Magnetic Resonance Isotropic Proton Density Imaging in Children with Developmental Hip Dysplasia Status Post SPICA Casting

1Sri Krishna Alapati, MSVI, 2Myka C. Veigel, DO, 3Neil Mardis, DO, 3Kristin Fickenscher, MD, 4John Anderson, MD

1University of Missouri – Kansas City School of Medicine
2Department of Radiology, University of Missouri – Kansas City
Departments of 3Radiology and 4Orthopedic Surgery, Children's Mercy Hospitals and Clinics

Introduction

- Physical examination of a pediatric patient diagnosed with developmental dysplasia of the hip (DDH) demonstrates a congenital abnormality of femoral head location in reference to the acetabulum. The term, DDH, encompasses a variety of anatomical positions ranging from subluxation to complete dislocation.
- The incidence is approximately 1.5 in every 1,000 live births. DDH is predominantly unilateral, most often affecting the left hip. It appears to be more common in Caucasian female infants. Certain risk factors identified in DDH include breech presentation at birth, a positive family history (20 percent), oligohydramnios, and joint laxity due to maternal hormones1. Oligohydramnios causes fetal deformation and compression resulting in a propensity for hip dysplasia. [1]

Methods

- Images acquired coronally through the acetabulum looking for proper femoral head placement and alignment
- Multiplanar reconstruction performed in axial and sagittal planes
- Patient in SPICA cast, therefore eliminating motion artifact and need for sedation
- Anterior and posterior surface coils are used for better resolution
- **No sedation**
- Ear protection is utilized

Images were independently reviewed by two pediatric radiologists and a pediatric orthopedic surgeon and were scored:

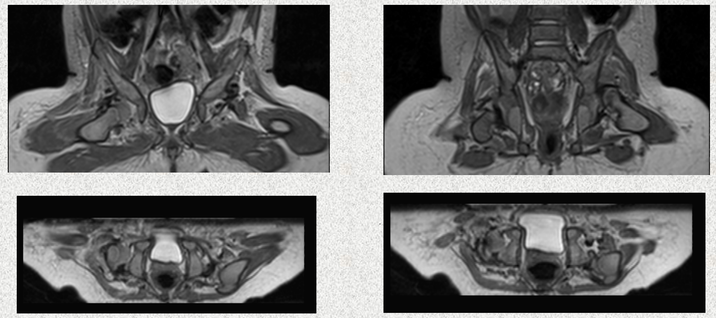
Strongly confident in femoral head location
Moderately confident in femoral head location
Weakly confident in femoral head location
Uncertain as to femoral head location

Inclusion Criteria:

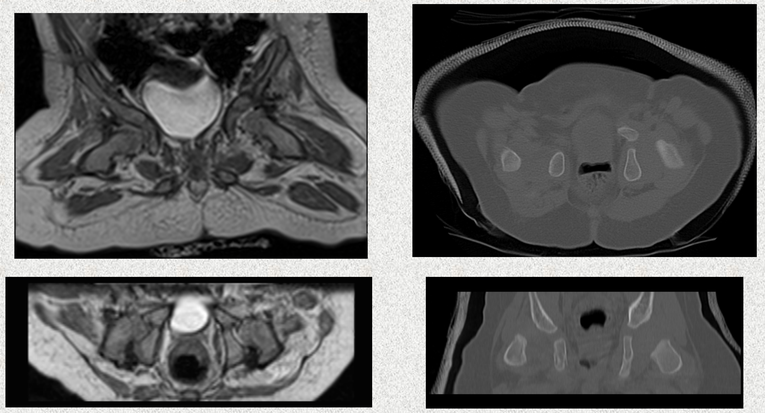
- Age — 6–18months
- Patients with developmental dysplasia of the hip, post operative femoral head reduction and SPICA casting
- Unclear reduction status, either because intra operative fluoro and plain films were inconclusive or because orthopedic surgeon was clinically unsure of reduction status

Results

10 sequential post operative SPACE three-dimensional isotropic proton density sequence MRI were reviewed. All three reviewers were strongly confident of femoral head position in each case. One case involved the use of MRI after Computed Tomography exam was insufficient in properly locating the femoral head.



Post Reduction MRI: Coronal PD SPACE with axial reformats confirms reduction of the right femoral head but reveals persistent posterior superior dislocation of the left femoral head, not seen on intra operative spot films.



Coronal PD SPACE with axial reformat confirms successful reduction of both hips.

Patient has delayed ossification of the right superior pubic ramus and right hip/acetabular dysplasia. The CT was inconclusive for successful reduction.

Discussion

- Various forms of imaging have been utilized in identifying femoral head position post operatively for DDH. Such modalities include CT, Ultrasound, and Radiographs. With CT there is better visualization of anatomy compared to ultrasound, yet more radiation exposure when compared to US/XR/MRI. With a CT exam, there is approximately 0.6-1.0 rad per examination [2]. CT can detect excessive abduction in spica cast that is not visible to the naked eye, known to cause avascular necrosis [2,3]
- Transinguinal ultrasound has also been used in the past, but a disadvantage is that US is operator dependent [4] The anatomical landmark, Shenton's line, allows for excellent demarcation of pediatric hip anatomy [5] Sometimes acoustic shadows interfere with visualization of structures in acetabulum [4] Eberhardt Et al. demonstrated in study published in 2009 that Transinguinal Ultrasound is more useful than XR in determining femoral head location

Conclusions

Use of PD SPACE MRI imaging for proper femoral head reduction in the acetabulum allows for:

- Quick imaging
- No required sedation
- Single plane acquisition with multiplanar reformats (istotropic sequence)
- No ionizing radiation exposure (ALARA- as low as reasonably achievable)
- Accurate assessment of femoral head location

References

1. O'Neill, James A. *Principles of Pediatric Surgery*. St. Louis, Mo.: Mosby, 2003. pp 855-856
2. Browning WH, Rosenkrantz H, Tarquinio T. Computed tomography in congenital hip dislocation. *J Bone Joint Surg* [*Am*] 1982; 64;27-31
3. Stanton RP, Capecci R. Computed Tomography for Early Evaluation of Developmental Dysplasia of the Hip. *Journal of Pediatric Orthopaedics.* 1992;12:727-730
4. Eberhardt, O., Zieger, M. Langendoerfer, M., Et al. Determination of hip reduction in spica cast treatment for DDH: a comparison of radiography and ultrasound. J Child Orthop (2009) 3:313-318
5. Smith BG, Kasser JR, Hey L et al (1997) Postreduction tomography in developmental dislocation of the hip: part I: analysis of measurement reliability. J Pediatr Orthop 17:626–630