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Extremity Compartment Syndrome

Extremity compartment syndrome (ECS) in children is a potential cause of permanent disability. Sustained increased pressure in the limb fascial compartments compromises circulation causing ischemia and necrosis of the contents within. Early recognition is critical in avoiding further disability. Diagnosis of compartment syndrome in children can be challenging due to poor cooperation, difficulty with communication and difficulty measuring compartment pressures of the affected limb in the conscious child. The most common risk factors for ECS in the pediatric age comprise tibial diaphysis fractures, soft-tissue injury, distal radius fracture, radius and ulna diaphysis fracture and crush injury. Extremity fractures causes most ECS in children (75%) followed by vascular injury, tibial osteotomy, and soft-tissue injury. ECS can also arise from extrinsic causes that exert pressure such as compressive casts or bandages, pneumatic antishock garments, or intrinsic factors that increase the volume inside the fascial envelops such as septic arthritis, intraosseous infusions, toxic venom, burns, intramuscular hematomas, hereditary bleeding disorders and viral diseases. An open fracture of the forearm or leg significantly increases the risk for ECS. Nontraumatic causes of limb compartment syndrome in children include ischemia-reperfusion events after arterial injury, thrombosis, burns, bleeding disorders and blunt injury. The pathogenesis of ECS is tissue damage leading to increased intracompartmental pressure way above the closing pressure of venules. Continued arterial inflow increases the pressure until the arterioles develop stasis and ischemia occurs. Prolonged ischemia beyond a six-hours period results in ischemic muscle which may result in myonecrosis, chronic contracture and permanent nerve damage. Compartment syndrome is a clinical diagnosis. The affected patient develops paresthesia, numbness, swelling and pain out of proportion or with passive movement of the extremity. Diminished pulses, pallor and progressive neurologic deficit are late findings less commonly seen. Pain is one of the earliest symptoms of ECS. Sensory deficit occurs before motor dysfunction. Paresthesia in the affected extremity is one of the first signs of hypoxia to nerve tissue within a compartment. Blood flow in the capillary circulation ceases when compartment pressure exceeds 35 mm Hg. The sensory nerves are affected first, followed by the motor nerves and muscle, fat and skin become involved later. ECS can be confirmed by the measurement of tissue compartment pressure greater than 30 mm of Hg. The normal pressure in a muscle compartment is less than 10-12 mm Hg. This diagnostic method is essential in uncooperative, altered mental status, very young or children with inconsistent clinical symptoms. Measurement of compartment pressure can be performed using a slit catheter, wick catheter, needle manometer, electronic arterial pressure transducer, or a solid-state transducer intra compartment catheter. Management of symptomatic ECS with

pressures above 30 mm Hg is urgent decompressive fasciotomy. Favorable outcomes are found in children who had a fasciotomy less than six hours from the time of diagnosis. After fasciotomy, limb compartment pressures should be monitored as progressive muscle swelling may continue as a result of toxic effects of infection. The lower leg is the most common location of acute ECS with the anterior and lateral compartments most frequently affected. Children tolerate increased intracompartmental pressure for longer periods of time than adults before tissue necrosis becomes irreversible. The most common complications after ECS in children is an unpleasant scar since wound closure after upper or lower extremity fasciotomies require split thickness skin graft. Silent compartment syndrome is defined as confirmed compartment syndrome without significant pain or absence of marked pain on passive motion. Pediatric patients generally achieve good outcomes even when presenting in a delayed fashion and undergoing fasciotomies after 24 hours of the initial event. Decompressive fasciotomy is recommended even if there is prolonged time from injury to diagnosis.

References:

1- Grottkau BE, Epps HR, Di Scala C: Compartment syndrome in children and adolescents. J Pediatr Surg. 40(4):678-82, 2005

2- Kanj WW, Gunderson MA, Carrigan RB, Sankar WN: Acute compartment syndrome of the upper extremity in children: diagnosis, management, and outcomes. J Child Orthop. 7(3):225-33, 2013

3- von Keudell AG, Weaver MJ, Appleton PT, et al: Diagnosis and treatment of acute extremity compartment syndrome. Lancet. 386(10000):1299-1310, 2015

4- Shirley ED, Mai V, Neal KM, Kiebzak GM: Wound closure expectations after fasciotomy for paediatric compartment syndrome. J Child Orthop. 12(1):9-14, 2018

5- Frei B, Sommer-Joergensen V, Holland-Cunz S, Mayr J: Acute compartment syndrome in children; beware of "silent" compartment syndrome: A CARE-compliant case report. Medicine (Baltimore). 99(23):e20504, 2020

6- Lin JS, Samora JB: Pediatric acute compartment syndrome: a systematic review and meta-analysis. J Pediatr Orthop B. 29(1):90-96, 2020

Diverticulitis in Children

The most common diverticulum in children causing surgical problems is the Meckel's diverticulum. In very rare occasion the pediatric patient can develop diverticular disease of the colon similar to that occurring in the adult. Such diverticular disease can lead to colonic diverticulitis. Diverticulitis is predominantly a disease of adults older than 50 years of age, being extremely rare in children. Low quantity dietary fiber, obesity, constipation, decreased physical activity, steroids, and smoking all predispose individuals to diverticulosis. Chronic increase intraluminal pressure leads to formation of pseudo-diverticular outpouching. Less than 5% of all patients with diverticula of any etiology develop diverticulitis. The prevalence in the population younger than 40 is only 10%. No matter the age group or etiology, diverticula can develop anywhere along the colon from the cecum and appendix to the sigmoid colon. When diverticular disease occurs in children, they are associated with alterations in the component of the colonic wall. Some genetic disorders in children are associated with diverticulitis due to weakening of the colonic wall by alteration of collagen or elastin synthesis within the tissues. They include cystic fibrosis, Ehlers-Danlos syndrome, Marfan syndrome and William-Beuren syndrome. Possible complications of

colonic diverticulosis include bleeding, inflammation (diverticulitis), and perforation. Symptoms depend on localization of the diverticula. Differential diagnosis includes colon cancer, Crohn's disease, ischemic colitis, pseudomembranous enterocolitis, and pelvic inflammatory disease. CT-Scan or MRI is utilized to diagnose diverticulitis. Ultrasound and MRI can be useful alternatives in the initial evaluation of a patient with suspected acute diverticulitis when CT imaging is not available or is contraindicated. Pediatric colonic diverticulitis is often associated with a more complicated course than that seen in adults' patients. Most pediatric cases have been described in the cecum or ascending colon as a true diverticulum. Right sided diverticulitis is relatively rare inflammatory condition affecting the cecum and ascending colon. The incidence in children has not been determined since most cases are incorporated into adult series. They may be found as solitary lesion, multiple lesions, or parts of generalized diverticulosis of the colon. Right colonic diverticula are predominantly congenital and solitary being true diverticula consisting of all layers of the bowel wall. Most children complain of right lower quadrant pain with tenderness associated with nausea and vomiting. Since they can mimic appendicitis, the diagnosis is often difficult. Nonoperative management with antibiotics and bowel rest is advocated by most, leaving resection or diverticulectomy for recurrent episodes, obstructing mass, abscess, fistula, or perforation. The recurrence rate of children managed successfully with intravenous antibiotics is 18%. Classic findings related to sigmoid diverticulitis in adults include left lower quadrant pain, fever, and leukocytosis. Complicated diverticulitis is defined as diverticulitis associated with uncontained, free perforation with systemic inflammatory response, fistula, abscess, stricture, or obstruction. Micro-perforation in the absence of a systemic inflammatory response is not considered complicated diverticulitis. Symptomatic uncomplicated disease is defined as diverticulosis with associated chronic abdominal pain in the absence of clinically overt colitis. CRP above 150 mg/L is associated with complicated diverticulitis. Elevated procalcitonin is associated with diverticulitis recurrence. Most cases resolved with antibiotics. Patients with recurrent symptoms, diverticular abscess, fistula, obstruction, or stricture will need surgery. An elective resection based on young age at presentation is not recommended. Management of pediatric patients with diverticulitis should be multidisciplinary, including GI, surgery, genetics, cardiology, and ophthalmology.

References:

1- Santin BJ, Prasad V, Caniano DA: Colonic diverticulitis in adolescents: an index case and associated syndromes. Pediatr Surg Int. 25(10):901-5, 2009

2- Ignacio RC Jr, Klapheke WP, Stephen T, Bond S: Diverticulitis in a child with Williams syndrome: a case report and review of the literature. J Pediatr Surg. 47(9):E33-5, 2012

3- Yano K, Muraji T, Hijikuro K, Shigeta K, Ieiri S: Cecal diverticulitis: Two pediatric cases. Pediatr Int. 61(9):931-933, 2019

4- Hall J, Hardiman K, Lee S, et al: The American Society of Colon and Rectal Surgeons Clinical Practice Guidelines for the Treatment of Left-Sided Colonic Diverticulitis. Dis Coln Rectum 63: 728-747, 2020

5- Cadiz EM, Doan S, Kruszewski P: An Unusual Case of Diverticulitis in a Teenager With a Complicated Clinical Course. J Pediatr Gastroenterol Nutr. 71(5):e142, 2020

6- Lee ZW, Albright EA, Brown BP, Markel TA: Congenital cecal diverticulitis in a pediatric patient. J Pediatr Surg Case Rep. 2021 Sep;72:101929. doi: 10.1016/j.epsc.2021.101929.
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7- Hatakeyama T, Okata Y, Miyauchi H, et al: Colonic diverticulitis in children: A retrospective study of 16 patients. Pediatr Int. 63(12):1510-1513, 2021

Inguinal Lymphadenopathy

Inguinal lymphadenopathy (IL) refers to the condition in which peripheral inguinal or groin lymph nodes become abnormally enlarged, sometimes tender to palpation causing concern to caretakers. Lymphadenopathy is a common clinical manifestation in the pediatric age group. It may be part of normal age-related physiology or in response to any local or generalized infection in the body. Inguinal adenopathy may be a symptom to several disease process, most commonly of infectious origin. The history of the child with IL should be studied carefully since it provides clues to the underlying disease. Most groin adenopathies are self-limited infections in young patients. When confronted with a child with IL laboratory tests, imaging studies and tissue diagnosis might be needed unless there is a clear explanation for the sudden growth of the lymph node. Ultrasound, a non-invasive and non-radiating imaging study, is the best study to assess lymph nodes in the groin and neck. CT-Scan should be avoided with peripheral lymphadenopathies to reduce radiation injury associated with this imaging modality. CT-Scan is more helpful with central lymph nodes in the thorax or abdominopelvic cavities. Fine needle aspiration (FNA) biopsy can be used as initial management. FNA biopsy is easy, safe, rapid and a cost-effective tool, but will need a cooperating child to be performed. Excisional biopsy of the enlarged lymph node is the gold standard procedure and in the groin the procedure is usually simple, fast, and free from major complications. In fact, the most common complication is seroma which resolves spontaneously in most cases. In the groin lymph nodes larger than 1.5 cm in children are abnormal. It must be determined if the lymphadenopathy is localized or generalized. Generalized lymphadenopathy is defined as the enlargement of two or more groups of noncontinuous groups of lymph nodes. It results from systemic illness like infections (viral, bacterial, fungal, and protozoan), malignancies, autoimmune disease, drugs reactions, histiocytic disorders, disseminated neoplastic diseases and storage disorders. If the child does not present with overt signs of malignancy, the lymph node can be safely watch for three to four weeks before considering biopsy. Benign lesions are more commonly encountered than malignant lesions in children and include benign reactive hyperplasia (by far the most common pathology; approximately 65-85%), chronic skin diseases, cat-scratch disease, toxoplasmosis, necrotizing granulomatosis, and non-necrotizing granulomatosis. Of the malignant conditions, non-Hodgkin lymphoma is the most common. FNA biopsy can be helpful in differentiating benign from malignant pathology but is often faced with failure due to quantity of tissue to provide a diagnosis. As mentioned previously, an open biopsy with removal of the whole adenopathy is almost always diagnostic. Chronic skin disorders are a cause of what is known as dermatopathic lymphadenopathy, an entity that represents a secondary immune response to a pathologic condition affecting primarily the skin.

References:

1- Ozkan EA, Goret CC, Ozdemir ZT, et al: Evaluation of peripheral lymphadenopathy with excisional biopsy: six-year experience. Int J Clin Exp Pathol. 8(11):15234-9, 2015

2- Garces S, Yin CC, Miranda RN, et al: Clinical, histopathologic, and immunoarchitectural features of dermatopathic lymphadenopathy: an update. Mod Pathol. 33(6):1104-1121, 2020
3- Khatri A, Mahajan N, Malik S, Rastogi K, Kumar P, Saikia D: Peripheral Lymphadenopathy in Children: Cytomorphological Spectrum and Interesting Diagnoses. Turk Patoloji Derg. 37(3):219-225, 2021
4- Sandoval AC, Reyes FT, Prado MA, Pena AL, Viviani TN: Cat-scratch Disease in the Pediatric Population: 6 Years of Evaluation and Follow-up in a Public Hospital in Chile. Pediatr Infect Dis J. 39(10):889-893, 2020
5- Abantanga FA: Groin and scrotal swellings in children aged 5 years and below: a review of 535 cases. Pediatr Surg Int. 19(6):446-50, 2003
6- Hasanbegovic E, Mehadzic S: [Etiology of lymphadenopathy in childhood]. Med Glas (Zenica). 7(2):132-6, 2010

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