■ HIP

MRI assessment of femoral head docking following closed reduction of developmental dysplasia of the hip

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Aims

Eccentric reductions may become concentric through femoral head 'docking' (FHD) following closed reduction (CR) for developmental dysplasia of the hip (DDH). However, changes regarding position and morphology through FHD are not well understood. We aimed to assess these changes using serial MRI.

Methods

We reviewed 103 patients with DDH successfully treated by CR and spica casting in a single institution between January 2016 and December 2020. MRI was routinely performed immediately after CR and at the end of each cast. Using MRI, we described the labrum-acetabular cartilage complex (LACC) morphology, and measured the femoral head to triradiate cartilage distance (FTD) on the midcoronal section. A total of 13 hips with initial complete reduction (i.e. FTD < 1 mm) and ten hips with incomplete MRI follow-up were excluded. A total of 86 patients (92 hips) with a FTD > 1 mm were included in the analysis.

Results

At the end of the first cast period, 73 hips (79.3%) had a FTD < 1 mm. Multiple regression analysis showed that FTD (p = 0.011) and immobilization duration (p = 0.028) were associated with complete reduction. At the end of the second cast period, all 92 hips achieved complete reduction. The LACC on initial MRI was inverted in 69 hips (75.0%), partly inverted in 16 hips (17.4%), and everted in seven hips (7.6%). The LACC became everted-congruent in 45 hips (48.9%) and 92 hips (100%) at the end of the first and second cast period, respectively. However, a residual inverted labrum was present in 50/85 hips (58.8%) with an initial inverted or partly inverted LACC.

Conclusion

An eccentric reduction can become concentric after complete reduction and LACC remodelling following CR for DDH. Varying immobilization durations were required for achieving complete reduction. A residual inverted labrum was present in more than half of all hips after LACC remodelling.

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Introduction

The primary goal of treating developmental dysplasia of the hip (DDH) is to obtain stable concentric reduction.[1,2] Closed reduction (CR) and spica casting is a common treatment for DDH in patients aged six to 24 months;[3-5] however, concentric reduction may not always be achieved by the initial CR due to the presence of a hypertrophic labrum-acetabular cartilage complex (LACC) and other soft-tissues in the acetabulum.[6] If eccentric reduction is successfully maintained by spica casting, the femoral head can be sufficiently seated in the acetabulum, and is accompanied by remodelling of the LACC. This is known as femoral head 'docking' (FHD) after CR for DDH, first described by Severin in 1941.[7]

Dysplastic hips which undergo initial eccentric CR can develop normally, though residual dysplasia

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is common.[8-14] It is generally believed that the quality of initial CR is significantly associated with long-term outcomes.[8,9,11,14]

Changes to the femoral head and LACC secondary to CR are well visualized by MRI. Watanabe et al[15] reported the use of MRI to observe changes in femoral head position and intra-articular soft-tissue over a three-week period following CR in a single DDH patient. Talathi et al[16] used quantitative indices on MRI to describe improvement of the femoral head position within the acetabulum over a three-week period after CR in a group of 29 DDH patients. However, the anatomical transition from an eccentric to a concentric reduction after FHD is not well described. Therefore, we aimed to assess FHD after initial eccentric reduction of DDH, and describe the changes in femoral head position and LACC morphology after serial spica casting.

Methods

Clinical data. The clinical data of patients with DDH aged six to 24 months, successfully treated with CR and spica casting at our institution between January 2016 and December 2020, were retrospectively reviewed after obtaining approval from the Institutional Review Board of our hospital (2022-087). Patients who underwent serial MRI immediately after CR and at the end of each cast were included. Exclusion criteria were initial MRI showing complete reduction and incomplete MRI follow-up or unavailable imaging.

Demographic data. Between January 2016 and December 2020, CR for DDH treatment was attempted in 147 hips (128 patients) at our institution. A total of 15 hips (12 patients) were found re-dislocated and 17 hips (13 patients) showed insignificant improvement in femoral head positioning on MRI scans at the end of first cast period. Overall, 115 hips (103 patients) were successfully treated (115/147, 78.2%). A FTD < 1 mm was obtained in the initial reduction of 13 hips (ten patients; 13/115, 11.3%) and were excluded; all were classified as IHDI grade 2. Serial MRI scans were unusable for ten hips (seven patients). In total, 92 hips (86 patients: five males, 81 females) were included in the study, with a mean age of 13.6 months (SD 5.1; 6 to 24) at initial reduction. Unilateral and bilateral hips were involved in 80 and six patients, respectively. Based on preoperative radiographs, 23, 51, and 18 hips were classified as IHDI grades 2, 3, and 4, respectively.

CR protocol for DDH. Pre-reduction plain radiographs were evaluated using the International Hip Dysplasia Institute (IHDI)[17] classification. Patients with IHDI grade 4 DDH underwent pre-reduction longitudinal skin traction for two weeks. CR was performed under general anaesthesia and the stability was assessed. Patients with a safe zone of > 20° were further treated by spica casing in the human position with 90° to 110° hip flexion and approximately 60° abduction. Adductor release was performed when the maximum abduction was < 60°, and the safe zone was < 30°. MRI (3.0 T MR750; GE Healthcare, USA) was performed within 24 hours after spica casting and at the end of each casting treatment, with rectally administered 0.05 g/kg chloral hydrate for sedation. Spica casting included two casting treatments, each period lasting two to three months (i.e. total casting of four to six months); a brace was applied for 12 hours a day for three months after the second cast period. The duration of immobilization was calculated from the initial reduction. Failures of CR were considered as either re-dislocation of the femoral head in the cast confirmed by MRI, or insignificant improvement in femoral head position on MRI at the end of the first cast period when compared to the initial CR.

Evaluation of MRI scans. MRI was performed using a 3.0 T MR scanner with an eight-channel cardiac coil, with the following protocol: routine SE T2WI repetition time (TR)/time to echo (TE) = 3,000/85 ms; Fat Suppression proton density-weighted imaging (PDWI) TR/TE = 2,500/40 ms; matrix = 320 × 256; field of view = 240 to 220 mm; slice thickness = 3.5 mm; slice gap = 0.5 mm; and number of acquisitions = three. The FTD was measured using midcoronal T2WI scans of the hip using a picture archiving and communication system (PACS; Carestream Health, USA). FTD was measured in a straight line connecting the centre of the femoral head and the centre of the triradiate cartilage (Figure 1a); measurements were performed on serial MRI scans. Complete reduction of the femoral head was defined as a FTD < 1 mm, as FTDs of 80 normal hips scanned in our database were all < 1 mm.

At the initial reduction, the morphology of LACC was classified into three types: inverted: the acetabular cartilage had a convex shape without an everted margin, and the labrum was inverted into the acetabulum (Figures 1a and 2a); everted: the acetabular cartilage and labrum were both everted (Figure 3a); and partly inverted: the acetabular cartilage was everted with a blunt margin, but the labrum was inverted into the acetabulum (Figure 3b), the cartilage and the labrum were indistinguishable on MRI, and part of the LACC was everted and part was inverted (Figure 3c).

At the end of each cast period, the LACC morphology was also classified into three types: inverted: the LACC was still completely inverted (Figure 1b); everted-incongruent: the lateral portion of the LACC was everted with a blunt margin, the labrum could be outside or inside of the acetabulum, and the cartilage surface was incongruent with the femoral head (Figure 2b); and everted-congruent: the lateral portion of the LACC was everted with a sharp or mildly blunt margin, and the cartilage surface was congruent with the femoral head (Figures 1c and 2c). The everted-congruent type was considered to represent a 'normal' shape after remodelling. On the midcoronal PDWI scans at the end of the second cast, a thin layer of fibrous tissue between the femoral head and acetabular cartilage was interpreted to be the residual inverted labrum (Figure 1d), though in some patients this did not exist (Figure 2d).

FTD measurement and LACC classification were evaluated by three independent observers (FZ, ZZ, YJ, all fellowship-trained paediatric orthopaedic surgeons) who were blinded to each other's assessments and the patient information.

Acetabular index, migration percentage, and avascular necrosis. For patients who had more than three years' follow-up, acetabular index (AI), migration percentage (MP),[18] and avascular necrosis (AVN) were evaluated on plain radiographs three years after the initial CR. The presence or absence of AVN was determined by three independent observers according to criteria described by Salter et al.[19]

Statistical analysis. Statistical analysis was performed using SPSS v. 17.0 (SPSS, USA). Interobserver reliability was assessed using the intraclass correlation coefficient (ICC). An

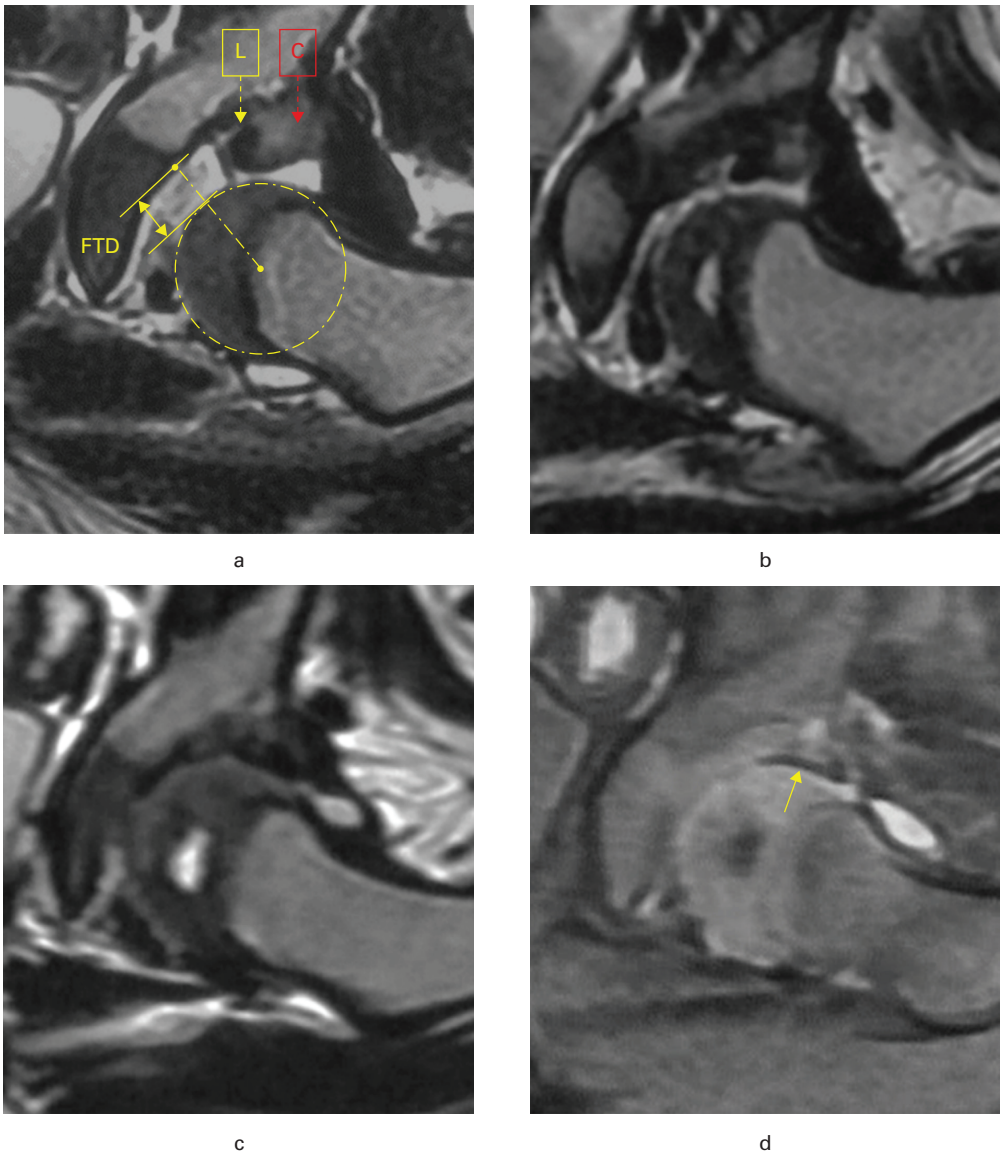

Fig. 1

MRI scans in the coronal plane of a 13-month-old female patient with left developmental dysplasia of the hip treated by closed reduction and spica cast immobilization. a) Immediately after the initial reduction, incomplete reduction (femoral head to tricartilage distance (FTD) = 6.68 mm) and inverted labrum-acetabular cartilage complex (LACC) are seen on the T2 weight image (T2WI) scan; FTD was calculated by the distance between the centre of the femoral head and the lateral edge of the triradiate cartilage minus the radius of the femoral head, and the morphology of the LACC was determined by the direction of acetabular labrum (low signal intensity, as shown by the yellow arrow) and cartilage (medium signal intensity, as shown by the red arrow). b) At the end of first cast with 67 days' immobilization, decreased FTD and inverted LACC are seen on the T2WI scan. c) At the end of second cast with a total of 171 days of immobilization, concentric reduction with complete reduction and congruent cartilage are seen on the T2WI scan. d) A residual inverted labrum was found between the femoral head and acetabular cartilage on proton density-weighted imaging scan as shown by the yellow arrow.

ICC of 1.0 represents perfect agreement. Intermediate correlation values were categorized according to Munro (0.9 to 1.0 = very high; 0.7 to 0.89 = high; 0.5 to 0.69 = moderate; 0.26 to 0.49 = low; 0.0 to 0.25 = little if any).[17,20] Continuous variables (age, duration of immobilization, FTD, AI, MP) were expressed as mean and standard deviation (SD), and differences between two groups were assessed using the independent-samples *t*-test. Categorical variables (IHDI grade, LACC morphology) were compared using the chi-squared test. A p-value ≤ 0.05 was considered statistically significant. Variables with $p < 0.10$ from univariate analysis were included in the multiple logistic regression analysis for the achievement of complete reduction at the end of the first cast period.

Results

Changes in femoral head position. The mean FTD of the 92 hips with initial eccentric reduction was 3.7 mm (SD 1.3; 1.5 to 6.8); the total immobilization duration at the end of first cast

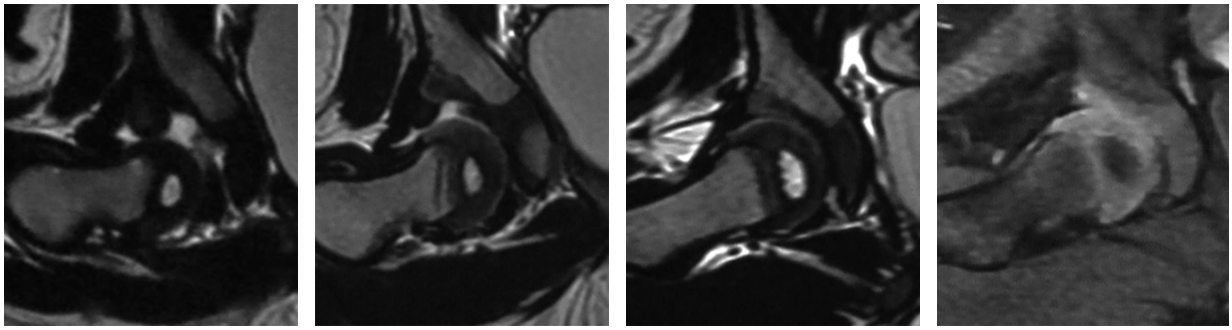

Fig. 2

MRI scans in the coronary plane of a 15-month-old female patient with right developmental dysplasia of the hip. a) Immediately after initial reduction and b) at the end of first cast with 76 days of immobilization, an everted-incongruent labrum-acetabular cartilage complex is seen. c) At the end of second cast with 157 days of immobilization, concentric reduction was obtained and d) no residual labrum was found.

Fig. 3

Labrum-acetabular cartilage complex (LACC) morphology (except inverted type) on MRI scans immediately after initial reduction. a) Everted LACC: the cartilage was everted without inverted labrum. b) Partly inverted LACC: the cartilage was everted with inverted labrum. c) Partly inverted LACC (overriding type): the entire LACC was divided into an inverted part and an everted part.

was 70.0 days (SD 15.5; 46 to 97). At the end of the first cast period, 73 hips (79.3%) had a FTD < 1 mm, i.e. complete reduction was achieved. The remaining 19 hips had a FTD > 1 mm; the mean FTD decreased from 4.8 mm (SD 1.1) to 2.1 mm (SD 1.3), and the difference was statistically significant ($p < 0.001$, independent-samples *t*-test). The total immobilization duration at the end of second cast was 133.4 days (SD 17.8; 106 to 179), and all 92 hips achieved FTD < 1 mm. There was a very high level of agreement between all observers in the FTD measurement with an ICC of 0.94 (95% confidence interval (CI) 0.91 to 0.96).

The complete and incomplete reduction groups at the end of first cast showed statistically significant differences in initial FTD, age at initial treatment, and immobilization duration, whereas differences in IHDI grade and initial LACC morphology were not significant (Table I). Multiple logistic regression analysis showed that the initial FTD ($p = 0.028$) and immobilization duration ($p = 0.011$) independently influenced the achievement of complete reduction at the end of first cast period (Table II).

Changes in LACC morphology. LACC morphology in initial reduction was classified as inverted, partly inverted, and everted in 69 (75%), 16 (17.4%), and seven (7.6%) hips, respectively. At the end of first cast period, the LACCs of nine hips remained inverted, 38 hips (41.3%) were everted-incongruent, and 45 hips (48.9%) were everted-congruent; none of the 19 hips that did not achieve complete reduction was everted-congruent. Among the 69 hips with initial inverted LACC, nine hips (13.1%) were still inverted, 33 hips (47.8%) were everted-incongruent, and 27 hips (39.1%) were everted-congruent (Table III). There was a high level of agreement between all observers in the evaluation of LACC morphology, with an ICC of 0.89 (95% CI 0.84 to 0.92) at the initial reduction and an ICC of 0.90 (95% CI 0.86 to 0.93) at the end of the first cast period.

At the end of the second cast period, all 92 hips achieved everted-congruent morphology; however, 50/85 (58.8%)

Table I. Univariate analysis of achievement of complete reduction at the end of the first cast period.

Variable	Complete reduction	Incomplete reduction	Statistic value	p-value
Hips, n	73	19		
Mean initial FTD, mm (SD)	3.4 (1.2)	4.8 (1.1)	-4.570	< 0.001
Mean age at reduction, mths (SD)	13.4 (5.1)	16.5 (3.9	-2.990	0.005
Mean duration of immobilization, days (SD)	71.1 (17.0)	64.1 (9.2)	2.447	0.017
IHDI grade, no. of hips (%)			2.762	0.251†
2	21 (91.3)	2 (8.7)		
3	38 (74.5)	13 (25.5)		
4	14 (77.8)	4 (22.2)		
Initial LACC morphology, no. of hips (%)			3.140	0.208†
Inverted	52 (75.4)	17 (24.6)		
Partly inverted	14 (87.5)	2 (12.5)		
Everted	7 (100)	0		

*Independent-samples *t*-test.
†Chi-squared test.
FTD, femoral head to triradiate cartilage distance; IHDI, International Hip Dysplasia Institute; LACC, labrum-acetabular cartilage complex; SD, standard deviation.

Table II. Multiple logistic regression analysis of achievement of complete reduction at the end of the first cast period.

Variables	OR (95% CI)	p-value
Age at reduction	0.887 (0.778 to 1.012)	0.076
Initial FTD	0.514 (0.307 to 0.859)	0.028
Duration of immobilization	1.054 (1.006 to 1.104)	0.011

CI, confidence interval; FTD, femoral head to triradiate cartilage distance; OR, odds ratio.

hips with an initial inverted or partly inverted LACC exhibited a residual inverted labrum between the femoral head and the acetabulum. In the 19 hips that did not achieve complete reduction at the end of first cast, 17 hips (89.5%) had a residual inverted labrum at the end of the second cast period. The age at treatment, initial FTD, IHDI grade, and initial LACC morphology were compared between the hips with and without residual inverted labrum. Patients with residual inverted labrum had significantly higher mean ages at treatment and initial FTD values than those without, although differences in IHDI grade and initial LACC morphology between the groups were not statistically significant (Table IV).

Radiological results at three years' follow-up after CR. A total of 61 patients with 67 hips had over three years of follow-up. The AI before reduction and three years after reduction were 35.8° (SD 5.0°; 25.0° to 46.0°) and 24.2° (SD 4.3°, 18.4° to 35.9°) respectively, ($p < 0.001$, independent-samples *t*-test). The AI in the 29 hips without a residual inverted labrum was 21.4° (SD 1.6°), and the AI in the 38 hips with a residual inverted labrum was 26.0° (SD 4.3°). The difference was significant ($p < 0.001$, independent-samples *t*-test). The MP three years after reduction was 14.0% (SD 8.1%; 2.2% to 41.2%). The MP was 16.6% (SD 9.0%) and 10.6% (SD 5.2%) in the hips with and without residual inverted labrum, respectively. The difference was significant ($p = 0.002$, independent-samples *t*-test).

According to Salter et al's[19] criteria, AVN developed in 11 out of 67 hips (16.4%). AVN occurred in none of the 14 hips with an IHDI grade 2, in five of the 40 (12.5%) hips with IHDI grade 3, and in six of the 13 (46.2%) hips with IHDI grade 4; the difference between groups was significant ($p = 0.003$, chi-squared test). AVN was independent of the initial LACC morphology ($p = 0.588$, chi-squared test). The rate of AVN in the hips with or without residual inverted labrum was 18.4% (7/38) and 13.8% (4/29), respectively; the difference was not significant ($p = 0.612$, chi-squared test).

Discussion

Using serial MRIs of patients with DDH undergoing CR, we described how eccentric reduction can become concentric. Our protocol enabled all patients to achieve concentric reduction and LACC remodelling; though varying durations of spica casting were required, and a residual inverted labrum was present in more than half of hips.

Children aged six to 24 months undergo CR treatment aiming to achieve concentric reduction, which is the basis for restoring normal hip development.[1-5] Initial CR does not always enable concentric reduction due to a hypertrophic LACC and other soft-tissue in the acetabulum.[6] In some institutions, open reduction is recommended if concentric reduction is not achieved with initial CR.[21] It has been demonstrated that DDH with initial eccentric reduction achieved by way of CR can also lead to normal development.[8-12] This is because an eccentric reduction, successfully maintained in a spica cast, can be transformed into a concentric one through FHD. However, the degree of eccentric reduction which would be acceptable in CR treatment remains controversial. Race and Herring[8] reported that reduction with < 7 mm medial dye pool (MDP) was adequate, while Gans and Sankar[22] concluded that a MDP ≤ 16% of the femoral head width (approximately 2 to 3 mm) is sufficient.

Although FHD was first described in 1941,[7] the details of the femoral head position and LACC morphology changes obtained during the FHD process are not well understood. MRI is often used to confirm the quality of reduction immediately after CR, as it enables clear observation of the femoral head position and LACC morphology. At our institution, we also perform MRIs at the end of each cast period. As demonstrated in this study, we are thus able to observe the complete FHD process using serial MRIs. Some studies have also observed the changes in femoral head position and LACC morphology over a three-week period,[15,16] or a five-week period[23] following CR; however, they did not observe the achievement of

Table III. Changes in labrum-acetabular cartilage complex morphology from initial reduction to the end of the first cast period.

At initial reduction	At the end of first cast, no. of hips (%)		
	Everted-congruent	**Everted-incongruent**	**Inverted**
Inverted	27 (39.1)	33 (47.8)	9 (13.1)
Partly inverted	11 (68.8)	5 (31.2)	0
Everted	7 (100)	0	0
Total	45 (48.9)	38 (41.3)	9 (9.8)

LACC, labrum-acetabular cartilage complex.

Table IV. Univariate analysis of residual inverted labrum at the end of the second cast period.

Variable	Inverted labrum present	Inverted labrum absent	Statistic value	p-value
Hips, n (%)	50 (58.8)	35 (41.2)		
Mean initial FTD, mm (SD)	4.1 (1.3)	3.4 (1.1)	2.614	0.011*
Mean age at reduction, months (SD)	15.3 (4.4)	12.0 (4.1)	3.199	0.002*
IHDI grade, no. of hips (%)			3.768	0.152†
2	9 (39.1)	11		
3	28 (54.9)	20		
4	13 (72.2)	4		
Initial LACC morphology, no. of hips (%)			0.110	0.740†
Inverted	40 (58.0)	29		
Partly inverted	10 (62.5)	6		

*Independent-samples *t*-test.
†Chi-squared test.
FTD, femoral head to triradiate cartilage distance; IHDI, International Hip Dysplasia Institute; LACC, labrum-acetabular cartilage complex; SD, standard deviation.

concentric reduction. Our study represents the first attempt to observe the detailed changes during the FHD process on serial MRI scans, and showed the transition from an eccentric to a concentric reduction.

Similar to our findings, Zhou et al[12] and Talathi et al[16] have also found that the femoral head moves medially and cranially into the acetabulum in the coronal plane. In our study, we directly measured the FTD on the midcoronal section, which was found to be consistent with the direction of the femoral head movement. Complete reduction was considered achieved when the femoral head reached the base of the acetabulum (i.e. FTD < 1 mm). In our study, only 11.3% of the hips achieved complete reduction in the initial reduction, similar to the results (8.6%) of Zhou et al.[12] This suggests that the goal of initial CR is not concentric reduction.

At the end of the first cast period, we confirmed considerable improvement in femoral head position with 79.3% of the hips achieving complete reduction. Our results revealed that a longer duration of immobilization was needed to achieve complete reduction if the initial incomplete reduction was of a lower quality. It was demonstrated that at the end of the second cast period, all hips achieved complete reduction. However, our results did not suggest that all incomplete reductions could reach complete reduction, as we discontinued the CR treatment if insufficient improvements in femoral head position were confirmed by MRI at the end of the first cast period. We have previously investigated what degree of incomplete reduction could achieve complete reduction.[24]

There is no consensus on the duration of spica casting following CR.[25,26] In some institutions, braces are applied after three months of cast immobilization,[12,16,25] which may be insufficient for some CRs of low quality. It was well known that the quality of reduction was indicated by the distance between the femoral head and bottom of the acetabulum. Here, a low-quality reduction was considerered as a reduction with large FTD. The exact quality of reduction that needs more than three months of cast immobilization requires further investigation. Zhou et al[12] performed three months of spica casting for all DDHs with stable CR; only 68.6% achieved concentric reduction by six months after CR. If CR is chosen for DDH patients with stable low-quality reduction, prolonged immobilization by cast should be recommended.

The inverted LACC is considered a potential obstruction for complete reduction and may affect subsequent hip development.[27,28] In our study, the remodelling of LACC morphology was clearly observed on MRI scans. The LACC remodelling went through two phases: pre- and post-complete reduction. During the pre-complete reduction phase, the inverted LACC is outwardly compressed by medial movement of the femoral head in a single direction, thus developing an everted-incongruent shape. After complete reduction, the acetabular cartilage is continuously compressed by the concentric movement of the femoral head in multiple directions, and gradually develops an everted-congruent shape. The everted or partly inverted LACC became everted-congruent much earlier than inverted LACC, because the process from inverted to everted-incongruent was skipped.

Watanabe et al[29] first reported the MRI finding of a membranous fibrous interposition between the femoral head and the acetabulum, and their histological examination revealed chondrometaplasia in the fibrous tissue. Zhou et al[12] found a similar interposition on MRI after CR for DDH. Additionally, Liu et al[30] found that the improvement of AI was affected by residual inverted labrum after CR over a four-year follow-up. We have also found that three years after CR in hips without a

residual inverted labrum, the AI and MP were both significantly lower than in hips with a residual inverted labrum. Our results revealed that younger DDH patients with better CR quality have a lower risk of residual inverted labrum. It is generally accepted that the quality of the initial CR and age at treatment are strongly correlated with the long-term outcome.[8-14] The residual inverted labrum may be a potential pathological factor that affects acetabular development.

The presence of an inverted labrum is believed to cause OA of the hip in adulthood.[31,32] A biomechanical study by Wang et al[33] reported that the interposition of an inverted labrum caused local stress concentration. We still need to study the effects of the residual labrum during long-term follow-up.

AVN is a serious complication of CR treatment, which can lead to the disturbance of femoral head and neck development and, ultimately, to the development of early-onset OA.[34,35] The rate of AVN in our study was 16.4%, and the risk was very high (46.2%) in the hips with IHDI grade 4. AVN was not found to be related to the LACC morphology. In our previous study,[36] we found that AVN after CR treatment was mainly related to the severity of dislocation (IHDI classification), and that if the reduction was maintained in a safe spica cast with appropriate abduction (generally less than 60°), the FHD process did not increase the risk of AVN.

There are several limitations to this study. First, the range of immobilization duration was relatively large owing to the retrospective nature of the study. Second, errors have inevitably occurred in measurements and assessments; however, the agreement between observers in our study was acceptable. Finally, long-term follow-up is needed to investigate the effects of the residual inverted labrum and LACC remodelling on clinical outcomes.

In conclusion, this study provides a detailed description of changes in femoral head position and LACC morphology occurring after CR of DDH, which helps to understand the FHD process. Our results demonstrate that an eccentric reduction can become concentric after complete reduction and LACC remodelling following CR for DDH within two to six months. Varying durations of immobilization were needed to achieve complete reduction, which depended on the quality of the initial reduction. The remodelling of LACC occurred depending on the movement of the femoral head. An everted-congruent LACC could only be obtained after achieving complete reduction. Residual inverted labrum existed in more than 50% of the hips, which was related to the age at treatment and quality of initial CR, and may be a risk factor for residual acetabular dysplasia and long-term degenerative change.

Take home message

- An eccentric reduction of higher quality can become concentric earlier following closed reduction for developmental dysplasia of the hip.
- The remodelling of the labrum-acetabular cartilage complex occurred depending on the movement of the femoral head. Residual inverted labrum is more likely to be found in older patients with worse reduction, and may be a risk factor for residual acetabular dysplasia.

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