Pediatric Musculoskeletal Ultrasound

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19.1 Introduction

US is particularly well suited to examination of the pediatric musculoskeletal system, as an exquisite depiction of the immature skeleton with large amounts of cartilaginous bone can be obtained in a well-tolerated and noninvasive way without using ionizing radiation or sedation. Although US has been widely used in the diagnosis of hip disorders in children, many other applications for US in the pediatric musculoskeletal system have been developed (Keller 2005). More than other imaging techniques, US is ideally suited to the evaluation of the soft-tissue structures, including tendons and ligaments, joints and muscles. In this chapter, we will review the use of US in developmental dysplasia and painful hip and will also describe its use in a variety of other musculoskeletal applications, including congenital, inflammatory and traumatic abnormalities. Spine disorders are not included in this chapter.

19.2 Hip Disorders

19.2.1 Developmental Dysplasia of the Hip

Developmental dysplasia of the hip, formerly referred to by the less appropriate term “congenital dysplasia of the hip,” can be defined as a deformity of the acetabulum to various extents, in which the femoral head may lie in its proper position, sublux or dislocate (Gerscovich 1997a). Based on physical findings, the reported incidence of this condition varies widely throughout the world, accounting for approximately 2–6/1000 live newborns (Gerscovich 1997a). The cause of hip dysplasia is multifactorial and seems to be related to late alteration during
pregnancy in an otherwise normally formed hip. A variety of constitutional (female gender, white race, etc.), mechanical (oligohydramnios, breech delivery, etc.) and functional (maternal estrogen levels blocking the maturation of collagen, familiarity, etc.) factors are implicated that lead to a gradual migration of the femoral head outside the acetabulum. From the pathophysiologic point of view, the acetabulum requires a normal relationship with the femoral head for its proper development. In the newborn, reducing a prenatal dislocation may allow a stable hip to develop. However, if dislocation is not recognized early, some adaptive changes make the femoral head more difficult to reduce. In particular, hip muscles tighten and shorten because they are not at the normal resting length, the acetabulum loses its concavity, the joint space fills in with fibrofatty tissue and the ligamentum teres and joint capsule become redundant (Gerscovich 1997a) (Fig. 19.2a,b). In other words, the reduction of the femoral head becomes unfeasible with simple manipulation. In order to avoid implications not only for the child and the family but also for the health care system, an early diagnosis of developmental dysplasia of the hip is, therefore, essential for establishing a proper and relatively easy treatment (Synder et al. 2006). Physical examination is a key element in identifying the disease: it includes inspection (shorter thigh due to superior dislocation of the femur, extra skin folds, loss of the mild hip and knee flexion when supine, etc.) and two basic stress tests: Ortolani’s maneuver, which checks for reduction of a dislocated hip (Fig. 19.2a), and Barlow’s maneuver, which attempts to elicit the dislocation of a normally positioned femoral head (Fig. 19.2b) (Gerscovich 1997a). The accuracy of physical examination is, however, not absolute, with <1% reported misdiagnoses (Tredwell and Davis 1989). Because radiography has several drawbacks for early imaging of hip dysplasia due to its use of ionizing radiation and the unossified status of relevant structures, US has provided an alternative imaging technique that has now changed the understanding of and approach to

Fig. 19.1a–c. Normal anatomy and developmental dysplasia of the hip. a,b Schematic drawings of a coronal view through the hip illustrate relevant anatomic structures a in normal states and b congenital dislocation. The disposition of the ossified and the cartilaginous bone is indicated by dark gray and light gray respectively. In a, the position of the ossified shaft (fs) and ossification centers of the femoral epiphysis (e) and greater trochanter (gt) are shown; the growth plate (gp) lies between the epiphysis and the metaphysis. The acetabular cavity is invested by a layer of hyaline cartilage and surrounded by a fibrocartilaginous rim, the labrum (L), which deepens its concavity. In its deepest part, the triradiate cartilage (tc) joins the ilium and the ischium (i). b Schematic drawing shows the abnormal relationship of a dislocated femoral head with the acetabulum. The femoral head migrates upward and laterally (arrows), leaving an empty acetabulum. Absence of apposition between the acetabular roof and femoral head during growth leads to a flattened shape of the femoral head, which is trapped above the labrum, and loss of concavity of the acetabular cartilage (asterisks). The joint capsule (arrowheads) is redundant. c Anteroposterior pelvic radiograph in an infant with left hip dislocation illustrates the lines and angles used for radiographic assessment of developing hip. Hilgenreiner’s line (a) is a horizontal line drawn through the top of the triradiate cartilages; Perkins’ line (b) is a vertical line passing through the lateral edge (arrowhead) of the acetabulum. These two lines divide the hip into four quadrants. In normal states, the femoral head (arrow) lies in the inner lower quadrant, whereas in the displaced hip, it moves in the outer ones. The acetabular angle ($) – a measure of the slope of the acetabular roof – is obtained between Hilgenreiner’s line and an oblique line (d) drawn through the outer edge of the acetabulum and the superolateral edge of the triradiate cartilage. At birth, this angle is abnormal if >26° in males and >30° in females.