ARTHROGRAPHY OF EARLY PERTHES' DISEASE

SWELLING OF THE LIGAMENTUM TERES AS A CAUSE OF SUBLUXATION

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Hip arthrography was performed in 19 patients in the initial stage of Perthes' disease. Sphericity and subluxation were measured and it was found that subluxation was independent of the femoral head deformity. We therefore tried to identify the cause of early subluxation: in seven patients a swollen ligamentum teres was thought to be responsible, and was associated with medial pooling of the contrast medium. A swollen ligamentum teres was seen in another seven cases; the other five arthrograms were normal. These findings were further clarified by enhanced CT scans, which confirmed that ligament swelling may be an important cause of early subluxation.

It is generally accepted that subluxation is an important prognostic factor in early Perthes' disease, although the cause has not yet been demonstrated. Plain radiographs do not provide enough detail and although arthographic studies have been published (Jonsäter 1953; Axer and Schiller 1972; Gershuni, Axer and Hendel 1978), the reason for subluxation remains unclear. We have examined further the process of subluxation in the early stages of the disease.

MATERIALS AND METHODS

Nineteen hips in the early stage of Perthes' disease were examined arthrographically at Chiba University Hospital and Chiba Rehabilitation Centre. Fourteen of the patients were boys. The average age at onset was 7.5 years (range 4.3 to 10.7 years) and the average interval from first symptoms to arthrography was 1.7 months (range 0.5 to 3.0 months). Arthograms were also undertaken in 10 normal hips, average age 5.5 years, using the unaffected side in Perthes' disease and cases of transient synovitis.

In 16 cases, arthrography was via an anterolateral approach under local anaesthesia, but three patients under five years of age had general anaesthesia. Three millilitres of amidotrizoic acid were injected into the hip and was sufficient to give clear images. Radiographs were taken with the leg in the neutral position, in abduction with medial rotation, abduction with lateral rotation, adduction, and in the Lauenstein position.

The following measurements were made of the affected hip in each case:

Sphericity. The ratio of the height of the femoral head to half the transverse diameter, measured in neutral rotation and in the Lauenstein position. Jonsäter (1953) defined this as the caput-index (Fig. 1).

Subluxation. This was recorded as the ratio of head

![Fig 1](image_url)

Measurements on the arthrogram: sphericity = h:D/2; subluxation index = A:B x 100; where D is the transverse diameter of the femoral head, h is the height of the femoral head from the centre of D, A is the medial joint space and B is the distance between the tip of the teardrop and the acetabular rim (see text).
displacement to acetabular size (Fig. 1). The distance between the most medial articular cartilage of the femoral head and the lateral border of the acetabular teardrop was measured, and also the distance between the tip of the teardrop and the most lateral point on the acetabular rim, measured in any position of the hip except adduction.

These measurements required care, because it is difficult to visualise the cartilage of the femoral head, especially its medial aspect, and especially with the hip in the neutral position. The shape of the femoral head can be made clearer by superimposing a tracing of the femoral head, made on an addition and neutral rotation film, upon the arthographic pictures in other positions. In eight cases an enhanced CT scan was also obtained.

RESULTS

Sphericity. The average sphericity of the femoral head on the films taken in the neutral position was 0.939 (range 0.900 to 0.987) and 0.999 (range 0.929 to 1.07) in the Lauenstein position (Table I). The sphericity was less in the anteroposterior view than in the Lauenstein view in all except one case; this suggests that any deformation of the femoral head occurs cylindrically. In the control group the average sphericity was 0.996 in the neutral views and 1.02 in the Lauenstein views.

Subluxation. The average displacement on the neutral anteroposterior views was 14.1%. This was significantly different from 8.5% for the control group, 9.3% in abduction with medial rotation, 10.7% in abduction with lateral rotation, and 8.1% in the Lauenstein position. Reduction of the subluxation was shown to be greatest in the Lauenstein position and it was also improved by abduction with medial rotation (Table I).

Correlations. We found no correlation between sphericity and subluxation in the neutral position, contrary to our expectation. This implies that subluxation is not necessarily associated with major deformation of the femoral head. Therefore, even when the femoral head was nearly spherical, subluxation had already occurred (Figs 2 and 3). In other words, subluxation appeared to precede deformation.

The cause of subluxation. In view of the findings on measurement, we re-examined all the arthrograms and in nearly all cases found some pooling of the contrast medium in the medial joint space. In 14 cases there was also a negative silhouette within this space and in seven cases this negative shadow lay between the depth of the acetabulum and the most medial aspect of the femoral head, thus appearing to prevent centring of the femoral head (see Fig. 2). We suggest that this appearance was a swollen ligamentum teres. We recognised three types of swelling: severe, in which the ligamentum teres appeared to fill part of the space completely (Fig. 2); moderate, in which the ligamentum teres was enlarged but loose in the space (Fig. 4); and normal, in which no swelling of the ligamentum teres was recognisable (Fig. 5).

The measurements of sphericity and subluxation for each type of ligamentum teres and for the controls are given in Table II. There was very little difference in

<table>
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<th>Sphericity Lauenstein</th>
<th>Subluxation index (per cent) Neutral</th>
<th>Abduction with medial rotation Neutral</th>
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Average 7 5 0.939 1.00 14.1 9.3 10.7 8.1
Arthrograms of Case 11. Figure 2 - In the neutral position. The femoral head is almost spherical, but there is noticeable subluxation. The swollen ligamentum teres (arrow) fills the medial joint space. Figure 3 - In the Lauenstein position. The subluxation is reduced and sphericity is apparent.

Figure 4 - Arthrogram of Case 1. The ligamentum teres (arrow) is seen inferiorly in the pooled medium and is more swollen than in the control group. Figure 5 - Arthrogram of Case 14. The size of the ligamentum teres was classified as normal, but some medial pooling of the contrast medium is seen.

Table II. Results in the three types of ligamentum teres

<table>
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<tr>
<th>Swelling of ligamentum teres</th>
<th>Number of hips</th>
<th>Age at onset (yr)</th>
<th>Age at onset (mth)</th>
<th>Sphericity Neutral</th>
<th>Sphericity Lauenstein</th>
<th>Subluxation index (per cent) Neutral</th>
<th>Abduction with medial rotation Neutral</th>
<th>Abduction with medial rotation Lauenstein</th>
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average sphericity, but the average neutral subluxation in the seven severe cases was 17.2%, in seven moderate cases it was 13.9% and in the five normals, 11.3%. This suggests that swelling of the ligamentum teres may be causally related to the subluxation seen in the initial stages of Perthes' disease. Reduction of subluxation produced by placing the hip in the Lauenstein position was much larger in the severe type (see Fig. 3); in the cases with apparently normal ligamentum teres the decrease in subluxation was much less.

To investigate further, some enhanced CT scans were made after the arthrography. Figure 6 shows such a scan in a case with the severe type of ligament swelling and subluxation of 15.7%. In the acetabulum just below the triradiate cartilage, where both surfaces of articular cartilage usually lie in contact, the swollen ligamentum teres is clearly seen. It appears to be pushing the femoral head laterally, with pooling of the contrast medium around it. Similar but less dramatic changes were noticed in the moderate type (Fig. 7). The mild subluxation seen in relation to the apparently normal ligament type, however, could not be explained on this basis (Fig. 8).

**DISCUSSION**

There are two theories with regard to the cause of subluxation in early Perthes' disease. The first is that it is secondary to thickening of the articular cartilage associated with deformation of the femoral head (Gershuni et al. 1978). The second is that it occurs primarily without thickening of the articular cartilage.

If the first theory is to be supported, then arthrograms should show thickening of the medial articular cartilage of the femoral head, which maintains contact between the head and the depth of the acetabulum. This theory cannot account for the pooling of the contrast medium shown by arthrography.

In 1953, Jonsäter suggested two other possible causes for early subluxation: a large tense exudate, and swelling of the soft tissue contents of the fossa acetabuli. He concluded that the most likely cause was soft tissue swelling and especially that of the ligamentum teres, but was not able to demonstrate this clearly. Axer and Schiller (1972) also suggested that hypertrophy of the ligamentum teres was one of the causes.

In our series we have shown a correlation between swelling and subluxation, but it is difficult to account for the subluxation in relation to the moderate and normal types of ligamentum teres. It seems possible that the moderate type of subluxation may occur as a result of initial swelling of the ligamentum teres, but this swelling then subsides without allowing the femoral head to regain its normal position. In the normal type, increased thickness of the articular cartilage may in fact account for the mild subluxation (Fig. 8).

Lippmann (1929) describes a specimen of the ligamentum teres, removed from a case of Perthes' disease, which showed obliteratorive thickening of the arteries, oedema and perivascular infiltration. Although we have no pathological data, we believe that swelling of the ligamentum teres may be a primary event because the time interval between onset of symptoms and arthro-

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Fig. 6 - Case 11, a swollen ligamentum teres (arrow) is delineated at its normal site, and appears to push the femoral head laterally. No marked thickening of the articular cartilage is seen. Figure 7 - Case 1, classified as showing moderate swelling. The femoral head is pushed out, but the silhouette of the swollen ligamentum teres (arrow) lies loose in the pooled medium. Figure 8 - Case 14, the femoral head is not pushed out by the ligamentum teres (arrow), but there is some thickening of the articular cartilage on the medial side of the femoral head.

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graphy in some of our cases was too short for secondary changes to have occurred.

We have studied the effect of leg position on subluxation. It is generally accepted that a position of abduction improves containment; indeed many orthotic devices attempt to maintain the hip in this position. In our cases subluxation was shown to be corrected in abduction, particularly when there was considerable swelling of the ligamentum teres. It appeared that the loose ligament could be forced into the inferior pouch of the acetabulum. This provides support for orthotic containment in those cases with severe subluxation. However, the best control of subluxation was shown to be in the Lauenstein position, where the short axis of the femoral head corresponds with the flat, weight-bearing surface of the acetabulum in the anteroposterior view. The articular surfaces complement each other and provide corrective moulding. Although a new congruity may develop in the presence of deformity of the femoral head, this will be established in a position determined by the subluxation. If, however, no alteration in the shape of the femoral head occurs, recentralisation may take place, particularly in younger children because of the greater thickness of articular cartilage.

We conclude that early severe subluxation and consequent incongruity, can be attributed to swelling of the ligamentum teres.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


