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Magnetic Resonance Imaging Evaluation of the Hip

As the hip is a deep joint with a complex anatomy and an articular cartilage relatively thin (1 to 2 mm), evaluation may be quite challenging[28,60]. Several studies have evaluated the reliability of magnetic resonance imaging (MRI) and magnetic resonance arthrogram (MRA) for detecting labral and chondral abnormalities (see Table E-1)[24,27,35,36,40,59,61-71]. Some authors consider MRA to be more accurate than MRI for evaluating labral lesions[35,36,61-63,65,66,68,69,71], but it seems that there are no major differences between the two methods in terms of cartilage evaluation[64]. Most cases of cartilage delamination are recognized indirectly by means of cartilage signal change, as the presence of synovial fluid between the subchondral bone and cartilage is frequently absent[40]. MRI signal loss may be associated with fibrous metaplasia of the hyaline cartilage or diffuse molecular changes of the extracellular matrix[38,40].

The use of intra-articular contrast may lead to capsule distension and filling of lesions and recesses[35,61]; nevertheless, its use may be controversial[28]. As MRA is an invasive method, it may require sedation or even general anesthesia for younger patients and it is not free of potential complications, such as infection. We considered that such risks were ethically unacceptable for a prospective study whose results might not directly benefit the patient.

Additionally, recent studies have suggested that noncontrast MRI is highly effective for evaluating intra-articular structures of the hip, with a high accuracy for the detection of labral and chondral lesions[24,59] and substantial interobserver agreement[24]; however, an adequate technique is imperative, particularly the use of a small flexible surface coil and a small field to provide high spatial resolution[64,67].

The sublabral recess[41,42] is characterized by a well-defined partial-thickness cleft that separates the labrum from the acetabular cartilage, located at the anteroinferior or posteroinferior portions of the acetabulum without adjacent intralabral or chondral abnormalities (see Fig. E-5).

Some classifications of labral abnormalities have been described in the literature[35,72,73], but we used a simplified system that takes into consideration the abnormality extent, with at least substantial intraobserver and interobserver agreement. Type-I findings correspond to small internal degeneration, probably correspondent to fibrovascular infiltration[73], and the fibrocartilaginous tissue is preserved. Type-II abnormalities are characterized by peripheral fissures or ruptures with preservation of the labral base. Type-III lesions may be unstable because they affect the labral base, but the labral tissue is still viable. Type-IV lesions have diffuse signal change and cystic degeneration, indicating severely injured and nonviable labral substance. Nevertheless, this classification system needs further study to establish its utility and surgical correlation.

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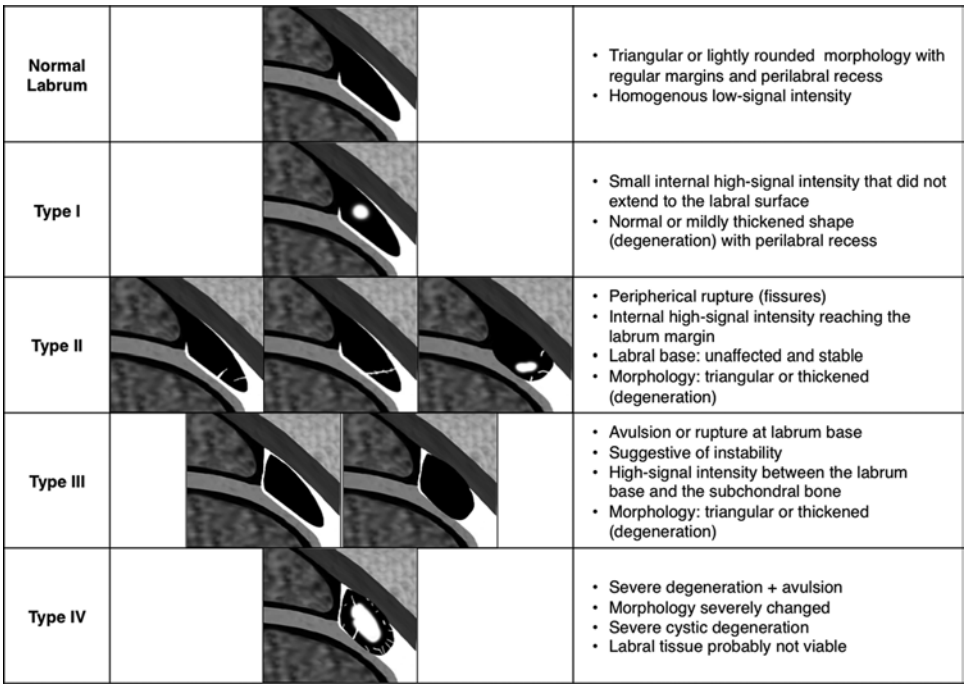

Fig. E-1

Classification used for MRI grading of labral findings. Type I represents intrasubstance fibrocartilage degeneration and types II through IV correspond to labral lesions.

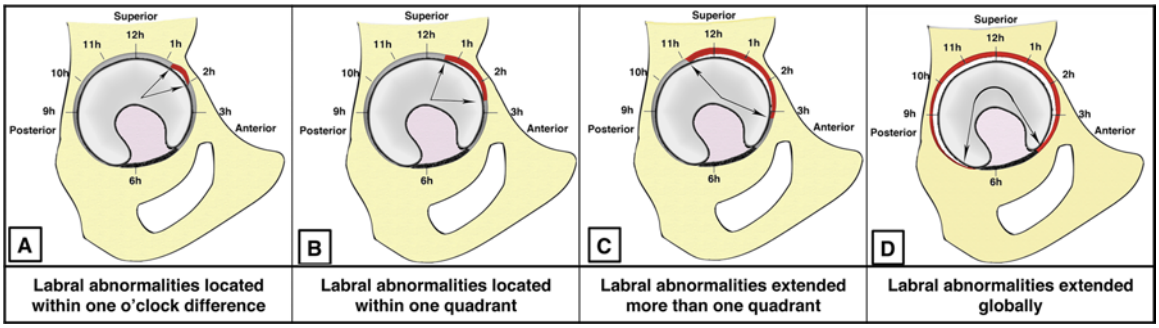

Fig. E-2

Classification of the extent of labral abnormalities according to the clock-face nomenclature. A reverse clock-face projection was used for the left hip; therefore, 3h was anterior and 9h was posterior for both the right and left hip.

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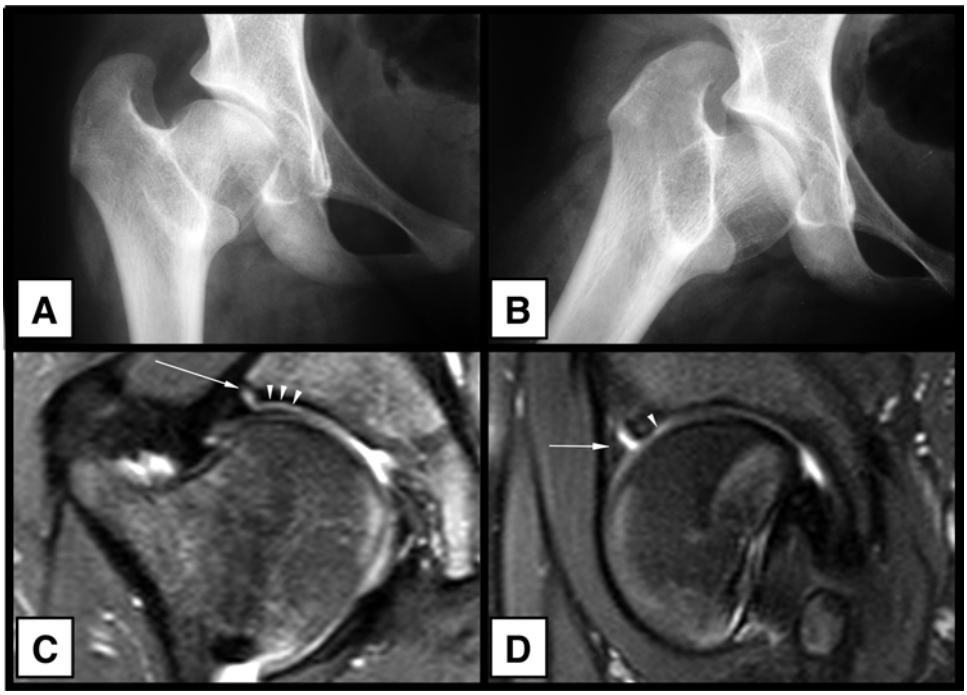

Fig. E-3

Figs. E-3A through E3-D A fourteen-year-old girl with Legg-Calvé-Perthes disease on the right side (prior to any surgery). **Fig. E-3A** Anteroposterior radiograph shows severe coxa brevis and coxa vara, and the greater trochanter is excessively high (Stulberg class III). Despite those deformities, the alpha angle was normal. **Fig. E-3B** The hip abduction anteroposterior radiograph shows the abnormal contact of the trochanter against the acetabular rim. Note the sclerotic reaction over the medial aspect of the trochanter. **Fig. E-3C** Coronal MRI scan of the hip shows a labral avulsion (type III; arrow) and a peripheral acetabular cartilage delamination (arrowheads) at 12h. **Fig. E-3D** Sagittal MRI scan of the hip confirms a type-III labral abnormality (arrow) present also at 2h and the cartilage abnormality (arrowhead).

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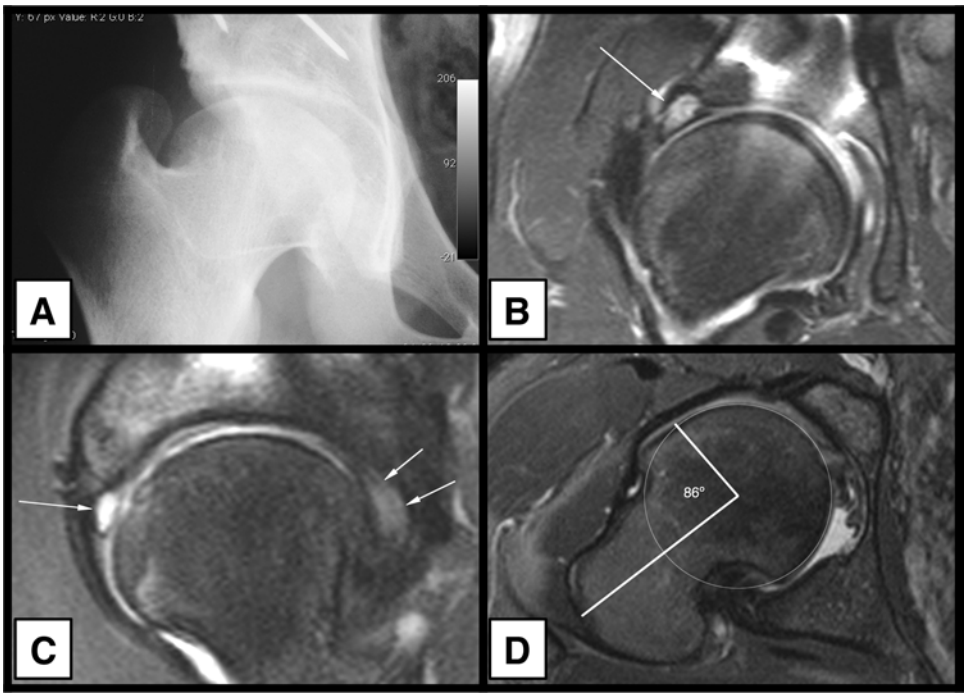

Fig. E-4

Figs. E-4A through E-4D A sixteen-year-old boy with Legg-Calvé-Perthes disease on the right side, treated by a Salter osteotomy. **Fig. E-4A** Anteroposterior radiograph shows coxa brevis and coxa magna, an overriding greater trochanter, an increased cephalic extrusion, and acetabular retroversion (Stulberg class III). **Fig. E-4B** Coronal MRI scan of the hip shows a torn labrum (type IV; arrow) at 12h. There is imaging interference because of the metallic wires. **Fig. E-4C** Sagittal MRI scan of the hip shows the torn labrum anteriorly at 2h (arrow), and posteriorly at 10h to 9h (arrows). **Fig. E-4D** Oblique axial MRI scan of the hip shows an alpha angle of 86°.

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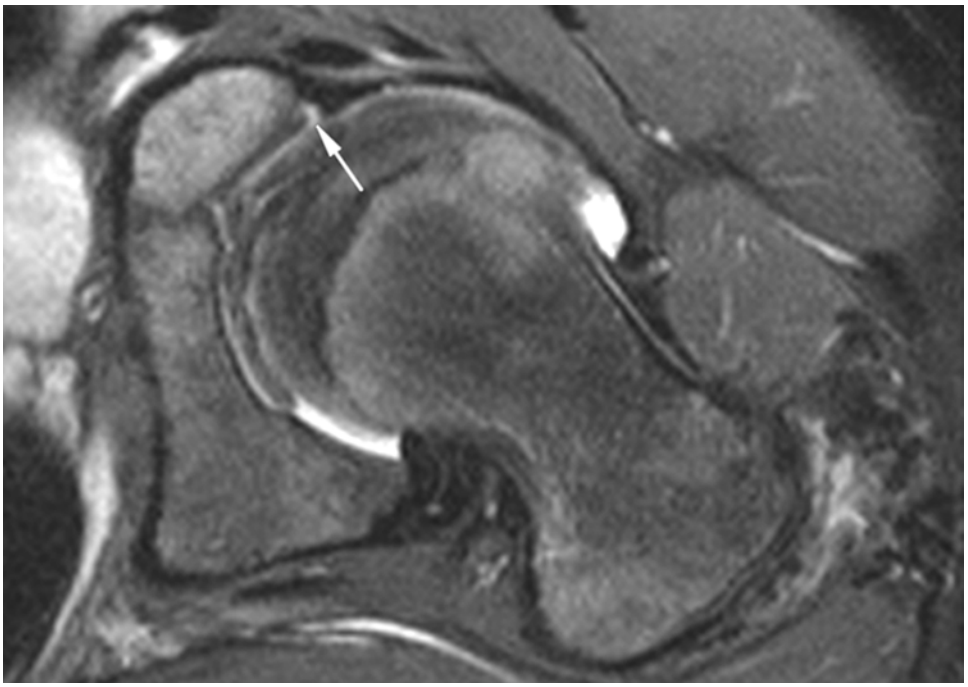

Fig. E-5

Oblique axial MRI scan of the hip between 3h and 4h shows an example of a sublabral recess (arrow).

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TABLE E-1 Range of Sensitivity, Specificity, and Accuracy of MRI and MRA Related to Imaging Evaluation of Acetabular Labral and Cartilage Abnormalities According to the Literature[24,27,35,36,40,59,61-71]

	MRI		MRA	
	Acetabular Labrum	Acetabular Cartilage	Acetabular Labrum	Acetabular Cartilage
Sensitivity	30%-97%	18%-94%	50%-100%	22%-81%
Specificity	33%-100%	75%-100%	44%-100%	33%-100%
Accuracy	33%-95%	84%-88%	64%-96%	50%-82%

TABLE E-2 Distribution of MRI Abnormalities of the Acetabular Labrum and Articular Cartilage Between Hips with an Alpha Angle of <55° and Hips with an Angle of ≥55°

MRI Evaluation	Alpha Angle of <55°	Alpha Angle of ≥55°
Acetabular labrum*		
No. (%) of hips	26 (44)	33 (56)
Normal labrum	14 (54)	1 (3)
Labral abnormality	12 (46)	32 (97)†‡
Acetabular cartilage*		
No. (%) of hips	22 (43)	29 (57)
Normal cartilage	17 (77)	10 (34)§
Cartilage abnormality	5 (23)	19 (66)§

*The acetabular labrum was evaluated in fifty-nine hips, and articular cartilage was evaluated in fifty-one hips. The values are given as the number of hips with the percentage in parentheses. †Most of the labral abnormalities were of higher stages (two [6%] were type I; four [12%], type II; fourteen [43%], type III; and twelve [36%], type IV). ‡$P < 0.001$. §$P < 0.01$.

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TABLE E-3 Distribution of MRI Abnormalities of Acetabular Labrum and Articular Cartilage Between the Stulberg Groups and the Presence or Absence of Acetabular Retroversion*

Acetabular Retroversion	Labral Abnormalities *(no. of affected hips/total no. in group)*	Acetabular Cartilage Abnormalities† *(no. of affected hips/total no. in group)*
Stulberg group		
Class I		
No	0/5 (0%)‡	1/5 (20%)
Yes	3/5 (60%)	1/4 (25%)
Class II		
No	6/8 (75%)	4/7 (57%)
Yes	7/9 (78%)	2/7 (28%)
Class III		
No	5/7 (71%)	2/6 (33%)
Yes	8/9 (89%)	4/9 (44%)
Class IV		
No	6/6 (100%)	4/6 (67%)
Yes	3/3 (100%)	2/2 (100%)
Class V		
No	2/2 (100%)	1/2 (50%)
Yes	5/5 (100%)	3/3 (100%)

*The MRI evaluation of the acetabular labrum was performed in fifty-nine hips. As cartilage imaging interference secondary to metallic implants occurred in eight of the fifty-nine hips, the evaluation of the acetabular cartilage was possible in only fifty-one hips. †No significant difference ($p = 0.15$) for cartilage abnormalities was found between Stulberg groups, with or without acetabular retroversion. ‡The Stulberg class-I group without acetabular retroversion showed a significant difference with regard to the absence of labral abnormalities ($p < 0.001$), but no significant difference was detected in the other groups with regard to MRI labral abnormalities ($p > 0.05$).