Chapter 1 : Pediatric Spine Center - CHOC Children's, Orange County

13 The Pediatric Spine. A. Jay Khanna, Bruce A. Wasserman, and Paul D. Sponseller. Specialized Pulse Sequences and Imaging Protocols. Standard pulse sequences for spinal imaging include SE T1-weighted and FSE T2-weighted images.

Trauma to the Pediatric Spine Introduction The anatomy and biomechanics of the pediatric spine differ significantly from that of the adult. These differences are related to intrinsic age-related tissue differences and the capacity for growth, remodeling, and regeneration. These differences also vary with growth and development of the spine and give rise to different patterns of injury in the immature spinal skeleton. The interpretation of the pediatric cervical spine can be difficult for those unfamiliar with the normal pattern of development and ossification of the spine. There is a real risk of both false-negative and false positive interpretative errors. There are a number of predictable epiphyses, apophyses, and synchondroses that may be misinterpreted radiographically as fractures. There is also a wide range of normal variants with specific morphological and radiological characteristics. In addition spinal movement patterns also differ from those expected in the adult. The appearance of the secondary ossification centers in the growing spine can be associated with radiographically subtle but significant physeal injuries. Although the pediatric spine assumes many of the adult radiographic features by the age of 8 years, as in the peripheral skeleton, potential injuries related to these relatively vulnerable physes should be given due diagnostic consideration. This implies that accident and emergency staff and radiologists are unlikely to see this injury on a regular basis in the same hospital. This lack of experience and teaching material increases the risks of missed diagnosis. Cervical spine injuries in particular may be more common than is currently recognized as they are easily overlooked on plain radiographs. Aufdermaur identified injuries through endplates of vertebral bodies in an autopsy study, but only 1 in 12 was suspected to have sustained a spinal injury before autopsy. However, in the older child and adolescent, sports-related injuries including diving, surfing, and cycling account for a number of cases. The pattern of cervical spine injury affecting the child differs from that in the adult. The upper cervical spine is more vulnerable to injury due to a number of anatomical and physiological features. These include the unique pattern of ossification of C1 and C2, the poorly developed neck musculature, the relatively large size of the head compared to the cervical spine in the child, the fulcrum of movement being located in the upper cervical spine in the young child as opposed to the mid to lower cervical region seen in the older child and adult, ligamentous laxity, and underdeveloped skeleton of the spinal motion segments. Adult type of injuries over 8 years of age occuring in the pediatric age group will not therefore be the emphasis of this chapter as they are covered in previous chapters. There are a number of subsets of spinal injury that are predominant or even unique to children. Trauma to the spine occurring at birth is rare, and although uncommon, trauma to the spine in nonaccidental injury has become increasingly recognized, while SCIWORA spinal cord injury without radiographic abnormality is more commonly seen in children than in adults. In order to understand the different patterns of injury and avoid errors of interpretation it is important to be familiar with the development of the spine, its radiological appearances and the range of normal variants before embarking on the imaging of the various pathological conditions. Development of the Vertebral Column The term centrum describes the central part of a developing vertebra. It encloses the notochord and gives rise to most of the vertebral body. In the centrum, endochondral ossification commences at approximately 9 weeks of fetal life. Bipartite centers anterior and posterior associated with the arrangement of the blood vessels may be encountered. Coronally cleft vertebrae may occur up to the age of 4 years and are considered to be a normal variation of endochondral ossification 3 that depends on varying patterns of vascular distribution. At birth most vertebrae have three ossific areasâ€”one for the centrum and one for each half of the neural arch. The ossific center of a centrum in the newborn is ovoid on a lateral radiograph. The ossific center of each vertebral centrum is separated from that of the neural arch by the broad radiolucent synchondrosis that contains uncalcified cartilage. Bony union takes place here between 3 and 6 years. Anteriorly and posteriorly there are small indentations or clefts that represent vascular channels running through the ossific center. As normal growth occurs, the vertebral bodies as seen on a lateral radiograph become more rectangular, while the height of the vertebral body compared with the disk space increases. In early childhood the vertebral endplate has a thick hyaline cartilage component. Growth forces at the diskovertebral interfaces, which are both elliptical in their enlargement contours, have an effect on the distribution of the cartilage components physes superiorly and inferiorly. There are no separate epiphyseal ossification centers in the growing human vertebrae, but due to the mechanics in operation the growth cartilage becomes increasingly thin centrally, with a thicker periphery laterally and anteriorly which becomes the ring apophysis. First visible at approximately 5 years they represent an annular recess that surrounds the vertebral body and will form the secondary ossification center of the vertebral endplate. The recess is filled with cartilage. Initially on lateral radiographs the ring apophysis appears set in a superior and inferior groove anteriorly at the borders of the developing vertebra. This is an area of active growth and remodeling carrying significant biomechanical shearing, compressive forces and not just traction stresses. Small calcific foci begin to appear in this cartilaginous rim at years in girls and years in boys. These foci slowly ossify and gradually unite to form a bony vertebral ringâ€"the vertebral ring apophysis. The neural arches of C1 and C2 show well-developed ossific areas bilaterally at birth, but perichondral ossification of the neural arches here and elsewhere is not complete at birth. The spinous processes do not yet possess their own ossific centers and are formed during the first year by amalgamation of the neural arches. This begins in the lumbar area and spreads to be complete in the cervical spine in the second year. Union may not occur in the atlas until the fourth to sixth year and in the sacrum until the seventh to tenth year. Fusion between the base and apex of the dens usually occurs by 12 years. Secondary centers of ossification apophyses form along the tips of the spinous processes during the years of adolescent growth years , formed as small ossific centers that eventually cap the entire tips of the spinous processes. These unite with the spinous processes when vertebral growth is complete. The tips of the transverse processes in the lumbar region show occasional development of secondary ossific centers. The first two cervical vertebrae are atypical. The central pillar of the axis develops as three segments: Ossification occurs in the order of the centrum, the base of the dens appearing at birth and finally the tip of the dens, the latter occurring before 2 years but not constantly present. The base of the dens has two centers of ossification. Normal Variants Visualization of the spine in its developmental stage reveals different stages of ossification. On the radiograph areas of lucency may be representative of cartilaginous development, so knowledge of the expected appearance and approximate age of appearance of different ossification centers will help in interpretation. Synchondroses have smooth well-corticated margins and occur at characteristic sites and awareness of this will avoid misinterpretation of these as fractures. The atlas and the axis have a different developmental and hence morphological appearance to the other vertebrae. It may, however, be absent resulting infailure of anterior fusion leaving a cleft. The body of C1 joins the neural arches by synchondroses that close by the seventh year, but the ring of C1 reaches its normal adult size by the fourth year Fig. The pattern and sequence of ossification of the axis, including the centrum, the odontoid process, and the apex of the odontoid process have been referred to above. The basilar odontoid synchondrosis usually fuses between 3 and 6 years of age but closure may be delayed. This should not be mistaken for a fracture. The vestigial form may still be visible up to the age of 11 years, represented by a fine sclerotic line, but should be clearly differentiated from a fracture line that will appear clearly lucent. Fractures of the peg typically occur above the level of the synchondrosis and may ultimately give rise to an os odontoideum see later. The ossification center at the apex of the odontoid process appears at approximately 2 years of age and fuses to the larger odontoidprocessatapproximately12 years. Sometimes the appearance of the apical ossification center may be delayed, or it may even not appear at all. Disturbances in alignment of the vertebral bodies in the cervical spine may arouse concern about underlying occult injury. Hypermobility, ligamentous laxity, and incomplete ossification may be responsible for these appearances. A number of normal variants occur in a child, which would give rise to alarm if seen in the adult patient. Pseudo Jefferson fracture pseudospreading of C1. In young children the ossification of the lateral mass of C1 often exceeds that of the ossification of C2 giving rise to what has been called the pseudospread of C1 on C2 Fig. Pseudo Jefferson fracture of C1 with lateral offset on the radiograph on the right arrow b due to unequal growth at the synchondroses of C1 producing elongation on the right as judged by the odontoid peg c.

Chapter 2 : Home - Pediatric Spine Foundation

Ideal for neurosurgeons, pediatric neurosurgeons, and orthopedic surgeons, Surgery of the Pediatric Spine is a comprehensive multidisciplinary reference for the surgical management of the most frequently encountered spine problems in the pediatric patient.

Print Pediatric Spinal Deformities Spinal conditions such as scoliosis curving of the spine , kyphosis increasing roundback of the spine , spondylolysis stress fracture of the spine , and spondylolisthesis movement of one part of the spine on another part may affect children during their early or late childhood years. The majority of spinal disorders do not require bracing or surgery although regular checkups are needed to ensure that the condition does not worsen. Emory surgeons may use a combination of bracing and spinal casting to prevent your child from needing spinal surgery. Emory pediatric orthopedic surgeons have a great deal of experience treating children with all types of spinal conditions, from mild to the most severe. Pediatric Scoliosis Scoliosis, or a curvature of the spine, is a condition that affects almost 7 million people in the U. While it does occur in adults, it is most commonly seen in children, especially girls, during periods of growth. Adolescent scoliosis is the most common spinal deformity affecting pre-teens and teenagers, however it does not always result in significant pain or discomfort. Scoliosis may also occur in younger children and is often referred to as early onset scoliosis EOS in children less than five years old. EOS may significantly worsen as the children grow and cause severe spinal deformity and problems with the lungs or other internal organs. Some researchers think genetics may play a role in who develops scoliosis, but it is not completely understood at this point. Pediatric Scoliosis Treatment Pediatric Scoliosis After Surgery X-RayOur pediatric orthopedic surgeons specialize in treating our younger patients under 21 years of age with all forms of scoliosis and other spinal disorders. Our extensive experience in spinal bracing and casting provides patients with nonsurgical alternatives for scoliosis to prevent or delay surgery. Some pediatric scoliosis patients, however, will require surgery to prevent long term problems with the spine, lungs, or other organs. Surgical Treatment Options Surgery may be indicated for larger or progressively worsening scoliosis. Surgery options include growing spine instrumentation such as growing rods or the Vertical Expandable Prosthetic Titanium Rib VEPTR in younger patients or spinal fusion in older teenagers and young adults. These procedures are designed to stop the scoliosis from progressing, decrease the size of the curvature, and get patients back to their activities as quickly as possible. The majority of patients who have scoliosis surgery are able to get back to their normal activities, including athletics, in just a few months. Meet our pediatric spine doctors. Pediatric Spondylolysis and Spondylolisthesis The most common cause of low back pain in adolescent athletes that can be seen on X-ray is a stress fracture in one of the bones vertebrae that make up the spinal column. Technically, this condition is called spondylolysis. It usually affects the fifth lumbar vertebra in the lower back. If the stress fracture weakens the bone so much that it is unable to maintain its proper position, the vertebra can start to shift out of place. This condition is called spondylolisthesis. If too much slippage occurs, the bones may begin to press on nerves and surgery may be necessary to correct the condition. Symptoms Some sports, such as gymnastics, weight lifting, and football, put a great deal of stress on the bones in the lower back. They also require that the athlete constantly overstretch hyperextend the spine. In either case, the result is a stress fracture on one or both sides of the vertebra. Pain usually spreads across the lower back and may feel like a muscle strain. Spondylolisthesis can cause spasms that stiffen the back and tighten the hamstring muscles, resulting in changes to posture and gait. If the slippage is significant, it may begin to compress the nerves and narrow the spinal canal. Pediatric Kyphosis Some degree of rounded curvature of the spine is normal. The term kyphosis is used to describe the spinal curve that results in an abnormally rounded back. X-rays will measure the degree of the kyphotic curve.

Chapter 3 : Trauma to the Pediatric Spine | Radiology Key

Pediatric cervical spine surgery is a treatment option for children who have injuries or abnormalities in the neck portion of the spine (cervical spine). Cervical spine injuries may be present at birth (congenital) or result from a car or motorcycle accident or other trauma.

Pediatric Sedation Protocols Formal sedation is often required for the successful MRI evaluation of the pediatric patient, and multiple studies and reviews have evaluated and recommended specific sedation protocols. The American Academy of Pediatrics has stated that careful medical screening and patient selection by knowledgeable medical personnel are needed to exclude patients at high risk for life-threatening hypoxia. Oral chloral hydrate is recommended for children less than 18 months old. However, the use of oral chloral hydrate is controversial because of its variable absorption, paradoxical effects, and nonstandardized dosing regimen. Older or larger children usually receive intravenous pentobarbital with or without fentanyl. Although several studies have reported the successful administration of sedation by trained nurses, 1 , 2 patients who may benefit from the expertise of an anesthesiologist include those with substantial comorbidities, such as the following: Alternate techniques include sleep deprivation and rapid, segmental scanning; the latter permits the acquisition of high-quality images without the use of sedation. The surgeon referring pediatric patients for MR images of the spine should be familiar with the sedation protocols and level of expertise at the selected facilities. Adolescents and Adults The lumbar spine is the most frequently imaged region in both children and adults. The lumbar spinal canal transitions from a round appearance in its proximal portion to a more triangular one distally. The lumbar facet joints are covered with 2 to 4 mm of hyaline cartilage. This cartilage can be nicely visualized on FSE pulse sequences and with gradient-echo pulse sequences. The epidural space and ligaments should also be carefully evaluated. The epidural fat is seen as high signal intensity on T1-weighted images; the ligamentum flavum shows minimally higher T1-weighted signal than do the other ligaments. The conus medullaris, usually located at the L1-L2 level, is best seen as a regional enlargement of the spinal cord on the sagittal images. The filum terminale extends from the conus medullaris to the distal thecal sac. The traversing nerve roots pass distally from the conus medullaris and extend anteriorly and laterally. These nerve roots exit laterally underneath the pedicle and into the neural foramen. The intervertebral disc, consisting of the cartilaginous end plates, annulus fibrosus, and the nucleus pulposus, normally shows increased T2 signal in its central portion. It is important to note that CSF pulsations often create artifacts that degrade the image of the lumbar spine; those artifacts must not be mistaken for a pathologic process. Evaluation of the cervical spine begins with the vertebral bodies. A mild lordosis is noted on sagittal images. On axial images, the spinal canal is triangular, with the base located anteriorly. It is important to note the normal variant dark band at the base of the dens that represents a remnant of the subdental synchondrosis; it should not be mistaken for a fracture. In adults, the facet joints are small and triangular, whereas in children they are relatively larger and flat. The spinal cord is elliptical in cross-section in the cervical spine. It is important to recognize that there is a difference in signal between the normal gray and white matter of the spinal cord. This signal heterogeneity should not be mistaken for intramedullary pathology. The intervertebral discs are similar in appearance to, but smaller than, those seen at the thoracic and lumbar levels. An important anatomic feature of the cervical spine is the prominent epidural venous plexus, which is not present in the thoracic or lumbar spine. A A sagittal T1-weighted image shows dark CSF arrow with small head , the conus medullaris terminating at the L1-L2 level arrow with large head , and the basivertebral channel arrowhead. Note the normal rectangular appearance of the vertebral bodies and the lumbar lordosis. Children Differences Between the Pediatric and Adult Spine Understanding the normal adult and adolescent spine leads to appreciation of the dynamic development of the pediatric spine. The MRI appearance of the growing spine is quite complex. Multiple substantial changes occur in the vertebral ossification center and the intervertebral discs that markedly alter the overall appearance of the spine, especially between infancy and 2 years of age. The spinal canal and neural foramina are larger, and there is less curvature. In addition, the overall signal intensity of the vertebral bodies is lower than that of the adult spine on T1-weighted images because of the abundance of red hematopoietic marrow relative to yellow fat marrow in the pediatric, adolescent, and young adult spine. By understanding the MRI appearance of this development process, the clinician is better equipped to differentiate normal from pathologic states. Full-Term Infant In the newborn, the overall size of the vertebral body is small relative to the spinal canal, and the spinal cord ends at approximately the L2 level. The lumbar spine does not show the usual lordosis and is straight. The vertebral bodies show markedly low signal intensity on T1-weighted images, with a thin central hyperintense band that likely represents the basivertebral plexus. The spongy bone of the ossification center is ellipsoidal rather than rectangular and is often mistaken for a disc. The intervertebral disc is relatively narrow and often contains a thin, bright central band on T2-weighted images that represents the notochordal remnants. The ossification centers begin to increase in signal intensity, starting at the end plates and progressing centrally. The neural foramina have not substantially changed at this age, remaining relatively large and ovoid in shape. The ossified portion of the vertebral body increases substantially in size and begins to assume its adult appearance, with near-complete ossification of the pedicles and the articular processes. The disc space and nucleus pulposus become longer and thinner. The cartilaginous end plate has decreased in size and is often difficult to identify. The neural foramen also begins to take its adult appearance as its inferior portion narrows. The ossification of the vertebral bodies and posterior elements is nearly complete, with a resultant decrease in the spinal canal diameter. The vertebral bodies also develop concave superior and inferior contours. The nucleus pulposus becomes smaller at this age and spans approximately half of the disc space in the sagittal plane. The neural foramina continue to narrow inferiorly. Conus Medullaris The spinal cord extends to the inferior aspect of the osseous spinal column in early fetal life. It is important to note the location of the conus medullaris on every pediatric spine MRI study Figs. A conus level below the L2-L3 interspace in children more than 5 years old is abnormal and indicates possible tethering. A A sagittal T1-weighted image shows rectangular vertebral bodies and a wide, thin intervertebral disc. Note that the conus medullaris terminates at the L1-L2 level arrow. B A T2-weighted image shows increased disc signal.

Chapter 4 : Spine: Back, Neck & Pediatric Spine | Orthopaedic & Spine Center of the Rockies

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Try Our Symptom Quiz! Viewed from the front, the spine will appear straight up and down; from the side, it will form a gradual S-curve. When this typical development is flawed, or altered, a condition called scoliosis may emerge. A trained medical professional can detect scoliosis in utero using ultrasound technology or at any point during childhood. The degree of curvature can vary widely from person to person. And, if not addressed, scoliosis can worsen as the individual ages. Childhood and adolescence are vital times for the development of the pediatric spine. If something develops abnormally at this age, it will most likely continue to exaggerate during adulthood. Although the cause of most cases of pediatric scoliosis is unknown, early detection is key to successful treatment of this condition. Symptoms of Pediatric Scoliosis As a parent, keep in mind that your child may not notice or feel symptoms of scoliosis. Your child most likely will not come to you with complaints of pain or stating that they notice a strange curve in their spine. However, if signs and symptoms are present, you will most likely notice them externally. Even so, sometimes the visible symptoms are far too subtle for the eye to see. Screening by a medical professional is suggested, and the use of X-rays or MRIs may be necessary to truly pinpoint the condition. With this knowledge, keep an eye out for the following symptoms of scoliosis: Unnatural curve or twist of the spine from side to side. An uneven appearance in the length of the legs, height of shoulders, or height of hips. One or both of the shoulder blades may protrude, fanning out unnaturally from the back. An observable and persistent hunched-over posture that favors one side is present. In severe cases, your child may experience pain or sore muscles in the back and legs. Lowenstein has years of training and experience in treating both pediatric and adult scoliosis , and has earned his place as one of the top three scoliosis doctors in the country. Causes of Pediatric Scoliosis There are three principal causes of pediatric scoliosis. The first, and most common cause, is idiopathic. In recent years, however, researchers have noted that this condition may have a genetic component. Idiopathic scoliosis is know to run in families. Other possible causes of idiopathic scoliosis may stem from environmental effects on uneven bone growth, hormonal imbalances, malnutritionâ€¦ The list goes on. Another cause of pediatric scoliosis lies in neuromuscular diseases. Conditions such as muscular dystrophy, spina bifida, and cerebral palsy can lead to spinal malformation. When the muscles form irregularly, develop weakness, or become stiff and spastic, they cannot support the spine adequately. This can cause the spine to grow in painful or abnormal directions. The third most common cause of pediatric scoliosis is congenital. With this type, we are referring to any scoliosis noticed at birth or resulting from fetal development while in the womb. The reasons for abnormal development may result from environmental factors or from a trauma of some sort. It is less likely that genetics plays a role in congenital scoliosis than they do in idiopathic scoliosis. However, your doctor can also perform tests while the baby is in utero to determine if spinal malformation is present. Pediatric Scoliosis Treatment Options Observation One of the main steps in treating pediatric scoliosis is observation, or watching the spine and ensuring progression does not worsen over time. Observation will involve monitoring the spine with periodic trips to the doctor and having X-ray or MRI images taken regularly. Bracing Bracing is a common form of treatment to correct mild to moderate abnormalities in spinal curvature. Braces are either made of rigid plastic or flexible elastic. Physical Therapy A physical therapist can work with you and your child to develop a treatment regimen that will both improve back health and boost mental wellness. Muscular strength and flexibility is important to spinal well-being and developing these skills can reduce pain. Scoliosis Surgery Extreme curvatures of the spine may require spinal fusion to correct. Using screws, hooks, and rods, your surgeon will mechanically fix the spine in a certain position to avoid further degeneration. Bone material will be added to fuse or reinforce existing bones.

Chapter 5 : Paediatric c-spine injuries

Compared to adjusting the adult spine, adjusting the pediatric spine requires a number of modifications depending on the age and clinical presentation of the patient. These changes can be made readily by the seasoned clinician familiar with differing strategies for the adjustment.

Wrist From the Greek word "skolios," scoliosis means bent. Normally, the spine is a straight line when viewed from the rear, from the neck to the tailbone, but curves slightly outward in the upper back and inward in the lower back. If the patient has scoliosis, though, the spine looks S or C-shaped. If a child is born with a curvature of the spine, it is called congenital scoliosis. If scoliosis is diagnosed when the child is younger than three years old, it is called infantile scoliosis. Between four and 10 years old, it is called juvenile scoliosis. Between ages 11 to 18 years old, it is adolescent scoliosis, which is by far the most common. Neuromuscular scoliosis refers to the nerves and muscles supporting the spine. It affects children with conditions such as spina bifida, cerebral palsy and muscular dystrophy. A curvature of 10 percent or more gives the child a diagnosis of pediatric scoliosis. Most children with scoliosis have slight curvatures, defined by small percentages, and do not need treatment. Three to five out of every 1, children have curves that are 50 percent or more. These cases almost always require treatment. How and when is pediatric scoliosis diagnosed? Excluding congenital scoliosis which is diagnosed at or even before birth, pediatric scoliosis symptoms usually begin when the child has a growth spurt just before puberty. This accelerated growth period typically occurs between the ages of 10 to 14; thus, regular screenings are especially important during this time of life. Until , students were tested for scoliosis in school. Since most states discontinued the mandate that required testing, scoliosis testing is not typically done in schools. Today, primary care doctors and pediatricians typically test patients for scoliosis during a school or sports physical by performing the Adams Forward Bend Test. To confirm pediatric scoliosis, the physicians at Midwest Orthopaedics at Rush use X-rays, magnetic resonance imaging MRIs , computerized tomography CT scans or bone scans. If the child has "protective genes," it will not progress. Who is likely to have pediatric scoliosis? Scoliosis is idiopathic, which means its cause is unknown. It runs in families, but not every parent with scoliosis has children with the condition. It is not an equal-opportunity condition; girls are more likely than boys to have scoliosis that is serious enough to require treatment. The larger the curve, the more likely it will progress. S-shaped curves and curves in the middle of the back progress more often. In a study conducted by the National Institutes of Health, female ballet dancers were more likely to have scoliosis if they had delayed menarche first periods or amenorrhea absence of menstruation. In rare cases, scoliosis is caused by an injury to the spine, a birth defect that affected the growth of the spine or neurological condition such as cerebral palsy or muscular dystrophy. What is the treatment for pediatric scoliosis? Non-surgical Treatment The typical scoliosis diagnosis is mild scoliosis, which requires no treatment. The child sees the physicians at Midwest Orthopaedics at Rush every six months for check-ups. The physicians watch for progression of the condition. A brace does not correct scoliosis but can prevent it from progressing. Children with moderate scoliosis wear braces until their bones have stopped growing. For girls, this is about two years after the onset of menstruation. For boys, it is when they have reached their full height. The physicians at Midwest Orthopaedics at Rush prescribe different types of braces for different degrees of scoliosis. The braces are plastic and molded to conform to the body. As the child grows, new braces must be made. Surgical Treatment Severe scoliosis often calls for spinal fusion or lumbar fusion surgery. The spine surgeons at Midwest Orthopaedics at Rush remove a joint from the spine and fill the gap with a bone graft. This makes the spine grow straight. Surgery complications can include infection, pain or nerve damage. Sometimes additional surgery is required. Through surgery, the physician safely corrects the curve while maintaining balance of the spine. An average amount of correction is usually 50 to 80 percent of the curve. The pediatric spine surgeons at Midwest Orthopaedics at Rush offer minimally invasive spine surgery MIS , while many other doctors still use the more invasive method. The traditional technique requires a five- to six-inch incision, but the minimally invasive technique requires a one- to two-inch incision. The result is less blood loss, a shorter recovery time and a lower risk of infection. After surgery, the patient usually stays in the hospital for a few days. The child must refrain from lifting or strenuous activities for six to nine months and from participating in sports that require upper body movement for six months to a year. What if the scoliosis goes untreated? Children with severe scoliosis who are not treated can develop heart and lung damage because the curvature of the spine moves the rib cage and causes it to interfere with these organs. If the spine curves enough, the child may have difficulty breathing. As adults, untreated pediatric scoliosis patients are more likely to suffer chronic back pain. The shoulders and hips are uneven and the ribs protrude. The patient becomes self-conscious and may suffer psychological problems.

Chapter 6 : Pediatric Trauma Society - Guidelines in Focus: Pediatric Cervical Spine

pediatric cervical spine injuries are uncommon account for 60% of spinal injuries in the pediatric population 3% of pediatric patients with cervical spine injury will present with neurologic deficits.

Development and clinical aspects of the pediatric spine 1. Neural and vertebral column embryogenesis 2. Biomechanics of the pediatric spine 3. Neuro and skeletal imaging studies of the pediatric spine 4. Clinical and pre-operatice evaluation 5. Anesthetic considerations in pediatric spinal procedures 6. Surgical Anatomy and approaches to the spine and spinal cord 7. Neuroanatomy of the spinal cord 8. Cervical anatomy and approaches 9. Thoracic and lumbar anatomy and approaches Lumbosacral junction and pelvis and approaches III. Congenital anomalies and developmental disorders Craniovertebral junction anomalies Chiari malformations and synringomyelia Tethered cord syndrome Intervertebral disc disease in adolescents Congenital and Development Lumbar Stenosis Spondylolysis and Spondylolithesis IV. Intramedullary spinal cord tumors Extramedullary spinal cord tumor Neurofibromatosis and the spine Primary tumors of the spine Metastatic tumors of the spine V. Vascular Malformations of the Pediatric Spine Spinal Cord AVM Spinal Cord and dural Av fistulas VI. Inflammatory and Infectious Diseases of the Pediatric Spine Inflamatory disease of the spine Pediatric and Neuromuscular Disease and Spinal Deformity Overview of neuromuscular spine deformity and treatment Pediatric Spinal Trauma and Surgical Management Spinal cord injury in children evaluation and early treatment principles Thoracolumbar spine trauma in children Injury modulation and spinal cord regeneration IX. Pediatric Spinal Deformities and Treatment Spine deformity secondary to dysplasias and other diseases Infantile and juvenile scoliosis Adolescent idiopathic scoliosis X. Special Techniques for Treatment of Spine Deformity Non-surgical management of spinal deformities Pediatric occipital cervical instrumentation Anterior cervical instrumentation in pediatrics Posterior cervical instrumentation in pediatrics Posterior instrumentation for Thoracic, thoracolumbar, and lumbar scoliosis Instrumentation for kyphosis Anterior instrumentation for Thoracic, thoracolumbar, and lumbar scoliosis Endoscopic and min-open techniques and fixations for idiopathic scoloiosis Thorascopic release and fusion in the prone position Osteotomies for correction of pediatric spine deformities Vertebrectomy and posterior substraction osteotomies for correction of severe spinal deformity Lumbosacral and sacropelvic fixation techniques Surgical techniques for correction of spondylolisthesis Expansion thoracoplasty and growing systems for complex young spine deformities Fusionless surgery for spine deformity Preop planning for revision surgery XI. Rehabilitation after pediatric spinal surgery Pediatric rehabilitation of children with spinal cord injury Close Product Description A single-volume reference for managing pediatric spine disorders and disease Ideal for neurosurgeons, pediatric neurosurgeons, and orthopedic surgeons, Surgery of the Pediatric Spine is a comprehensive multidisciplinary reference for the surgical management of the most frequently encountered spine problems in the pediatric patient. An overview of developmental and clinical aspects provides essential information on biomechanics, neuroimaging, preoperative evaluation, anesthesia, and neurophysiological monitoring. The book goes on to present the surgical anatomy and various approaches to the spine and spinal cord. Chapters are grouped into easy-to-reference sections that are organized by type of problem, including congenital anomalies and developmental disorders; neoplasms; vascular malformations; inflammatory and infectious diseases; neuromuscular disease; trauma; and deformities. The book also presents special techniques for the treatment of spinal deformity, such as osteotomy, vertebrectomy, VEPTR expansion thoracoplasty, and fusionless techniques. A chapter devoted to the rehabilitation of children with spinal cord injury covers the principles and key concepts in treatment, as well as the possible secondary complications and challenges that are unique to pediatric patients. Clinical insights from well-known experts in the fields of neurosurgery, pediatric neurosurgery, and orthopedics Detailed information for each stage of management guides the reader through clinical presentation, diagnostic studies, indications, operative techniques, nonsurgical treatments, possible complications, and outcomes More than 1, illustrations and images demonstrate key concepts Numerous cases in selected chapters illustrate management principles and treatment outcomes An invaluable resource for multidisciplinary approaches to patient care, this comprehensive text provides readers with a solid foundation in the specific issues associated with treating the pediatric patient with spine disease and disorders. Neurosurgery Ideal for neurosurgeons, pediatric neurosurgeons, and orthopedic surgeons, Surgery of the Pediatric Spine is a comprehensive multidisciplinary reference for the surgical management of the most frequently encountered spine problems in the pediatric patient. Read More A single-volume reference for managing pediatric spine disorders and disease Ideal for neurosurgeons, pediatric neurosurgeons, and orthopedic surgeons, Surgery of the Pediatric Spine is a comprehensive multidisciplinary reference for the surgical management of the most frequently encountered spine problems in the pediatric patient.

Chapter 7 : Pediatric cervical spine surgery - Mayo Clinic

Traumatic spinal cord injury (SCI) in pediatrics, although uncommon, can be devastating. Whereas there have been many evidence-based adult trials in SCI management, the data in the pediatric population are limited.

References MRI is the modality of choice for the detailed assessment of the spine in pediatric patients due to the combination of its multiplanar capabilities, excellent soft tissue contrast and lack of ionizing radiation. Neonatal patients may have spine imaging with ultrasound for certain indications because the posterior vertebral structures are still cartilaginous until approximately six weeks of age. However, MRI may still be required for further evaluation, especially if there are neurological symptoms. Occult Spinal Dysraphisms Patients with congenital spinal anomalies may present with cutaneous manifestations open neural tube defects, atypical "dimples", hairy patch, hemangiomas, pigmented skin patches or fatty lumps or with tethered cord syndrome TCS. Open spinal dysraphisms and closed spinal dysraphisms with associated mass or atypical "dimple" are typically diagnosed in the perinatal period with ultrasound and may even be diagnosed prenatally. Occult spinal dysraphisms more commonly present in the years of rapid vertical growth years , but can present at any age. Scoliosis frequently accompanies this syndrome, but is rarely the solitary complaint. Considering that the location of the conus is typically abnormally low, accurately assessing its position is of critical importance Figure 1. Spinal malformations in these children can also range from a single subtle anomaly to multiple gross abnormalities. Given the spectrum of findings seen with these congenital anomalies of the spine, whole spine MRI imaging is necessary, at least for initial evaluation. Sagittal T1 A and T2 B weighted imaging of the lumbar spine displays a low lying conus along with syringohydromyelia upper arrow in B seen along the distal thoracic spine and upper lumbar spine. A T1 linear hyperintensity is seen along the cauda equina nerve roots extending from the region of the conus is consistent with a fatty filum arrow in A. The conus terminates into a filum terminale cyst at the sacral level lower arrow in B. The large majority of these children have idiopathic scoliosis with no other structural defect. Plain radiography is the standard method for monitoring the curvature of the spine in these children and may be sufficient for preoperative planning and post-operative assessment. T2 weighted imaging of the cervical spine displays low-lying cerebellar tonsils black arrow projecting approximately 5 mm below the foramen magnum. There is also associated cystic dilatation of the central canal white arrow. However, scoliosis can be associated with a tumor, Chiari I malformation, syringohydromyelia, tethered cord anomaly and intradural or extradural cysts. In Chiari I the cerebellar tonsils protrude through the foramen magnum and may be asymptomatic and incidental, Chiari I malformations can also, although infrequently, lead to syringomyelia Figure 2 and neurological deficits. While severe spinal malformations will often be diagnosed in neonates, milder causative malformations may go undetected for many years. The first indication of a secondary scoliosis may be new or rapidly progressive scoliosis, especially if the curvature is left-sided, or it the child presents with pain or neurological symptoms, such as loss of bowel or bladder control or leg weakness. Because surgical intervention can reduce symptoms and prevent further deterioration, early identification can be beneficial. Therefore, MRI is recommended for these children. Pain Persistent back pain is rare in healthy children who have no recent history of trauma and should be taken seriously. It can be a manifestation of infectious e. Often, symptoms are non-specific and may wax and wane. Physicians may conducts tests for common causes for back pain, such as renal ultrasound for kidney stones or spinal radiography. However, these may not reveal the cause of the pain and more information may be needed from MRI. Adolescent athletes, such as those involved in gymnastics, skating, soccer, swimming, or diving, can experience low back pain associated with repetitive stress. This may be due to spondylolysis Figure 3 , which results from a defect of the pars interarticularis of the vertebral posterior elements. Radiography is the primary tool for the diagnosis of spondylolysis. However, if symptoms are suggestive of spondylolysis and radiographs are normal, further imaging is warranted. Traditionally, a radionuclide bone scan is used for this purpose. However, MRI has the advantages of no ionizing radiation and can detect edema that is associated with stress lesions in both the pars and the adjacent pedicles. In addition, MRI has the ability to diagnose other causes of pain. MRI images of an adolescent with spondylolysis. Arrows in A axial and B sagittal images show a pars interarticularis defect in a patient with back pain. Pain can also be due to an undiagnosed tumor. The most common intramedullary spinal neoplasms in children are astrocytomas and ependymomas Figure 4 that may present with pain, neurological deficits, and gait abnormalities. Indications of a spinal cord tumor may be seen on radiography as an expansion of the vertebral column but this condition is best diagnosed with MRI. There are several types of bony tumors of the spine, which can present with pain including aggressive hemangiomas aneurysmal bone cysts, chondroblastomas, osteoid osteomas and metastases e. These tumors can be difficult to visualize with radiographs. Although CT imaging shows superior bony detail, MRI has advantages in superior soft tissue evaluation and the absence of ionizing radiation. Fat saturated T1 weighted imaging of the lumbar spine with gadolinium reveals an approximately 1 cm intradural mass black arrow lying just inferior to the conus white arrow. The mass is in close continuity with the cauda equina nerve roots. Symptomatic degenerative changes are rare in the pediatric population and when present may be related to genetic factors. While disk narrowing can be seen with radiography, the degenerative changes are best visualized with MRI. Spinal infections also present with symptoms of pain, generally accompanied with fever. Discitis is more common in young children, with a mean age of 2. Osteomyelitis is more typically found in older children with systemic illness. In both cases, radiography will not reveal any signs until three weeks after disease onset but can be visualized with MRI much earlier because of the increased sensitivity to inflammation. Procedure Children are typically at least six years old before they are able to remain still long enough for MRI scanning without sedation or anesthesia, although a few children are able to do so at a younger age. A child life specialist will explain to the child what to expect and employs a number of strategies to reduce anxiety. If the child is to receive anesthesia, a pediatric anesthesiologist will administer a short-acting anesthetic agent. The patient may also require advanced airway management during the sedation, at the discretion of the anesthesiologist. Contrast is not routinely administered and is added depending on the specific clinical situation. Typical scenarios for the use of contrast include: Pediatric MRI spine protocols are custom-tailored for each specific indication. This is in contrast to typical adult spine protocols, which are typically based on the anatomic segment of interest cervical, thoracic or lumbar. Many of the protocols include at least limited whole spine imaging. Presentations that are concerning for TCS require accurate placement of the conus. Chiari I malformations are associated with syringohydromyelia which can vary in location from the cervical spine through the conus, which makes whole spine screening essential upon first diagnosis or with new symptoms. Alternatively, a new diagnosis of a syringohydromyelia necessitates not only complete spine imaging, but also consideration of brain imaging to exclude a Chiari I malformation. Contrast may also be considered for the evaluation of a new syringohydromyelia as occult neoplasms can present in this fashion. A child life specialist is available to speak with families to provide some information about what the child will experience by calling The form also requests information on other tests that will be done immediately before or after the requested examination s while still under anesthesia or sedation. This information, together with the physical and clinical history, will determine whether the patient will receive sedation or anesthesia. Examinations using sedation or anesthesia are only conducted on the main campus. Chiari type I malformation in a pediatric population. Dormans JP and Moroz L Infection and tumors of the spine in children. Scoliosis and Chiari malformation Type I in children. J Neurosurg Pediatr 7: Sports-related injury of the pediatric spine. Radiol Clin North Am Imaging in childhood scoliosis: Postgrad Med J MRI of the neonatal and paediatric spine and spinal canal. Eur J Radiol Disk degenerative disease in childhood: MRI findings in 12 patients.

DOWNLOAD PDF THE PEDIATRIC SPINE I

Chapter 8 : The Pediatric Spine | Radiology Key

Spinal Cord Injury (SCI) in the pediatric population is relatively rare but carries significant psychological and physiological consequences. An interdisciplinary group of experts composed of medical and surgical specialists treating patients with SCI formulated the following questions: 1) What is.

Pediatric spinal trauma Description Four generalized injury patterns have been recognized in pediatric spine trauma: While these injuries are rare and often carry a good prognosis, the mortality rate for certain of these injuries is relatively high. Structure and function The pediatric spine undergoes significant change during the first fifteen years of life. The immature spine becomes progressively less mobile and progressively more adult-like as the child reaches adolescence. Several anatomical features present in the pediatric spine allow for increased mobility. Early in life, the spinal synchondroses are open allowing greater movement within a given vertebral level, but most are fused by eight years of age. Greater cervical motion is afforded by the relatively horizontal orientation of the facets in the young spine. Upper cervical facets change their angulation from 30 degrees at birth to degrees by adolescence. Similarly, the lower cervical spine changes orientation of facets from 55 degrees to 70 degrees. As the facets become more vertical, the spine becomes more restricted in movements. Children also have more wedge-shaped vertebrae than adults allowing for greater forward flexion. Lastly, the uncinate processes, which restrict lateral and rotational movement, are virtually absent in kids less than 10 years old. In addition to osseous differences, the pediatric spine differs from the adult one regarding soft tissue structures too. There is relative ligamentous laxity e. In young children, these properties allow the spine to lengthen to a much greater degree than the spinal cord resulting in a high incidence of spinal cord injury without vertebral column damage higher incidence of SCIWORA in young. While the spinal column may stretch up to two inches before disruption occurs, the spinal cord may rupture with stretching of as little as one centimeter. Moreover, while the fulcrum for cervical motion hinges on C2-C3 early in life, by age 10, the center of motion has changed to C5-C6. The biomechanical features of the immature spine result in a much higher prevalence of injury above C4 in children who are younger than eight years of age and progressively higher incidences of subaxial cervical, thoracic, and lumbar spine injuries with increasing age. In Finland, the incidence of pediatric spinal injuries has been reported at 66 per children per year. One recent study has suggested that while the proportion of injuries occurring at the cervical region is higher in younger children less than 8 years old , the lumbar region may be most affected in older children. Several studies have confirmed that the level of spinal injury can be correlated to the age of the patient. The age-adjusted incidence of cervical spine injury among US children has been reported at 74 per children per year. However, a more recent study in Finland found a rate four times lower than this. There may be several possibilities to explain this finding but most likely, the difference may be attributed to advances in automobile safety regulations, as motor vehicle accidents are the leading cause of pediatric spine trauma. Much of the original epidemiological studies were from the ss and in the ensuing years, the introduction of better safety features for automobiles and car-seats may account for less frequent traumatic injury. Regarding the spinal cord, the incidence of injury ranges from This rate is higher than in adults likely because of the biomechanical properties of the immature spine and associated injuries in children. While increased flexibility in the pediatric spine may be protective in cases of minor trauma where mobility allows for motion without injury , in cases of major trauma, that same mobility may lead to catastrophic outcome as that mobility allows the cord to distract to dangerous lengths. Most reports have documented an equal distribution of spine trauma between boys and girls, but one study showed a ratio of 2: Although not well reported, the distribution among injury patterns is as follows: Some of these values have widely disparate rates. This disparity likely reflects whether the definition applies to the use of MRI or not i. Clinical presentation Biomechanical and anatomical features, such as increased head to body ratio, ligamentous laxity, muscle weakness, and facet orientation, place children at particular risk for upper cervical spinal injury. Atlanto-occipital injuries in children are often fatal and are associated with severe cord and brainstem damage. Yet, there have been some reports of patients surviving this injury with intact neurological function. Atlanto-axial instability secondary to tear of the transverse ligament is uncommon and tends to occur in younger kids as the properties of the immature spine tend to focus the load on the upper cervical spine. Injuries in children most commonly occur in the setting of motor vehicle collisions. One of the more frequent injuries seen is fracture of the odontoid. Subaxial spine injuries occur more frequently in older rather than younger children as the fulcrum of motion migrates from C to C as the spine develops. Thoracic and lumbar injuries are also more commonly seen in this population. These injuries include fracture-dislocations, burst fractures, simple compression fractures, facet dislocations, or fracture dislocations and posterior ligamentous injuries. In addition to fracture and dislocation combinations, children with spine trauma may have no manifestation of injury radiographically but still have spinal damage. While fractures or fractures with subluxation are more common in kids older than nine years, SCIWORA is more common in younger children. It is more common in younger kids likely because of spinal elasticity that allows bones and ligaments, but not the cord, to stretch without damage. Younger children with SCIWORA almost always sustain complete spinal cord injuries while older children with SCIWORA year olds often have incomplete lesions, likely reflecting the mechanism of injury in the setting of increased head to body ratio and increased flexibility in young kids leading to more severe damage. Complete lesions result in total loss of sensation and movement below the level of injury. Examples of incomplete lesions are the following: Generally, return of function begins within 72 hours of injury with return of the bulbocavernososus reflex first the lowest relex arc from S1-S3. Alternatively, patients may present in neurogenic shock. This scenario results from impairment of the descending sympathetic pathways resulting in loss of vasomotor tone and sympathetic innervation to the heart. It is characterized by the triad of hypotension, bradycardia, and peripheral vasodilation. Associated injuries significantly compound the morbidity and mortality of spinal trauma. Multiple studies have suggested that almost all fatalities in cases of spine trauma have an associated injury. Therefore, a high index of suspicion must exist for such injuries. The most commonly associated injury has been craniocerebral injury. Several other associations have been found: Seat-belt injuries, also known as flexion-distraction injuries or Chance fractures are are commonly associated with other injuries. About half of all patients with these injuries have associated GI injuries including jejunal transection and small bowel perforation. They have also been reported in conjunction with aortic dissection. In addition to other organ system injuries, multi-level spinal injury must be ruled out as well. Objective evidence Radiographic studies of the immature spinal column allow more complete evaluation of injuries, but must be interpreted with a thorough understanding of pediatric anatomy and biomechanics. Not all pediatric trauma patients need to be evaluated radiographically. If the patient is alert and conversant with no evidence of intoxication, if there is no midline tenderness, no neuro deficits, and no distracting injury, then radiographs are not necessary. Lee et al proposed the following ten risk factors for cervical spine injury for which if any are met, immobilization and radiographic evaluation are mandated: Mechanism suggestive of possible cervical spine injury 3.

Chapter 9 : Radiology Rounds - April - Pediatric Spine MRI

Pediatric scoliosis is a rather well-known, but uncommon, condition in which a child's or an adolescent's spine develops with abnormal curvature or rotations. A trained medical professional can detect scoliosis in utero (using ultrasound technology) or at any point during childhood.

Management of pediatric cervical spine and spinal cord injuries. It addresses several different facets of pediatric cervical spine management, including prehospital immobilization, imaging, and injury management. The solitary Level I recommendation involves the use of CT to determine the condyle-C1 interval in patients with atlantooccipital dislocation. This is a thankfully rare, but quite serious injury. More commonly, this guideline speaks to the value of assessing the cervical spine of injured children WITHOUT the use of imaging, if certain criteria are met: These recommendations are supported at a Level II grade of evidence. Perhaps even better is that the section on imaging walks through the available evidence regarding the different modalities for the pediatric cervical spine. Whatever your current practice, this section of the guideline is quite informative. Three recent publications contribute to our understanding of pediatric cervical spine management. Pediatric cervical spine injury evaluation after blunt trauma: Decision analysis pediatric Cspine This is a novel study designed to determine the optimal method to screen for cervical spine injuries in blunt trauma patients younger than 19 years old. The study design uses a decision analysis tree, constructed from a literature-based hypothetical population. Sensitivity analysis was utilized to balance missed injuries with malignancy risk. In this hypothetical cohort, clinical clearance and screening plain radiography with focused CT use were preferred to a CT all strategy. The Need for Standardization and an Evidence-based Protocol. Survey Cspine clearance practices Practice patterns for clearance of the pediatric cervical spine at 25 separate institutions were surveyed. Of these institutions, 21 were level 1 trauma centers. Despite the fact that these centers shared similar characteristics, the patterns of practice were quite different. This article highlights the wide variability of personnel and practice to clear the pediatric cervical spine across different institutions. Outcomes of pediatric patients with persistent midline cervical spine tenderness and negative imaging results after trauma. J Trauma Acute Care Surg. The authors conclude that the overall incidence of clinically significant findings in patients with midline cervical spinal tenderness but with negative initial imaging study findings after blunt trauma is extremely low 1. The patients in this study followed up in a specialty spine clinic, but the authors suggest that children who are discharged home from the ED in rigid cervical collars could potentially be referred to their primary care providers for initial follow-up, as opposed to subspecialists. Patients with persistent midline cervical tenderness or any other concerning signs or symptoms at the time of follow up should be evaluated in a subspecialty spine clinic. Link to care pathways: These are a few example of how different institutions are managing these children. These care pathways use different approaches based on patient age and on patient neurological status. Example 2 has a great section on skin care and pressure ulcer prevention for patients in cervical collars. Does the care pathway at your institution address this? Example 3 does not use CT at all in the listed care pathway, but it does invoke early neurosurgery consultation. This would put decisions about CT in the hands of the neurosurgery consultants. Example 5 incorporates a risk assessment based on injury mechanism, but some of the others do not. What do you think? What are you doing at your institution? What have you learned? If you want to submit your C-spine care pathway, email it to: