EVALUATION OF THE ACETABULAR LABRUM BY MR ARTHROGRAPHY

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Since January 1993 we have carried out MR arthrography on 23 patients with clinical symptoms and signs of abnormality of the acetabular labrum. Most of the patients were young adults. Such symptoms are known precursors of osteoarthritis, and therefore early and accurate evaluation is required.

We assessed the value of MR arthrography of the hip as a minimally-invasive diagnostic technique, in a prospective study and compared the findings with those at subsequent operations. All the patients complained of groin pain; 22 had a positive acetabular impingement test and 15 had radiological evidence of hip dysplasia.

In 21 of the patients, MR arthrography suggested either degeneration or a tear of the labrum or both. These findings were confirmed at operation in 18 patients, but there was no abnormality of the labrum in the other three. In two of the patients, MR arthrography erroneously suggested an intact labrum. Both MR arthrography and intraoperative inspection located lesions of the superior labrum most often, and these appeared slightly larger on arthrography than at operation.

We consider that MR arthrography is a promising diagnostic technique for the evaluation of abnormalities of the acetabular labrum.

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The acetabular rim syndrome (ARS) is characterised by recurrent episodes of sharp groin pain and painful acetabular impingement. It is most often seen in patients with dysplasia of the hip¹ and is increasingly being recognised as a cause of their pain.² The acetabular labrum shows hypertrophy, degeneration, and/or tears as a result of an abnormal acetabular load. These changes have been identified as early precursors of osteoarthritis of the hip.³ Accurate diagnosis of the syndrome is required to prevent or delay early damage, since most of the patients are young adults.

Although the primary diagnosis of ARS is by clinical examination and conventional radiographs they do not accurately show the location and extent of the lesion in the labrum. This information is essential when planning extra-articular augmentation procedures⁴ such as a Chiari pelvic ostotomy⁵ or a shelf procedure, since damage to the labrum will prejudice the result.⁶

Improvements in MR arthrography⁷ have given enhanced visualisation of labral integrity⁸ allowing better management. We have compared our assessment of the labrum in patients with ARS using MR arthrography with subsequent intraoperative findings.

PATIENTS AND METHODS

We reviewed 23 patients with ARS in whom there was uncertainty as to the exact location and extent of the abnormality. After clinical assessment and plain radiography MR arthrography was undertaken.

Clinical and radiological findings. The patients were young adults with a mean age of 40 ± 2 years. There were 14 women and 9 men. They all had a history of intermittent groin pain for up to 15 years (mean 3.5 years), mostly elicited by rotational movement without a significant initiating event. Six had night pain. A full range of joint movement was present but six described episodes of locking. All but one had discomfort and a sensation of apprehension when performing an impingement provocation test. This involves flexion, adduction and internal rotation for the anterosuperior acetabular rim (21/23), and hyperextension, abduction and external rotation for the posteroinferior rim (5/23).¹ Acetabular dysplasia was present in 15 of the patients assessed by plain radiography.

Table I. Details of the technique employed

Imaging	Axial and coronal oblique:
	T1-weighted spin-echo sequence (TR 740, TE 20)
	FLASH (fast low angle shot) 2D sequence (TR 500.0, TE 10, flip angle 90°)
	Sagittal-oblique
	T1-weighted spin-echo sequence (TR 774, TE 20)
	T2-weighted turbo-spin-echo sequence (TR 4500, TE 96)
Resolution	High-resolution matrix 512 × 340 pixels, zoom factor 1.25, field of view 200 × 200 mm

MR arthrography. The acetabular labrum was examined using a high-field scanner (Siemens Vision 1.5T; Siemens, Erlangen, Germany) with a field strength of 1.5 Tesla and flexible surface coils to provide high resolution. For MR arthrography, between 5 and 25 ml of gadolinium-DTPA were injected intra-articularly. This caused local discomfort in one patient. Details of the imaging technique are given in Table I. Before injection, the position of the needle tip at the outer third of the neck of the femur was checked by fluoroscopy. Injection of a contrast medium to check that the needle lay within the joint was rarely needed.

Axial, coronal-oblique and sagittal-oblique T1W1, T2W1 and gradient-echo (GRE) sequences were adjusted to the acetabular plane (Fig. 1). The normal labrum has a pointed, triangular shape with sharp margins and a low signal intensity in the T1- and T2-weighted sequences similar to that of cortical bone. In the GRE-weighted sequences, it has a higher signal intensity similar to fibrous

tissue. There is a continuous attachment of the labrum to the bony rim of the acetabulum. When degeneration is present the labrum shows a considerable increase in signal intensity (T2W1 and GRE); there is also a volume increase when there is myxoid degeneration. Osseous metaplasia produces an elongated and pointed image with a signal quality similar to that of cortical bone. A tear is shown by a linear band of high signal intensity within the labrum or at the transition between the labrum and acetabular cartilage, depending on the size, position and shape of the rupture.

In a long-standing tear, synovial tissue may extrude cranially into a gap between the labrum and the bony acetabular rim, forming a soft-tissue ganglion which lies between the joint capsule and the acetabular rim. The rupture may extend over the whole length of its visible attachment to the acetabulum. To localise a tear we used a clock-face system in which 12 o'clock pointed towards the

Fig. 1a

Sagittal oblique section of a tear (case 15) as seen on MR arthrography (a). Coronal oblique sections of a tear and myxoid degeneration (case 7) (b) and a tear accompanied by a soft-tissue ganglion (case 9) (c).

Fig. 1b

Fig. 1c

Fig. 2

Diagram showing the clockwise location of the labral lesions.

head of the patient (Fig. 2).

The average delay between MR arthrography and operation was 5 ± 4 months. The location and extent of the lesion of the labrum and the presence of hypertrophy or degeneration were noted at the operation (Fig. 2). A tear was demonstrated by passing a hook between the labrum and the subchondral bone. In two patients, part of a resected labrum was studied histologically.

Data analysis and statistics. We did not undertake a retrospective re-review of the radiographs or MR arthrograms. The sensitivity of MR arthrography was defined as the ratio of the abnormal labrum, as diagnosed by MR arthrography, to the finding of an abnormal labrum intra-operatively, and specificity as the ratio of the absence of

abnormality by MR arthrography to the absence of abnormality at operation. Values are presented as the mean $\pm$ SEM. Statistical comparisons were performed by non-parametric tests.

RESULTS

MR arthrography suggested labral damage in 21 of the 23 patients. There appeared to be labral degeneration in 19, a tear in 12 and both in 10. At operation the labrum was explored by capsulotomy (14), surgical dislocation (7) or arthroscopy (2) (Table II). In nine patients, the labrum was left intact but in 14 hips partial resections were performed. No attempt was made to repair a tear. The histological examination of specimens from two patients showed myxoid and osseous metaplasia containing bone marrow within the labrum (cases 3 and 19).

Since ARS is usually associated with dysplasia of the hip producing insufficient containment, the surgical treatment in 18 of the 23 patients was by reorientation using a periacetabular osteotomy (PAO) or extra-articular augmentation by a Chiari procedure. In two hips an intertrochanteric extension osteotomy was performed and in the other hip severe cartilage damage in the weight-bearing area necessitated a total replacement arthroplasty.

MR arthrography suggested a labral lesion in 21 out of 23 patients while at operation damage was found in 20. Assuming that operative exploration accurately reflects the presence of labral lesions, the sensitivity of MR arthrography for detecting hypertrophy, degeneration and/or tears

Table II. Clinical details and results in 23 patients with acetabular rim syndrome

Case	Clinical diagnosis*	MR arthrography diagnosis		Surgical diagnosis		Exploration	Labral resection
		Tear	Degeneration	Tear	Degeneration		
1	ARS	No	Yes	Yes	Yes	Capsulotomy	Yes
2	CDH	No	Yes	No	No	Capsulotomy	No
3	ARS	No	No	No	Yes	Capsulotomy	Yes †
4	CDH	No	Yes	No	Yes	Capsulotomy	No
5	CDH + OA	No	Yes	Yes	Yes	Capsulotomy	Yes
6	ARS	Yes	No	No	No	Surgical dislocation	No
7	CDH	No	Yes	Yes	No	Capsulotomy	No
8	CDH + OA	No	Yes	No	Yes	Capsulotomy	No
9	CDH + ARS	Yes	Yes	Yes	No	Capsulotomy	No
10	CDH	‡	Yes	Yes	No	Capsulotomy	No
11	ARS	Yes	No	Yes	‡	Arthroscopy	Yes
	ARS §	Yes	No	Yes	‡	Surgical dislocation	Yes §
12	CDH	Yes	Yes	Yes	Yes	Capsulotomy	No
13	CDH + ARS	Yes	Yes	Yes	Yes	Capsulotomy	Yes
14	CDH + OA	Yes	Yes	Yes	No	Capsulotomy	Yes
15	CDH + ARS	Yes	Yes	Yes	‡	Arthroscopy	Yes
16	CA	Yes	Yes	Yes	Yes	Surgical dislocation	Yes
17	CDH	No	Yes	No	No	Capsulotomy	No
18	CDH + OA	Yes	Yes	Yes	No	Capsulotomy	Yes
19	CDH + ARS	Yes	Yes	No	Yes	Surgical dislocation	Yes †
20	ARS	No	Yes	Yes	Yes	Surgical dislocation	Yes
21	ARS	Yes	Yes	Yes	Yes	Surgical dislocation	Yes
22	OA + ARS	No	No	Yes	No	Surgical dislocation	Yes
23	ARS	Yes	Yes	Yes	Yes	Surgical dislocation	Yes

* ARS, acetabular rim syndrome; CDH, congenital dysplasia of the hip; OA, osteoarthritis

† histological analysis

‡ no comment in the MRI or surgical report

§ second surgery

Table III. Sensitivity and specificity of MR arthrography in detecting labral lesions, by *percentage* and number

	Sensitivity		Specificity	
Overall	90	19/21	0	0/3
Degeneration	92	11/12	22	2/9
Tear	63	10/16	71	5/7

was between 63% and 90%, while the specificity was above 70% in patients with labral tears only (Table III). MR arthrography and surgical inspection showed an almost identical distribution of the lesions with most located superiorly (Fig. 3). The most common site for a tear was at the junction of the labrum and the articular cartilage, varying in size from a minor detachment to one involving the entire circumference of the attachment. With MR arthrography the lesions appeared slightly larger than at operation (Table IV).

DISCUSSION

Although labral tears have been described after minor trauma,^{9,10} during traumatic dislocation of the hip^{11,12} or idiopathically,¹³ most of our patients had associated dysplasia of the joint. With a shallow acetabulum the labrum is exposed to increased load resulting in degeneration and/or

detachment from the rim (Fig. 1). Once a tear is present the femoral head lacks its peripheral cover and eventually there is migration out of the joint. Labral detachment predisposes to extraosseous ganglia in soft tissues and splits in the labrum¹⁴ or acetabular cartilage^{15,16} allowing the penetration of synovial fluid into subchondral bone, predisposing to intraosseous ganglia. These morphological and structural alterations of the cartilage and bone lead to degenerative arthritis.^{1,17}

Labral abnormality is diagnosed clinically by the acetabular impingement test² in which the sensation of groin pain has been attributed to the participation of the labrum in proprioceptive and nociceptive functions similar to those of the meniscus of the knee.¹⁸ The presence of underlying skeletal abnormality can be assessed by conventional radiography but this does not provide information concerning the labrum.

It is difficult to carry out imaging studies on the hip because of the redundant joint capsule which, in the absence of joint fluid, masks other structures. Experimental studies using intra-articular gadolinium for MR imaging have shown the potential for demonstrating abnormalities of the labrum.⁸ We have shown a high sensitivity for detecting both labral degeneration and tears. In only three of our patients did intraoperative inspection not confirm the MR arthrography. In two of these the duration between MR arthrography and surgery was approximately one year, more than twice as long as for most of the others. The joint was inspected openly in most cases, but an abnormality of the labrum may be missed especially with arthroscopy alone. In one patient, persistent groin pain required a second intervention. While a labral tear was seen at both arthroscopy and the subsequent surgical exploration and dislocation, the exact extent was only apparent after the latter procedure (case 11).

The calculated specificity of MR arthrography was better for labral tears than for degeneration. This may be because at operation only the surface of the labrum can be seen while intralabral and undersurface alterations escape inspection.

MR arthrography can provide information concerning a wide spectrum of abnormality of the hip.¹⁹⁻²¹ We have shown it to give accurate assessment of abnormalities of the labrum and additional advances in MR technology such as dynamic imaging will increase this further.

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Fig. 3

Frequency distribution for the location of labral pathology as shown by MR arthrography (dashed line) or observed at operation (solid line).

Table IV. Location and size of the labral lesion (mean $\pm$ SEM)

	MR arthrography	Operative inspection	p value*
Location (clockwise)	12.0 $\pm$ 0.3	12.3 $\pm$ 0.3	0.5117
Size (% of entire labrum)	37 $\pm$ 5	25 $\pm$ 5	0.0865

* comparison of MR arthrography and operative inspection

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