FEMORAL OSTEOTOMY IN PERTHES' DISEASE

RESULTS AT MATURITY

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Upper femoral osteotomy is a recognised treatment for selected patients with Perthes' disease. The results of this procedure were investigated at skeletal maturity in 44 patients (48 hips). The indication for operation was Catterall group II, III and IV hips with 'head-at-risk' signs. Harris and Iowa scores were calculated clinically, and each hip was assigned radiographically to one of the five Stulberg classes, its initial Catterall grading checked and other relevant indices measured.

Results showed excellent clinical function. Shortening was present in 14 hips (29%) and a positive Trendelenburg's sign was seen in 12 (25%). On radiographic assessment 58% of hips were Stulberg class I or II, with a good prognosis. The results of femoral osteotomy were better than those for conservatively treated hips in all age groups except those under five years.

Femoral osteotomy was first proposed nearly 40 years ago to contain the femoral head in Perthes' disease (Soeur and De Racker 1952) but its place in the management remains controversial. Various workers have shown that such treatment in certain patients seems to improve radiographic results in the short term (Lloyd-Roberts, Catterall and Salamon 1976; Muirhead-Allwood and Catterall 1982). The yardstick by which all treatments should be judged is the function and radiological appearance of the affected hip in adult life. Although the long-term prognosis for hips treated conservatively is known (Ratliff 1967; Brotherton and McKibbin 1977; McAndrew and Weinstein 1984; Ippolito, Tudisco and Farsetti 1987), the fate of the surgically treated hip has not been established.

Stulberg, Cooperman and Wallenstein (1981) have related the radiographic appearance of the hip at maturity to long-term prognosis. In a review of 170 hips affected by Perthes' disease, followed for 30 to 40 years, they recognised five classes of hip at maturity which may be divided into three groups based on congruency (Table I): classes I and II are spherically congruent and have no increased likelihood of arthritis; classes III and IV are aspherically congruent and develop osteoarthritis in late adulthood; and class V is aspherically incongruent and arthritis develops before age 50 years. The classification is independent of age in adults, and of the presence or absence of degenerative change.

We have reviewed, at maturity, a group of patients treated by femoral osteotomy and given a prognosis based on Stulberg's classification. With this classification we could compare the results of conservative treatment and femoral osteotomy.

Table 1. The Stulberg classification

<table>
<thead>
<tr>
<th>Class</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Completely normal hip</td>
</tr>
<tr>
<td>II</td>
<td>Spherical femoral head, with abnormalities of head, neck and/or acetabulum</td>
</tr>
<tr>
<td>III</td>
<td>Non-spherical but not flat femoral head, with abnormalities of head, neck and/or acetabulum</td>
</tr>
<tr>
<td>IV</td>
<td>Flat femoral head with abnormalities of head, neck and/or acetabulum</td>
</tr>
<tr>
<td>V</td>
<td>Flat femoral head with normal femoral neck and normal acetabulum</td>
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</tbody>
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PATIENTS AND METHODS

At the Royal National Orthopaedic Hospital and the Hospital for Sick Children, Great Ormond Street, operative containment of the femoral head by varus derotation femoral osteotomy has been done in patients with Perthes' disease requiring definitive treatment. These included all 'at risk' hips; group 2 and 3 hips in patients over seven years of age and not at risk; and group 4 patients in whom severe flattening of the head occurred, as demonstrated by arthrography (Catterall 1971; Muirhead-Allwood and Catterall 1982).

Thirty-five male and nine female skeletally mature patients, of the 61 who had had operations, were available for clinical and radiographic review. Four patients had bilateral involvement, making a total of 48 hips. Twenty-seven left and 21 right hips were affected. The mean age at onset was 6.4 years (range 3 to 13), and the mean age at follow-up was 18.9 years (range 16 to 28). At diagnosis 13 hips were classified as Catterall group 2, 23 as group 3 and 12 as group 4.

At review, each patient answered a questionnaire and hip function was evaluated. Each hip was thus scored with both Harris (1969) and Iowa (Larson 1963) scales. Anteroposterior and lateral radiographs were taken, and each hip was assigned to one of the five Stulberg classes. Indices also measured were: acetabular cover, the C-E angle of Wiberg, the acetabular angle of Sharp, lateral subluxation, femoral-neck angle, trochanteric height, and femoral head size and Mose rating (Mose 1964). Finally, the radiographs made at the onset of the disease were reviewed and the Catterall classification checked. All assessments were done independently by at least two of the authors.

RESULTS

Clinical assessment. All patients were satisfied with their hip function; this was reflected by the high Harris and Iowa scores, the mean scores being 97.8 (range 83 to 100) and 97.2 (range 86 to 100), respectively. Thirty-two patients (73%) denied any symptoms associated with their hips, and 29 (66%) took part regularly in competitive sport.

The measured range of hip movement was almost universally good, with only three patients having limitation of abduction. No fixed deformities were noted.

Table II. Relation between Stulberg class and Catterall group in 48 hips

<table>
<thead>
<tr>
<th>Catterall group</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>10</td>
<td>9</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

Table III. Comparison of patients reported by Ippolito et al (1987) and the present series

<table>
<thead>
<tr>
<th>Age at diagnosis (yr)</th>
<th>Catterall group</th>
<th>Ippolito et al 1987 (n=53)</th>
<th>Coates et al 1990 (n=44)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5 to 8</td>
<td>2</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9 to 13</td>
<td>2</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

Table IV. Comparison of long-term results of conservative and operative series

<table>
<thead>
<tr>
<th>Stulberg class (per cent)</th>
<th>I and II</th>
<th>III to V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ippolito et al 1987 (excluding Catterall group 1)</td>
<td>38</td>
<td>62</td>
</tr>
<tr>
<td>Coates et al 1990</td>
<td>58</td>
<td>42</td>
</tr>
</tbody>
</table>

Twelve hips (25%) showed a positive or delayed-positive Trendelenburg's sign. There was shortening in the ipsilateral lower limb in 14 (29%) but this was less than 2.5 cm in all but two and did not correlate with age at operation or severity of the disease. Two female patients were concerned about the appearance of the operation scar.

Radiographic assessment. The presence of fused growth plates at the proximal femur and iliac crest confirmed skeletal maturity in all cases. As expected, trochanteric overgrowth was generally greater in both the Trendelenburg-positive and short-leg groups. Osteoarthritic changes were noted on the radiographs of three of the
eight hips treated before the age of five years, but on only
two of the 40 hips treated after this age. However, follow-
up in the older groups was less by an average of 3.9 years.

Twenty-eight hips (58%) were in either Stulberg
class I or II, and could therefore be said to have a good
prognosis; 16 were in class III, three in class IV and one
in class V. Table II shows the relation between Stulberg
class and Catterall group. The distribution of hips in theive Stulberg classes was similar to that in the four
Catterall groups.

Because of our policy of operative containment of
the femoral head in severe Perthes' disease, we did not
have a group of similarly affected patients treated
conservatively for comparison. However, Ippolito et al
(1987) reviewed the long-term results of 61 patients with
Perthes' disease treated conservatively with bed rest,
traction and prolonged weight-relief. Their results were
expressed in terms of initial Catterall groupings and of
final Stulberg classes, making comparison with our
review feasible.

Table III shows the distribution of Catterall groups
within each age group for our series and that of Ippolito
et al (1987). In general the patients in both reports are
similar, but Ippolito et al included group I cases which
have been excluded from our series.

Comparison of the two series (Fig. 1) shows that the
advantage of operative treatment seems to be confined
to children over five years old. Under this age 50% had
Stulberg class III hips or worse, whereas none of the
conservatively treated hips were worse than class II.
Table IV shows the eventual Stulberg classes of the
patients in two series. A higher proportion of the hips
treated surgically fell into Stulberg classes I and II,
despite the inclusion in the conservatively treated group
of patients in Catterall group 1 and those in groups 2 and
3 who did not meet our criteria for operative treatment.

In an attempt to explain the less impressive outcome
of osteotomy in children under five years, we examined
serial radiographs of individuals (Table V). Cases 1 to 4
did very well; the varus neck angles were remodelled,
good acetabular cover was obtained, and Stulberg classes
I and II were achieved. In the remaining four patients
(cases 5 to 8) a persistently varus femoral-neck angle and
less acetabular cover downgraded the results to Stulberg
class III or V. Review of the postoperative radiographs
in these cases showed evidence of at least temporary
interruption of growth at the anterolateral portion of the
capital femoral physis. In Figure 2a a Harris growth-
arrest line shows that there has been resumption of
growth in the normal 2:1 differential ratio between neck
and trochanter (O'Brien 1985); this hip became a Stulberg
class II. In Figure 2b the Harris growth-arrest line
indicates that although growth had resumed, the normal
2:1 ratio had not been re-established; this hip deteriorated
to a Stulberg class III with a short varus femoral neck.
Figure 3 shows injudicious positioning of a Coventry
crutch in the proximal femoral growth plate.

**DISCUSSION**

Numerous methods have been described for the assess-
ment of the outcome of Perthes' disease and its treatment.
These have been based either on a combination of clinical
and radiographic features (Ratliff 1956; Catterall 1971)
or on the geometry of the hip judged by radiographic
appearance (Heyman and Herndon 1950; Mose 1964;
Mose et al 1977).

All our patients were skeletally mature and showed
clearly that the clinical state does not necessarily reflect
the radiographic appearance of the hip. The Harris and
Iowa hip scores may be appropriate for the assessment
of older patients with osteoarthritis, but are insensitive

![Fig. 2a](image1)

![Fig. 2b](image2)

Radiographs taken after femoral osteotomy. Both show a Harris growth-arrest line. In (2a) there has been failure to resume growth at neck and greater trochanter in the usual 2:1 ratio which is seen in (2b).
in younger patients, who may show considerable radiographic abnormalities but remain almost free of symptoms.

A surprising finding was the lack of correlation between shortening and neck–shaft angle, and the presence of a positive Trendelenburg sign. Both these factors should be more common in the older child in whom there is less time for remodelling of the induced varus to occur. A high greater trochanter commonly remained despite an improvement in femoral-neck angle. This finding reflects the fact that the dorsal aspect of the neck and the trochanteric growth plate are a continuous structure, and elongation of the neck would not necessarily alter the relation of the trochanter to the femoral head as it remodels. In the older child a short varus femoral neck does not seem to prejudice the result with respect to osteoarthritis, but care must be taken not to induce undue varus, which in some patients may be required for full otherwise have been expected to remodel in the younger child (Clothier 1979). The observations suggest that where ‘at risk’ signs are present in the younger child, a major growth disturbance may be present in the femoral neck which may prejudice the result of varus femoral osteotomy.

There are several possible reasons for this further growth disturbance. Incomplete containment of the femoral head, and excessive varus, may both lead to abnormal pressure on the lateral margin of the growth plate (Barnes 1980; Heikkinen and Puranen 1980). Damage to the physis is also possible as a result of injudicious internal fixation (Fig. 3). In each of the four patients with an eventual poor result, one or more of these factors could be demonstrated.

Disturbance of growth in the femoral head has been noted as a feature of Perthes’ disease (Catterall 1981). Our observation of a transient, localised growth disturb-

<table>
<thead>
<tr>
<th>Case</th>
<th>Age at diagnosis (yr)</th>
<th>Stulberg class</th>
<th>CE angle (degrees)</th>
<th>Acetabular angle (degrees)</th>
<th>Per cent cover</th>
<th>Femoral-neck angle (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>I</td>
<td>25</td>
<td>41</td>
<td>77</td>
<td>135</td>
</tr>
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<td>2</td>
<td>3</td>
<td>I</td>
<td>42</td>
<td>34</td>
<td>100</td>
<td>132</td>
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<td>I</td>
<td>28</td>
<td>40</td>
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<td>4</td>
<td>II</td>
<td>30</td>
<td>35</td>
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<td>III</td>
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<td>33</td>
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<tr>
<td>6</td>
<td>3</td>
<td>III</td>
<td>6</td>
<td>48</td>
<td>60</td>
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</tr>
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<td>3</td>
<td>III</td>
<td>22</td>
<td>41</td>
<td>75</td>
<td>102</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>V</td>
<td>9</td>
<td>42</td>
<td>66</td>
<td>115</td>
</tr>
</tbody>
</table>

containment of the femoral head. When considerable abduction is needed for containment, alternative treatments without these complications should be considered.

Although clinical assessments give information about present hip function, future function can only be predicted radiographically. The Stulberg classification provides the means to do this and allows a valid comparison of the results at maturity in different series.

We have shown a clear advantage in surgical containment for patients over the age of five years. This finding contradicts the generally held belief (Canario et al 1980) that better results are achieved by operation in younger patients than in older patients, but accords with Snyder’s (1975) view that there are considerable problems in the younger child with Perthes’ disease, which is far from the benign condition suggested by others.

In the under fives, the findings (Table V) suggest a failure to recover from the induced varus, which would

![Fig. 3](https://example.com/f3.png)

Radiograph showing injudicious positioning of a Coventry screw in the proximal femoral growth plate.
ance suggests that femoral-neck growth has been further disrupted by containment surgery in some cases. Knowledge of the blood supply of the femoral head and physis indicates that younger patients may be especially vulnerable to this complication.

The undesirable long-term consequences of the operative regimen for this group as a whole included unsatisfactory scarring (2%) and limb shortening (29%). The latter is sometimes regarded as unacceptable by surgeons opposed to femoral osteotomy. It should, however, be recognised that 24% of the conservatively treated patients reported by Canario et al (1980) had similar shortening. This difference is not statistically significant and the shortening can be seen as a consequence of the disease and not necessarily of its operative treatment.

Thus, for patients aged five years and over at the time of diagnosis, a policy of operative containment of the femoral head in severe Perthes' disease has given results at skeletal maturity that are considerably better than those obtained by nonoperative methods, without an unacceptable level of late complications.

However, although some patients under age five at operation did well, others had poor long-term results compared with hips treated conservatively. If operative containment by femoral osteotomy is contemplated in this group, containment should be demonstrated by arthrography and the amount of varus must be the minimum necessary to contain the femoral head. Extreme care should be taken with the positioning of internal fixation, in order to prevent further damage to the growth plate. It is possible that innominate osteotomy for these cases could provide satisfactory anterior cover for the femoral head, leaving the upper femur free of further insult during the avascular phase of the disease.

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**


