



## Evaluation of reduction quality with magnetic resonance imaging after closed or open reduction of the hip in the treatment of developmental dysplasia of the hip

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**Study analyses the usefulness of Magnetic resonance imaging (MRI) after closed or open reduction in the treatment of developmental dysplasia of the hip (DDH).**

We reviewed 20 consecutive MRI studies performed without sedation after spica cast placement in 16 patients with DDH. MRI evaluation was carried out within 24 hours after cast application. Both coronal and axial sequences are used to determine whether the femoral head is concentrically reduced, subluxed or frankly dislocated.

Except in two cases where there were difficulties in assessing the concentric reduction of the hip due to the quality of radiographs, MRI examination confirmed subluxation of the hip on coronal and axial images in patients with DDH.

Especially in the hips with unossified femoral head or if there is suspicion of reduction quality, MRI is a safe and reliable imaging modality.

**Keywords:** Developmental dysplasia of the hip ; Post-reduction MRI.

### INTRODUCTION

Developmental Dysplasia of the Hip (DDH) is a well described congenital pediatric condition resulting in underdevelopment of the acetabulum

(5). It affects the pediatric hip joint and may present with or without instability (7). The first goal of the treatment is to obtain a concentric and stable reduction and the secondary goal is to minimize the abnormality or erosion of the acetabular socket or femoral head as the child develops (2). Various imaging modalities can be used to confirm the reduction and joint congruency after application of a hip spica cast for DDH (6). The main advantage of MRI is that it can assess the hip joint in multiple planes and also it is superior to other imaging modalities in delineating soft tissue structures (3). We present the MRI results of patients treated by closed or open reduction and spica cast application

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for DDH. Our study analyses the superiority of MRI after closed or open reduction and evaluate the quality of the reduction.

### MATERIAL AND METHODS

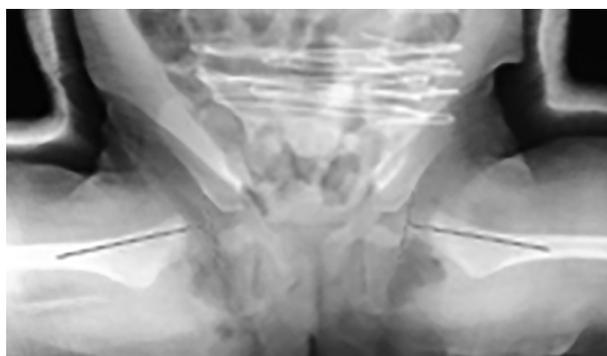
A prospective study was undertaken after obtaining the appropriate Institutional Review Board approval from the participating institutions. Informed consent was obtained from each patient after a careful explanation of risks and benefits. 16 patients between the ages of three to 13 months with DDH were evaluated. All were treated between 2011 and 2013. Among the 16 children there were 14 girls and 2 boys. The DDH diagnosis was applied at the age of one month. Four of them had a right, eight left and four had bilateral DDH. Of the 16 treated patients two infants had underlying disease or syndrome such as immune deficiency and muscular dystrophy. Total 20 dysplastic hip were evaluated.

Initial treatment in eight patients was Pavlic harness but concentric reduction was not achieved. The mean beginning age of our treatment was five month and four days. Eleven hips were treated by closed reduction and spica cast and nine hips with open reduction. Hip reduction quality was assessed by A-P radiographs made prior and after the application of a hip spica cast. Closed or open reduction under fluoroscopic guidance was performed in all cases. A spica cast was applied to maintain the hip on the position of maximal stability, without exceeding the limits. Both of hips were carried out as the same protocols. Neither anesthesia nor sedation were given during MRI examination.

The patients were placed in a supine position with the leg position limited by the cast. MRI examination couldn't be performed in one overweight patient due to hip flexion and abduction. The studies were scheduled in advance and it took 3 min time slots. Review of all sequences on the studies was independently performed by the pediatric radiologists experienced in musculoskeletal MRI and two orthopedic surgeons. MRI evaluation was carried out directly after cast application accompanied with a 1,5 tesla MRI (Magnetom



**Fig. 1a.** — Frontal radiography before closed reduction and spica cast application shows bilateral developmental dysplasia of the hips

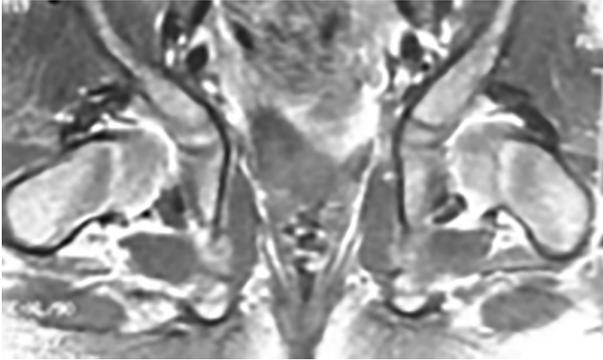


**Fig. 1b.** — Frontal radiography after spica cast application shows acceptable reduction of the both hips

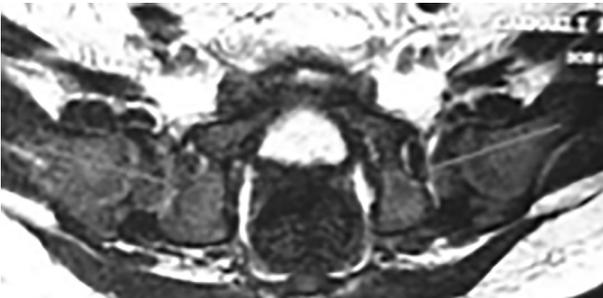
Aera, Siemens, Erlangen-Germany) in surface coil. Coronal and axial T2 sequences (TR:1000, TE: 126, flip angle 140, resolution: 320x70, FOV: 220x220 mm, section thickness 3 mm, time 1.20 min.) has been taken in both hip. Due to the overall small sample size and even smaller numbers within each sequence subset, no statistical analysis was possible.

### RESULTS

The hip reduction was evaluated intraoperatively by antero-posterior radiographs, after closed or open reduction and spica cast application in all cases. In nine cases (ten hips), the hip reduction was successful using conservative treatment (Figure 1.a,b,c,d). In the five (eight hips) cases, because of remaining hip instability following closed reduction, an open reduction and stabilization was performed. Although in two cases, the radiographs (Figure 2.a,b)



**Fig. 1c.** — Coronal imaging performed using a T2- weighted fast spin echo (FSE) technique clearly demonstrates the anatomy of the hips and the relationship of the left femoral heads to the acetabula shows concentric reduction of hips



**Fig. 1d.** — Axial T2 weighted MRI images also describes reduction quality as well

and arthrography (Figure 2.c) noted the concentric reduction of the hip, MRI examination showed subluxation of the hip on coronal (Figure 2.d,e) and axial images in these patients.

## DISCUSSION

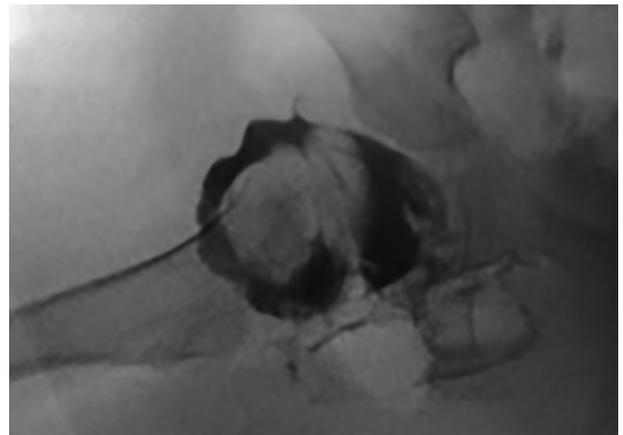
Concentric hip reduction is very important for the healing process and remodeling of the acetabulum. Within the spica cast it's inconvenient to analyze the quality of reduction. Imaging methods for assessing the position of the femoral head in the acetabulum are various such as, plane radiographs, arthrography, USG, CT and MRI. It is well known that plane radiography and CT couldn't show the femoral head comprehensively, this results in insufficient reduction due to lack of illustration of the centralization of femoral head. Arthrography is an invasive technique and cannot be performed once spica cast is in situ. USG is informative



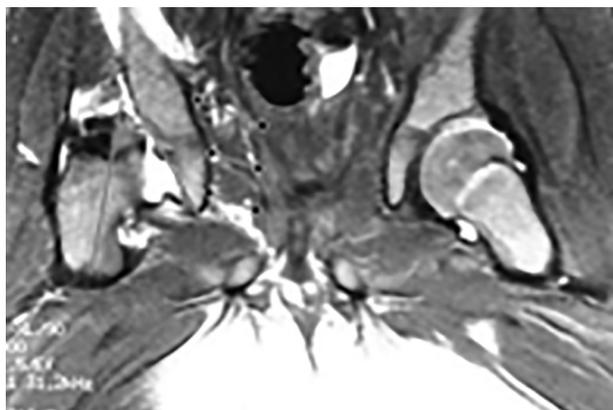
**Fig. 2a.** — Frontal radiography shows left unilateral hip dislocation



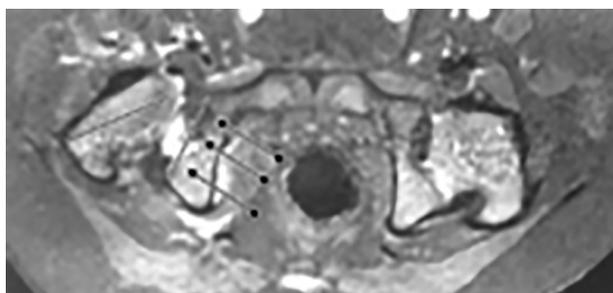
**Fig. 2b.** — Frontal radiography after spica cast application shows acceptable reduction of the left hip



**Fig. 2c.** — Left hip arthrography shows acceptable reduction



**Fig. 2d.** — Coronal T2 weighted images shows the left femoral head is smaller than the right and is slightly laterally displaced by hypertrophic, fatty pulvinar within the joint space



**Fig. 2e.** — An axial T2-weighted fast spin echo image shows lateral displacement of the hypoplastic left femoral head. The left acetabulum is dysplastic and is filled with fatty pulvinar

tool in newborns, however it is very difficult to perform in a Spica cast which has a hyperflexion and abduction. MRI is gaining popularity as a first choice imaging modality after reduction and spica cast application for DDH. This stems from fact that, MRI does not induce ionization of particles and can be performed without the need for sedation. We have identified two suspicious hip in terms of concentric reduction in plane radiographs after closed reduction and spica cast application but MRI detected persistent non-concentric reduction so open reduction was performed in these patients.

According to Laor et al. (4) and Jaramillo et al. (8), we performed our examination without sedation, directly after orthopedic intervention at a time when the general anesthesia still had a postnarcotik effect.

Duffy et al. (1) reported that transverse plane can show only 38 % concentric reduced hips whereas in coronal sequences this value was up to 71%. We

also realized our examination in two sequences; coronal and axial. It provides powerful information about concentric reduction of hip joint.

We can actually get only necessary MRI sequences to determine the concentric reduction of hip joint and this minimizes the cost compared to traditional MRI. MRI scans, after closed or open reduction and spica cast application can describe the results of treatment and avoid serious pitfalls.

In conclusion, our MRI protocol in post-reduction DDH patient's assessment provides fast and adequate images, does not expose the ionizing radiation, and can be performed quickly. Immobilization in a spica cast often precludes the need for sedation. Our study supports routine use of MRI as a valuable investigative tool for early identification of non-concentric reduction or dislocation after conservative or surgical treatment of DDH in patients who do not have an ossified femoral head.

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## REFERENCES

1. **Duffy CM, Taylor FN, Coleman L, Graham HK, Natrass GR.** Magnetic resonance imaging evaluation of surgical management in developmental dysplasia of the hip in childhood. *J Ped Orthop.* 2002 ;22 : 92-100.
2. **Ge Y, Cai H, Wang Z.** Quality of reduction and prognosis of developmental dysplasia of the hip: a retrospective study. *Hip int* 2016 ; 26 : 355-9.
3. **Hareendranathan AR, Zonoobi D, Mabee M et al.** Hip segmentation from MRI volumes in infants for DDH diagnosis and treatment planning. Conference proceedings: Annual International Conference of the IEEE Engineering in Medicine and Biology Society IEEE Engineering in Medicine and Biology Society Annual Conference. 2016 ; 2016 : 1046-9.
4. **Laor T.** Spica MRI after closed reduction for developmental dysplasia of the hip. *Ped Radiol.* 2011 ; 41 : 790.
5. **McNally EG, Tasker A, Benson MK.** MRI after operative reduction for developmental dysplasia of the hip. *J Bone Joint Surg (Br).* 1997 ; 79 : 724-6.
6. **Mitchell PD, Chew NS, Goutos I et al.** The value of MRI undertaken immediately after reduction of the hip as a predictor of long-term acetabular dysplasia. *J Bone Joint Surg (Br).* 2007 ; 89 : 948-52.

7. **Murray KA, Crim JR.** Radiographic imaging for treatment and follow-up of developmental dysplasia of the hip. *Seminars in ultrasound, CT, and MR.* 2001 ; 22 : 306-40.
8. **Rosenbaum DG, Servaes S, Bogner EA, Jaramillo D, Mintz DN.** MR Imaging in Postreduction Assessment of Developmental Dysplasia of the Hip: Goals and Obstacles. *Radiographics.* 2016 ; 36 : 840-54.