

Magnetic resonance imaging evaluation of the effects of closed reduction in infants with developmental dysplasia of the hip

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To the Editor: Manual closed reduction has become the most common treatment for infants with developmental dysplasia of the hip (DDH), especially those under 18 months old, because it can minimize the limitations of the post-operative range of motion of the hip joint and reduce iatrogenic avascular necrosis.^[1] As 90% of children with symptomatic DDH have lesions on the acetabular labrum, we initiated a magnetic resonance imaging (MRI) study of acetabular labrums of dysplastic hips to determine how magnetic resonance-based parameters and contents of joint space could be used to evaluate the therapeutic effect of closed reduction in DDH patients.^[2]

This is a descriptive and retrospective study. A total of 23 patients (four male and 19 female) were included in the study, all of them were less than 18 months old and undergone closed reduction surgery in the Third Affiliated Hospital of Southern Medical University from January 2016 to December 2017 during the study period. Patients were inspected using a 1.5-T MRI scanner (Ingenia, Philips, the Netherlands) with the femurs at an abduction angle of 60°. Clear and qualified MRI data of the hip were collected within one week before and after the surgery. One study^[3] found that the MRI-based parameters, such as labral angle (LA) and zone of compressive force (ZCF), could be used to evaluate the structure of the labrum. Figure 1A shows the measurement of LA, which is the angle between the labrum and the acetabulum. Line H is a baseline that was drawn horizontally through the superior aspect of the triradiate cartilage, and a second line was drawn through the bony margin of the acetabulum. Following this, a line was determined representing the direction of the labrum (Line A), which is the midline between the inner and outer appendages (points B and C) and the distal apex. Figure 1B shows the determination of ZCF. ZCF is a zone entered by a line perpendicular to Line H, then tilted inward 16° (the resultant force of partial body weight and the abductor muscle group) and passed through the center of the femoral head, which is used to

assess the relationship between the affected hip and the compression force acting on it.^[4] The upper part of the acetabular bone is divided into three equal areas, which are numbered as 2, 3, and 4, with zone 1 consisting of the labrum alone. All parameters were measured three times on proton-density-weighted spectral pre-saturation attenuated inversion recovery sequence by two radiologists with more than 10 years of experience, then averaged. We observed and classified three kinds of post-operative conditions in DDH patients, including concentric reduction, near reduction, and mild subluxation, which are different from the clinical classification. These assessments were based on the MRI results of LA* (affected-unaffected side), ZCF, and joint space content.

Results indicated that eight cases experienced a complete concentric reduction, eight cases experienced near reduction, and seven cases displayed mild subluxation. Figures 1C–E show the MRI examples of concentric reduction, near reduction, and mild subluxation, respectively. The LA* values of the cases with concentric reduction were all <0° (average -15°). Additionally, all ZCF measures were in the 3-area and transverse acetabular ligaments were observed. The LA* of the cases with near reduction were all <0° (average -4.5°). As for the ZCF assessment, two cases were in area 2, two cases were in area 4, and the remaining five cases were in area 3, and there were transverse acetabular ligaments and fibrous tissue observed in the hip joint space. Seven cases showed mild subluxation, with an average LA* value of 1°. ZCF assessment yielded four cases in area 4 and four cases in area 3. There were transverse acetabular ligaments, iliac ligaments, and fibrous tissue embedded within the hip joint gap.

Through comparative observations of MRI of patients pre- and post-operation, most cases were found to achieve concentric and near reduction. After multiple follow-up surveys, most patients showed no sequelae or defects in movement. We believe closed reduction to be the

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DOI:
10.1097/CM9.0000000000001269

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Chinese Medical Journal 2021;134(5)

Received: 11-08-2020 Edited by: Ning-Ning Wang

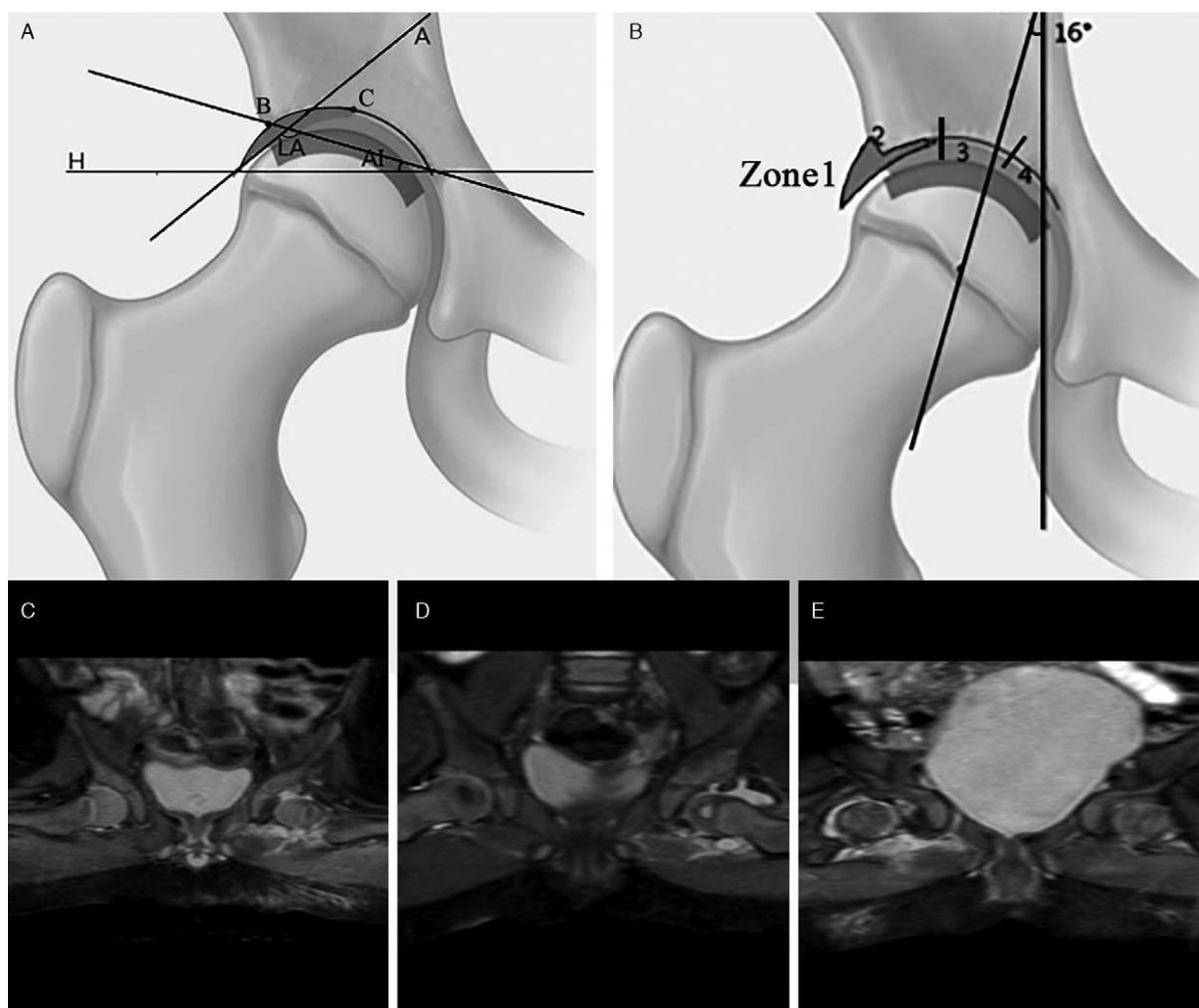


Figure 1: The determination of the MRI-based parameters and the MRI examples of three kinds of post-operative conditions. (A) Measurement of LA; (B) Determination of the ZCF; (C) PDW-SPAIR image showing that the left hip achieved concentric reduction after surgery; (D) PDW-SPAIR image showing that the left hip achieved near reduction after surgery. (E) PDW-SPAIR image showing that the right hip achieved mild subluxation after surgery. LA: Labral angle; MRI: Magnetic resonance imaging; PDW-SPAIR: Proton-density-weighted spectral pre-saturation attenuated inversion recovery; ZCF: Zone of compressive force; AI: acetabular index.

appropriate method for treating DDH in infants. In many dysplastic hips and hips in which treatment had failed, the labrum was less elastic than normal, and, in abduction, the labrum does not return to the normal position. Accordingly, we observed that LA is larger before the procedure, and reduced after restoration. The lower the post-operative LA value, the better the surgical effect. The epiphyses of femoral heads were mostly located in the 3-region of the ZCF, which was the best position of the femoral head relative to acetabulum. Further, if area 3 could not be reached, it was preferable for the femoral head to be located in area 4 rather than area 1 during restoration.^[4] It can be observed by MRI that patients with DDH often have materials embedded in the joint space, which may cause reduction failure. For refractory or complicated DDH, we can analyze the contents of joint space via MRI to ascertain the cause of the contents and determine the most suitable treatment.

In conclusion, this study demonstrated that MRI can be used as a tool to evaluate the curative effect of DDH in young children after closed reduction and plaster external fixation.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients' guardians have given their consent for their images and other clinical information to be reported in the article. The patients' guardians understand that their names and initials will not be published and due efforts will be made to conceal the identity of the patient, although anonymity cannot be guaranteed.

Acknowledgements

The authors thank Dr. Xue-Mei Lin of the pediatric orthopedics department for providing clinical case data.

Funding

This study was supported by the grants from the Science and Technology Planning Project of Guangdong Province (No. 2017ZC0099) and the Science and Technology Planning Project of Tianhe district of Guangzhou City (No. 201704KW037).

Conflicts of interest

None.

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How to cite this article: Li MF, Zhao J, Tan XL, Zhang LY. Magnetic resonance imaging evaluation of the effects of closed reduction in infants with developmental dysplasia of the hip. *Chin Med J* 2021;134:611–613. doi: 10.1097/CM9.0000000000001269