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MRI assessment after reduction in developmental dysplasia of hip

Gelişimsel kalça displazisinde redüksiyon sonrası MRG ile değerlendirilmesi

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SUMMARY

Objective: In this study, the effectiveness of magnetic resonance imaging (MRI) in patients with developmental dysplasia of the hip (DDH) after reduction was examined.
Method: Forty-two hips of 31 patients treated between 2003 and 2012 were examined prospectively. The femur head and acetabulum interaction were examined by MRI performed postreduction.
Results: The average follow-up period was 40.47 ± 36.52 months. Eleven, 10 and 10 patients were diagnosed as bilateral (B), right (R) sided and left (L) sided, respectively. The average age on MRI was 13.1 months (min, 5; max, 24). MRI was obtained without sedation, except in three patients. The mean MRI duration was 5.21 min (range, 3.55–10.50 min). Concentric reduction was monitored in 19 hips of 15 patients. Postreduction redislocation was monitored in eight hips of six patients.
Conclusions: MRI was beneficial in DDH because it was able to assess the hip extensively, did not require anesthesia, and did not use radiation. MRI provided advanced structural information that enabled the assessment of potential prevention of reduction. MRI was found to be an effective treatment scheduling method for DDH at an early period postreduction. MRI should be used more commonly in DDH.
Keywords: Developmental dysplasia of the hip, magnetic resonance imaging, reduction

ÖZET

Amaç: Bu çalışmanın amacı, Gelişimsel kalça displazisi (GKD) olan hastalarda redüksiyon sonrası değerlendirmede manyetik resonans görüntülemenin (MRG) etkinliğinin incelenmesidir.
Yöntem: 2003-2012 yılları arasında tedavi edilen 31 hastanın kırkiki kalçası prospektif olarak incelendi. Redüksiyon sonrası femur başı ve asetebulum ilişkisi değerlendirildi.
Bulgular: Ortalama takip süresi 40.47 ± 36.52 ay idi. MRG ile değerlendirme yaş ortalaması 13,1 ay (min, 5; max, 24). Ortalama MRG süresi 5,21 dakika (3,55-10,50). Konsantrik redüksiyon 15 hastanın 19 kalçasında gözlendi. Redüksiyon sonrası tekrar çıkık 6 hastanın sekiz kalçasında gözlendi.
Sonuç: MRG; radyasyon içermemesi ve iyi yumuşak doku değerlendirmesi sağlaması nedeniyle iyi bir yöntemdir. GKD'de kalça redüksiyonu sonrası değerlendirmede ve erken dönem tedavi planlamada MRG etkin bir yöntemdir. GKD'de MRG daha sık kullanılmalıdır.
Anahtar Sözcükler: Gelişimsel kalça displazisi, Manyetik Rezonans Görüntüleme, Redüksiyon

INTRODUCTION

Developmental dysplasia of the hip (DDH) is a common condition in newborns. The incidence rate varies between 1% and 5% in Europe [1]. Application of the Pavlik bandage is the first line of treatment for infants <6 months old. In patients diagnosed after the first 6 months of birth or after unsuccessful use of the Pavlik bandage, the condition is treated with plaster immobilization after open or closed reduction [2, 3]. Reduction needs to be sustainable for hip development [2]. For this reason, it is essential to verify the femoral head position after treatment [2]. Plain radiography, ultrasonography (US), arthrography, computed tomography (CT), and magnetic resonance imaging (MRI) are used to evaluate reduction in DDH. CT and plain radiography are insufficient for revealing the cartilage structure. Arthrography is commonly used but it is an invasive technique and requires general anesthesia. In addition, arthrography is impossible to repeat after the plaster is applied. US is helpful during early childhood but it is difficult to evaluate during late childhood and after plaster is applied. On the other hand, MRI provides fast and satisfactory imaging without requiring radiation or anesthesia[4]. In this study, the effectiveness and utility of MRI for monitoring and assessing patients with DDH after reduction treatment were investigated prospectively, and findings were compared with those of postreduction plain radiography.

MATERIAL AND METHODS

Patients who consulted at our clinic between 2003 and 2012, were diagnosed as having DDH, and were willing to participate were included in this study. Approval of the local ethics committee was obtained. Forty-two hips of 31 patients were included and prospectively followed (Table 1). Of the 31 patients, 11 involved bilateral DDH, 10 involved right-sided DDH, and 10 involved left-sided DDH. The average follow-up period was 40.47 ± 36.52 months. The median follow-up period was 26 months. Closed reduction and spica cast were performed under general anesthesia. Four patients had a history of unsuccessful Pavlik bandage usage. Five patients underwent open reduction with no closed reductions performed. In all patients, post spica cast reduction of hips was demonstrated using plain pelvis anteroposterior radiography. MRI was performed 1 week after reduction. The average MRI age was 13.1 months (minimum, 5 months; maximum, 24 months). Three patients were sedated during imaging, and remaining patients were not sedated. One of the parents accompanied their child during imaging. The average imaging period was 5.21 min (range, 3.55–10.50 min). A 1.5T MRI instrument (Exelart; Toshiba, Tokyo, Japan) was used for imaging. Coronary and sagittal plane images were obtained by using T1 and T2 sequences (T2-weighted fast-spin echo: repetition time (TR)/echo time (TE), 4100/100 ms; T1-weighted imaging: TR/TE, 550/15 ms, 4-mm thick sections were obtained). Two orthopedists and a senior orthopedic assistant evaluated all MRIs. The condition of the reduction in the coronary and sagittal plane images and presence of soft tissue structures interfering with reduction were analyzed. The study data was analyzed using SPSS (ver. 14.0). The data were presented in tables with case numbers and percentages, and P values of <0.05 were taken to indicate statistical significance.

RESULTS

Only three patients required sedation. Although imaging performed without sedation showed some artifacts caused by movement, none prevented evaluation of the relationship between the femoral bone and acetabulum. In 19 hips of 15 patients, concentric reduction was examined by MRI. Six hips of four patients had a history of unsuccessful Pavlik bandage usage, and concentric reduction was also examined by MRI in patients after closed reduction plastering. Eight hips of five patients who did not go through closed reduction were openly reduced. Patients who underwent concentric reduction were also examined by MRI. Consequently, 33 hips (78.5%) of 24 patients underwent concentric reduction and MRI (shape). A second spica cast was applied after 45 days to those patients who went through concentric reduction. The patients recovered without any need for additional operations after treatment.

Table 1. Characteristics of all the patients. (F: female, M: male, R: right, L: left, B: bilateral)

Patients (no)		Sex	Side	MRI age (month)	MRI findings after reduction
1		F	R	8	Dislocation, inverted labrum
2		F	L	16	Concentric reduction
3		F	B	24	Concentric reduction
4		F	B	14	Concentric reduction
5		F	B	17	Hypertrophy L.Teres,
6		F	L	16	Hypertrophy L.Teres
7		F	L	7	Concentric reduction
8		F	B	9	Concentric reduction
9		F	R	13	Concentric reduction
10		F	R	15	Concentric reduction
11		F	R	16	Concentric reduction
12		M	B	8	Concentric reduction
13		F	L	15	Concentric reduction
14		F	B	12	Concentric reduction
15		F	R	8	Concentric reduction
16		F	R	6	Concentric reduction
17		F	B	15	Concentric reduction
18		F	R	14	Concentric reduction
19		F	L	18	Evert labrum
20		F	B	15	Dislocation, hypertrophy L. Teres and labrum
21		F	R	12	Concentric reduction
22		F	L	5	Concentric reduction
23		F	R	16	Hipertrofiye lig. teres
24		F	R	7	Concentric reduction
25		F	B	18	Everte hipertrofiye labrum
26		F	L	7	Concentric reduction
27		F	B	12	Concentric reduction
28		F	L	8	Concentric reduction
29		F	L	18	Hypertrophy L.Teres
30		F	L	10	Concentric reduction
31		F	B	9	Concentric reduction

Inside the pelvipedal plaster, redislocation of two hips of two patients was observed on MRI; one of the patients had a dislocated right hip and inverted labrum. Closed reduction and spica cast were reapplied. The patient recovered without need for additional surgical operations. In the other patient, intra-articular hypertrophic ligamentum teres and labrum were observed by MRI; open reduction and Salter osteotomy were then performed for this patient. Following pelvipedal plaster treatment, redislocation of the joints of eight hips in six patients with hypertrophic ligamentum teres and a pulvinar or everted labrum was observed. Open reduction and Salter osteotomy were again recommended for these patients. Two of those patients developed a type 4 avascular necrosis (AVN; osteonecrosis) after the operation. The type 2 AVN on the right hip of another patient who underwent open reduction was kept under observation. The patient recovered during the follow-up period.

DISCUSSION

Various imaging methods have been used to evaluate DDH. In our study, 42 hips of 31 patients were examined by MRI following plain radiography verification after reduction. The effectiveness and utility of MRI were analyzed. MRI is a commonly used imaging method, but it can only provide limited imaging in late-diagnosed patients with DDH [5]. Arthrography may be used intraoperatively to evaluate hip anatomy and

structures preventing reduction. Attention should be given to contrast medium concentration and to avoid extravasation or causing damage to vasomotor nerves during needle placement [6]. The radiation load should be considered when requesting CT [1, 7, 8]. Although MRI is not regularly used in DDH, its indications are increasing. MRI is an effective method for evaluating reduction because it has no ionizing radiation, reveals soft-tissue structures thoroughly (particularly the acetabular rim, cartilage structures, and labrum), and has multiplanar imaging capability [7, 9, 10]. The high cost, sedation requirement, and imaging time are disadvantages [1, 6, 11]. We used sedation in three of 31 patients. There are reports of studies conducted with and without sedation during MRI[6,12]. We observed that we could obtain satisfactory imaging without sedating patients who underwent plastering. Immobilization under plaster reduces the need for sedation. Hypoxia under sedation is one of the major complications [13].

In our study, concentric reduction in 33 hips (78.5%) of 24 patients and redislocation within a plaster in 4.7% of the patients were observed. The redislocation rates within a plaster that we obtained were similar to those reported in the literature. In a study in which patients were treated conservatively and prospectively followed, post spica cast hip positions were first verified by plain radiography and then MRI was performed. MRI has been described as a safe and suitable method for evaluation of hip reduction after conservative treatment. Furthermore, it has been emphasized that MRI was still useful in situations when reduction was doubtful[4]. In a study in which 34 patients were examined by MRI the second day after reduction, 79.4% showed full reduction, 14.7% showed partial dislocation, and 5.9% showed full dislocation[14]. In another study, the redislocation rate evaluated by MRI after surgical reduction was 17.7% in 13 cases [3].

Some authors do not recommend MRI in postreduction follow-up because of the high rate of unacceptable positions after MRI [7]. Ömeroğlu et al emphasized that before a patient leaves the operation room, it is necessary to determine clinically and radiologically if the hip is reduced. Arthrography is recommended for reduction evaluation. Those authors also stated that redislocation would probably not occur after a concentric reduction performed by experienced professionals [15].

Imaging time depends on the anatomical location and the sequence that is used [12]. In our study, the MRI acquisition time was 5.21 min on average. Loar et al indicated 3 min, Conroy et al indicated 5 min, and Chin et al indicated 8.9 min for the imaging time [2, 8, 9]. Protocols that shorten the imaging time have been identified in the literature. The patients were scanned the first week after the reduction. Because extending the period after reduction until the first scan may disrupt the treatment course, MRI should be performed early after reduction.

MRI is superior in evaluating postsurgery complications, such as acute osteonecrosis of the femoral head and infection. AVN of the femoral head is one of the major complications of DDH treatment. AVN was seen in three patients that were followed up. Smooth recovery in the patient with type 2 AVN was observed. In patients with type 4 AVN, hips were reduced on radiographic images filmed with patients who underwent spica cast but hypertrophic ligamentum teres was detected. In these three patients, development of AVN was thought to be associated with improper position of the hip inside the plaster, compulsive manipulations during reduction, and vein injuries during surgical treatment [16, 17, 18] . Presence of an ossific nucleus prior to closed or open reduction decreases the risk of AVN occurrence. Some defined risk mitigating parameters are preoperative traction, open reduction, adductor tenotomy, and hip immobilization in human positions. Additionally, reduction age is also an important parameter [19]. No strong correlation was found between age, sex, dislocation degree, ossific nucleus development, reduction quality of patients <18 months old treated with medial approach, and the risk of AVN development. Left-sided male patients treated between 13 and 15 months of age have been found to be slightly more vulnerable to ischemic changes [17].

When MRIs of patients who underwent spica cast or patients who experienced post spica cast redislocation were examined, pathological changes, such as labral pathology or hypertrophic ligamentum teres that filled up the joints, were observed (figure 1- 2). Even though the reduction was verified by plain radiography after closed reduction and spica cast under general anesthesia, reductions obtained in these cases resulted in redislocation during the early or late period. Eight hips (19.04%) of six patients were redislocated after the spica cast treatment.

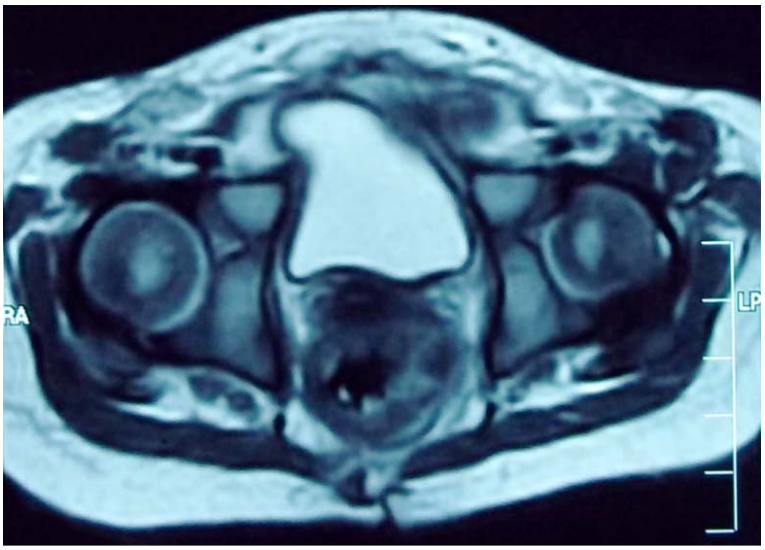

Figure 1. Magnetic resonance image of the femoral head in the acetabulum after concentric reduction is shown.

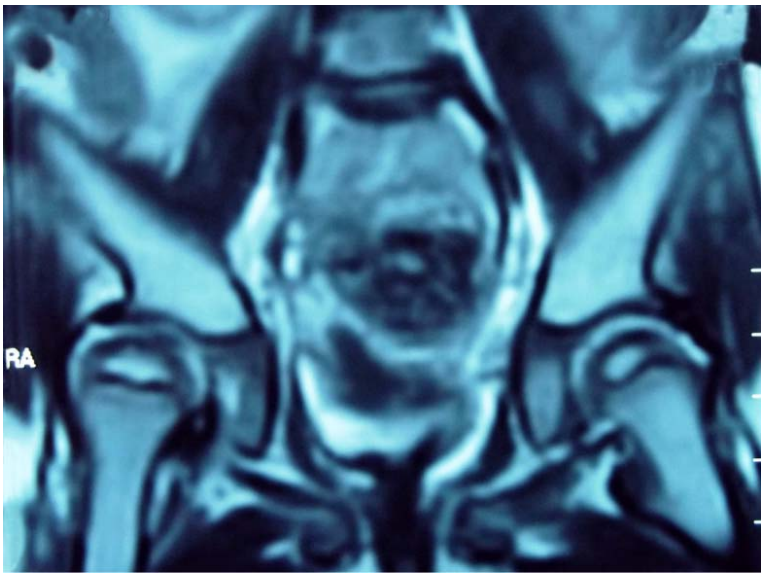

Figure 2. An image of the joints and surrounding soft tissue is shown.

Performing MRI in every case with DDH may be costly [1, 11] because although it is relatively cheaper in our country than in others, MRI is the most expensive imaging method among those used for DDH cases [10]. However, the data it provides is very valuable, and its area of usage in DDH is increasing [20, 21, 22].

MRI is useful in DDH because it enables comprehensive evaluations of the hip, requires no anesthesia, and does not emit ionizing radiation. MRI supplies information in advance that can show structures that may prevent reduction. When performed soon after reduction, MRI is an effective treatment planning method for DDH. We believe that MRI usage in DDH should be increased.

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