MRI AFTER OPERATIVE REDUCTION FOR DEVELOPMENTAL DYSPLASIA OF THE HIP

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We performed MRI on 13 infants after operative reduction for developmental dysplasia of the hip (DDH). Using an axial gradient-echo sequence, MRI accurately depicted the acetabular anatomy and confirmed adequate reduction in 12 patients. The one patient with redislocation after surgery was correctly identified. MRI can be carried out quickly, inexpensively and without risk of radiation and is the investigation of choice to confirm adequate reduction in DDH.


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Most infants with developmental dysplasia of the hip (DDH) are treated by reduction of the dislocated femoral head which is maintained with splintage. In a few cases, reduction may be prevented by either an inverted labrum, hypertrophy of the transverse ligament or of the pulvinar, or compression of the capsule by the iliopsoas tendon and constriction into an hourglass shape. Surgery is then required. After open reduction, the position of the femoral head is maintained by a plaster spica cast, the application of which is critical. In general, the hip is held in 90° of flexion, but abduction must be carefully controlled. Too little will produce redislocation and too much may lead to undue pressure on the femoral head with an increased risk of avascular necrosis. The compromise is usually the ‘human’ rather than the ‘frog’ position. Neither hip should be abducted more than 55° to 60°.

Normal acetabular development depends on concentric reduction of the femoral head. It is therefore important to check the hip after application of the cast to ensure that the head has not redislocated. Plain films are difficult to interpret since the acetabular anatomy is obscured by the cast. Tomography is helpful, particularly if an intraoperative arthrogram has been carried out and the contrast has not been reabsorbed. Ultrasound through a window in the cast has the advantage of not using ionising radiation, although concern has been expressed that the repaired window weakens the cast. Axial CT is useful, but also involves ionising radiation. We have therefore used MRI for evaluation after reduction for DDH and we now present our results.

PATIENTS AND METHODS

We examined 13 consecutive patients over a 20-month period. There were 11 girls and two boys with a mean age of 10 months (5 to 16). MRI was performed with a Siemens 1T Impact MRI system (Siemens, UK) using a body Helmholtz coil. Two patients had axial T1-weighted images (TR = 700, TE = 15, 280 FOV), and the remaining ten all had gradient-echo T2*-weighted images (TR = 540, TE = 18, FA = 40°). Slice thickness was 4 mm non-interleaved with a 0.1 mm interslice gap on a 256 squared matrix. Scanning time for ten slices with two excitations was three minutes. Three patients had both T1 and T2* image sets. All the scans were carried out without sedation. The plaster cast, augmented by foam pillows, reduced patient movement. Four infants required a second scan after the first had failed due to movement. This decision was made by the supervising radiographer before the patient was removed from the magnet.

RESULTS

A transverse plane was the most useful for assessing the relationship between the femoral head and acetabulum (Figs 1 and 2). With this sequence and plane, the ossific nucleus is identified as a low-signal structure within the high-signal unossified hyaline cartilage. The ossified areas of the anterior and posterior columns are also seen as intermediate- to low-signal structures, separated by a band of high signal representing the triradiate cartilage. The
unossified portions of the anterior and posterior columns augment acetabular depth to a degree depending on the severity of acetabular dysplasia. The unossified anterior and posterior walls return high-signal intensity on T2*-weighting. We also performed coronal sections on some patients (Fig. 3), but these are not necessary for assessing the position of the femoral head.

DISCUSSION

The diagnosis of DDH and its classification depend on a combination of clinical and ultrasound examinations. Most infants have dislocated or dislocatable hips which are reducible. After successful reduction, the hip is held in a splint or harness. Ultrasound has an important role in confirming reduction and following progressive acetabular development.\(^1\)

Operative open or closed reduction is necessary for patients in whom reduction cannot be achieved conservatively. It is important to ensure that the newly-reduced hip has remained in the joint after application of a spica cast. Plain radiographs may be difficult to interpret and problems in obtaining an adequate lateral view may result in posterior displacement being overlooked. The acetabular anatomy is often better shown by tomography, particularly if there is residual contrast within the joint, but this involves a relatively high dose of radiation. Various other methods have been described using ultrasound and CT. To examine the hip with ultrasound in the presence of a spica cast, a window has to be cut to allow access for the transducer.\(^2\) Harcke and Kumar\(^3\) suggest that this weakens the cast and risks dislocation. Ultrasound is, however, a cheap procedure which, although difficult to learn, can be very effective in expert hands. CT has also been shown to be useful\(^4\) and to keep the radiation to a minimum, the examination can be limited to one or two carefully selected slices. The dose then becomes comparable to that of conventional radio-}

logical examinations.\(^5\)

MRI accurately depicts the normal anatomy of the infant hip.\(^6\) Preoperatively, various causes of failure of the hip to relocate can be demonstrated. Johnson, Wood and Jackson\(^7\) suggest that MRI under sedation may have a role before operative reduction, and may possibly replace peroperative arthrography. Fisher, O’Brien and Davis\(^8\) described the MRI appearance in eight patients with DDH treated with a hip spica. They used a coronal T1-weighted image in one case to confirm reduction.

Our study assesses the value of MRI after operative reduction (Fig. 4). Despite their young age, adequate scans were obtained in all patients without sedation. This can be made easier by examining patients either in the postoperative period while they are still recovering from anaesthesia, or after a feed. Movement artefact is reduced by the presence of the spica cast and can be further limited by

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Fig. 1 – A gradient-echo T2*-weighted axial scan showing both femoral heads lying in an adequate position within the acetabula after operative reduction of the left hip. The left ossific nucleus is small compared with the right.

Fig. 2 – Diagram of the normal anatomy. The femoral head (F) with a central darker ossific centre is surrounded by bright non-ossified hyaline cartilage. Acetabular landmarks include the ossified portion of the ischium (I) and pubis, separated by the bright triradiate cartilage (T). The femoral head lies within the concavity formed by the ischium and pubis, at or just posterior to the triradiate cartilage (B = bladder, R = rectum).

Fig. 3 – A gradient-echo T2*-weighted coronal scan showing both femoral heads after reduction of the left hip. This scan provided no additional information to that shown in the axial scan (see Fig. 1).
judicious use of pillows and foam sponges. Only four of the 13 patients in this study required a second sequence to provide adequate images.

Either T1- or T2*-weighted-images can be used, but we felt that the improved contrast between cartilage and bone on gradient-echo T2* images gave better resolution. We therefore favoured a single T2* axial set as the sequence of choice. With any of these sequences, the relationship of the femoral head to the acetabulum is easily assessed. The degree of abduction can also be seen so that extreme positions may be avoided. In very young infants, there is considerably more unossified cartilage than ossified and clear differentiation of the joint space may be difficult. The ossific nuclei of the femoral head, ischium and pubis are easily seen. An imaginary line is drawn joining both triradiate cartilages. When reduced, the ossific nucleus of the femoral head should lie anterior to this line. If the contralateral hip is normal, comparison is often helpful. We did not find that coronal imaging conferred any benefit in the assessment of reduction of the femoral head.

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REFERENCES