10 with skull fractures or miscellaneous injuries. Computer tomography has proved to be of great assistance in precise identification of site and size of subdural/intracerebral hematomas in abused children and in identifying posterior fossa lesions and providing longitudinal assessment of sequelae of cerebral trauma. Also the role of the Child Protection Team in management of such acutely injured children is defined.

Merten DF. Osborne DR. : Craniocerebral trauma in the child abuse syndrome. *Pediatric Annals*. 12(12):882-7, 1983 Dec. (Medline ID 84094685)

Craniocerebral trauma, and more specifically intracranial injury, is the most devastating consequence of child abuse. Cranial computed tomography provides a sensitive method for evaluation of the abused child for craniocerebral injury. CT may be particularly useful for demonstrating intracranial lesions that might not be immediately evident from clinical examination. The CT findings may also clarify the nature of the trauma, both cranial and intracranial, with detail not otherwise possible. It is therefore surprising that an expanded role for CT in evaluation of child abuse has not received wider general consideration or acceptance. Discussions of child abuse either fail to note CT in evaluation of the abused child or give the subject only cursory attention. Caffey's initial admonition that the presence of unexplained fractures in the long bones warrants investigation for subdural hematoma has gone largely unheeded. A high index of suspicion for abuse, especially in the young infant, should be sufficient reason to request cranial CT. In some cases of abuse without acute neurologic abnormality chronic sequelae, otherwise unsuspected, may be demonstrated by follow-up CT.

Merten DF. Osborne DR. Radkowski MA. Leonidas JC. : Craniocerebral trauma in the child abuse syndrome: **radiological observations**. *Pediatric Radiology*. 14(5):272-7, 1984. (Medline ID 84296869)

Experience with craniocerebral trauma in 712 physically abused children is reviewed. Ninety-three (13%) had evidence of head trauma (cranial and/or intracranial). Seventy-seven of these patients had computed tomography (CT) of the head, and 47 had CT evidence of intracranial injury. Extracerebral fluid collections, predominantly convexity subdural hemorrhage, were the most common acute intracranial lesions. Concurrent intracranial and skeletal trauma (cranial and/or extracranial) was present in 33 of the 47 patients (70%) with intracranial injury. A high incidence of skull fractures (45%) in those children with intracranial lesions suggest a significant role for impact head injuries ("battering") in the pathogenesis of craniocerebral trauma in the child abuse syndrome. Greater emphasis on CT examination in evaluation of the abuse infant and child is recommended.

Muhler E. : [Sonographic follow-up of pronounced brain concussion in a 3-week-old infant following trauma caused by shaking]. [German] *Klinische Padiatrie*. 198(1):49-52, 1986 Jan-Feb. (Medline ID 86173054)

Cerebral sonography was performed in a 3 week old whiplash shaken baby who had no external marks of injury and no skull fracture. On the day of admission, increased echogenicity in the white matter could be correlated with hypodense contusional lesions in the cranial computerized tomography. Sonographic follow-up showed multiple cystic defects in the white matter and later on marked dilatation of the adjacent lateral ventricle. In all infants with open anterior fontanel presenting with unexplained clouding of consciousness and/or external marks of child abuse, cerebral sonography should be a basic diagnostic method.

Patterson RJ. Brown GW. Salassi-Scotter M. Middaugh D. : Head injury in the conscious child. *American Journal of Nursing*. 92(8):22-7, 1992 Aug. (Medline ID 92397938)

This report reviews the nursing management of a head-injured conscious child. In addition to basic principles, specific issues regarding child abuse detection and reporting are discussed.

Roussey M. Dabadie A. Betremieux P. Lefrancois MC. Journal H. Gandon Y. : [Not-always-apparent abuse: the shaken baby syndrome]. [French] *Archives Francaises de Pediatrie*. 44(6):441-4, 1987 Jun-Jul. (Medline ID 87297840)

The authors report 3 cases of infants presenting with cerebral lesions related to violent head shaking. They emphasize the diagnostic difficulties when the classical signs of the battered child (marks of blows, fractures) are lacking. The traumatism is rarely recognized: only the negativity of the usual medical causes of subdural hematoma, meningeal or retinal hemorrhage and a peculiar familial history lead to the possible diagnosis of shaken baby syndrome. The value of skull CT-scan is major, showing intracranial lesions which could not be found before. Because of the observed lesions, evolution is often severe.

Sato Y. Yuh WT. Smith WL. Alexander RC. Kao SC. Ellerbroek CJ. : Head injury in child abuse: evaluation with MR imaging. *Radiology*. 173(3):653-7, 1989 Dec. (Medline ID 90047647)

To evaluate the usefulness of magnetic resonance (MR) imaging in the diagnosis of head injury in child abuse, the authors compared the findings at head MR imaging and computed tomography (CT) in 19 abused children. Subdural hematomas (15 cases), cortical contusions (six cases), and shearing injuries (five cases) were demonstrated to particular advantage with MR imaging. CT remained superior in the detection of subarachnoid hemorrhage. MR imaging appears to be valuable in the assessment of patients with suspected intracranial injury due to child abuse.

Saulsbury FT. Alford BA. : Intracranial bleeding from child abuse: the value of skull radiographs. *Pediatric Radiology*. 12(4):175-8, 1982. (Medline ID 83038320)

Two infants with intracranial bleeding are described. Each had extensive evaluations aimed at uncovering vascular anomalies or bleeding diatheses. Plain skull radiographs that demonstrated fractures led to the correct diagnosis of child abuse. This report serves to emphasize the value of the plain skull radiograph in the evaluation of infants with intracranial bleeding.

Schneider V. Woweries J. Grumme T. : [Trauma inflicted on a baby by shaking (author's transl)]. [German] *MMW - Munchener Medizinische Wochenschrift*. 121(5):171-6, 1979 Feb 2. (Medline ID 79114240)

In a baby aged 8 months the forensic post-mortem revealed injuries to the parasagittal pontine veins without visible evidence of traumatic violence. The mother later admitted to having grabbed the baby laterally by the chest and shaken it. This had

resulted in an angular acceleration of the head about a transversal axis and, by the lag of the brain due to its inertia, in the fatal vascular lesions mentioned. The twin child admitted to hospital with comparable signs rapidly developed via an acute hygroma a generalized cerebral atrophy such as is actually to be expected in senescence only.

Sinal SH. Ball MR. : Head trauma due to child abuse: serial computerized tomography in diagnosis and management. *Southern Medical Journal*. 80(12):1505-12, 1987 Dec. (Medline ID 88099694)

We studied both the clinical features and CT findings in 24 children who had acute head trauma as a result of child abuse. Twenty-three of them were less than 1 year of age. The diagnosis of whiplash shaken infant syndrome was made in 17. Serial CT, done in 50% of the cases, was useful in managing the medical, legal, and social aspects of the cases and in predicting the neurologic outcome. Three children died and 12 others suffered serious neurologic sequelae. The other five children has lesser degrees of deficit; one was lost to follow-up. Three were neurologically normal on follow-up visits. Two siblings of these children died of child abuse, indicating the necessity for continuing intervention in the abused child's family to prevent further abuse.

Spaide RF. : Shaken baby syndrome. Ocular and computed tomographic findings. *Journal of Clinical Neuro-Ophthalmology*. 7(2):108-11, 1987 Jun. (Medline ID 87280775)

Violent shaking of young infants has a variety of ocular and systemic sequelae, including retinal and subdural hemorrhages, seizures, coma, and death. The syndrome can be difficult to recognize because of the lack of external signs. The retinal examination and computed tomographic findings are absolutely essential for making the diagnosis, but very little information is available concerning this disorder in the ophthalmology literature. This paper presents the findings of a case of shaken baby syndrome and discusses the challenges in diagnosis.

Spear RM. Chadwick D. Peterson BM. : Fatalities associated with misinterpretation of bloody cerebrospinal fluid in the 'shaken baby syndrome' [letter]. *American Journal of Diseases of Children*. 146(12):1415-7, 1992 Dec. (Medline ID 93089296)

This letter briefly discusses two fatal cases of intracranial bleeding secondary to nonaccidental trauma. In both cases, lumbar puncture yielded CSF which was highly suggestive of hemorrhage but was erroneously attributed to a "traumatic tap." Differentiating between a true traumatic tap and a tap containing bloody CSF from subarachnoid hemorrhage is discussed. CT and direct ophthalmoscopy are suggested as routine screening in such cases.

Tsai FY. Zee CS. Aphthorp JS. Dixon GH. : Computed tomography in child abuse head trauma. *Journal of Computed Tomography*. 4(4):277-86, 1980 Dec. (Medline ID 81137005)

Forty-five head trauma cases from 177 child-abuse patients are reported. Intracranial injuries include acute epidural and subdural hematomas, subdural effusion, cerebral contusion, and atrophy (subdural effusion and cerebral contusion being most frequently seen). Incidence of skull fracture among the 45 patients is about 38%. Sixty-five percent of the 17 skull fracture patients also had intracranial injury, and 78% of the 28 patients with normal skulls had intracranial injury. CT should be the primary tool for evaluating child-abuse head trauma.

Wilkinson WS. Han DP. Rappley MD. Owings CL. : Retinal hemorrhage predicts neurologic injury in the shaken baby syndrome. *Archives of Ophthalmology*. 107(10):1472-4, 1989 Oct. (Medline ID 90025937)

Shaken baby syndrome consists of intracranial and intraocular hemorrhage in the absence of signs of direct trauma in infants who have sustained whiplash/shaking injuries. We evaluated 14 consecutive cases of presumed shaken baby syndrome seen at the University of Michigan Hospitals, Ann Arbor, between August 1983 and March 1988, to determine if the severity of retinal hemorrhage was predictive of the severity of acute neurologic injury. The severity of retinal hemorrhage was based on the type and size of hemorrhage and the extent of fundus involvement. We found a significant correlation between retinal hemorrhage severity and acute neurologic findings. Diffuse fundus involvement, vitreous hemorrhage, or large subhyaloid hemorrhages were associated with more severe acute neurologic injury.

Zepp F. Bruhl K. Zimmer B. Schumacher R. : Battered child syndrome: cerebral ultrasound and CT findings after vigorous shaking. *Neuropediatrics*. 23(4):188-91, 1992 Aug. (Medline ID 93025424)

Child abuse by whiplash-shaking can lead to severe cerebral damage, neurological defects and mental retardation. Cerebral damage has been found with and without external evidence of head injury. We report the sonographic findings in two children

after traumatization due to repetitive vigorous whiplash shaking. Cerebral sonography revealed cerebral edema at admission or within 48 hours thereafter. Follow-up studies demonstrated development of marked brain atrophy in both cases. The sonographic findings were confirmed by cranial computerized tomography. Doppler sonography was used to monitor cerebral perfusion by measuring intracranial blood flow. The clinical history of the patients demonstrates that cerebral sonography in combination with Doppler sonography not only serves as a diagnostic tool but also allows adjustment of therapy to the actual clinical status of the patient.

Zimmerman RA. Bilaniuk LT. Bruce D. Schut L. Uzzell B. Goldberg HI. : Interhemispheric acute subdural hematoma: a computed tomographic manifestation of child abuse by shaking. *Neuroradiology*. 16:39-40, 1978. (Medline ID 79114912)

Parieto-occipital interhemispheric acute subdural hematomas (IASH) were found in 17 (61%) of 28 abused children examined by computed tomography, presenting with neurologic symptoms. CT demonstration of IASH correlated with injury due to severe shaking, the presence of retinal hemorrhages, and the absence of the stigmata of battering. Subsequent computed tomographic examination in these patients demonstrated infarction in 50%, and cerebral atrophy in 100%.

Zimmerman RA. Bilaniuk LT. Bruce D. Schut L. Uzzell B. Goldberg HI. : Computed tomography of craniocerebral injury in the abused child. *Radiology*. 130(3):687-90, 1979 Mar. (Medline ID 79137752)

Computed tomography (CT) was performed in 26 infants and children with craniocerebral trauma related to abuse during a 41-month period. The pattern of brain injury differed from that seen in the nonabused traumatized infant or child. Parieto-occipital acute interhemispheric subdural hematoma (AIHSH) with associated parenchymal injury was the most frequent finding (58%). Follow-up by CT in patients with AIHSH demonstrated infarction in half and cerebral atrophy in all.

Zimmerman RA. Russell EJ. Yurberg E. Leeds NE. : Falx and interhemispheric fissure on axial CT: II. Recognition and differentiation of interhemispheric subarachnoid and subdural hemorrhage. *Ajnr: American Journal of Neuroradiology*. 3(6):635-42, 1982 Nov-Dec. (Medline ID 83071417)

Interhemispheric hyperdensity or unenhanced computed tomography was originally considered a sign of subarachnoid hemorrhage, the "falx sign." It has since been identified as a normal feature and has also been seen with interhemispheric subdural hemorrhage. To determine the differential features of interhemispheric hemorrhage, 50 patients with subarachnoid hemorrhage and 32 patients with interhemispheric subdural hematomas were reviewed. Subarachnoid hemorrhage produced anterior interhemispheric hyperdensity only, with a zigzag contour and extension from the calvarium to the rostrum of the corpus callosum. Interhemispheric subdural hematomas produce unilateral crescentic hyperdensities that are largest in the posterior superior part of the fissure, behind and above the splenium of the corpus callosum. Interhemispheric hyperdensity in children is more complex. Because the anterior part of the fissure is narrow in younger patients, subarachnoid hemorrhage may go undetected. Likewise, interhemispheric subdural hematomas in children are smaller and more difficult to recognize. They produce asymmetric thickening of the falx shadow with extension over the tentorium. They are, however, of great significance since they are generally seen in abused patients and carry a poor prognosis.

Zimmerman RA. Bilaniuk LT. : Pediatric head trauma. [Review] *Neuroimaging Clinics of North America*. 4(2):349-66, 1994 May. (Medline ID 94363066)

Head trauma is a frequent cause of morbidity and mortality in the pediatric population. The type of injury that results depends on the mechanism of trauma and the age of the patient. Newborns, after difficult delivery, may have posteriorly located subdural hematomas owing to tearing of tentorium and venous structures. Young infants are particularly susceptible to shaking injury because of their weak neck muscles and thus may sustain subdural hematomas, shearing injuries, and diffuse swelling. As the child becomes mobile, falls become the number one cause of accidental injury, frequently producing fractures and contusions. In older children and teenagers, motor vehicle accidents predominate as the cause of severe head injury, particularly DAI. By appreciating these and other pertinent factors, the radiologist knows what to search for in a study; knows which modality, CT or MR, to use; and can frequently indicate the prognosis. Most importantly, the radiologist may be the first one to bring attention to the possibility of child abuse. [References: 44]

CHILD ABUSE — RETINAL HEMORRHAGE

Carter JE. McCormick AQ. : Whiplash shaking syndrome: retinal hemorrhages and computerized axial tomography of the brain. *Child Abuse & Neglect*. 7(3):279-86, 1983. (Medline ID 84105971)

Three cases of whiplash shaking injury of infants are presented. All children presented with seizures and had minimal signs of external injury. Examination of the retina revealed extensive retinal hemorrhages. These were missed on initial examination and were only discovered after pupillary dilatation. The presence of these pale-centered retinal hemorrhages suggested the diagnosis of child abuse and skeletal surveys and thorough social histories confirmed the diagnosis. Despite extensive retinal hemorrhages, computerized axial tomography (C.T.) scan showed minimal inter-hemispheric bleeding. In contrast to the "Battered Child Syndrome," all the findings in whiplash shaking syndrome of infants are subtle and demand an awareness, an index of suspicion and a thorough examination which may include extensive retinal examination following dilatation of the pupils. This latter examination is frequently not performed by family physicians and residents so that the syndrome may be missed. A fourth case is also discussed where shaking is admitted on initial presentation but said to be done for resuscitation. This poses an immense diagnostic dilemma to the pediatrician since in this case the child presented later with all the signs of physical abuse.

Giangiaco J. Khan JA. Levine C. Thompson VM. : Sequential cranial computed tomography in infants with retinal hemorrhages. *Ophthalmology*. 95(3):295-9, 1988 Mar. (Medline ID 89015656)

Five whiplash-shaken infants presented initially with lethargy, vomiting, irritability, and intraocular hemorrhage and had sequential cranial computed tomography (CT). In three of the five infants, results of the initial CT scans of the head were either normal or demonstrated subtle abnormalities. However, significant subdural hemorrhages which were demonstrated by subdural aspiration developed subsequently in all three infants. Results of repeat CTs of the head showed progressive ventricular dilation and symmetrical bilateral fronto-parietal subdural hematomas. The retinal hemorrhages preceded both the clinical and radiologic recognition of subdural hematoma. Results of the initial head CT of the remaining two children showed intracerebral hemorrhages, cerebral edema and subsequently subdural hematoma. The finding of unexplained retinal hemorrhages in some infants, even though the initial CT head scan may show only minimal changes, warrants monitoring of the head circumference, fundus, and repeat head CT as indicated.

Greenwald MJ. Weiss A. Oesterle CS. Friendly DS. : Traumatic retinoschisis in battered babies. *Ophthalmology*. 93(5):618-25, 1986 May. (Medline ID 86258483)

Five infants who were victims of physical abuse had extensive bilateral retinal hemorrhages on initial evaluation and subsequently developed signs of permanent retinal damage. None showed external evidence of trauma to the eyes. Vitreous hemorrhage developed after a delay of several days or more in three cases that were followed closely from the time of the traumatic incident. In several eyes, apparent intraretinal blood-filled cavities were seen acutely in the macular region and elsewhere. Late scarring of the macula typically had a cystic or crater-like configuration. Electroretinography showed loss or reduction of the positive B-wave with preservation of the negative A-wave in every case. We propose that splitting of the retina resulting from the direct mechanical effects of violent shaking was responsible for all of these findings.

Han DP. Wilkinson WS. : Late ophthalmic manifestations of the shaken baby syndrome. *Journal of Pediatric Ophthalmology & Strabismus*. 27(6):299-303, 1990 Nov-Dec. (Medline ID 91202312)

We examined six children between 12 and 55 months after an initial shaking injury to determine whether visually significant retinal abnormalities persisted, despite clearing of intraocular hemorrhage. In two children (age 21 months and 6.7 years at follow-up), visual acuity was reduced due to macular folds occurring in the region of previous large subhyaloid hemorrhages. A third child (age 3.2 years) had a midperipheral lacunar defect of the retinal pigment epithelium which was not visually significant. Cerebral injury was responsible for an apparent profound visual loss in three children. Our findings indicate that both macular folds and cortical injury are functionally significant complications of the shaken baby syndrome.

Harcourt B. Hopkins D. : Ophthalmic manifestations of the battered-baby syndrome. *British Medical Journal*. 3(771):398-401, 1971 Aug 14. (Medline ID 71278981)

Eleven battered babies who had ocular manifestations of their abuse are presented. Eight of these suffered a permanent impairment of visual function. Ten had extensive intraocular haemorrhage, and the importance of this physical sign in the diagnosis of the syndrome and in the development of a consequent visual handicap is emphasized.

Smith WL. Alexander RC. Judisch GF. Sato Y. Kao SC. : Magnetic resonance imaging evaluation of neonates with retinal hemorrhages. *Pediatrics*. 89(2):332-3, 1992 Feb. (Medline ID 92131607)

Retinal venous hemorrhages occur frequently in association with head trauma. They also occur frequently in full-term neonates after vaginal delivery. This study randomly selected ten full-neonates for imaging studies to determine the incidence of cranial trauma in parturition. None of the study neonates showed evidence of intracranial injury by MR imaging. All infants are clinically healthy. In addition to these results, tradeoffs between CT and MR imaging of the brain are discussed and largely resolved in favor of MR.

Spaide RF. : Shaken baby syndrome. Ocular and computed tomographic findings. *Journal of Clinical Neuro-Ophthalmology*. 7(2):108-11, 1987 Jun. (Medline ID 87280775)

Violent shaking of young infants has a variety of ocular and systemic sequelae, including retinal and subdural hemorrhages, seizures, coma, and death. The syndrome can be difficult to recognize because of the lack of external signs. The retinal examination and computed tomographic findings are absolutely essential for making the diagnosis, but very little information is available concerning this disorder in the ophthalmology literature. This paper presents the findings of a case of shaken baby syndrome and discusses the challenges in diagnosis.

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Shaken baby syndrome consists of intracranial and intraocular hemorrhage in the absence of signs of direct trauma in infants who have sustained whiplash/shaking injuries. We evaluated 14 consecutive cases of presumed shaken baby syndrome seen at the University of Michigan Hospitals, Ann Arbor, between August 1983 and March 1988, to determine if the severity of retinal hemorrhage was predictive of the severity of acute neurologic injury. The severity of retinal hemorrhage was based on the type and size of hemorrhage and the extent of fundus involvement. We found a significant correlation between retinal hemorrhage severity and acute neurologic findings. Diffuse fundus involvement, vitreous hemorrhage, or large subhyaloid hemorrhages were associated with more severe acute neurologic injury.

COLPOSCOPY

Adams JA. Wells R. : Normal versus abnormal genital findings in children: how well do examiners agree? [see comments]. *Child Abuse & Neglect*. 17(5):663-75, 1993 Sep-Oct. (Medline ID 94036287)

In order to determine how well medical examiners agree on the significance of certain anogenital findings in children, preselected colposcopic photographs of the anogenital area of 16 patients were shown to 170 medical examiners (82% pediatricians) who were blinded as to the history on each patient. Findings rated most frequently as being suggestive or indicative of penetrating injury included immediate anal dilatation with no stool present (85%), hymenal transection (84%), marked narrowing of the hymenal rim with notching (81%), and a posterior fourchette scar (75%). The agreement between the participants and the experts on the abnormal cases (mean 81%) was significantly higher than on the normal cases (mean 71%, $p < .001$) and on genital findings (78%) than on anal findings (63%, $p = .000$). Higher experience level (more cases seen per month) was associated with significantly higher agreement between the participants and the experts on five of eight normal cases and two of four abnormal cases. Use of a colposcope was also associated with higher overall agreement with the experts (74% vs. 44%, $p < .0001$).

Adams JA. Harper K. Knudson S. Revilla J. : Examination findings in legally confirmed child sexual abuse: it's normal to be normal. *Pediatrics*. 94(3):310-7, 1994 Sep. (Medline ID 94344696)

BACKGROUND. Studies of alleged victims of child sexual abuse vary greatly in the reported frequency of physical findings based on differences in definition of abuse and of "findings." This study was designed to determine the frequency of abnormal findings in a population of children with legal confirmation of sexual abuse, using a standardized classification system for colposcopic photographic findings. **METHODS.** Case files and colposcopic photographs of 236 children with perpetrator conviction for sexual abuse, were reviewed. The photos were reviewed blindly by a team member other than the examiner, and specific anatomical findings were noted and classified as normal to abnormal on a scale of 1 to 5. Historical and behavioral information, as well as legal outcome was recorded, and all data entered into a dBase III program. Correlations were sought

between abnormal findings and other variables. RESULTS. The mean age of the patients was 9.0 years (range 8 months to 17 years, 11 months), with 63% reporting penile-genital contact. Genital examination findings in girls were normal in 28%, nonspecific in 49%, suspicious in 9%, and abnormal in 14% of cases. Abnormal anal findings were found in only 1% of patients. Using discriminant analysis, the two factors which significantly correlated with the presence of abnormal genital findings in girls were the time since the last incident, and a history of blood being reported at the time of the molest. CONCLUSIONS. Abnormal genital findings are not common in sexually abused girls, based on a standardized classification system. More emphasis should be placed on documenting the child's description of the molestation, and educating prosecutors that, for children alleging abuse: "It's normal to be normal."

Brayden RM. Altemeier WA 3d. Yeager T. Muram D. : Interpretations of colposcopic photographs: evidence for competence in assessing sexual abuse?. *Child Abuse & Neglect*. 15(1-2):69-76, 1991. (Medline ID 91230490)

Accurate assessment of physical findings for child sexual abuse is medically and legally important. This study evaluated (1) interobserver reliability of clinicians rating colposcopic photographs, and (2) correlates of reliable interpretations. Seventy physicians and two nurse practitioners, divided by professional levels, assessed colposcopic photographs and completed a questionnaire. Ratings by a professional with extensive experience in this field were used as an accuracy standard. Leaders in the field of child sexual abuse assessment made significantly more "accurate" assessments than pediatricians, pediatric and family practice residents, and intern physicians. Leaders made fewer "inaccurate" interpretations than interns. Predictors of agreement with standard assessments, although weak, were knowledge of female perineal anatomy and professional level. Total number of sexual abuse examinations conducted and knowledge of sexually transmitted diseases as acquired by children were not significant predictors of accurate assessment. The findings are interpreted as to their potential relevance to actual sexual abuse evaluations of children.

Brayden R. : Normal versus abnormal genital finding in children: how well do examiners agree? [letter; comment]. *Child Abuse & Neglect*. 18(10):887-9, 1994 Oct. (Medline ID 95103369)

The author, Dr. Brayden, responds to a paper by Adams and Wells on interobserver reliability in colposcopy, disagreeing with their selection methods and arguing that selection of the data such that the consensus group actually reached consensus made the study unrealistic. Drs. Adams and Wells agreed, but point out in their rebuttal that the study was not designed for representative sampling; it was designed rather to determine the extent of agreement between examiners on normal, suspicious, and abnormal cases.

Busuttill A. : A biopsied vaginal lesion in a child alleging abuse. *Medicine, Science & the Law*. 34(3):253-6, 1994 Jul. (Medline ID 95058032)

In a six-year-old child presenting with vaginal bleeding, considered to be the consequence of sexual abuse by a stepfather, a colposcopically identified vaginal lesion was biopsied. This showed a chronic inflammatory lesion which could have been the consequence of recurrent, self-inflicted, masturbatory injury. Various controversial aspects of this case are discussed.

Ferris DG. Miller MD. : Colposcopic accuracy in a residency training program: defining competency and proficiency. *Journal of Family Practice*. 36(5):515-20, 1993 May. (Medline ID 93246769)

BACKGROUND. The determination of proficiency in procedural skills has evoked keen interest, but meaningful guidelines are limited by the absence of pertinent clinical data. Colposcopic accuracy is defined as the clinical correlation between a colposcopic impression and a histologic report. The colposcopic accuracy of physicians in a university-based family practice residency colposcopy program was evaluated. METHODS. Demographic information, clinical findings, and laboratory results of patients evaluated by colposcopy were prospectively recorded. Colposcopic accuracy was calculated based on the agreement of the colposcopic impression with the histologic interpretation within one histologic grade. RESULTS. Colposcopic examinations were performed on 282 patients. Histologic evidence of premalignant cervical disease was identified in 115 patients as follows: mild dysplasia, 72; moderate dysplasia, 24; and severe dysplasia, 19. The colposcopic impression agreed within one histologic grade in 188 of 205 patients for a colposcopic accuracy rate of 91.7% (95% CI = 87.1% to 95.1%). CONCLUSIONS. Given an acceptable latitude of clinical correlation between the colposcopic impression and histologic interpretation, the colposcopic accuracy of family physicians compared favorably with that reported by other colposcopists. The more common colposcopic errors were overestimation of low-grade disease and underestimation of high-grade disease. Colposcopic accuracy at an essential minimal proficiency level of 80% should form the basis for assessing specialized perceptual ability and therefore determining colposcopic competency.

Kerns DL. Ritter ML. Thomas RG. : Concave hymenal variations in suspected child sexual abuse victims. *Pediatrics*. 90(2 Pt 1):265-72, 1992 Aug. (Medline ID 92350618)

The purpose of this study was to describe and analyze the characteristics of, and the clinical correlates to, concave hymenal variations in a large number of suspected child sexual abuse victims. Thirteen hundred eighty-three female child and adolescent suspected sexual abuse victims were comprehensively evaluated. Photocolposcopy was used for the anogenital examinations. Concave hymenal variations were found in 174 patients (12.6%). Sixty-one (35.1%) were anterior. Of these, 40 (65.6%) were curved and smooth, and 21 (34.4%) were angular and/or irregular. One hundred (57.5%) were posterior/lateral. Of these, 33 (33%) were curved and smooth, and 67 (67%) were angular and/or irregular. Thirteen patients (7.5%) had multiple hymenal concavities. Posterior/lateral location was associated with penile-vaginal contact ($P = .004$), penetration ($P = .006$), stranger perpetrator ($P = .032$), hymenal rim narrowing (P less than $.001$), and posterior fourchette abnormality ($P = .049$). Angular and/or irregular features were associated with penile contact ($P = .005$), vaginal contact ($P = .035$), penile-vaginal contact specifically (P less than $.001$), penetration ($P = .046$), abnormal general physical examination ($P = .018$), and hymenal rim narrowing (P less than $.001$). Logistic regression analysis demonstrated that age-specific prevalence trends for posterior/lateral (P less than $.001$) and angular and/or irregular ($P = .011$) concavities were consistent with acquired anatomic findings. An interobserver exercise with five "blinded" raters evaluating photographs of 49 patients showed significant agreement among observers in sorting posterior/lateral and angular concavities into the diagnostic categories "suggestive of trauma" and "trauma." (ABSTRACT TRUNCATED AT 250 WORDS)

McCann J. Voris J. Simon M. Wells R. : Perianal findings in prepubertal children selected for nonabuse: a descriptive study [see comments]. *Child Abuse & Neglect*. 13(2):179-93, 1989. (Medline ID 89303588)

The results of the perianal portion of a project designed to collect normative data of the anogenital anatomy from a representative sample of prepubertal children is presented. A total of 318 children were examined by three physicians from a child sexual abuse evaluation program. After screening for the onset of puberty and the possibility of undetected abuse, 267 subjects remained. The sample included 161 girls and 106 boys ranging in age from 2 months to 11 years. The perianal findings that were encountered with the greatest frequency included erythema (41%), increased pigmentation (30%), and venous engorgement (52%) after two minutes in the knee-chest position. Wedge-shaped smooth areas in the midline, with or without depressions, were found both anterior and posterior to the anus in 26% of the children. Anal skin tags/folds were discovered anterior to the anus in 11%. In 49% of the children there was some dilatation of the anus which opened and closed intermittently in 62%. Flattening of the anal verge and rugae occurred during dilatation by the midpoint of the examination in 44% and 34%, respectively. Perianal findings that were found infrequently in all subgroups included skin tags/folds (0%) and scars (1%) outside the midline, anal dilatation greater than 20 mm without the presence of stool in the rectal ampulla (1.2%), irregularity of the anal orifice after complete dilatation (3%), and prominence of the anal verge (3%). No abrasions, hematomas, fissures, or hemorrhoids were encountered. Less commonly detected findings within specific subgroups included perianal erythema in girls (32%) as compared to boys (57%), pigmentation in the lighter skinned white children (22%) when compared to black (53%) and Hispanic (58%) children, and venous congestion at the beginning of the examination (7%) when compared to the same findings after four minutes in the knee-chest position (73%). There were no perianal skin tags/folds found in the boys. The relatively high incidence of perianal soft tissue changes that were found in this study, when compared to the frequency of similar observations in children suspected of having been sexually abused, reemphasizes the caution medical examiners must exercise in rendering an opinion as to the significance of medical findings.

McCann J. Voris J. Simon M. Wells R. : Comparison of genital examination techniques in prepubertal girls [see comments]. *Pediatrics*. 85(2):182-7, 1990 Feb. (Medline ID 90115206)

The results of three separate methods used to examine prepubertal girls are compared and a technique for measuring hymenal orifice diameters from colposcopic photographs is presented. A total of 172 girls who were examined by three techniques during their evaluation in a clinic for suspected child sexual abuse victims were studied. Their ages ranged from 10 months to 11 years with a mean of 5 years, 8 months. The examination techniques used were the supine position with labial separation, the supine position with labial traction, and the knee-chest position. The knee-chest position (98%) and the supine traction method (96%) proved to be superior to the supine separation technique (86%) in opening the vaginal introitus. The largest vertical transhymenal diameters were produced in the knee-chest position, whereas the greatest transverse horizontal spans were generated by the supine traction procedure. Other soft tissue changes were noted but not quantified. A multimethod approach to the examination of the sexually abused child is recommended to take advantage of the strengths of each technique.

McCann J. : Use of the colposcope in childhood sexual abuse examinations. [Review] *Pediatric Clinics of North America*. 37(4):863-80, 1990 Aug. (Medline ID 90340909)

The addition of the colposcope to the armamentarium of the medical investigator of childhood sexual abuse has many advantages. The ability to accurately record anatomic findings has implications for the medical community, the judicial system,

the accused, the victim, and the family. Through the use of the photographs produced by this instrument, examiners can inspect physical findings without the time constraints imposed by the short attention span of the young child. If necessary, colleagues can be consulted and interpretations discussed. The availability of these photographs to the courts has reduced the need to re-examine the child for another opinion. The colposcopic photograph has also proved to be an excellent teaching and research tool. As an aid to teaching, the photographs and slides produced by this instrument help the instructor demonstrate anatomic findings while allowing the student time to ask questions. As a research tool, this instrument has opened up a myriad of possibilities for medical examiners. It has facilitated the collection of clinical data, it has allowed the standardization of examination techniques, and with the help of computers it has made possible the sophisticated analysis of the information collected. The colposcope has limitations. Aside from its cost, it is a difficult instrument to use in the examination of the young child. The time required for an examination can increase substantially as the examiner attempts to maneuver the scope into a proper position. During this procedure, the maintenance of the child in a suitable state of relaxation, while avoiding further emotional trauma, can be a challenge. The reality that the photograph is two dimensional and represents only the findings at that moment will always be a limiting factor in its use as a means of assessing a child's anatomy. Even the multimethod approach employed to offset this problem may compound the situation by further increasing the length of the examination. Most of these and other dilemmas encountered in the use of the colposcope can be solved by additional experience with this instrument. Despite the improvements brought about by the introduction of the colposcope, more advanced technology may be needed to help solve some of the problems currently plaguing medical examiners. The use of video tape could provide a solution to the documentation of the changes that occur in the soft tissues as the child moves or becomes more or less relaxed. The potential of the computer appears unlimited, and its application to the problem of the interpretation of findings could make a significant contribution to the field. (ABSTRACT TRUNCATED AT 250 WORDS) [References: 36]

McCann J. Wells R. Simon M. Voris J. : Genital findings in prepubertal girls selected for nonabuse: a descriptive study. *Pediatrics*. 86(3):428-39, 1990 Sep. (Medline ID 90356312)

This project was designed to collect normative data on the genital anatomy from a sample of nonabused prepubertal girls. A total of 114 girls between the ages of 10 months and 10 years were examined and photographed with a colposcope. After screening for the onset of puberty and the possibility of undetected abuse, 93 subjects remained. Examination techniques included a supine labial separation approach, a supine labial traction method, and a prone knee-chest position. Common genital finding included erythema of the vestibule (56%), periurethral bands (50.6%), labial adhesions (38.9%), lymphoid follicles on the fossa navicularis (33.7%), posterior fourchette midline avascular areas (25.6%), and urethral dilation with labial traction (14.9%). The hymenal orifice opened more frequently during the knee-chest (95.2%) and the labial traction (90.5%) methods than with the supine separation (79.3%) approach. Hymenal findings included mounds (33.8%), projections (33.3%), and "septal remnants"/midline hymenal tags (18.5%). Intravaginal findings of vaginal ridges (90.2%) and rugae (88.7%) were found primarily through the labial traction approach. The cervix was visualized without the use of speculum in 69% of the children during the knee-chest examination. Unusual findings included posterior fourchette friability (4.7%), anterior hymenal clefts (1.2%), and notches of the hymen (6%). One child had an imperforate hymen (1.2%) and 2 (2.5%) had hymenal septa. A vaginal discharge was detected in 2 (2.6%) and a foreign body in 1 (1.3%). Tables that include the vertical and horizontal hymenal orifice diameters by age group and by method are presented.

McCann J. Voris J. Simon M. : Genital injuries resulting from sexual abuse: a longitudinal study. *Pediatrics*. 89(2):307-17, 1992 Feb. (Medline ID 92131601)

Three children who incurred genital injuries as a result of sexual assaults were followed up on a longitudinal basis to document the anatomical changes which ensued. The subjects, who were 4 months, 4 years 5 months, and 9 years of age, were followed up for periods ranging from 14 months to 3 years. A multi-method examination approach and a 35-mm camera mounted on a colposcope were used to examine and record their injuries. Signs of the acute damage disappeared rapidly, and the wounds healed without complications. Following the resolution of the acute injuries, the changes created by the trauma remained relatively stable throughout the prepubertal years. The most persistent findings were irregular hymenal edges and narrow rims at the point of the injury. Over time the jagged, angular margins smoothed off. Disruption of the hymen exposed underlying longitudinal intravaginal ridges whose hymenal attachments created mounds or projections. There was little apparent scar formation. Even the injuries to the posterior fourchettes healed with minimal scar tissue and left only the slightest evidence of the trauma. With the onset of puberty, the hymenal changes in the oldest subject were obscured by the hypertrophy of this membrane. An examination technique which used a Q-tip to separate the redundant tissues demonstrated that the signs of trauma had survived.

McCann J. Voris J. : Perianal injuries resulting from sexual abuse: a longitudinal study. *Pediatrics*. 91(2):390-7, 1993 Feb. (Medline ID 93141301)

Four children who incurred perianal injuries as a result of a sexual assault were followed on a longitudinal basis to document the anatomical changes that ensued. The subjects, whose ages ranged from 4 to 8 years, were followed from 1 week to 14 months. They were examined in both supine and prone knee-chest positions and a 35-mm camera mounted on a colposcope was used to record their injuries. At the time of the initial examination, there were a variety of findings including erythema of the tissues, edema of the skin folds, localized venous engorgement, dilation of the external anal sphincter, and lacerations of different depths. Superficial lacerations reepithelized within 1 to 11 days. The second-degree wounds in two of the children were healed by the 1- and 5-week return visits, leaving narrow bands of scar tissue. In the two subjects who were followed the longest, signs of both a second-degree laceration and a surgically repaired third-degree injury had virtually disappeared by 12 to 14 months after the assaults. The wounds in one subject, infected with a herpes simplex type 2 virus, remained erythematous for a longer period of time than did similar injuries in the other children. A skin tag created by the avulsion of the tissues in one subject persisted, although it became less obvious as it retracted into the redundant folds of the perianal tissues over time.

Muram D. : Child sexual abuse –genital tract findings in prepubertal girls. I. The unaided medical examination. *American Journal of Obstetrics & Gynecology*. 160(2):328-33, 1989 Feb. (Medline ID 89132664)

In a prospective study 205 prepubertal girls (mean age, 5.4 years) determined by Child Protective Services to be victims of sexual abuse were examined. Sixty-five girls (32%) had normal-appearing genitalia, 45 girls had nonspecific findings, and 95 girls had findings considered to be specific for sexual abuse. Whereas normal-appearing genitalia were most often observed in girls reporting digital assault, specific findings were more commonly observed in girls reporting genitogenital assault. Overall it was possible to document the presence of abnormal genital findings indicating or strongly suggesting sexual abuse in only 46% of the patients in this study group. Failure to document findings suggestive of abuse in half of the girls highlights the limitations of the medical evaluation in validating sexual abuse.

Muram D. Elias S. : Child sexual abuse –genital tract findings in prepubertal girls. II. Comparison of colposcopic and unaided examinations. *American Journal of Obstetrics & Gynecology*. 160(2):333-5, 1989 Feb. (Medline ID 89132665)

In recent years the inspection of the vulva of sexually abused girls by magnification with a colposcope has become increasingly popular. However, data concerning the usefulness of colposcopy in such evaluations are lacking. In a prospective study, 130 prepubertal girls (mean age 5.5 years) who were identified by child protective agencies to be victims of sexual abuse were evaluated both by an unaided examination and by colposcopy. If the colposcopic findings differed from those of the unaided inspection, the macroscopic examination was repeated to determine whether the abnormality could have been detected without magnification. Altogether, 92 of the 130 girls were found to have abnormal findings. In the majority of girls with abnormalities (96%), the abnormalities were observed during the unaided examination. Of the four patients in whom the findings were detected initially by the colposcopic examination, these findings were observed during the repeat unaided examination. The findings were observed by colposcopic examination alone in only one patient. We conclude that unaided examination is adequate for the evaluation of most victims of sexual abuse.

Soderstrom RM. : Colposcopic documentation. An objective approach to assessing sexual abuse of girls. *Journal of Reproductive Medicine*. 39(1):6-8, 1994 Jan. (Medline ID 94223647)

Accurate measurements of the genital anatomy of victims of child sexual abuse can be documented with colposcopic photography. Most colposcopies available, however, do not have a built-in measuring grid for medicolegal documentation. Because of the unique optics designed for the colposcope, an accurate comparison can be provided if the measuring tool is photographed in the same focal plane and at the same magnification as the object of concern. Properly labeled slides may then be used as clear evidence in court.

Teixeira WR: Hymenal colposcopic examination in sexual offenses. *American Journal of Forensic Medicine & Pathology*. 2(3):209-15, 1981 Sep. (Medline ID 82110850)

Colposcopy, a method of more detailed examination of the cervix, widely used in the world but the application of this technique to forensic examinations is not. This presentation offers the benefits of the use of colposcopy in the examination of sexual assaults on women in a city in Brazil by a Medical Examiner of Mogi das Cruzes in the State of Sao Paulo near the megapolis of the same name. In 11.80%, or 59 of the 500 cases examined by the author, this technique has been of value to determine unsuspected trauma, fringed hymen, infantile hymen, healing, and accurate information in questionable cases.

Woodling BA. Heger A. : The use of the colposcope in the diagnosis of sexual abuse in the pediatric age group. *Child Abuse & Neglect*. 10(1):111-4, 1986. (Medline ID 86160937)

This brief communication by Woodling and Heger on the use of colposcopy in the assessment of children who may have been sexually exploited raises some interesting and exciting new dimensions to our diagnostic approach. These are presented by the authors as early findings. The readers should note that standards have not yet been established completely, and findings in normal children need to be further delineated, especially for young girls who are athletically inclined, e.g., gymnasts as well as victims of accidental genital trauma. Our field urgently awaits these data.

COMPUTERIZED TOMOGRAPHY

Ball WS Jr. : Nonaccidental craniocerebral trauma (child abuse): MR imaging [editorial]. *Radiology*. 173(3):609-10, 1989 Dec. (Medline ID 90047635)

This editorial addresses the issue of CT versus MR imaging as a first study in suspected child abuse. CT is recommended overall, because of its superior ability to detect subarachnoid hemorrhage, its use for evaluating the calvaria, its ease of performance in the unstable acutely injured child, and its ability to image the chest and abdomen when indicated. MR is recommended for detection of injury when CT is normal or equivocal and the clinical picture suggests cerebral injury. MR is also preferred for evaluation of subacute or chronic abuse, since CT may miss intraparenchymal injury and misinterpretation of scar tissue is possible.

Bennett HS. French JH. : Elevated intracranial pressure in whiplash-shaken infant syndrome detected with normal computerized tomography. *Clinical Pediatrics*. 19(9):633-4, 1980 Sep. (Medline ID 81002682)

This report briefly discusses the limitations of CT imaging in diagnosing elevated intracranial pressure in a single case. A fifteen-month-old child was admitted with signs of WSIS, including bilateral retinal hemorrhages, bilateral decerebrate posturing, bradycardia, hypertension, and irregular respirations. While clinical signs of elevated intracranial pressure were present and radiography of the skeleton showed old fractures, CT images remained normal on the first and fifth hospital day.

Bernardi B. Zimmerman RA. Bilaniuk LT. : Neuroradiologic evaluation of pediatric craniocerebral trauma. [Review] *Topics in Magnetic Resonance Imaging*. 5(3):161-73, 1993 Summer. (Medline ID 93349507)

Although cranial computed tomography (CT) remains the initial diagnostic test in the evaluation and triage of the pediatric head-injury patient, magnetic resonance imaging (MRI) has become the next step in the diagnostic evaluation of those with focal or diffuse neurologic deficits. MRI is better able to demonstrate the extent and location of both hemorrhagic and nonhemorrhagic injury, thereby providing prognostic information. In nonaccidental head injury, MRI has proved valuable in detecting subtle subacute contusions and even not so subtle chronic subdural hematomas that may be difficult to see on CT or that can mimic enlargement of the subarachnoid space on CT. [References: 61]

Bird CR. McMahan JR. Gilles FH. Senac MO. Apthorp JS. : Strangulation in child abuse: CT diagnosis. *Radiology*. 163(2):373-5, 1987 May. (Medline ID 87176406)

The central nervous system is commonly affected in child abuse. Between April 1985 and July 1986 three infants were identified in whom the primary mode of injury had been strangulation. In each case computed tomography (CT) demonstrated a large cerebral infarction confined to vascular territories associated with small subdural hematomas. There was no history or visible evidence of significant head trauma. Autopsy of one infant confirmed the presence of a hemispheric infarct, thin subdural hematoma, and an area of subintimal hemorrhage in the carotid artery ipsilateral to the infarct. The remaining two patients survived with residual hemiparesis. CT findings of a large cerebral infarction with an associated subdural hematoma in an infant without a history of a significant trauma should suggest the possibility of child abuse and may be the primary manifestation of abuse in some patients.

Bruce DA. Zimmerman RA. : Shaken impact syndrome. [Review] *Pediatric Annals*. 18(8):482-4, 486-9, 492-4, 1989 Aug. (Medline ID 89366351)

The authors present a comprehensive discussion of the presentation, management, and diagnosis of shaken impact syndrome. Suspicion is urged for any child under one year of age with altered consciousness, particularly with a history of minor trauma.

CT is recommended as a first imaging modality, with discussion of the characteristic features of shaken impact syndrome in this imaging modality. Management both of acute resuscitation and followup care is discussed.

Carter JE. McCormick AQ. : Whiplash shaking syndrome: retinal hemorrhages and computerized axial tomography of the brain. *Child Abuse & Neglect*. 7(3):279-86, 1983. (Medline ID 84105971)

Three cases of whiplash shaking injury of infants are presented. All children presented with seizures and had minimal signs of external injury. Examination of the retina revealed extensive retinal hemorrhages. These were missed on initial examination and were only discovered after pupillary dilatation. The presence of these palecentered retinal hemorrhages suggested the diagnosis of child abuse and skeletal surveys and thorough social histories confirmed the diagnosis. Despite extensive retinal hemorrhages, computerized axial tomography (C.T.) scan showed minimal inter-hemispheric bleeding. In contrast to the "Battered Child Syndrome," all the findings in whiplash shaking syndrome of infants are subtle and demand an awareness, an index of suspicion and a thorough examination which may include extensive retinal examination following dilatation of the pupils. This latter examination is frequently not performed by family physicians and residents so that the syndrome may be missed. A fourth case is also discussed where shaking is admitted on initial presentation but said to be done for resuscitation. This poses an immense diagnostic dilemma to the pediatrician since in this case the child presented later with all the signs of physical abuse.

Coant PN. Kornberg AE. Brody AS. Edwards-Holmes K. : Markers for occult liver injury in cases of physical abuse in children. *Pediatrics*. 89(2):274-8, 1992 Feb. (Medline ID 92131595)

Children suffering physical abuse are at risk for abdominal trauma. When the abdominal trauma is not evident clinically and remains occult, the child's condition can rapidly deteriorate before the diagnosis is made, and delay may occur in the activation of child protective services. The use of markers for abdominal trauma in the evaluation of cases of child physical abuse was examined. Children younger than 12 years presenting to the Emergency Department at the Children's Hospital of Buffalo from August 1989 through April 1990 for the evaluation of suspected physical abuse were prospectively entered in the project. All patients had a complete history and physical examination performed. Those patients who did not show any signs of abdominal injury had the following laboratory tests done: (1) levels of liver transaminases, lactate dehydrogenase, and alkaline phosphatase; (2) amylase level; and (3) urinalysis. Of 49 patients without clinical signs of abdominal trauma, 4 children had elevated transaminase levels. Three of these 4 patients had liver lacerations documented by subsequent abdominal computed tomographic scans. A new finding of transaminase levels as markers of occult liver injury in children suffering physical abuse is reported.

Cohen RA. Kaufman RA. Myers PA. Towbin RB. : Cranial computed tomography in the abused child with head injury. *AJR. American Journal of Roentgenology*. 146(1):97-102, 1986 Jan. (Medline ID 86073816)

Cranial computed tomographic (CT) findings are described in 37 children with head injuries resulting from physical abuse. CT findings included subarachnoid hemorrhage (27 patients), cerebral edema (24), cerebral hemorrhage (11), and subdural hematoma (nine). Intravenous contrast material was administered in 10 children in whom there were neurologic symptoms or signs but no history or physical signs of trauma or abuse. In five of these children, increased vascularity was seen in areas that later showed infarction. Eight children were studied by both CT and sonography. Sonography detected 50% fewer abnormalities than did CT. It was found that children with skull fracture had the same range of injuries as children without fracture, and they had a higher incidence of subarachnoid hemorrhage. In acutely traumatized children, cranial CT should be the method of choice to provide the most accurate diagnosis and documentation of injury. Skull radiographs should also be obtained because they sometimes show fractures not recognized by CT.

Ellison PH. Tsai FY. Largent JA. : Computed tomography in child abuse and cerebral contusion. *Pediatrics*. 62(2):151-4, 1978 Aug. (Medline ID 79011666)

Cerebral contusion is considered to be the lesion leading to neurological sequelae of mental retardation and cerebral palsy in abused children. This has been difficult to document other than at autopsy or craniotomy by previously available techniques. Acute contusion or hemorrhage presumably secondary to contusion is readily documented by computed tomography (CT). We are reporting the cases of four children with alleged or suspected abuse and CT evidence of cerebral contusion. The contusion has been found both with and without external evidence of head injury.

Farrell WL. Rawson RD. Steffens RS. Stephens D. : Computerized axial tomography as an aid in bite mark analysis: a case report. *Journal of Forensic Sciences*. 32(1):266-72, 1987 Jan. (Medline ID 87139886)

A case is presented to demonstrate the use of computerized axial tomography (CAT) to develop precise registration of incisal edges for comparison to bite marks. Emphasis is drawn to the availability of CAT Scanning equipment and the importance of understanding its use as an adjunct or alternative to already accepted methods of incisal registration.

Giangiaco J. Khan JA. Levine C. Thompson VM. : Sequential cranial computed tomography in infants with retinal hemorrhages. *Ophthalmology*. 95(3):295-9, 1988 Mar. (Medline ID 89015656)

Five whiplash-shaken infants presented initially with lethargy, vomiting, irritability, and intraocular hemorrhage and had sequential cranial computed tomography (CT). In three of the five infants, results of the initial CT scans of the head were either normal or demonstrated subtle abnormalities. However, significant subdural hemorrhages which were demonstrated by subdural aspiration developed subsequently in all three infants. Results of repeat CTs of the head showed progressive ventricular dilation and symmetrical bilateral fronto-parietal subdural hematomas. The retinal hemorrhages preceded both the clinical and radiologic recognition of subdural hematoma. Results of the initial head CT of the remaining two children showed intracerebral hemorrhages, cerebral edema and subsequently subdural hematoma. The finding of unexplained retinal hemorrhages in some infants, even though the initial CT head scan may show only minimal changes, warrants monitoring of the head circumference, fundus, and repeat head CT as indicated.

Hansen KK. : Twins and child abuse. *Archives of Pediatrics & Adolescent Medicine*. 148(12):1345-6, 1994 Dec. (Medline ID 95039518)

This case report discusses two female twins, one of which presented to the emergency department with what was diagnosed as shaken baby syndrome. Her sister, though asymptomatic, was evaluated with CT, MR, and skeletal survey and was found to have intracranial blood as well. Because MR images were the only ones on which unequivocal evidence of cranial trauma were found, the authors strongly recommend MR as the imaging modality of choice in evaluation of nonaccidental trauma.

Harwood-Nash DC. : Abuse to the pediatric central nervous system. [Review] *Ajnr: American Journal of Neuroradiology*. 13(2):569-75, 1992 Mar-Apr. (Medline ID 92230633)

This report reviews skull fractures, intracerebral hematomas (particularly parafalcial and intrafalcial hematomas), ischemic changes, and the "white cerebellum" sign, where the normal cerebellum appears bright on CT, relative to darker, globally ischemic cerebral hemispheres. CT and MR imaging are discussed, and specific recommendations for case management are made.

Jones JN. Schwarz HJ. Shoop JD. : Computed tomography of the brain. *Current Problems in Diagnostic Radiology*. 6(4):1-60, 1976 Jul-Aug. (Medline ID 77114986)

This comprehensive report discusses all aspects of CT imaging of the brain. It includes discussion of the technical aspects of computed tomographic scanning, the anatomy and pathology of the structures and lesions which can be imaged, and covers specific details of specific conditions. Specific reference is made to the issues of imaging the traumatized infant brain, particularly in regard to Caffey's whiplash shaken infant syndrome.

Kirks DR. : Radiological evaluation of visceral injuries in the battered child syndrome. *Pediatric Annals*. 12(12):888-93, 1983 Dec. (Medline ID 84094686)

Diagnostic imaging plays an important role in the recognition, evaluation, and follow-up of visceral injuries in the battered child syndrome. Conventional radiography is important for the diagnosis of associated skeletal fractures, pulmonary parenchymal injury, gastric dilatation, and pneumoperitoneum. An upper gastrointestinal series is the examination of choice in suspected intramural duodenal hematoma. Ultrasonography is helpful in the diagnosis of retroperitoneal hematoma, acute traumatic pancreatitis, and pancreatic pseudocyst. Nuclear scintigraphy is valuable if injury is limited to the liver or spleen. CT is the imaging modality of choice for assessing generalized blunt abdominal trauma as well as evaluating the extent of injuries to the liver, spleen, pancreas, kidneys, and mesentery.

Levin AV. Magnusson MR. Rafto SE. Zimmerman RA. : Shaken baby syndrome diagnosed by magnetic resonance imaging. [Review] *Pediatric Emergency Care*. 5(3):181-6, 1989 Sep. (Medline ID 90115504)

We report an infant with Shaken Baby syndrome (SBS) who presented with status epilepticus. The initial evaluation with computerized axial tomography (CAT scan) of the head was normal, and there was no history or physical finding consistent with physical abuse or shaking. This prompted an extensive evaluation to determine the etiology of the seizures. An ophthalmology consultation revealed the presence of severe bilateral retinal hemorrhages, which raised the possibility of SBS. Magnetic resonance imaging (MRI) showed cerebral hemorrhages, hemorrhagic contusions, and bilateral subtemporal subdural hematomas. This is the first reported case of SBS diagnosed by magnetic resonance imaging following a normal initial CAT

scan. MRI may be a valuable tool in the diagnosis of brain injury in SBS and may be particularly valuable when the CAT scan of the head is normal, the etiology of neurologic injury is unclear, and the presence of retinal hemorrhages raises the suspicion of SBS. [References: 32]

Merten DF. Osborne DR. : Craniocerebral trauma in the child abuse syndrome. *Pediatric Annals*. 12(12):882-7, 1983 Dec. (Medline ID 84094685)

Craniocerebral trauma, and more specifically intracranial injury, is the most devastating consequence of child abuse. Cranial computed tomography provides a sensitive method for evaluation of the abused child for craniocerebral injury. CT may be particularly useful for demonstrating intracranial lesions that might not be immediately evident from clinical examination. The CT findings may also clarify the nature of the trauma, both cranial and intracranial, with detail not otherwise possible. It is therefore surprising that an expanded role for CT in evaluation of child abuse has not received wider general consideration or acceptance. Discussions of child abuse either fail to note CT in evaluation of the abused child or give the subject only cursory attention. Caffey's initial admonition that the presence of unexplained fractures in the long bones warrants investigation for subdural hematoma has gone largely unheeded. A high index of suspicion for abuse, especially in the young infant, should be sufficient reason to request cranial CT. In some cases of abuse without acute neurologic abnormality chronic sequelae, otherwise unsuspected, may be demonstrated by follow-up CT.

Merten DF. Osborne DR. Radkowski MA. Leonidas JC. : Craniocerebral trauma in the child abuse syndrome: radiological observations. *Pediatric Radiology*. 14(5):272-7, 1984. (Medline ID 84296869)

Experience with craniocerebral trauma in 712 physically abused children is reviewed. Ninety-three (13%) had evidence of head trauma (cranial and/or intracranial). Seventy-seven of these patients had computed tomography (CT) of the head, and 47 had CT evidence of intracranial injury. Extracerebral fluid collections, predominantly convexity subdural hemorrhage, were the most common acute intracranial lesions. Concurrent intracranial and skeletal trauma (cranial and/or extracranial) was present in 33 of the 47 patients (70%) with intracranial injury. A high incidence of skull fractures (45%) in those children with intracranial lesions suggest a significant role for impact head injuries ("battering") in the pathogenesis of craniocerebral trauma in the child abuse syndrome. Greater emphasis on CT examination in evaluation of the abuse infant and child is recommended.

Merten DF. : [Role of radiography in the diagnosis of battered children]. [Review] [French] *Journal de Radiologie*. 66(8-9):485-95, 1985 Aug-Sep. (Medline ID 86143477)

Radiological imaging plays an important role in diagnosis of the child abuse syndrome. The radiologist must identify specific foci of injury and document that such injuries are the result of abuse. The capacity to identify abuse-related injuries (sensitivity) has been greatly enhanced by technological advances in radiological imaging including radionuclide scintigraphy (skeletal injury); cranial computed tomography (craniocerebral injuries); and body computed tomography/ultrasonography (abdominal injury). This increased sensitivity has resulted in a greater appreciation of the magnitude of abuse related injuries. Specificity, differentiation between accidental and non-accidental injuries, depends on knowledge of the radiologic characteristics and pattern of abuse-related trauma. Specific injuries must be viewed in light of known pathologic response of anatomic structures to mechanical forces, and determination of the chronology of trauma. [References: 33]

Nimkin K. Teeger S. Wallach MT. DuVally JC. Spevak MR. Kleinman PK. : Adrenal hemorrhage in abused children: imaging and postmortem findings. *AJR. American Journal of Roentgenology*. 162(3):661-3, 1994 Mar. (Medline ID 94152583)

OBJECTIVE. Adrenal hemorrhage associated with child abuse has received little attention in published reports. We review imaging studies or pathologic findings of adrenal hemorrhage in five cases of proved child abuse. SUBJECTS AND METHODS. The imaging findings in three children with adrenal hemorrhage were analyzed retrospectively. All three had abdominal CT scans and skeletal radiographs. One also had abdominal sonograms and MR images. The pathologic findings in two other abused children with adrenal hemorrhage who died of head injuries were also studied. In all five cases, a history of trauma was not initially known; child abuse was later confirmed. RESULTS. Unilateral hemorrhage in the right adrenal gland was found in all patients. Enhanced CT scans of the abdomen showed a low-attenuation, oval mass separating the limbs of the adrenal gland. Sonograms in one case showed a small, heterogeneous mass in the right adrenal gland. MR images obtained 3 weeks later showed an area of high signal intensity within the right adrenal gland on both T1- and T2-weighted images, consistent with subacute hemorrhage. In both deceased children, autopsy showed hemorrhage in the right adrenal gland, mainly within the medulla with some extension beyond the capsule in one case. All five children had associated abdominal visceral injuries or rib fractures or both, on the same side as the hemorrhage. CONCLUSION. Imaging findings of adrenal hemorrhage are similar to those previously described in patients with accidental trauma. Pathologic sections of the gland reveal predominantly medullary involvement with hemorrhage. The presence of adrenal hemorrhage in a child should prompt a search for other associated injuries and raise the possibility of unsuspected trauma.

Rogers LF. Poznanski AK. : Imaging of epiphyseal injuries. [Review] *Radiology*. 191(2):297-308, 1994 May. (Medline ID 94204193)

There have been many advances in the diagnosis and treatment of epiphyseal injuries in the 30 years since the publication of the landmark article by Drs Robert Salter and William Harris. They are the subject of this review. The anatomic features of the physis, epiphysis, and metaphysis are presented, and histologic studies of human and experimental physal injuries are described. The recently recognized histologic, anatomic, and imaging characteristics of bone bridging of the physis resulting in growth disturbances are reviewed. Modification in and additions to the original Salter-Harris classification system have been proposed. The role and technique of computed tomography and magnetic resonance imaging in the assessment of the initial injury and analysis of subsequent growth disturbance are discussed. [References: 97]

Roussey M. Dabadie A. Betremieux P. Lefrancois MC. Journal H. Gandon Y. : [Not-always-apparent abuse: the shaken baby syndrome]. [French] *Archives Francaises de Pediatrie*. 44(6):441-4, 1987 Jun-Jul. (Medline ID 87297840)

The authors report 3 cases of infants presenting with cerebral lesions related to violent head shaking. They emphasize the diagnostic difficulties when the classical signs of the battered child (marks of blows, fractures) are lacking. The traumatism is rarely recognized: only the negativity of the usual medical causes of subdural hematoma, meningeal or retinal hemorrhage and a peculiar familial history lead to the possible diagnosis of shaken baby syndrome. The value of skull CT-scan is major, showing intracranial lesions which could not be found before. Because of the observed lesions, evolution is often severe.

Sato Y. Yuh WT. Smith WL. Alexander RC. Kao SC. Ellerbroek CJ. : Head injury in child abuse: evaluation with MR imaging. *Radiology*. 173(3):653-7, 1989 Dec. (Medline ID 90047647)

To evaluate the usefulness of magnetic resonance (MR) imaging in the diagnosis of head injury in child abuse, the authors compared the findings at head MR imaging and computed tomography (CT) in 19 abused children. Subdural hematomas (15 cases), cortical contusions (six cases), and shearing injuries (five cases) were demonstrated to particular advantage with MR imaging. CT remained superior in the detection of subarachnoid hemorrhage. MR imaging appears to be valuable in the assessment of patients with suspected intracranial injury due to child abuse.

Sinal SH. Ball MR. : Head trauma due to child abuse: serial computerized tomography in diagnosis and management. *Southern Medical Journal*. 80(12):1505-12, 1987 Dec. (Medline ID 88099694)

We studied both the clinical features and CT findings in 24 children who had acute head trauma as a result of child abuse. Twenty-three of them were less than 1 year of age. The diagnosis of whiplash shaken infant syndrome was made in 17. Serial CT, done in 50% of the cases, was useful in managing the medical, legal, and social aspects of the cases and in predicting the neurologic outcome. Three children died and 12 others suffered serious neurologic sequelae. The other five children has lesser degrees of deficit; one was lost to follow-up. Three were neurologically normal on follow-up visits. Two siblings of these children died of child abuse, indicating the necessity for continuing intervention in the abused child's family to prevent further abuse.

Sivit CJ. Taylor GA. Eichelberger MR. : Visceral injury in battered children: a changing perspective. *Radiology*. 173(3):659-61, 1989 Dec. (Medline ID 90047648)

Abdominal or lower thoracic visceral injury was present in 14 of 69 children (20.3%) examined after suspected physical abuse. Of these, 10 were hemodynamically stable and examined with abdominal computed tomography (CT); four were hemodynamically unstable, taken directly to surgery, or died in the emergency room. In the group studied with CT, injuries to solid abdominal organs were most common (hepatic [n = 5], splenic [n = 3], renal [n = 1], adrenal [n = 1], and pancreatic [n = 1]) followed by pulmonary contusion or laceration (n = 2) and pneumoperitoneum due to duodenal transection (n = 1). No additional radiographic abnormalities were noted in five of these children. In the group not studied with CT, injuries to the intestinal tract and mesentery were most common (n = 3), followed by solid organ injury (hepatic [n = 1] and renal [n = 1]) and pulmonary contusion (n = 1). Intestinal, mesenteric, and pancreatic injuries were associated with a poor outcome. CT should be the examination of choice in abused children with suspected intraabdominal injury.

Sivit CJ. Eichelberger MR. Taylor GA. : CT in children with rupture of the bowel caused by blunt trauma: diagnostic efficacy and comparison with hypoperfusion complex. *AJR. American Journal of Roentgenology*. 163(5):1195-8, 1994 Nov. (Medline ID 95067483)

OBJECTIVE. The purpose of this study was to determine the sensitivity and specificity of CT in diagnosing bowel rupture in children after blunt trauma and to compare CT findings in children with bowel rupture with those in children with the hypoperfusion complex. SUBJECTS AND METHODS. Twenty-one (1%) of 1488 children who had contrast-enhanced CT of the abdomen after blunt trauma had a bowel rupture subsequently verified at surgery or autopsy. Thirty-three additional children had a characteristic hypoperfusion complex at CT. The CT scans in all 1488 children were prospectively evaluated for the following findings: peritoneal fluid, extraluminal air, bowel wall enhancement, bowel wall thickening, and bowel dilatation. RESULTS. The most common CT findings in children with bowel rupture were peritoneal fluid (14, 67%) and bowel wall enhancement (13, 62%). One or more of the five studied CT findings were noted in 20 of the 21 children with bowel rupture and in 64 of the 1467 children without bowel rupture (sensitivity 95%, specificity 96%). Thirty-three children who had one or more of the CT findings and did not have bowel rupture had the hypoperfusion complex. CONCLUSION. Our results show that CT is accurate in the diagnosis of bowel rupture after blunt trauma in children. The most common findings are peritoneal fluid and bowel wall enhancement. CT findings in children with bowel rupture may overlap with those in children with the hypoperfusion complex.

Sklar EM. Quencer RM. Bowen BC. Altman N. Villanueva PA. : Magnetic resonance applications in cerebral injury. [Review] *Radiologic Clinics of North America*. 30(2):353-66, 1992 Mar. (Medline ID 92159337)

CT and MR imaging are complementary in the evaluation of cerebral head trauma. CT is still more useful for the initial evaluation of the acutely unstable patient who has a head injury. However, many lesions are identified by MR imaging such as cortical contusions, small subdural hematomas, and diffuse axonal injuries that may not be seen on CT examinations. In addition, MR angiography can play an important role in the diagnostic evaluation of the trauma patient. MR angiography can be clinically useful in delineating vascular abnormalities such as arterial occlusions, arteriovenous fistulae, dissecting aneurysms, and venous sinus occlusion. In pediatric trauma, MR imaging appears to be superior to CT in assessing head injuries, particularly those due to child abuse. [References: 44]

Spaide RF. : Shaken baby syndrome. Ocular and computed tomographic findings. *Journal of Clinical Neuro-Ophthalmology*. 7(2):108-11, 1987 Jun. (Medline ID 87280775)

Violent shaking of young infants has a variety of ocular and systemic sequelae, including retinal and subdural hemorrhages, seizures, coma, and death. The syndrome can be difficult to recognize because of the lack of external signs. The retinal examination and computed tomographic findings are absolutely essential for making the diagnosis, but very little information is available concerning this disorder in the ophthalmology literature. This paper presents the findings of a case of shaken baby syndrome and discusses the challenges in diagnosis.

Tolia V. Patel AS. Amundson GM. : Pancreatic fracture secondary to child abuse: the role of computed tomography in its diagnosis. *Clinical Pediatrics*. 29(11):667-8, 1990 Nov. (Medline ID 91092079)

Pancreatitis in children is relatively uncommon and usually due to trauma, viral infections, congenital anomalies, or idiopathic causes. Child abuse is a well recognized cause of traumatic pancreatitis. We present the case of an infant with a pancreatic fracture caused by child abuse, diagnosed by computed tomography (CT), which progressed to a pseudocyst and resolved with conservative medical management.

Tsai FY. Zee CS. Aphthorp JS. Dixon GH. : Computed tomography in child abuse head trauma. *Journal of Computed Tomography*. 4(4):277-86, 1980 Dec. (Medline ID 81137005)

Forty-five head trauma cases from 177 child-abuse patients are reported. Intracranial injuries include acute epidural and subdural hematomas, subdural effusion, cerebral contusion, and atrophy (subdural effusion and cerebral contusion being most frequently seen). Incidence of skull fracture among the 45 patients is about 38%. Sixty-five percent of the 17 skull fracture patients also had intracranial injury, and 78% of the 28 patients with normal skulls had intracranial injury. CT should be the primary tool for evaluating child-abuse head trauma.

Wing SD. Osborn AG. Wing RW. : The vertex scan: an important component of cranial computed tomography. *AJR. American Journal of Roentgenology*. 130(4):765-7, 1978 Apr. (Medline ID 78141979)

Physicians who monitor cranial computed tomography occasionally omit the most superior aspects of the brain and calvarium because of time limitations and overloaded scanning schedules. In addition, standardized CT reporting forms as well training

literature distributed by some manufacturers support the concept that a complete CT series consists of three scan pairs. Omission of a vertex scan pair results in failure to visualize 10%-15% of the brain volume. We have reviewed the results of 2,000 consecutive CT studies to determine the number and variety of pathologic entities that would have been missed had a vertex scan not been obtained. The most significant or sole abnormality was present on the vertex scan alone in 3% of the cases. Examples are presented. A true vertex levels should be obtained in every routine CT examination.

Zepp F. Bruhl K. Zimmer B. Schumacher R. : Battered child syndrome: cerebral ultrasound and CT findings after vigorous shaking. *Neuropediatrics*. 23(4):188-91, 1992 Aug. (Medline ID 93025424)

Child abuse by whiplash-shaking can lead to severe cerebral damage, neurological defects and mental retardation. Cerebral damage has been found with and without external evidence of head injury. We report the sonographic findings in two children after traumatization due to repetitive vigorous whiplash shaking. Cerebral sonography revealed cerebral edema at admission or within 48 hours thereafter. Follow-up studies demonstrated development of marked brain atrophy in both cases. The sonographic findings were confirmed by cranial computerized tomography. Doppler sonography was used to monitor cerebral perfusion by measuring intracranial blood flow. The clinical history of the patients demonstrates that cerebral sonography in combination with Doppler sonography not only serves as a diagnostic tool but also allows adjustment of therapy to the actual clinical status of the patient.

Zimmerman RA. Bilaniuk LT. Bruce D. Schut L. Uzzell B. Goldberg HI. : Interhemispheric acute subdural hematoma: a computed tomographic manifestation of child abuse by shaking. *Neuroradiology*. 16:39-40, 1978. (Medline ID 79114912)

Parieto-occipital interhemispheric acute subdural hematomas (IASH) were found in 17 (61%) of 28 abused children examined by computed tomography, presenting with neurologic symptoms. CT demonstration of IASH correlated with injury due to severe shaking, the presence of retinal hemorrhages, and the absence of the stigmata of battering. Subsequent computed tomographic examination in these patients demonstrated infarction in 50%, and cerebral atrophy in 100%.

Zimmerman RA. Bilaniuk LT. Bruce D. Schut L. Uzzell B. Goldberg HI. : Computed tomography of craniocerebral injury in the abused child. *Radiology*. 130(3):687-90, 1979 Mar. (Medline ID 79137752)

Computed tomography (CT) was performed in 26 infants and children with craniocerebral trauma related to abuse during a 41-month period. The pattern of brain injury differed from that seen in the nonabused traumatized infant or child. Parieto-occipital acute interhemispheric subdural hematoma (AIHSH) with associated parenchymal injury was the most frequent finding (58%). Follow-up by CT in patients with AIHSH demonstrated infarction in half and cerebral atrophy in all.

Zimmerman RD. Russell EJ. Yurberg E. Leeds NE. : Falx and interhemispheric fissure on axial CT: II. Recognition and differentiation of interhemispheric subarachnoid and subdural hemorrhage. *Ajnr: American Journal of Neuroradiology*. 3(6):635-42, 1982 Nov-Dec. (Medline ID 83071417)

Interhemispheric hyperdensity or unenhanced computed tomography was originally considered a sign of subarachnoid hemorrhage, the "falx sign." It has since been identified as a normal feature and has also been seen with interhemispheric subdural hemorrhage. To determine the differential features of interhemispheric hemorrhage, 50 patients with subarachnoid hemorrhage and 32 patients with interhemispheric subdural hematomas were reviewed. Subarachnoid hemorrhage produced anterior interhemispheric hyperdensity only, with a zigzag contour and extension from the calvarium to the rostrum of the corpus callosum. Interhemispheric subdural hematomas produce unilateral crescentic hyperdensities that are largest in the posterior superior part of the fissure, behind and above the splenium of the corpus callosum. Interhemispheric hyperdensity in children is more complex. Because the anterior part of the fissure is narrow in younger patients, subarachnoid hemorrhage may go undetected. Likewise, interhemispheric subdural hematomas in children are smaller and more difficult to recognize. They produce asymmetric thickening of the falx shadow with extension over the tentorium. They are, however, of great significance since they are generally seen in abused patients and carry a poor prognosis.

Zimmerman RA. Bilaniuk LT. : Pediatric head trauma. [Review] *Neuroimaging Clinics of North America*. 4(2):349-66, 1994 May. (Medline ID 94363066)

Head trauma is a frequent cause of morbidity and mortality in the pediatric population. The type of injury that results depends on the mechanism of trauma and the age of the patient. Newborns, after difficult delivery, may have posteriorly located subdural hematomas owing to tearing of tentorium and venous structures. Young infants are particularly susceptible to shaking injury because of their weak neck muscles and thus may sustain subdural hematomas, shearing injuries, and diffuse swelling. As the child becomes mobile, falls become the number one cause of accidental injury, frequently producing fractures and contusions.

In older children and teenagers, motor vehicle accidents predominate as the cause of severe head injury, particularly DAI. By appreciating these and other pertinent factors, the radiologist knows what to search for in a study; knows which modality, CT or MR, to use; and can frequently indicate the prognosis. Most importantly, the radiologist may be the first one to bring attention to the possibility of child abuse. [References: 44]

FORENSICS

Besant-Matthews PE. : Medical aspects of forensic medicine and dentistry. *Dental Clinics of North America*. 21(1):33-45, 1977 Jan. (Medline ID 77091656)

This report covers the interaction of the physician and the dentist in the process of gathering forensic evidence. Medical and medicolegal aspects are discussed.

Farrell WL. Rawson RD. Steffens RS. Stephens D. : Computerized axial tomography as an aid in bite mark analysis: a case report. *Journal of Forensic Sciences*. 32(1):266-72, 1987 Jan. (Medline ID 87139886)

A case is presented to demonstrate the use of computerized axial tomography (CAT) to develop precise registration of incisal edges for comparison to bite marks. Emphasis is drawn to the availability of CAT Scanning equipment and the importance of understanding its use as an adjunct or alternative to already accepted methods of incisal registration.

GASTROINTESTINAL SERIES

Kirks DR. : Radiological evaluation of visceral injuries in the battered child syndrome. *Pediatric Annals*. 12(12):888-93, 1983 Dec. (Medline ID 84094686)

Diagnostic imaging plays an important role in the recognition, evaluation, and follow-up of visceral injuries in the battered child syndrome. Conventional radiography is important for the diagnosis of associated skeletal fractures, pulmonary parenchymal injury, gastric dilatation, and pneumoperitoneum. An upper gastrointestinal series is the examination of choice in suspected intramural duodenal hematoma. Ultrasonography is helpful in the diagnosis of retroperitoneal hematoma, acute traumatic pancreatitis, and pancreatic pseudocyst. Nuclear scintigraphy is valuable if injury is limited to the liver or spleen. CT is the imaging modality of choice for assessing generalized blunt abdominal trauma as well as evaluating the extent of injuries to the liver, spleen, pancreas, kidneys, and mesentery.

Kleinman PK. Brill PW. Winchester P. : Resolving duodenal-jejunal hematoma in abused children. *Radiology*. 160(3):747-50, 1986 Sep. (Medline ID 86288008)

Acute intramural duodenal-jejunal hematoma is a classical finding in the battered child syndrome. The radiographic findings of a large obstructing intramural mass associated with the "coiled-spring" appearance generally raise the question of child abuse in any patient without appropriate accidental injury. In this study the radiologic features of resolving duodenal-jejunal hematoma are detailed in five abused children. The results show that the coiled-spring appearance is an acute phenomenon associated with a well-localized intramural hematoma. In the resolving phase, localized mural masses in the lateral aspect of the descending duodenum and fold thickening are indications of prior intramural hemorrhage. When these radiologic features are encountered in a child with nonspecific abdominal complaints, child abuse should be suspected. Furthermore, in patients with suspected occult trauma, resolution of abdominal symptoms should not deter the radiologist from performing an upper gastrointestinal tract series, which may provide evidence of child abuse.

HEAD TRAUMA

Bernardi B. Zimmerman RA. Bilaniuk LT. : Neuroradiologic evaluation of pediatric craniocerebral trauma. [Review] *Topics in Magnetic Resonance Imaging*. 5(3):161-73, 1993 Summer. (Medline ID 93349507)

Although cranial computed tomography (CT) remains the initial diagnostic test in the evaluation and triage of the pediatric head-injury patient, magnetic resonance imaging (MRI) has become the next step in the diagnostic evaluation of those with focal or diffuse neurologic deficits. MRI is better able to demonstrate the extent and location of both hemorrhagic and

nonhemorrhagic injury, thereby providing prognostic information. In nonaccidental head injury, MRI has proved valuable in detecting subtle subacute contusions and even not so subtle chronic subdural hematomas that may be difficult to see on CT or that can mimic enlargement of the subarachnoid space on CT. [References: 61]

Goldstein B. Kelly MM. Bruton D. Cox C. : Inflicted versus accidental head injury in critically injured children. *Critical Care Medicine*. 21(9):1328-32, 1993 Sep. (Medline ID 93380352)

OBJECTIVES: To assess the frequency of inflicted head injury in critically injured children; the severity of neurologic injury; the neurologic outcome; and the historical, socioeconomic, physical, and radiologic factors associated with inflicted head injury. DESIGN: Prospective clinical study. SETTING: Multidisciplinary pediatric intensive care unit (ICU). PATIENTS: Consecutive cases (n = 40) of severe head injury admitted to a pediatric ICU. INTERVENTIONS: None. MEASUREMENTS AND MAIN RESULTS: Fourteen (35%) of 40 cases of head injury were due to inflicted head injury. Eleven (79%) of 14 inflicted head injury cases were due to child abuse and three (21%) were due to neglect. The severity of neurologic injury, as measured by the admission Glasgow Coma Scale, was worse in cases of inflicted head injury (7.1 +/- 0.7 [SE] [inflicted] vs. 9.9 +/- 0.8 [accidental]; p = .04). Glasgow Outcome Scores were worse after inflicted head injury (2 +/- 1 inflicted] vs. 4 +/- 1 [accidental]; p = .004). In victims of child abuse, we found the combination of any two of the following three factors was associated with inflicted head injury: an inconsistent history/physical examination; retinal hemorrhages; or parental risk factors (alcohol or drug abuse, previous social service intervention within the family, or a past history of child abuse or neglect). CONCLUSIONS: This study confirms that severity of neurologic injury and neurologic outcome in cases of inflicted head injury are worse than in any other type of childhood head injury. We believe that a combination of any two of the above three risk factors may prove to be a reliable marker of inflicted head injury in children admitted to a pediatric ICU and will lead to an early and definitive diagnosis.

Hawkes CD. : Craniocerebral trauma in infancy and childhood. *Clinical Neurosurgery*. 11:66-75, 1964. (Medline ID 66071013)

“The proper management of an infant or child with a head injury depends upon recognition of the difference in response to trauma of the immature nervous system as compared to that with which one is accustomed to dealing in adults. The ‘softness of’ the brain, the ununited or less firmly united condition of the cranial bones, and the thinness and elastic characteristics of the skull influence the reaction to injury. ... The clinical picture of intracranial bleeding, whether epidural or subdural, is often insidious in its development, and yet the effect of such accumulations of blood may be disastrous to the developing nervous system. There is no substitute for careful neurological observation in the management of these patients. Only by looking for the subtle manifestations of complications of the head injury can their diagnosis and treatment be accomplished in time to minimize an adverse effect on the immature brain.”

Howard MA. Bell BA. Uttley D. : The pathophysiology of infant subdural haematomas. *British Journal of Neurosurgery*. 7(4):355-65, 1993. (Medline ID 94030673)

The widely accepted theories concerning the pathophysiology of infant subdural haematoma (SDH) were formulated in the pre-computed tomographic (CT) scan era. Violent shaking is considered to be a crucial cause of SDH in non-accidentally injured infants. This theory has been re-examined in a clinical and CT scan review, and our findings have been correlated with results of recent head injury research. A retrospective review was conducted of all head injured infants (up to 18 months old) treated at Atkinson Morley’s Hospital over a recent 20-year period (n = 100). Twenty-eight infants with a SDH were identified. CT scans were reviewed and each SDH greater than 0.5 cm thick was morphometrically analysed. Seventeen infants were Caucasian, 10 were non-Caucasian and one was of mixed race. A race-dependent pattern of SDH pathophysiology was noted, with non-Caucasian infants with a head injury more likely to have a SDH than Caucasian infants (67 v 21%, p < 0.01). All had a history of, or radiographic and clinical findings most consistent with, an impact injury, and non-Caucasian infants were significantly more likely to have a normal scalp examination despite the impact injury (p < 0.05) and to have developed the SDH after a relatively trivial fall (p < 0.01). They were also more likely to have a large (> 0.5 cm thick) SDH (p < 0.05), and to suffer post-traumatic seizures (p < 0.05). Our findings do not support shaking as the only cause of infant SDH formation and also suggest that non-accidental injury is a less common cause of SDH than it is believed to be.

Johnson DL. Duma C. Sivit C. : The role of immediate operative intervention in severely head-injured children with a Glasgow Coma Scale score of 3. *Neurosurgery*. 30(3):320-3; discussion 323-4, 1992 Mar. (Medline ID 92319233)

In an attempt to improve and expedite the care of head-injured children, data have been published recommending burr hole exploration in lieu of computed tomography for children with signs of brain stem compression or with a Glasgow Coma Scale score of 3. Exploratory burr holes revealed a high incidence of subdural hematomas, and removal of the hematomas improved survival. We are reporting 19 consecutive children with Glasgow Coma Scale scores of 3. Coma score evaluation was

confounded by intubation, sedation, pharmacological paralysis, and posttraumatic seizures. We found no radiographical or postmortem pathological evidence of intracranial hemorrhage, which would warrant operative intervention. A high incidence of multisystem injuries and high cervical spine injuries would have made early intervention both dangerous and inappropriate. Although there is a definite role for emergency trephination, routine exploratory burr holes for children with a Coma score of 3 is not justified.

Kriel RL. Krach LE. Panser LA. : Closed head injury: comparison of children younger and older than 6 years of age. *Pediatric Neurology*. 5(5):296-300, 1989 Sep-Oct. (Medline ID 90026560)

The outcomes of 97 children with severe closed head injuries referred to a regional rehabilitation center were studied. Patients were divided according to referral source and age (less than 6 and greater than or equal to 6 years). Patients referred from more distant sources had worse outcomes in terms of cognition, motor ability, and brain atrophy for both age groups. Children 6 years of age and older had better cognitive, motor, and brain atrophy outcomes than younger patients for each referral origin. These results do not support the hypothesis that the youngest children have the best recovery after profound closed head injury. All abused children were younger than 6 years of age; compared to other age-matched, closed head injury patients, these children had significantly worse cognitive and motor abilities.

Lorber J. Bhat US. : Posthaemorrhagic hydrocephalus. Diagnosis, differential diagnosis, treatment, and long-term results. *Archives of Disease in Childhood*. 49(10):751-62, 1974 Oct. (Medline ID 75053448)

The clinical features, investigations, and results of treatment are described in a series of 47 infants with posthaemorrhagic hydrocephalus. 7 were unfit for treatment; 3 had medical (isosorbide) treatment alone, 2 of whom made a good recovery; the remaining 37 were surgically treated. 32 (68%) survived for 18 months to 16 years, but 12 of them are severely affected mentally and/or physically. The results can be considered satisfactory in 19 (40%), though there are only 9 (19%) without detectable sequelae. The most serious adverse prognostic features on admission were acute illness with active bleeding or neurological signs such as spasticity, fits, visual defects, or subdural effusions, and such infants did not recover without severe sequelae. The degree of hydrocephalus was also of prognostic value. Since results could have been far better with better management, it is hoped that the publications of this series will lead to better care and prognosis.

Obenchain TG. Becker DP. : Chronic bilateral subdural hematoma of infancy: clinical and radiographic follow-up of six cases. *Bulletin of the Los Angeles Neurological Societies*. 38(2):69-79, 1973 Apr. (Medline ID 73173304)

The authors describe experience with six infants with chronic bilateral subdural hematomas who had subdural peritoneal shunts inserted when fluid persisted after repeated subdural aspirations. Two patients were cured, but four had persistent subdural fluid collections despite adequately functioning shunts. The authors discuss the necessity for relieving intracranial pressure, while accounting for the varying results of different series by referring to the degree of atrophy present in individual cases rather than by the specific mode of therapy.

Salmon JH. : Subdural hematoma in infancy. Suggestions for diagnosis and management. *Clinical Pediatrics*. 10(10):597-9, 1971 Oct. (Medline ID 72071627)

The author discusses the pathogenesis and diagnosis of subdural hematoma in infants. Diagnostic subdural taps are recommended in children whose clinical picture is consistent with subdural hematoma.

Sklar EM. Quencer RM. Bowen BC. Altman N. Villanueva PA. : Magnetic resonance applications in cerebral injury. [Review] *Radiologic Clinics of North America*. 30(2):353-66, 1992 Mar. (Medline ID 92159337)

CT and MR imaging are complementary in the evaluation of cerebral head trauma. CT is still more useful for the initial evaluation of the acutely unstable patient who has a head injury. However, many lesions are identified by MR imaging such as cortical contusions, small subdural hematomas, and diffuse axonal injuries that may not be seen on CT examinations. In addition, MR angiography can play an important role in the diagnostic evaluation of the trauma patient. MR angiography can be clinically useful in delineating vascular abnormalities such as arterial occlusions, arteriovenous fistulae, dissecting aneurysms, and venous sinus occlusion. In pediatric trauma, MR imaging appears to be superior to CT in assessing head injuries, particularly those due to child abuse. [References: 44]

Zimmerman RA. Bilaniuk LT. : Pediatric head trauma. [Review] *Neuroimaging Clinics of North America*. 4(2):349-66, 1994 May. (Medline ID 94363066)

Head trauma is a frequent cause of morbidity and mortality in the pediatric population. The type of injury that results depends on the mechanism of trauma and the age of the patient. Newborns, after difficult delivery, may have posteriorly located subdural hematomas owing to tearing of tentorium and venous structures. Young infants are particularly susceptible to shaking injury because of their weak neck muscles and thus may sustain subdural hematomas, shearing injuries, and diffuse swelling. As the child becomes mobile, falls become the number one cause of accidental injury, frequently producing fractures and contusions. In older children and teenagers, motor vehicle accidents predominate as the cause of severe head injury, particularly DAI. By appreciating these and other pertinent factors, the radiologist knows what to search for in a study; knows which modality, CT or MR, to use; and can frequently indicate the prognosis. Most importantly, the radiologist may be the first one to bring attention to the possibility of child abuse. [References: 44]

INTRAVENOUS UROGRAPHY

Rosenberg HK. Gefter WB. Lebowitz RL. Mahboubi S. Rosenberg H. : Prolonged dense nephrograms in battered children. Suspect rhabdomyolysis and myoglobinuria. *Urology*. 21(3):325-30, 1983 Mar. (Medline ID 83173288)

Prolonged, dense nephrograms were seen on intravenous urography in 5 cases of child abuse presenting with possible renal injury. Each child had oliguria, elevated muscle enzymes, and pigmented urine positive for blood, but without red cells on microscopic examination. These findings are suggestive of myoglobinuria. The abnormalities resolved with appropriate fluid and electrolyte management. This complication of child abuse, not previously emphasized, may be suggested by the urographic findings. Possible factors contributing to the dense nephrograms are presented.

MAGNETIC RESONANCE IMAGING

Ball WS Jr. : Nonaccidental craniocerebral trauma (child abuse): MR imaging [editorial]. *Radiology*. 173(3):609-10, 1989 Dec. (Medline ID 90047635)

This editorial addresses the issue of CT versus MR imaging as a first study in suspected child abuse. CT is recommended overall, because of its superior ability to detect subarachnoid hemorrhage, its use for evaluating the calvaria, its ease of performance in the unstable acutely injured child, and its ability to image the chest and abdomen when indicated. MR is recommended for detection of injury when CT is normal or equivocal and the clinical picture suggests cerebral injury. MR is also preferred for evaluation of subacute or chronic abuse, since CT may miss intraparenchymal injury and misinterpretation of scar tissue is possible.

Bernardi B. Zimmerman RA. Bilaniuk LT. : Neuroradiologic evaluation of pediatric craniocerebral trauma. [Review] *Topics in Magnetic Resonance Imaging*. 5(3):161-73, 1993 Summer. (Medline ID 93349507)

Although cranial computed tomography (CT) remains the initial diagnostic test in the evaluation and triage of the pediatric head-injury patient, magnetic resonance imaging (MRI) has become the next step in the diagnostic evaluation of those with focal or diffuse neurologic deficits. MRI is better able to demonstrate the extent and location of both hemorrhagic and nonhemorrhagic injury, thereby providing prognostic information. In nonaccidental head injury, MRI has proved valuable in detecting subtle subacute contusions and even not so subtle chronic subdural hematomas that may be difficult to see on CT or that can mimic enlargement of the subarachnoid space on CT. [References: 61]

Fobben ES. Grossman RI. Atlas SW. Hackney DB. Goldberg HI. Zimmerman RA. Bilaniuk LT. : MR characteristics of subdural hematomas and hygromas at 1.5 T. *AJR. American Journal of Roentgenology*. 153(3):589-95, 1989 Sep. (Medline ID 89349111)

MR images of 24 patients with 33 subdural collections were retrospectively reviewed to determine the spectrum of MR findings associated with such lesions. The lesions were dated by history, when available. Hematomas were grouped as follows: acute, four; early subacute, four; late subacute, four; chronic, 13. Six collections were classified as rehemorrhage; and two patients had CSF hygromas. Subdural hematomas evolved in a pattern similar to intracerebral hemorrhage with the exception of chronic subdural hematomas, in which isointensity or hypointensity relative to gray matter was observed on short TR/TE images compared with the persistent very high signal intensity noted in chronic parenchymal hematomas. Hemosiderin was rarely seen in chronic hematomas. These findings are most likely the result of the absence of a blood-brain barrier, which allowed clearance

and dilution of blood products. Subdural hematomas with repeat hemorrhage demonstrated multiple phases of bleeding with layering phenomenon and more frequent hemosiderin deposition. It is possible that the clearance of blood products, as observed in chronic subdural hematomas, is impaired or poorly functional when rehemorrhage occurs. The persistence of high signal from methemoglobin in a hematoma that is expected to be in the chronic phase also suggests repeated hemorrhage. Acute CSF subdural hygromas had signal intensities identical to CSF without MR evidence of blood products. At surgery, clear fluid under pressure was found. MR imaging, with its unique ability to delineate the various phases of hemorrhage, is well suited to the evaluation of subdural hemorrhage.

Hansen KK. : Twins and child abuse. *Archives of Pediatrics & Adolescent Medicine*. 148(12):1345-6, 1994 Dec. (Medline ID 95039518)

This case report discusses two female twins, one of which presented to the emergency department with what was diagnosed as shaken baby syndrome. Her sister, though asymptomatic, was evaluated with CT, MR, and skeletal survey and was found to have intracranial blood as well. Because MR images were the only ones on which unequivocal evidence of cranial trauma were found, the authors strongly recommend MR as the imaging modality of choice in evaluation of nonaccidental trauma.

Hardy PA. Kucharczyk W. Henkelman RM. : Cause of signal loss in MR images of old hemorrhagic lesions. *Radiology*. 174(2):549-55, 1990 Feb. (Medline ID 90116411)

Old hemorrhagic lesions in the brain are characteristically surrounded by a band of hemosiderin-containing tissue. This region is typically of low signal intensity on long-echo-time (TE) radio-frequency (RF) spin-echo magnetic resonance (MR) images and on gradient-echo MR images. To determine the cause of signal loss in this band, the authors measured the signal that arises from imaging such a region with use of an RF spin-echo technique with a 180 degrees pulse incrementally displaced from TE/2. The incremental loss of signal was small. Using an agar phantom containing iron particles, the authors also showed that signal loss results primarily from diffusion in magnetic gradients. They conclude that most signal loss in the dark band surrounding areas of late-stage hemorrhage arises from diffusion in areas of magnetic inhomogeneity.

Harwood-Nash DC. : Abuse to the pediatric central nervous system. [Review] *Ajnr: American Journal of Neuroradiology*. 13(2):569-75, 1992 Mar-Apr. (Medline ID 92230633)

This report reviews skull fractures, intracerebral hematomas (particularly parafalcial and intrafalcial hematomas), ischemic changes, and the "white cerebellum" sign, where the normal cerebellum appears bright on CT, relative to darker, globally ischemic cerebral hemispheres. CT and MR imaging are discussed, and specific recommendations for case management are made.

Levin AV. Magnusson MR. Rafto SE. Zimmerman RA. : Shaken baby syndrome diagnosed by magnetic resonance imaging. [Review] *Pediatric Emergency Care*. 5(3):181-6, 1989 Sep. (Medline ID 90115504)

We report an infant with Shaken Baby syndrome (SBS) who presented with status epilepticus. The initial evaluation with computerized axial tomography (CAT scan) of the head was normal, and there was no history or physical finding consistent with physical abuse or shaking. This prompted an extensive evaluation to determine the etiology of the seizures. An ophthalmology consultation revealed the presence of severe bilateral retinal hemorrhages, which raised the possibility of SBS. Magnetic resonance imaging (MRI) showed cerebral hemorrhages, hemorrhagic contusions, and bilateral subtemporal subdural hematomas. This is the first reported case of SBS diagnosed by magnetic resonance imaging following a normal initial CAT scan. MRI may be a valuable tool in the diagnosis of brain injury in SBS and may be particularly valuable when the CAT scan of the head is normal, the etiology of neurologic injury is unclear, and the presence of retinal hemorrhages raises the suspicion of SBS. [References: 32]

Nimkin K. Teeger S. Wallach MT. DuVally JC. Spevak MR. Kleinman PK. : Adrenal hemorrhage in abused children: imaging and postmortem findings. *AJR. American Journal of Roentgenology*. 162(3):661-3, 1994 Mar. (Medline ID 94152583)

OBJECTIVE. Adrenal hemorrhage associated with child abuse has received little attention in published reports. We review imaging studies or pathologic findings of adrenal hemorrhage in five cases of proved child abuse. SUBJECTS AND METHODS. The imaging findings in three children with adrenal hemorrhage were analyzed retrospectively. All three had abdominal CT scans and skeletal radiographs. One also had abdominal sonograms and MR images. The pathologic findings in two other abused children with adrenal hemorrhage who died of head injuries were also studied. In all five cases, a history of trauma was not initially known; child abuse was later confirmed. RESULTS. Unilateral hemorrhage in the right adrenal gland was found in all patients. Enhanced CT scans of the abdomen showed a low-attenuation, oval mass separating the limbs of the adrenal gland. Sonograms in one case showed a small, heterogeneous mass in the right adrenal gland. MR images obtained 3

weeks later showed an area of high signal intensity within the right adrenal gland on both T1- and T2-weighted images, consistent with subacute hemorrhage. In both deceased children, autopsy showed hemorrhage in the right adrenal gland, mainly within the medulla with some extension beyond the capsule in one case. All five children had associated abdominal visceral injuries or rib fractures or both, on the same side as the hemorrhage. CONCLUSION. Imaging findings of adrenal hemorrhage are similar to those previously described in patients with accidental trauma. Pathologic sections of the gland reveal predominantly medullary involvement with hemorrhage. The presence of adrenal hemorrhage in a child should prompt a search for other associated injuries and raise the possibility of unsuspected trauma.

Rogers LF. Poznanski AK. : Imaging of epiphyseal injuries. [Review] *Radiology*. 191(2):297-308, 1994 May. (Medline ID 94204193)

There have been many advances in the diagnosis and treatment of epiphyseal injuries in the 30 years since the publication of the landmark article by Drs Robert Salter and William Harris. They are the subject of this review. The anatomic features of the physis, epiphysis, and metaphysis are presented, and histologic studies of human and experimental physal injuries are described. The recently recognized histologic, anatomic, and imaging characteristics of bone bridging of the physis resulting in growth disturbances are reviewed. Modification in and additions to the original Salter-Harris classification system have been proposed. The role and technique of computed tomography and magnetic resonance imaging in the assessment of the initial injury and analysis of subsequent growth disturbance are discussed. [References: 97]

Sato Y. Yuh WT. Smith WL. Alexander RC. Kao SC. Ellerbroek CJ. : Head injury in child abuse: evaluation with MR imaging. *Radiology*. 173(3):653-7, 1989 Dec. (Medline ID 90047647)

To evaluate the usefulness of magnetic resonance (MR) imaging in the diagnosis of head injury in child abuse, the authors compared the findings at head MR imaging and computed tomography (CT) in 19 abused children. Subdural hematomas (15 cases), cortical contusions (six cases), and shearing injuries (five cases) were demonstrated to particular advantage with MR imaging. CT remained superior in the detection of subarachnoid hemorrhage. MR imaging appears to be valuable in the assessment of patients with suspected intracranial injury due to child abuse.

Sklar EM. Quencer RM. Bowen BC. Altman N. Villanueva PA. : Magnetic resonance applications in cerebral injury. [Review] *Radiologic Clinics of North America*. 30(2):353-66, 1992 Mar. (Medline ID 92159337)

CT and MR imaging are complementary in the evaluation of cerebral head trauma. CT is still more useful for the initial evaluation of the acutely unstable patient who has a head injury. However, many lesions are identified by MR imaging such as cortical contusions, small subdural hematomas, and diffuse axonal injuries that may not be seen on CT examinations. In addition, MR angiography can play an important role in the diagnostic evaluation of the trauma patient. MR angiography can be clinically useful in delineating vascular abnormalities such as arterial occlusions, arteriovenous fistulae, dissecting aneurysms, and venous sinus occlusion. In pediatric trauma, MR imaging appears to be superior to CT in assessing head injuries, particularly those due to child abuse. [References: 44]

Smith WL. Alexander RC. Judisch GF. Sato Y. Kao SC. : Magnetic resonance imaging evaluation of neonates with retinal hemorrhages. *Pediatrics*. 89(2):332-3, 1992 Feb. (Medline ID 92131607)

Retinal venous hemorrhages occur frequently in association with head trauma. They also occur frequently in full-term neonates after vaginal delivery. This study randomly selected ten full-term neonates for imaging studies to determine the incidence of cranial trauma in parturition. None of the study neonates showed evidence of intracranial injury by MR imaging. All infants are clinically healthy. In addition to these results, tradeoffs between CT and MR imaging of the brain are discussed and largely resolved in favor of MR.

Zimmerman RA. Bilaniuk LT. : Pediatric head trauma. [Review] *Neuroimaging Clinics of North America*. 4(2):349-66, 1994 May. (Medline ID 94363066)

Head trauma is a frequent cause of morbidity and mortality in the pediatric population. The type of injury that results depends on the mechanism of trauma and the age of the patient. Newborns, after difficult delivery, may have posteriorly located subdural hematomas owing to tearing of tentorium and venous structures. Young infants are particularly susceptible to shaking injury because of their weak neck muscles and thus may sustain subdural hematomas, shearing injuries, and diffuse swelling. As the child becomes mobile, falls become the number one cause of accidental injury, frequently producing fractures and contusions. In older children and teenagers, motor vehicle accidents predominate as the cause of severe head injury, particularly DAI. By appreciating these and other pertinent factors, the radiologist knows what to search for in a study; knows which modality, CT or MR, to use; and can frequently indicate the prognosis. Most importantly, the radiologist may be the first one to bring attention to the possibility of child abuse. [References: 44]

PHOTOGRAPHY — NONVISIBLE SPECTRUM

Barsley RE. West MH. Fair JA. : Forensic photography. Ultraviolet imaging of wounds on skin. *American Journal of Forensic Medicine & Pathology*. 11(4):300-8, 1990 Dec. (Medline ID 91112567)

The use of ultraviolet light (UVL) to study and document patterned injuries on human skin has opened a new frontier for law enforcement. This article discusses the photographic techniques involved in reflective and fluorescent UVL. Documentation of skin wounds via still photography and dynamic video photographic techniques, which utilize various methods of UV illumination, are covered. Techniques important for courtroom presentation of evidence gathered from lacerations, contusions, abrasions, and bite marks are presented through case studies and controlled experiments. Such injuries are common sequelae in the crimes of child abuse, rape, and assault.

Bramble SK. Creer KE. Qiang WG. Sheard B. : Ultraviolet luminescence from latent fingerprints. *Forensic Science International*. 59(1):3-14, 1993 Apr. (Medline ID 93279616)

Illumination of latent fingerprints on white paper using 266-nm radiation from a Nd:YAG laser and photographic detection of their ultraviolet fluorescence, produces images with good ridge detail. The detection rate was 69% in a survey of fingerprints from 34 people compared with only 23% using an argon-ion laser at 514 nm. Prolonged exposure to UV light decreased the inherent UV fluorescence intensity but no adverse effects were observed on subsequent treatment with 1,8-diazafloren-9-one or ninhydrin.

Golden GS. : Use of alternative light source illumination in bite mark photography. *Journal of Forensic Sciences*. 39(3):815-23, 1994 May. (Medline ID 94275431)

Recent investigation regarding the optical properties of human skin has led to studies measuring autofluorescence, absorption, and reflectance of monochromatic light during exposure both in vitro and in vivo environments. The Stokes Shift deviation in absorbed and reflected light energy that occurs when skin is illuminated by 450 nanometer visible blue light can produce an augmentation in the appearance of pattern injuries when viewed through colored blocking filters. This paper demonstrates a comparison between photographic appearances of several bitemarks inflicted on living and deceased persons to determine the corroborability and usefulness of fluorescent versus full spectrum visibility of bitemark pattern injuries.

Hempling SM. : The applications of ultraviolet photography in clinical forensic medicine. *Medicine, Science & the Law*. 21(3):215-22, 1981 Jul. (Medline ID 82012677)

This report discusses the uses of reflective UV i David TJ. Sobel MN. : Recapturing a five-month-old bite mark by means of reflective ultraviolet photography. *Journal of Forensic Sciences*. 39(6):1560-7, 1994 Nov. (Medline ID 95114565)

After a brutal rape, which the victim survived, a bite mark was photographed and other evidence was collected. It was not until several months later when the bite mark became a critical piece of evidence, that the problem with its collection became apparent to the prosecutor. The photograph of the bite mark taken by law-enforcement officials at the time of the crime did not include a reference scale. Therefore the bite mark was of little evidentiary value. The authors subsequently examined the victim (five months later) and "recaptured" the bite mark pattern with a proper

Krauss TC. Warlen SC. : The forensic science use of reflective ultraviolet photography. *Journal of Forensic Sciences*. 30(1):262-8, 1985 Jan. (Medline ID 85159484)

Reflective ultraviolet photography has many forensic science applications particularly in child abuse, rape, homicide, and bite mark cases. The potential of this relatively simple and inexpensive procedure has not been fully explored. The procedure for its use in bite mark cases is presented.

Stoilovic M. : Detection of semen and blood stains using polilight as a light source. *Forensic Science International*. 51(2):289-96, 1991 Oct. (Medline ID 92112157)

Photoluminescence spectra of dry untreated semen have been measured and a suggested method for rapid detection of untreated semen stains is derived from these measurements. The method is presented in the form of a flow chart to cover most crime scene situations. The absorption spectrum of dry untreated blood has also been measured and a suggested method for enhancement and photography of blood stains is derived from this measurement. The method is presented in the form of a flow chart. Both methods are based on the use of a high intensity light source such as the Polilight.

West M. Barsley RE. Frair J. Stewart W. : Ultraviolet radiation and its role in wound pattern documentation [see comments]. *Journal of Forensic Sciences*. 37(6):1466-79, 1992 Nov. (Medline ID 93085344)

The history of ultraviolet illumination in photography is discussed. Particular attention is devoted to the forensic aspects of ultraviolet photography as it relates to patterned injury on human skin. The authors discuss the theory underlying ultraviolet illumination of wounds on skin as well as the equipment required for this type of imaging.

West MH. Barsley RE. Hall JE. Hayne S. Cimrmancic M. : The detection and documentation of trace wound patterns by use of an alternative light source [see comments]. *Journal of Forensic Sciences*. 37(6):1480-8, 1992 Nov. (Medline ID 93085345)

This article is a discussion of the use of narrow-band light sources coupled with cameras equipped with band-pass filters to document patterned injuries on human skin. Several case reports are included.

PHOTOGRAPHY — VISIBLE SPECTRUM

Anonymous.: *Photographic Documentation of Child Abuse. [Practice Guideline]* American Professional Society on the Abuse of Children. 1995.

Butts JD. : Measuring wounds on autopsy photographs [letter]. *American Journal of Forensic Medicine & Pathology*. 7(4):356, 1986 Dec. (Medline ID 87097178)

This brief letter underscores the difficulty of measuring wound sizes on autopsy photographs and recommends that documentation of sizes be accomplished by separate documentation, rather than by informal size measurements from photographs.

Henham AP. Lee KA. : Photography in forensic medicine. *Journal of Audiovisual Media in Medicine*. 17(1):15-20, 1994 Jan. (Medline ID 94308461)

Forensic photography, although similar to medical photography, has different aims, and different objectives. The main consideration is that the images are taken primarily for legal reasons, therefore the results must be accurate and detailed, and of use in court. The photographer must have an understanding of the technical requirements as well as the related medical and legal requirements. Autopsy photography must produce the minimum delay to the autopsy as well as being extremely reliable, as the images are not repeatable. This requires a combination of easily portable equipment and additional technical support. A good photograph clearly demonstrates the required information and minimizes distortion and misleading information. Factors to consider include identification, backgrounds, lighting, colour, scale, perspective, orientation and cropping. The requirements for the effective photographic documentation of forensic subjects are discussed, with reference to the current practices of a specialist forensic pathology service in South Melbourne, Victoria, Australia.

Lawrence RD. : Inaccuracy of measuring wounds on autopsy photographs. *American Journal of Forensic Medicine & Pathology*. 6(1):17-8, 1985 Mar. (Medline ID 85171883)

This paper demonstrates the inaccuracy of using a ruler placed in an autopsy photograph for measuring wounds shown in that photograph. Wounds should be measured, not on the photographs, but on the body, and dimensions should be recorded in the autopsy protocol.

Muller-Kolbl S. Bratzke H. Steinbach T. Beier G. : [Biomechanical analysis of movement using stroboscopy]. [German] *Beitrage zur Gerichtlichen Medizin*. 47:287-94, 1989. (Medline ID 90056325)

In cases when violence has occurred in some form and its associated forces are subject to expert evaluation. For a mathematical assessment of the intensity of the acting forces there is often a lack of confident basis data, which is why an experimental study is necessary. A simple testing arrangement with a photcamera and flashlight in stroboscopic mode provides a convincing pictorial representation of movement and velocity. The method is described with some examples of applications by experts.

Reynolds LR Jr. : Photography and patient's rights. *Journal of Biological Photography*. 53(3):117-20, 1985 Jul. (Medline ID 85288935)

Ricci LR. : Medical forensic photography of the sexually abused child. *Child Abuse & Neglect*. 12(3):305-10, 1988. (Medline ID 89002206)

The dramatic increase in reports of sexual abuse has resulted in increasing referrals to physicians for medical evaluation and has placed demands on physicians to adequately and expertly assess these children. High quality, close-up photographs of significant lesions can be an important part of this evaluation. Camera systems recommended vary from colposcopes to close-up 35-mm systems to instant cameras. Physicians who examine sexually abused children should have ready access to an adequate photographic system, as well as basic knowledge of camera operation, film procedures, and medicolegal implications. Case studies and discussion are used to review colposcopic and close-up 35-mm camera techniques available to the physician to photograph the sexual abuse victim.

Ricci LR. : Photographing the physically abused child. Principles and practice. *American Journal of Diseases of Children*. 145(3):275-81, 1991 Mar. (Medline ID 91165794)

Photographic documentation of significant findings is an important part of any child abuse evaluation. High-quality photographs of significant physical findings may be important in helping courts to adjudicate whether child abuse has taken place. The physician evaluating abused children should ensure adequate photographic documentation of visible lesions. Physicians who care for abused children should be familiar with the basic principles and techniques of clinical photography. These include good equipment, adequate lighting, and planned composition. Equally important is a working knowledge of camera equipment, film procedure, and medicolegal implications. This review outlines for the practicing physician the basic concepts and techniques of photographing abused children.

Wessels IF. Oeinck C. : Modifying a Polaroid camera for close-up documentation. *Ophthalmic Surgery*. 24(4):281-4, 1993 Apr. (Medline ID 93309831)

A standard plus-three-diopter trial lens held in front of the objective lens of an inexpensive Polaroid camera produces close-up photographs of acceptable quality. This simple technique can be used to inexpensively document indications for plastic surgery and provide medicolegal documentation. The 23-millimeter-diameter trial lens provided acceptable resolution, but reduced depth of field; it must be well-centered to avoid vignetting.

RADIOGRAPHY

English PC. Grossman H. : Radiology and the history of child abuse. *Pediatric Annals*. 12(12):870-4, 1983 Dec. (Medline ID 84094683)

This overview of radiology as it relates to child abuse covers the sociological history of child abuse (dating back into history) and correlates it to the seminal work by Caffey and Kempe which uncovered the syndrome and revealed its radiologic signs.

Fleisher G. Ludwig S. McSorley M. : Interpretation of pediatric x-ray films by emergency department pediatricians. *Annals of Emergency Medicine*. 12(3):153-8, 1983 Mar. (Medline ID 83150748)

This study compared the interpretation of pediatric roentgenograms by emergency department pediatricians and radiologists. Data were available from 532 of 600 children who had 564 radiographic studies during a six-week period: 217 examinations of the chest, 200 of the extremities, 74 of the skull, 35 of the abdomen, and 38 of miscellaneous structures. The emergency department pediatricians and the radiologists were in agreement in 91.1% of the cases. Among the 50 of 564 (8.9%) discordant studies, only seven (1.2%) required changes in therapy. The results attest to the accuracy of emergency department pediatricians in interpreting the usual types of films ordered in their department. However, this group specifically erred in the identification of subtle fractures and the detection of abnormalities incidental to the primary purpose for which the film was obtained. Future educational programs should address these areas of deficiency.

Haller JO. Bass IS. Sclafani SJ. : Imaging evaluation of traumatic hematuria in children. *Urologic Radiology*. 7(4):211-8, 1985. (Medline ID 86098347)

The 3 major causes of traumatic hematuria in children are accidents, iatrogenic damage, and child abuse. While computerized tomography plays a major role in the evaluation of accidental trauma, ultrasound and routine radiography are important in the work-up of iatrogenic hematuria and injuries caused by child abuse. This paper reviews the role of these imaging modalities in diagnosing traumatic hematuria in children.

Kleinman PK. : Schmid-like metaphyseal chondrodysplasia simulating child abuse. *AJR. American Journal of Roentgenology*. 156(3):576-8, 1991 Mar. (Medline ID 91135611)

Schmid metaphyseal chondrodysplasia is characterized by mild to moderate flaring and irregularity of the metaphyses, a normal spine, and frequently short stature. It is rarely diagnosed in patients younger than 2 years old without a reported family history of the condition. This report describes a case of metaphyseal chondrodysplasia radiologically resembling the Schmid type in a 5-month-old patient with an apparent leg-length discrepancy. Child abuse was initially suspected radiologically, until additional radiographs of the patient and his father were obtained. Subsequently, another sibling with similar radiologic features was born.

Kleinman PK. Spevak MR. : Variations in acromial ossification simulating infant abuse in victims of sudden infant death syndrome. *Radiology*. 180(1):185-7, 1991 Jul. (Medline ID 91271544)

A variation in ossification of the acromial process of the scapula is described. Postmortem radiographs, obtained in 78 infants who died of sudden infant death syndrome, showed an ossific opacity adjacent to the acromial process in 10 infants (13%). This finding was noted bilaterally in six patients and unilaterally in four patients. No two ossicles were identical. Histologically, no growth plate cartilage was evident between the bony structure and the acromion proper; therefore, this appeared to represent a "pseudoepiphyseal." Superficially, this normal variation may appear similar to an acromial fracture resulting from infant abuse. However, a careful analysis of the findings of this normal variation should help prevent any confusion with inflicted injury.

Kirks DR. : Radiological evaluation of visceral injuries in the battered child syndrome. *Pediatric Annals*. 12(12):888-93, 1983 Dec. (Medline ID 84094686)

Diagnostic imaging plays an important role in the recognition, evaluation, and follow-up of visceral injuries in the battered child syndrome. Conventional radiography is important for the diagnosis of associated skeletal fractures, pulmonary parenchymal injury, gastric dilatation, and pneumoperitoneum. An upper gastrointestinal series is the examination of choice in suspected intramural duodenal hematoma. Ultrasonography is helpful in the diagnosis of retroperitoneal hematoma, acute traumatic pancreatitis, and pancreatic pseudocyst. Nuclear scintigraphy is valuable if injury is limited to the liver or spleen. CT is the imaging modality of choice for assessing generalized blunt abdominal trauma as well as evaluating the extent of injuries to the liver, spleen, pancreas, kidneys, and mesentery.

Knight B. : How radiography aids forensic medicine. *Radiography*. 50(589):5-10, 1984 Jan. (Medline ID 84120056)

Leonidas JC. : Skeletal trauma in the child abuse syndrome. *Pediatric Annals*. 12(12):875-81, 1983 Dec. (Medline ID 84094684)

This review paper discusses the skeletal manifestations of child abuse. It includes specific recommendations about which imaging studies should be used and discusses a variety of patterns of skeletal injury in the abused child. Scintigraphy is recommended for its sensitivity, but its lack of specificity is noted.

Merten DF. Radkowski MA. Leonidas JC. : The abused child: a radiological reappraisal. *Radiology*. 146(2):377-81, 1983 Feb. (Medline ID 83092007)

Radiological findings in 563 abused infants and children who were studied retrospectively emphasize the limitations of diagnostic imaging, specifically radiographic examination of the skeleton. Skeletal trauma was detected in less than one-third of all patients and was uncommon beyond two years of age. Fractures were rarely present without clinical evidence of physical abuse. Radiographic features considered specific for child abuse (epiphyseal-metaphyseal, rib fractures) or highly suggestive (occult, multiple/repetitive fractures) were distinctly infrequent and limited to infancy. A more efficacious approach to radiological evaluation based on clinical presentation is offered.

Merten DF. : [Role of radiography in the diagnosis of battered children]. [Review] [French] *Journal de Radiologie*. 66(8-9):485-95, 1985 Aug-Sep. (Medline ID 86143477)

Radiological imaging plays an important role in diagnosis of the child abuse syndrome. The radiologist must identify specific foci of injury and document that such injuries are the result of abuse. The capacity to identify abuse-related injuries (sensitivity) has been greatly enhanced by technological advances in radiological imaging including radionuclide scintigraphy (skeletal injury); cranial computed tomography (craniocerebral injuries); and body computed tomography/ultrasonography (abdominal injury). This increased sensitivity has resulted in a greater appreciation of the magnitude of abuse related injuries. Specificity, differentiation between accidental and non-accidental injuries, depends on knowledge of the radiologic characteristics and pattern of abuse-related trauma. Specific injuries must be viewed in light of known pathologic response of anatomic structures to mechanical forces, and determination of the chronology of trauma. [References: 33]

Pickett WJ. Faleski EJ. Chacko A. Jarrett RV. : Comparison of radiographic and radionuclide skeletal surveys in battered children. *Southern Medical Journal*. 76(2):207-12, 1983 Feb. (Medline ID 83120258)

A review of 13 cases of suspected child abuse in which radionuclide (RN) scans, radiographic skeletal surveys, and sufficient follow-up were available showed that the RN scans were insensitive, even though fractures were more than 48 hours old at the time of the scan. Frequently missed lesions included skull and extremity fractures. Furthermore, soft tissue and visceral abnormalities that were identified on radiographic examination went undetected on RN scan. We conclude that, although the RN scan may augment the radiographic examination, it should not be used alone to screen for the battered child.

Radkowski MA. : The battered child syndrome: pitfalls in radiological diagnosis. *Pediatric Annals*. 12(12):894-903, 1983 Dec. (Medline ID 84094687)

The author discusses a variety of conditions, both congenital and acquired, that can predispose to skeletal injury or present with skeletal lesions similar to those of child abuse. The duty of all physicians who care for the victims of abuse to consider a thorough differential diagnosis is stressed. Case histories and radiographs which illustrate the discussion are included.

Rogers LF. Poznanski AK. : Imaging of epiphyseal injuries. [Review] *Radiology*. 191(2):297-308, 1994 May. (Medline ID 94204193)

There have been many advances in the diagnosis and treatment of epiphyseal injuries in the 30 years since the publication of the landmark article by Drs Robert Salter and William Harris. They are the subject of this review. The anatomic features of the physis, epiphysis, and metaphysis are presented, and histologic studies of human and experimental physal injuries are described. The recently recognized histologic, anatomic, and imaging characteristics of bone bridging of the physis resulting in growth disturbances are reviewed. Modification in and additions to the original Salter-Harris classification system have been proposed. The role and technique of computed tomography and magnetic resonance imaging in the assessment of the initial injury and analysis of subsequent growth disturbance are discussed. [References: 97]

Saulsbury FT. Alford BA. : Intracranial bleeding from child abuse: the value of skull radiographs. *Pediatric Radiology*. 12(4):175-8, 1982. (Medline ID 83038320)

Two infants with intracranial bleeding are described. Each had extensive evaluations aimed at uncovering vascular anomalies or bleeding diatheses. Plain skull radiographs that demonstrated fractures led to the correct diagnosis of child abuse. This report serves to emphasize the value of the plain skull radiograph in the evaluation of infants with intracranial bleeding.

Simpson K. : The use of radiography in the investigation of crime. *Radiography*. 46(541):14-6, 1980 Jan. (Medline ID 80146468)

Thompson BM. Finger W. Tonsfeldt D. Aprahamian C. Troiano P. Hendley G. Mateer J. Stueven H. : Rib radiographs for trauma: useful or wasteful?. *Annals of Emergency Medicine*. 15(3):261-5, 1986 Mar. (Medline ID 86128453)

In trauma to the chest, the clinical impression and the physical findings of rib fractures are nonspecific. Fractures often are not seen on initial films. The principal diagnostic goal should be the detection of significant complications (pneumothorax, hemothorax, major vascular injury, or pulmonary contusion) requiring admission. The therapeutic effort should be to provide pain relief and prevent the delayed development of atelectasis or pneumonia in patients with painful chest wall injuries, whether or not a fracture is detected initially. An upright posteroanterior chest radiograph has the greatest yield in detecting fractures and complications resulting from them. Tomograms and expiratory, oblique, and "coned-down" views should not be done routinely.

The use of these more specific examinations may be indicated, however, in such cases as trauma to ribs 1 to 3 or 9 to 12. Their selective use in isolated cases (trauma to ribs 1 to 3 or 9 to 12) and suspected child abuse may indicate the need for these more specific examinations. Because detection of pulmonary complications of chest trauma is most important, a delayed or repeat upright posteroanterior chest radiograph may be the most cost-effective second radiograph. Significant medical care cost savings may be appreciated by limiting the use of specific rib views to instances in which it might influence the patient's therapy.

Wolf FM. Miller JG. Bozynski ME. Schlesinger A. Rosen DS. Weiner GM. Fliegel JE. : Effects of experience and case difficulty on the interpretation of pediatric radiographs. *Academic Medicine*. 69(10 Suppl):S31-3, 1994 Oct. (Medline ID 95000089)

Pediatric radiography is potentially quite different from the study of adult radiography. This report describes an experiment where house officers were asked to interpret pediatric radiographs, with a small panel of experts providing the consensus answer. In general housestaff did well at interpretation of pediatric radiographs, although an overall error rate of 16% should be reduced. Diagnoses which were more commonly encountered in the ICU or inpatient settings were more likely to be answered correctly.

RADIOLOGY

Cohen MD. Daneman A. Royal SA. Haggstrom JA. : Subspecialization in pediatric radiology. *Pediatric Radiology*. 22(5):331-6, 1992. (Medline ID 93026791)

Within radiology there is an increasing trend towards specialization in North America [1]. Although some radiologists still consider themselves as generalists, every radiologist has eliminated some aspect of imaging from his repertoire [2]. Within some specialty areas of radiology further subspecialization is beginning to take place. This subspecialization is being affected by conflicting forces, some of which are pushing us towards increased subspecialization in our daily clinical work, while other forces are inhibiting such subspecialization.

Fatteh AV. Mann GT. : The role of radiology in forensic pathology. *Medicine, Science & the Law*. 9(1):27-30, 1969 Jan. (Medline ID 70266032)

This brief report discusses the role of the radiologist in forensic pathology. The importance (medical and medicolegal) of X-rays in detecting the characteristic appearance of abuse fractures is discussed.

Forman HP. Leonidas JC. Kirks DR. : Clinical activities of pediatric radiologists in the United States and Canada: 10-year follow-up. *Radiology*. 175(1):127-9, 1990 Apr. (Medline ID 90193104)

The members of the Society for Pediatric Radiology were surveyed in 1989 about their involvement with newer imaging modalities. Results were compared with those obtained in a similar study performed 10 years earlier. The performance and monitoring of imaging studies increased dramatically, with most respondents now being involved with ultrasound (US) and computed tomography (CT), and almost one-half involved with magnetic resonance (MR) imaging. When equipment became available, pediatric radiologists were quicker to assume control of MR imaging than US and CT. In most large pediatric centers, imaging with all current modalities and of all organ systems has become the responsibility of pediatric radiologists. These findings are in contrast to those obtained in 1979, when pediatric imaging practices primarily consisted of conventional radiography and fluoroscopy.

Kleinman PK. : Diagnostic imaging in infant abuse. [Review] *AJR. American Journal of Roentgenology*. 155(4):703-12, 1990 Oct. (Medline ID 90379101)

This review covers a broad set of topics in imaging and infant abuse. The mechanism of injury is discussed, followed by the histopathology of the characteristic metaphyseal fractures. Cranial injuries and their mechanism are discussed. Certain findings are virtually pathognomonic for child abuse; others are more equivocal. Finally, detailed recommendations for imaging in cases of suspected child abuse are presented.

Miller TQ. : The role of the radiologist on the child abuse team. *Journal of the National Medical Association*. 74(7):647-51, 1982 Jul. (Medline ID 83010413)

Physicians in most jurisdictions are mandated to report all suspected cases of child abuse to the appropriate authorities. Often in a position to initially suspect child abuse, the radiologist must be aware of the roentgenographic manifestations of the various forms of child abuse. In recognition of the difficulty for an individual to maintain expertise in all aspects of child abuse, multidisciplinary teams have evolved to share responsibility in the diagnosis and treatment of child abuse as well as aid in prosecution of the perpetrator and in family therapy when applicable.

Wolf FM. Miller JG. Bozynski ME. Schlesinger A. Rosen DS. Weiner GM. Fliegel JE. : Effects of experience and case difficulty on the interpretation of pediatric radiographs. *Academic Medicine*. 69(10 Suppl):S31-3, 1994 Oct. (Medline ID 95000089)

Pediatric radiography is potentially quite different from the study of adult radiography. This report describes an experiment where house officers were asked to interpret pediatric radiographs, with a small panel of experts providing the consensus answer. In general housestaff did well at interpretation of pediatric radiographs, although an overall error rate of 16% should be reduced. Diagnoses which were more commonly encountered in the ICU or inpatient settings were more likely to be answered correctly.

SCINTIGRAPHY

Kirks DR. : Radiological evaluation of visceral injuries in the battered child syndrome. *Pediatric Annals*. 12(12):888-93, 1983 Dec. (Medline ID 84094686)

Diagnostic imaging plays an important role in the recognition, evaluation, and follow-up of visceral injuries in the battered child syndrome. Conventional radiography is important for the diagnosis of associated skeletal fractures, pulmonary parenchymal injury, gastric dilatation, and pneumoperitoneum. An upper gastrointestinal series is the examination of choice in suspected intramural duodenal hematoma. Ultrasonography is helpful in the diagnosis of retroperitoneal hematoma, acute traumatic pancreatitis, and pancreatic pseudocyst. Nuclear scintigraphy is valuable if injury is limited to the liver or spleen. CT is the imaging modality of choice for assessing generalized blunt abdominal trauma as well as evaluating the extent of injuries to the liver, spleen, pancreas, kidneys, and mesentery.

Kleinhans E. Kentrup H. Alzen G. Skopnik H. Bull U. : [A false negative bone scintigram in a biparietal skull fracture in a case of a Battered Child Syndrome]. [German] *Nuklearmedizin*. 32(4):206-7, 1993 Aug. (Medline ID 93382811)

The case of a small girl is reported who after a head injury showed radiologically two fractures of the skull whereas the bone scintigram done eight days later with ^{99m}Tc-DPD was normal. The possible reasons for this discrepancy are discussed.

Koenigsberg M. Freeman LM. : Radionuclide bone imaging. [Review] *Current Problems in Diagnostic Radiology*. 6(5):1-54, 1976 Sep-Oct. (Medline ID 77114987)

This comprehensive report discusses radionuclide bone imaging from a variety of perspectives. It includes a detailed explanation of the physics and physiology of scintigraphy, a review of the instrumentation and procedure, and a discussion of interpretation. Various specific conditions are discussed, including the detection of child abuse in a child with normal roentgenographic imaging.

Leonidas JC. : Skeletal trauma in the child abuse syndrome. *Pediatric Annals*. 12(12):875-81, 1983 Dec. (Medline ID 84094684)

This review paper discusses the skeletal manifestations of child abuse. It includes specific recommendations about which imaging studies should be used and discusses a variety of patterns of skeletal injury in the abused child. Scintigraphy is recommended for its sensitivity, but its lack of specificity is noted.

Merten DF. : [Role of radiography in the diagnosis of battered children]. [Review] [French] *Journal de Radiologie*. 66(8-9):485-95, 1985 Aug-Sep. (Medline ID 86143477)

Radiological imaging plays an important role in diagnosis of the child abuse syndrome. The radiologist must identify specific foci of injury and document that such injuries are the result of abuse. The capacity to identify abuse-related injuries (sensitivity) has been greatly enhanced by technological advances in radiological imaging including radionuclide scintigraphy (skeletal injury); cranial computed tomography (craniocerebral injuries); and body computed tomography/ultrasonography (abdominal injury). This increased sensitivity has resulted in a greater appreciation of the magnitude of abuse related injuries. Specificity, differentiation between accidental and non-accidental injuries, depends on knowledge of the radiologic characteristics and pattern of abuse-related trauma. Specific injuries must be viewed in light of known pathologic response of anatomic structures to mechanical forces, and determination of the chronology of trauma. [References: 33]

Pickett WJ. Faleski EJ. Chacko A. Jarrett RV. : Comparison of radiographic and radionuclide skeletal surveys in battered children. *Southern Medical Journal*. 76(2):207-12, 1983 Feb. (Medline ID 83120258)

A review of 13 cases of suspected child abuse in which radionuclide (RN) scans, radiographic skeletal surveys, and sufficient follow-up were available showed that the RN scans were insensitive, even though fractures were more than 48 hours old at the time of the scan. Frequently missed lesions included skull and extremity fractures. Furthermore, soft tissue and visceral abnormalities that were identified on radiographic examination went undetected on RN scan. We conclude that, although the RN scan may augment the radiographic examination, it should not be used alone to screen for the battered child.

Sty JR. Starshak RJ. Hubbard AM. : Radionuclide evaluation in childhood injuries. [Review] *Seminars in Nuclear Medicine*. 13(3):258-81, 1983 Jul. (Medline ID 84017643)

Radionuclide techniques serve an important role in evaluating childhood injuries. Frequently, they can be employed as the initial and definitive examination. At times they represent the only modality that will detect specific injuries such as the skeletal system. Familiarity with the advantages and limitations of tracer techniques will insure appropriate management of childhood injuries. [References: 154]

SEXUAL ABUSE

Adams JA. Wells R. : Normal versus abnormal genital findings in children: how well do examiners agree? [see comments]. *Child Abuse & Neglect*. 17(5):663-75, 1993 Sep-Oct. (Medline ID 94036287)

In order to determine how well medical examiners agree on the significance of certain anogenital findings in children, preselected colposcopic photographs of the anogenital area of 16 patients were shown to 170 medical examiners (82% pediatricians) who were blinded as to the history on each patient. Findings rated most frequently as being suggestive or indicative of penetrating injury included immediate anal dilatation with no stool present (85%), hymenal transection (84%), marked narrowing of the hymenal rim with notching (81%), and a posterior fourchette scar (75%). The agreement between the participants and the experts on the abnormal cases (mean 81%) was significantly higher than on the normal cases (mean 71%, $p < .001$) and on genital findings (78%) than on anal findings (63%, $p = .000$). Higher experience level (more cases seen per month) was associated with significantly higher agreement between the participants and the experts on five of eight normal cases and two of four abnormal cases. Use of a colposcope was also associated with higher overall agreement with the experts (74% vs. 44%, $p < .0001$).

Adams JA. Harper K. Knudson S. Revilla J. : Examination findings in legally confirmed child sexual abuse: it's normal to be normal. *Pediatrics*. 94(3):310-7, 1994 Sep. (Medline ID 94344696)

BACKGROUND. Studies of alleged victims of child sexual abuse vary greatly in the reported frequency of physical findings based on differences in definition of abuse and of "findings." This study was designed to determine the frequency of abnormal findings in a population of children with legal confirmation of sexual abuse, using a standardized classification system for colposcopic photographic findings. METHODS. Case files and colposcopic photographs of 236 children with perpetrator conviction for sexual abuse, were reviewed. The photos were reviewed blindly by a team member other than the examiner, and specific anatomical findings were noted and classified as normal to abnormal on a scale of 1 to 5. Historical and behavioral

information, as well as legal outcome was recorded, and all data entered into a dBase III program. Correlations were sought between abnormal findings and other variables. RESULTS. The mean age of the patients was 9.0 years (range 8 months to 17 years, 11 months), with 63% reporting penile-genital contact. Genital examination findings in girls were normal in 28%, nonspecific in 49%, suspicious in 9%, and abnormal in 14% of cases. Abnormal anal findings were found in only 1% of patients. Using discriminant analysis, the two factors which significantly correlated with the presence of abnormal genital findings in girls were the time since the last incident, and a history of blood being reported at the time of the molest. CONCLUSIONS. Abnormal genital findings are not common in sexually abused girls, based on a standardized classification system. More emphasis should be placed on documenting the child's description of the molestation, and educating prosecutors that, for children alleging abuse: "It's normal to be normal."

Anonymous. : Sexual assault. ACOG Technical Bulletin Number 172 – September 1992. *International Journal of Gynaecology & Obstetrics*. 42(1):67-72, 1993 Jul. (Medline ID 93374156)

This clinical practice guideline from the American College of Obstetricians and Gynecologists discusses the management of a variety of situations falling under the umbrella of "sexual assault." Specific recommendations about examination and photography of injuries are made, with specific reference to the case of assaulted children.

Baldwin DD. Landa HM. : Common problems in pediatric gynecology. [Review] *Urologic Clinics of North America*. 22(1):161-76, 1995 Feb. (Medline ID 95159270)

A knowledge of the special concerns and physiology in pediatric female patients allows the physician to obtain pertinent histories and appropriate examinations. This information permits diagnosis and treatment of sequelae of sexual abuse, common gynecologic infections, and trauma. More complex problems, such as determination of sources of vaginal bleeding and endocrinopathies, also can be evaluated. Finally, benign and malignant conditions affecting the internal and external genitalia may be diagnosed and treated or referred to a subspecialist as needed. [References: 76]

Berson NL. Herman-Giddens ME. Frothingham TE. : Children's perceptions of genital examinations during sexual abuse evaluations. *Child Welfare*. 72(1):41-9, 1993 Jan-Feb. (Medline ID 93114120)

Children's reactions to the medical evaluation of sexual abuse and the methods that enhance their coping ability have not been well addressed in the literature. For many children, a genital examination can be highly stressful, and may even trigger memories of the sexual abuse itself. Stress can be reduced by preparing the child for the examination, by giving the child greater control, and by debriefing the child (and parents) afterward. Research is needed to develop the most effective techniques for reducing children's stress during a genital examination.

Bharti DR. : Idiopathic fetal ascites associated with pregnancy from father-daughter incest. A case report. *Journal of Reproductive Medicine*. 39(1):49-51, 1994 Jan. (Medline ID 94223644)

A 15-year-old primigravida registered late for antenatal care (23 weeks). Ultrasound examination revealed massive idiopathic fetal ascites necessitating in utero paracentesis at 27 weeks. The family was socially dislocated, and the patient's alcoholic father doted on her. A live female fetus with ascites and multiple congenital abnormalities was delivered at 34 weeks. Following repeated hospitalization, the infant died of pneumonitis, at 5 months of age; autopsy could not determine the cause of the ascites. Young pregnant teenagers from broken homes with doting behavior from an alcoholic father should be suspected of being incest victims.

Brayden RM. Altemeier WA 3d. Yeager T. Muram D. : Interpretations of colposcopic photographs: evidence for competence in assessing sexual abuse?. *Child Abuse & Neglect*. 15(1-2):69-76, 1991. (Medline ID 91230490)

Accurate assessment of physical findings for child sexual abuse is medically and legally important. This study evaluated (1) interobserver reliability of clinicians rating colposcopic photographs, and (2) correlates of reliable interpretations. Seventy physicians and two nurse practitioners, divided by professional levels, assessed colposcopic photographs and completed a questionnaire. Ratings by a professional with extensive experience in this field were used as an accuracy standard. Leaders in the field of child sexual abuse assessment made significantly more "accurate" assessments than pediatricians, pediatric and family practice residents, and intern physicians. Leaders made fewer "inaccurate" interpretations than interns. Predictors of

agreement with standard assessments, although weak, were knowledge of female perineal anatomy and professional level. Total number of sexual abuse examinations conducted and knowledge of sexually transmitted diseases as acquired by children were not significant predictors of accurate assessment. The findings are interpreted as to their potential relevance to actual sexual abuse evaluations of children.

Brayden R. : Normal versus abnormal genital finding in children: how well do examiners agree? [letter; comment]. *Child Abuse & Neglect*. 18(10):887-9, 1994 Oct. (Medline ID 95103369)

The author, Dr. Brayden, responds to a paper by Adams and Wells on interobserver reliability in colposcopy, disagreeing with their selection methods and arguing that selection of the data such that the consensus group actually reached consensus made the study unrealistic. Drs. Adams and Wells agreed, but point out in their rebuttal that the study was not designed for representative sampling; it was designed rather to determine the extent of agreement between examiners on normal, suspicious, and abnormal cases.

Busuttill A. : A biopsied vaginal lesion in a child alleging abuse. *Medicine, Science & the Law*. 34(3):253-6, 1994 Jul. (Medline ID 95058032)

In a six-year-old child presenting with vaginal bleeding, considered to be the consequence of sexual abuse by a stepfather, a colposcopically identified vaginal lesion was biopsied. This showed a chronic inflammatory lesion which could have been the consequence of recurrent, self-inflicted, masturbatory injury. Various controversial aspects of this case are discussed.

Connon AF. Davidson GP. Moore DJ. : Anal size in children: the influence of age, constipation, rectal examination and defaecation [see comments]. *Medical Journal of Australia*. 153(7):380-3, 1990 Oct 1. (Medline ID 91014818)

With the increase in the number of reported cases of child abuse it is important that medical practitioners should know the normal values for the size of the anus. Children aged 3 months to 15 years, attending a paediatric gastroenterology clinic for a routine examination, had a photographic record made of the anus 30 seconds after exposure of the anus as part of a standardised examination protocol. Anorectal disease, including Crohn's disease was present in eight children. Analysis of the 54 children without anorectal disease indicated that the anteroposterior diameter of the anus was less than 10.0 mm and the transverse diameter was less than or equal to 2.0 mm. Age, sex of the child, digital rectal examination, time since last defaecation and the capacity and contents of the rectum were unrelated to the size of the anus. In view of the difficulties which arise in suspected child abuse, medical practitioners should gain experience of the normal appearance and size of the anus. This can best be validated within a medicolegal framework if some form of standardised examination protocol is used. The key element of such an examination is not the position in which the child is examined but the time taken to observe the anus, to allow any dynamic changes to occur. An inspection time of 30 seconds in a cooperating conscious child is recommended.

Crane S. : Child sexual abuse: evaluation and treatment. [Review] *Current Opinion in Obstetrics & Gynecology*. 6(6):531-5, 1994 Dec. (Medline ID 95201180)

Child sexual abuse and its disturbingly high prevalence have received increased attention during the past 2 decades, but the availability of adequate training and support services for this complex problem remain deficient. The identification of victims and early, effective intervention are necessary goals. This review provides a brief summary on the subject of child sexual abuse with an emphasis on recent progress in optimal evaluation. [References: 29]

Harvey IM. Nowlan WA. : Reflex and dilatation: a clinical epidemiological evaluation. *Paediatric & Perinatal Epidemiology*. 3(3):294-301, 1989 Jul. (Medline ID 89366905)

The recent controversy surrounding the use of the reflex anal dilatation (RAD) sign in cases of suspected sexual abuse is a general illustration of the difficulties clinicians face in determining which symptoms, signs or laboratory tests to use in their daily practice. The evidence required fully to evaluate RAD is incomplete. The specificity in particular is uncertain. Sufficient evidence is, however, available to permit a quantitative examination of the test's performance under various circumstances. Our analysis suggests that, at the prevalence of anal abuse reported in one large series of children referred to paediatricians with suspected sexual abuse (13%), only if the specificity of the test is 99% or greater, may the positive predictive value of RAD be as high as 90%. At the likely prevalence of anal abuse in the general child population (less than 0.5%), however, an even higher specificity of 99.99% would be necessary to achieve a similar positive predictive value.

Jenkins PH. Howell RJ. : Child sexual abuse examinations: proposed guidelines for a standard of care. [Review] *Bulletin of the American Academy of Psychiatry & the Law*. 22(1):5-17, 1994. (Medline ID 94250946)

A review of the literature regarding child sexual abuse examinations is presented and a proposal for a more objective and stringent standard of care is made. Current limitations in sexual abuse examinations include examiner bias, faulty procedures or diagnostic materials, and varied or conflicting roles of the judicial, social service, and mental health systems. Examiners in such cases should have adequate and specific training, be a neutral party appointed by the court, record the proceedings, and have access not only to the alleged victim, but also to the accused and to other parties during the examination. [References: 58]

Kerns DL. Ritter ML. Thomas RG. : Concave hymenal variations in suspected child sexual abuse victims. *Pediatrics*. 90(2 Pt 1):265-72, 1992 Aug. (Medline ID 92350618)

The purpose of this study was to describe and analyze the characteristics of, and the clinical correlates to, concave hymenal variations in a large number of suspected child sexual abuse victims. Thirteen hundred eighty-three female child and adolescent suspected sexual abuse victims were comprehensively evaluated. Photocolposcopy was used for the anogenital examinations. Concave hymenal variations were found in 174 patients (12.6%). Sixty-one (35.1%) were anterior. Of these, 40 (65.6%) were curved and smooth, and 21 (34.4%) were angular and/or irregular. One hundred (57.5%) were posterior/lateral. Of these, 33 (33%) were curved and smooth, and 67 (67%) were angular and/or irregular. Thirteen patients (7.5%) had multiple hymenal concavities. Posterior/lateral location was associated with penile-vaginal contact ($P = .004$), penetration ($P = .006$), stranger perpetrator ($P = .032$), hymenal rim narrowing (P less than $.001$), and posterior fourchette abnormality ($P = .049$). Angular and/or irregular features were associated with penile contact ($P = .005$), vaginal contact ($P = .035$), penile-vaginal contact specifically (P less than $.001$), penetration ($P = .046$), abnormal general physical examination ($P = .018$), and hymenal rim narrowing (P less than $.001$). Logistic regression analysis demonstrated that age-specific prevalence trends for posterior/lateral (P less than $.001$) and angular and/or irregular ($P = .011$) concavities were consistent with acquired anatomic findings. An interobserver exercise with five "blinded" raters evaluating photographs of 49 patients showed significant agreement among observers in sorting posterior/lateral and angular concavities into the diagnostic categories "suggestive of trauma" and "trauma." (ABSTRACT TRUNCATED AT 250 WORDS)

Ladson S. Johnson CF. Doty RE. : Do physicians recognize sexual abuse?. *American Journal of Diseases of Children*. 141(4):411-5, 1987 Apr. (Medline ID 87181582)

The dramatic increase in the incidence of reports of sexual abuse has placed demands on physicians to assess children for possible sexual abuse. We conducted a survey of urban pediatricians to determine their knowledge of and attitudes about sexual abuse. These physicians were found to have limited knowledge about the social and medical aspects of sexual abuse. The lack of knowledge these physicians display about prepubescent female anatomy and about the association of venereal diseases with sexual abuse decreases their recognition and reporting of sexual abuse. There is a need for physicians to improve their knowledge and skills in the diagnosis of sexual abuse if further abuse and its serious consequences are to be minimized.

Lafferty PM. Lawson GM. Orr JD. Scobie WG. : The role of the paediatric surgeon in alleged child sexual abuse. *Journal of Pediatric Surgery*. 25(4):434-7, 1990 Apr. (Medline ID 90230076)

Two-hundred-ninety cases of alleged child sexual abuse (CSA) were reported in Edinburgh and the Lothian region over the 7-year period from 1982 through 1988. We have found an increase in the incidence of alleged CSA, which has resulted in greater involvement of the paediatric surgeon. CSA was found to be occurring with increasing frequency in younger children. The physical examination and the role of general anaesthesia are discussed.

Lamb ME. : The investigation of child sexual abuse: an interdisciplinary consensus statement. [Review] *Child Abuse & Neglect*. 18(12):1021-8, 1994 Dec. (Medline ID 95153479)

In addition to a comprehensive discussion of sexual abuse, its incidence, and its signs, this report presents a set of clinical practice guidelines for the interview with the victim of sexual abuse, as well as guidelines for the physical examination. Colposcopic examination is discussed as a way to standardize and improve the anogenital examination.

Lazebnik R. Zimet GD. Ebert J. Anglin TM. Williams P. Bunch DL. Krowchuk DP. : How children perceive the medical evaluation for suspected sexual abuse. *Child Abuse & Neglect*. 18(9):739-45, 1994 Sep. (Medline ID 95094026)

This study investigated how 99 children who were examined for suspected sexual abuse (SSA) perceived their own medical evaluation experiences. Each child was interviewed about the degree of pain and fear associated with the experience, the

kindness of the doctor, general fear of doctor visits, and degree of fear associated with a hypothetical second examination. The majority of children did not perceive their SSA examination to be strongly negative. However children did report greater fear associated with the SSA evaluation compared to an ordinary doctor visit. Using multiple regression, general fear of doctor visits and fear and pain associated with the SSA examination contributed to the prediction of intensity of fear about a hypothetical second SSA evaluation. Perceived kindness of the doctor, patient sex and age, and physician sex and age did not contribute to the regression equation. The relatively low reported rate of intense distress associated with medical evaluation of SSA suggests that fear and pain can be minimized and effectively managed for many children. The results of the regression analysis suggest that previous negative medical experiences may play an important role in determining how a child interprets the experience of an SSA medical evaluation.

McCann J. Voris J. Simon M. Wells R. : Perianal findings in prepubertal children selected for nonabuse: a descriptive study [see comments]. *Child Abuse & Neglect*. 13(2):179-93, 1989. (Medline ID 89303588)

The results of the perianal portion of a project designed to collect normative data of the anogenital anatomy from a representative sample of prepubertal children is presented. A total of 318 children were examined by three physicians from a child sexual abuse evaluation program. After screening for the onset of puberty and the possibility of undetected abuse, 267 subjects remained. The sample included 161 girls and 106 boys ranging in age from 2 months to 11 years. The perianal findings that were encountered with the greatest frequency included erythema (41%), increased pigmentation (30%), and venous engorgement (52%) after two minutes in the knee-chest position. Wedge-shaped smooth areas in the midline, with or without depressions, were found both anterior and posterior to the anus in 26% of the children. Anal skin tags/folds were discovered anterior to the anus in 11%. In 49% of the children there was some dilatation of the anus which opened and closed intermittently in 62%. Flattening of the anal verge and rugae occurred during dilatation by the midpoint of the examination in 44% and 34%, respectively. Perianal findings that were found infrequently in all subgroups included skin tags/folds (0%) and scars (1%) outside the midline, anal dilatation greater than 20 mm without the presence of stool in the rectal ampulla (1.2%), irregularity of the anal orifice after complete dilatation (3%), and prominence of the anal verge (3%). No abrasions, hematomas, fissures, or hemorrhoids were encountered. Less commonly detected findings within specific subgroups included perianal erythema in girls (32%) as compared to boys (57%), pigmentation in the lighter skinned white children (22%) when compared to black (53%) and Hispanic (58%) children, and venous congestion at the beginning of the examination (7%) when compared to the same findings after four minutes in the knee-chest position (73%). There were no perianal skin tags/folds found in the boys. The relatively high incidence of perianal soft tissue changes that were found in this study, when compared to the frequency of similar observations in children suspected of having been sexually abused, reemphasizes the caution medical examiners must exercise in rendering an opinion as to the significance of medical findings.

McCann J. Voris J. Simon M. Wells R. : Comparison of genital examination techniques in prepubertal girls [see comments]. *Pediatrics*. 85(2):182-7, 1990 Feb. (Medline ID 90115206)

The results of three separate methods used to examine prepubertal girls are compared and a technique for measuring hymenal orifice diameters from colposcopic photographs is presented. A total of 172 girls who were examined by three techniques during their evaluation in a clinic for suspected child sexual abuse victims were studied. Their ages ranged from 10 months to 11 years with a mean of 5 years, 8 months. The examination techniques used were the supine position with labial separation, the supine position with labial traction, and the knee-chest position. The knee-chest position (98%) and the supine traction method (96%) proved to be superior to the supine separation technique (86%) in opening the vaginal introitus. The largest vertical transhymenal diameters were produced in the knee-chest position, whereas the greatest transverse horizontal spans were generated by the supine traction procedure. Other soft tissue changes were noted but not quantified. A multimethod approach to the examination of the sexually abused child is recommended to take advantage of the strengths of each technique.

McCann J.: Use of the colposcope in child sexual abuse examinations. [Review] *Pediatric Clinics of North America*. 37(4):863-80, 1990 Aug. (Medline ID 90340909)

The addition of the colposcope to the armamentarium of the medical investigator of childhood sexual abuse has many advantages. The ability to accurately record anatomic findings has implications for the medical community, the judicial system, the accused, the victim, and the family. Through the use of the photographs produced by this instrument, examiners can inspect physical findings without the time constraints imposed by the short attention span of the young child. If necessary, colleagues can be consulted and interpretations discussed. The availability of these photographs to the courts has reduced the need to re-examine the child for another opinion. The colposcopic photograph has also proved to be an excellent teaching and research tool. As an aid to teaching, the photographs and slides produced by this instrument help the instructor demonstrate anatomic findings while allowing the student time to ask questions. As a research tool, this instrument has opened up a myriad of possibilities for medical examiners. It has facilitated the collection of clinical data, it has allowed the standardization of examination techniques, and with the help of computers it has made possible the sophisticated analysis of the information collected. The colposcope has limitations. Aside from its cost, it is a difficult instrument to use in the examination of the young child. The time required for

an examination can increase substantially as the examiner attempts to maneuver the scope into a proper position. During this procedure, the maintenance of the child in a suitable state of relaxation, while avoiding further emotional trauma, can be a challenge. The reality that the photograph is two dimensional and represents only the findings at that moment will always be a limiting factor in its use as a means of assessing a child's anatomy. Even the multimethod approach employed to offset this problem may compound the situation by further increasing the length of the examination. Most of these and other dilemmas encountered in the use of the colposcope can be solved by additional experience with this instrument. Despite the improvements brought about by the introduction of the colposcope, more advanced technology may be needed to help solve some of the problems currently plaguing medical examiners. The use of video tape could provide a solution to the documentation of the changes that occur in the soft tissues as the child moves or becomes more or less relaxed. The potential of the computer appears unlimited, and its application to the problem of the interpretation of findings could make a significant contribution to the field. (ABSTRACT TRUNCATED AT 250 WORDS) [References: 36]

McCann J. Wells R. Simon M. Voris J. : Genital findings in prepubertal girls selected for nonabuse: a descriptive study. *Pediatrics*. 86(3):428-39, 1990 Sep. (Medline ID 90356312)

This project was designed to collect normative data on the genital anatomy from a sample of nonabused prepubertal girls. A total of 114 girls between the ages of 10 months and 10 years were examined and photographed with a colposcope. After screening for the onset of puberty and the possibility of undetected abuse, 93 subjects remained. Examination techniques included a supine labial separation approach, a supine labial traction method, and a prone knee-chest position. Common genital finding included erythema of the vestibule (56%), periurethral bands (50.6%), labial adhesions (38.9%), lymphoid follicles on the fossa navicularis (33.7%), posterior fourchette midline avascular areas (25.6%), and urethral dilation with labial traction (14.9%). The hymenal orifice opened more frequently during the knee-chest (95.2%) and the labial traction (90.5%) methods than with the supine separation (79.3%) approach. Hymenal findings included mounds (33.8%), projections (33.3%), and "septal remnants"/midline hymenal tags (18.5%). Intravaginal findings of vaginal ridges (90.2%) and rugae (88.7%) were found primarily through the labial traction approach. The cervix was visualized without the use of speculum in 69% of the children during the knee-chest examination. Unusual findings included posterior fourchette friability (4.7%), anterior hymenal clefts (1.2%), and notches of the hymen (6%). One child had an imperforate hymen (1.2%) and 2 (2.5%) had hymenal septa. A vaginal discharge was detected in 2 (2.6%) and a foreign body in 1 (1.3%). Tables that include the vertical and horizontal hymenal orifice diameters by age group and by method are presented.

McCann J. Voris J. Simon M. : Genital injuries resulting from sexual abuse: a longitudinal study. *Pediatrics*. 89(2):307-17, 1992 Feb. (Medline ID 92131601)

Three children who incurred genital injuries as a result of sexual assaults were followed up on a longitudinal basis to document the anatomical changes which ensued. The subjects, who were 4 months, 4 years 5 months, and 9 years of age, were followed up for periods ranging from 14 months to 3 years. A multi-method examination approach and a 35-mm camera mounted on a colposcope were used to examine and record their injuries. Signs of the acute damage disappeared rapidly, and the wounds healed without complications. Following the resolution of the acute injuries, the changes created by the trauma remained relatively stable throughout the prepubertal years. The most persistent findings were irregular hymenal edges and narrow rims at the point of the injury. Over time the jagged, angular margins smoothed off. Disruption of the hymen exposed underlying longitudinal intravaginal ridges whose hymenal attachments created mounds or projections. There was little apparent scar formation. Even the injuries to the posterior fourchettes healed with minimal scar tissue and left only the slightest evidence of the trauma. With the onset of puberty, the hymenal changes in the oldest subject were obscured by the hypertrophy of this membrane. An examination technique which used a Q-tip to separate the redundant tissues demonstrated that the signs of trauma had survived.

McCann J. Voris J. : Perianal injuries resulting from sexual abuse: a longitudinal study. *Pediatrics*. 91(2):390-7, 1993 Feb. (Medline ID 93141301)

Four children who incurred perianal injuries as a result of a sexual assault were followed on a longitudinal basis to document the anatomical changes that ensued. The subjects, whose ages ranged from 4 to 8 years, were followed from 1 week to 14 months. They were examined in both supine and prone knee-chest positions and a 35-mm camera mounted on a colposcope was used to record their injuries. At the time of the initial examination, there were a variety of findings including erythema of the tissues, edema of the skin folds, localized venous engorgement, dilation of the external anal sphincter, and lacerations of different depths. Superficial lacerations reepithelized within 1 to 11 days. The second-degree wounds in two of the children were healed by the 1- and 5-week return visits, leaving narrow bands of scar tissue. In the two subjects who were followed the longest, signs of both a second-degree laceration and a surgically repaired third-degree injury had virtually disappeared by 12 to 14 months after the assaults. The wounds in one subject, infected with a herpes simplex type 2 virus, remained erythematous for a longer period of time than did similar injuries in the other children. A skin tag created by the avulsion of the tissues in one subject persisted, although it became less obvious as it retracted into the redundant folds of the perianal tissues over time.

Muram D. : Child sexual abuse. [Review] *Obstetrics & Gynecology Clinics of North America*. 19(1):193-207, 1992 Mar. (Medline ID 92262060)

It is estimated that the number of child victims of sexual assault is in excess of 200,000 per year. Many of these children are brought to emergency room facilities or to their private physician's office for evaluation. The recent advances in the area of diagnosis and management of children who are the victims of sexual abuse are presented. [References: 36]

Pokorny SF. : The genital examination of the infant through adolescence. [Review] *Current Opinion in Obstetrics & Gynecology*. 5(6):753-7, 1993 Dec. (Medline ID 94114859)

The genital examination of the young female is a relatively new procedure for many clinicians. It was not felt important until physicians became involved with the examination of survivors of childhood sexual abuse; from these examinations it is apparent that young females also have a broad array of genital conditions which need clinical evaluation and intervention. This review of the recent literature on the techniques employed by a variety of clinicians demonstrates the limitations placed on our knowledge of pediatric and adolescent gynecologic conditions by technical and psychosocial parameters. [References: 19]

Ricci LR. : Medical forensic photography of the sexually abused child. *Child Abuse & Neglect*. 12(3):305-10, 1988. (Medline ID 89002206)

The dramatic increase in reports of sexual abuse has resulted in increasing referrals to physicians for medical evaluation and has placed demands on physicians to adequately and expertly assess these children. High quality, close-up photographs of significant lesions can be an important part of this evaluation. Camera systems recommended vary from colposcopes to close-up 35-mm systems to instant cameras. Physicians who examine sexually abused children should have ready access to an adequate photographic system, as well as basic knowledge of camera operation, film procedures, and medicolegal implications. Case studies and discussion are used to review colposcopic and close-up 35-mm camera techniques available to the physician to photograph the sexual abuse victim.

Saywitz KJ. Goodman GS. Nicholas E. Moan SF. : Children's memories of a physical examination involving genital touch: implications for reports of child sexual abuse. *Journal of Consulting & Clinical Psychology*. 59(5):682-91, 1991 Oct. (Medline ID 92064840)

Evaluation of child sexual abuse often necessitates interviewing children about genital touch, yet little scientific research exists on how best to obtain children's reports of genital contact. To examine this issue, 72 five- and seven-year-old girls experienced a standardized medical checkup. For half of the children, the checkup included a vaginal and anal examination (genital condition); for the other half, the checkup included a scoliosis examination instead (nongenital condition). The children's memories were later solicited through free recall, anatomically detailed doll demonstration, and direct and misleading questions. The majority of children in the genital condition revealed vaginal and anal contact only when asked directly about it. Children in the nongenital condition never falsely reported genital touch in free recall or doll demonstration; when asked directly, the false report rate was low. Significant age differences in free recall and doll demonstration, found only in the nongenital condition, implicated socioemotional factors as suppressing the reports of older children who experienced genital contact.

Soderstrom RM. : Colposcopic documentation. An objective approach to assessing sexual abuse of girls. *Journal of Reproductive Medicine*. 39(1):6-8, 1994 Jan. (Medline ID 94223647)

Accurate measurements of the genital anatomy of victims of child sexual abuse can be documented with colposcopic photography. Most colposcopies available, however, do not have a built-in measuring grid for medicolegal documentation. Because of the unique optics designed for the colposcope, an accurate comparison can be provided if the measuring tool is photographed in the same focal plane and at the same magnification as the object of concern. Properly labeled slides may then be used as clear evidence in court.

Steiner H. Taylor M. : Description and recording physical signs in suspected child sexual abuse. [Review] *British Journal of Hospital Medicine*. 40(5):346-51, 1988 Nov. (Medline ID 89167392)

The identification of child sexual abuse may depend on the accurate interpretation of abnormal physical signs. Therefore, it is necessary to have a consistent vocabulary and a full and accurate record of the findings (Report of the Inquiry into Child Abuse in Cleveland 1987). Our suggestions are intended to promote the development of a standard acceptable to all concerned with these problems. [References: 30]

Stratakis CA. Graham W. DiPalma J. Leibowitz I. : Misdiagnosis of perianal manifestations of Crohn's disease. Two cases and a review of the literature. [Review] *Clinical Pediatrics*. 33(10):631-3, 1994 Oct. (Medline ID 95112489)

Two cases are described, both of female patients with perianal manifestations of Crohn's disease, both initially misdiagnosed as HPV infection and/or sexual abuse. In both cases, this misdiagnosis delayed the true diagnosis of Crohn's disease, thus delaying effective treatment as well.

Wiseman MR. Vizard E. Bentovim A. Leventhal J. : Reliability of video taped interviews with children suspected of being sexually abused [see comments]. *BMJ*. 304(6834):1089-91, 1992 Apr 25. (Medline ID 92266081)

OBJECTIVE – To determine the reliability of judgments about the likelihood of child sexual abuse based only on video recorded interviews. **DESIGN** – Blinded rating of likelihood of abuse by seven professional groups and comparison with consensus rating. **SETTING** – Child and adolescent psychiatry centre. **SUBJECTS** – Four people from each of seven professional disciplines: specialist psychiatrists, general psychiatrists, experimental psychologists, trainee social workers, trainee clinical psychologists, lawyers, and police. **MAIN OUTCOME MEASURE** – Rating of 12 recorded interviews. **RESULTS** – Agreement between the consensus panel and professional groups was 83% (151/183) for high likelihood cases (seven cases) and 89% (118/132) for low likelihood cases (five). Specialist psychiatrists and the police were better able to identify high likelihood cases than were other groups with less experience of interviewing sexually abused children (91% (48/53) v 79% (102/129); $p = 0.05$). **CONCLUSIONS** – Raters could accurately distinguish children with low likelihood of abuse on interview evidence alone, but those with more experience of dealing with sexual abuse were better at identifying high likelihood cases.

ULTRASOUND

Haller JO. Bass IS. Sclafani SJ. : Imaging evaluation of traumatic hematuria in children. *Urologic Radiology*. 7(4):211-8, 1985. (Medline ID 86098347)

The 3 major causes of traumatic hematuria in children are accidents, iatrogenic damage, and child abuse. While computerized tomography plays a major role in the evaluation of accidental trauma, ultrasound and routine radiography are important in the work-up of iatrogenic hematuria and injuries caused by child abuse. This paper reviews the role of these imaging modalities in diagnosing traumatic hematuria in children.

Hernanz-Schulman M. Genieser NB. Ambrosino M. : Sonographic diagnosis of intramural duodenal hematoma. *Journal of Ultrasound in Medicine*. 8(5):273-6, 1989 May. (Medline ID 89236500)

Intramural duodenal hematoma, sometimes accompanied by retroperitoneal extension, is a frequent injury resulting from blunt abdominal trauma in childhood. In fact, it may be the first sign of child abuse identified in the young child. The typical appearance of this injury on upper gastrointestinal examination was described by Felson, although its radiographic variability has been stressed more recently. We have encountered two cases of intramural duodenal hematoma diagnosed with sonography. In the appropriate clinical setting, this diagnosis may be made with specificity using state-of-the-art equipment and technique. Computerized tomography (CT) and barium meal (UGI) studies were done in these cases and the multimodality appearance of the injury is discussed.

Jaspan T. Narborough G. Punt JA. Lowe J. : Cerebral contusional tears as a marker of child abuse – detection by cranial sonography. *Pediatric Radiology*. 22(4):237-45, 1992. (Medline ID 92396453)

A series of 6 infants subjected to child abuse is presented in whom contusional tears of subcortical white matter were detected during life by intracranial sonography. The sonographic appearances of this highly pathognomonic marker of shaking injury are described for the first time and their significance discussed. On the basis of our experience we suggest that high resolution cranial sonography is an extremely valuable part of the diagnostic work up in cases of suspected non-accidental injury.

Kirks DR. : Radiological evaluation of visceral injuries in the battered child syndrome. *Pediatric Annals*. 12(12):888-93, 1983 Dec. (Medline ID 84094686)

Diagnostic imaging plays an important role in the recognition, evaluation, and follow-up of visceral injuries in the battered child syndrome. Conventional radiography is important for the diagnosis of associated skeletal fractures, pulmonary parenchymal injury, gastric dilatation, and pneumoperitoneum. An upper gastrointestinal series is the examination of choice in suspected intramural duodenal hematoma. Ultrasonography is helpful in the diagnosis of retroperitoneal hematoma, acute traumatic pancreatitis, and pancreatic pseudocyst. Nuclear scintigraphy is valuable if injury is limited to the liver or spleen. CT is the imaging modality of choice for assessing generalized blunt abdominal trauma as well as evaluating the extent of injuries to the liver, spleen, pancreas, kidneys, and mesentery.

Merten DF.: [Role of radiography in the diagnosis of battered children]. [Review] [French] *Journal de Radiologie*. 66(8-9):485-95, 1985 Aug-Sep. (Medline ID 86143477)

Radiological imaging plays an important role in the diagnosis of the child abuse syndrome. The radiologist must identify specific foci of injury and document that such injuries are the result of abuse. The capacity to identify abuse-related injuries (sensitivity) has been greatly enhanced by technological advances in radiological imaging including radionuclide scintigraphy (skeletal injury); cranial computed tomography (craniocerebral injuries); and body computed tomography/ultrasonography (abdominal injury). This increased sensitivity has resulted in a greater appreciation of the magnitude of abuse related injuries. Specificity, differentiation between accidental and non-accidental injuries, depends on knowledge of the radiologic characteristics and pattern of abuse-related trauma. Specific injuries must be viewed in light of known pathologic response of anatomic structures to mechanical forces, and determination of the chronology of trauma. [References: 33]

Muhler E. : [Sonographic follow-up of pronounced brain concussion in a 3-week-old infant following trauma caused by shaking]. [German] *Klinische Padiatrie*. 198(1):49-52, 1986 Jan-Feb. (Medline ID 86173054)

Cerebral sonography was performed in a 3 week old whiplash shaken baby who had no external marks of injury and no skull fracture. On the day of admission, increased echogenicity in the white matter could be correlated with hypodense contusional lesions in the cranial computerized tomography. Sonographic follow-up showed multiple cystic defects in the white matter and later on marked dilatation of the adjacent lateral ventricle. In all infants with open anterior fontanel presenting with unexplained clouding of consciousness and/or external marks of child abuse, cerebral sonography should be a basic diagnostic method.

Nimkin K. Teeger S. Wallach MT. DuVally JC. Spevak MR. Kleinman PK. : Adrenal hemorrhage in abused children: imaging and postmortem findings. *AJR. American Journal of Roentgenology*. 162(3):661-3, 1994 Mar. (Medline ID 94152583)

Nwosu UC. Bharti DR. : Idiopathic fetal ascites associated with pregnancy from father-daughter incest. A case report. *Journal of Reproductive Medicine*. 39(1):49-51, 1994 Jan. (Medline ID 94223644)

A 15-year-old primigravida registered late for antenatal care (23 weeks). Ultrasound examination revealed massive idiopathic fetal ascites necessitating in utero paracentesis at 27 weeks. The family was socially dislocated, and the patient's alcoholic father doted on her. A live female fetus with ascites and multiple congenital abnormalities was delivered at 34 weeks. Following repeated hospitalization, the infant died of pneumonitis, at 5 months of age; autopsy could not determine the cause of the ascites. Young pregnant teenagers from broken homes with doting behavior from an alcoholic father should be suspected of being incest victims.

Orel SG. Nussbaum AR. Sheth S. Yale-Loehr A. Sanders RC. : Duodenal hematoma in child abuse: sonographic detection. *AJR. American Journal of Roentgenology*. 151(1):147-9, 1988 Jul. (Medline ID 88238304)

The clinical signs and symptoms of duodenal injury caused by child abuse are often nonspecific, and external signs of trauma may be absent. In four children with unexplained gastrointestinal symptoms, sonography detected and showed the extent of a duodenal hematoma resulting from child abuse. In two of the children, sonography was also used to follow the evolution of the duodenal hematoma.

Thorburn RJ. Lipscomb AP. Reynolds EO. Blackwell RJ. Cusick G. Shaw DG. Smith JF. : Accuracy of imaging of the brains of newborn infants by linear-array real-time ultrasound. *Early Human Development*. 6(1):31-46, 1982 Jan. (Medline ID 82116773)

Comparisons were made in 69 newborn infants of the appearance of the brain as visualised by linear-array real-time ultrasound, computerised tomography and at autopsy, in order to evaluate the accuracy of ultrasound for the detection of lesions in the brain. Ultrasound was found to give a good estimate of the presence and extent of haemorrhage into the germinal layer and ventricles, and also to be very useful for assessing the appearance of the ventricular system. Ultrasound diagnosed extradural haemorrhages but was unhelpful for identifying subarachnoid haemorrhages or lesions in the posterior fossa.

Zepp F. Bruhl K. Zimmer B. Schumacher R. : Battered child syndrome: cerebral ultrasound and CT findings after vigorous shaking. *Neuropediatrics*. 23(4):188-91, 1992 Aug. (Medline ID 93025424)

Child abuse by whiplash-shaking can lead to severe cerebral damage, neurological defects and mental retardation. Cerebral damage has been found with and without external evidence of head injury. We report the sonographic findings in two children after traumatization due to repetitive vigorous whiplash shaking. Cerebral sonography revealed cerebral edema at admission and within 48 hours thereafter. Follow-up studies demonstrated development of marked brain atrophy in both cases. The sonographic findings were confirmed by cranial computerized tomography. Doppler sonography was used to monitor cerebral perfusion by measuring intracranial blood flow. The clinical history of the patients demonstrates that cerebral sonography in combination with Doppler sonography not only serves as a diagnostic tool but also allows adjustment of therapy to the actual clinical status of the patient.

VIDEORECORDING

Wiseman MR. Vizard E. Bentovim A. Leventhal J. : Reliability of video taped interviews with children suspected of being sexually abused [see comments]. *BMJ*. 304(6834):1089-91, 1992 Apr 25. (Medline ID 92266081)

OBJECTIVE – To determine the reliability of judgments about the likelihood of child sexual abuse based only on video recorded interviews. **DESIGN** – Blinded rating of likelihood of abuse by seven professional groups and comparison with consensus rating. **SETTING** – Child and adolescent psychiatry centre. **SUBJECTS** – Four people from each of seven professional disciplines: specialist psychiatrists, general psychiatrists, experimental psychologists, trainee social workers, trainee clinical psychologists, lawyers, and police. **MAIN OUTCOME MEASURE** – Rating of 12 recorded interviews. **RESULTS** – Agreement between the consensus panel and professional groups was 83% (151/183) for high likelihood cases (seven cases) and 89% (118/132) for low likelihood cases (five). Specialist psychiatrists and the police were better able to identify high likelihood cases than were other groups with less experience of interviewing sexually abused children (91% (48/53) v 79% (102/129); $p = 0.05$). **CONCLUSIONS** – Raters could accurately distinguish children with low likelihood of abuse on interview evidence alone, but those with more experience of dealing with sexual abuse were better at identifying high likelihood cases.