Prognosis in Perthes' disease

A COMPARISON OF RADIOLOGICAL PREDICTORS

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We compared the prognostic value of the Catterall grouping, the Salter-Thompson grading, the arthrographic shape of the femoral head, and the Herring lateral pillar grouping during the fragmentation stage of Perthes' disease in 73 patients with 81 affected hips. Radiographs were available for study from the onset of the disease until skeletal maturity. We used the Stulberg classification to assess outcome.

The Herring grade and arthrographic sphericity proved to be the best predictors of final outcome. Combining these two values further increased the predictive value. All but one patient in Herring group A achieved an excellent outcome. In Herring group B, the age of the child and the sphericity of the femoral head influenced the end result. If the child was less than seven years old at the onset of symptoms the prognosis was invariably good and all spherical hips in group B had a good outcome with Stulberg grades 1 or 2. Moderately and severely deformed hips on arthrography resulted in Stulberg 3 and 4 hips. None of the hips in Herring group C had a normal appearance at maturity and the outcome was not significantly influenced by the age at onset or the arthrographic appearance.

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Since the original description of Perthes' disease, various radiological prognostic factors and classifications have been described. The commonest are the Catterall grouping, involving the 'head-at-risk' signs,^{1,2} the Salter and Thompson grading³ and the classification of Herring et al.⁴ A

prospective study by Fulford, Lunn and Macnicol⁵ showed that the functional result predicted by the arthrographic appearances at initial examination was more accurate than the Catterall grouping.

The aim of management in Perthes' disease is to minimise hip deformity. A rational treatment plan relies on early recognition and an accurate prognosis. The diagnosis is usually not difficult, but the best means of identifying the likely outcome and improving it is controversial. We compared the predictive value of various radiological gradings.

Patients and Methods

We reviewed retrospectively the radiographs and clinical details of all patients who had presented to this hospital with Perthes' disease since 1966 and had reached skeletal maturity. The clinical notes and radiographs of 73 such patients, with 81 affected hips, were available for study from the onset of the disease. There were 69 boys (77 hips) and four girls (four hips); 8 had bilateral Perthes' disease. The age at onset of symptoms ranged from 2 years 5 months to 9 years 6 months.

In 73 hips we performed arthrography during the fragmentation stage. We used the criteria of Fulford et al⁵ with anteroposterior, abduction, internal rotation and true lateral views (Fig. 1) to classify the deformity of the femoral head. The head was considered to be spherical if there was no loss of contour in all four views, mildly deformed if there was loss of contour in one view, moderately deformed if there was loss in two views and severely deformed when loss of contour was evident in three or more views.

We classified all hips according to the Catterall grouping and the 'head-at-risk' signs were noted, as were the presence and extent of any subchondral fracture. The Salter and Thompson grading³ and Herring lateral pillar classification⁴ were also applied.

Radiographs at maturity were available for all 81 hips at a mean age of 21 years (18 to 31). These were assessed by the classification of Stulberg, Cooperman and Wallensten.⁶

Thirty-eight patients (40 hips) had had a varus osteotomy of the proximal femur and 35 (41 hips) had been treated conservatively.

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Fig. 1a

Fig. 1b

Fig. 1c

Fig. 1d

Anteroposterior (a), abduction (b), internal rotation (c) and true lateral (d) arthrographic views of the hip.

Table I. The mean Stulberg score related to prognostic factors. The number of patients in each Stulberg category is given

Factor	Stulberg classification				Score
	1	2	3	4	
Arthrography					
Spherical	19	14	2	0	1.51
Mild deformity	5	8	7	0	2.00
Moderate deformity	2	1	7	1	2.64
Severe deformity	0	1	4	2	3.14
Herring grade					
A	17	0	1	0	1.11
B	13	22	12	1	2.02
C	0	5	8	2	2.80
Catterall grade					
1	3	0	0	0	1.00
2	13	7	4	0	1.62
3	11	12	13	2	2.16
4	3	8	4	1	2.19
Salter-Thompson group					
A	15	1	1	0	1.18
B	15	26	20	3	2.17
Lateral subluxation					
No	23	20	8	1	1.75
Yes	7	7	13	2	2.34
Age at the onset in years					
Less than 5	10	7	2	0	1.57
5 to 6	13	7	4	0	1.63
6 to 7	4	9	4	1	2.11
More than 7	3	4	11	2	2.60

Results

Arthrography showed that 35 femoral heads were spherical, 20 mildly deformed, 11 moderately deformed and 7 severely deformed. According to the Catterall classification 3 hips were group 1, 24 group 2, 38 group 3 and 16 group 4. Using the Herring classification 18 hips were A, 48 hips B, and 15 hips C. The appearance of the hip at maturity, as measured by the classification of Stulberg et al,⁶ was scored on a five-point scale on which 1 was good and 4 was poor; no patient scored 5. Thirty patients were good, 27 scored 2, 21 scored 3 and three were poor. The radiological results were very similar to the clinical outcomes.

Table I shows the association between outcome and each of the six prognostic factors assessed at the early fragmentation stage. Arthrographic sphericity, Herring grade and Salter-Thompson grading were significant at $p < 0.001$ while lateral subluxation and Catterall grouping were significant at $p < 0.01$. The age at the onset of the disease was also independently predictive of outcome.

The strength of the relationship between the Stulberg classification and the different prognostic factors as expressed by Spearman rank correlation coefficients was as follows: sphericity, 0.53; Herring grade, 0.57; Catterall grade, 0.26; lateral subluxation, 0.30; Salter-Thompson

Table II. Mean Stulberg score related to the combined score from arthrographic sphericity (scored from 1 = spherical to 4 = severely deformed), Herring grade (scored as 1 = A, 2 = B, and 3 = C) and age at the onset of the disease (scored as 1 = less than 5, 2 = 5 to 6, 3 = 6 to 7, and 4 = more than 7 years old)

Combined score	Stulberg score			
	1	2	3	4
3	3	0	0	0
4	7	2	0	0
5	9	3	1	0
6	4	13	1	0
7	2	4	3	0
8	1	0	6	0
9	0	2	6	1
10	0	0	3	0
11	0	0	0	2

group, 0.45; age at the onset of disease, 0.42; combined arthrogram and Herring grade, 0.67; and combined arthrogram, Herring grade and age, 0.73.

In a series of ordinal logistic regressions of the Stulberg grade against the other factors both arthrographic sphericity and Herring grade were independently predictive after adjusting for one another ($p < 0.001$), but neither the Catterall group nor the Salter-Thompson grading added significantly to the prediction of outcome derived from the other two factors. The age of the patient was independently predictive ($p < 0.01$). The combination of age, sphericity, and Herring grading further improved the predictive value, which was reflected in an increased Spearman rank correlation score of 0.73. The coefficients of sphericity, Herring grade and age in the logistic regression were -1.51 , -2.97 and -0.99 , respectively.

These findings suggest that a combined scale incorporating the three independent factors listed above would give a better prediction than any of the individual factors alone. Table II shows the outcome in relation to the combined score from the arthrographic appearance, Herring grading and the age at the onset of Perthes' disease.

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Radiographs showing the femoral epiphysis divided into lateral, central and medial segments (a), Herring group A with no involvement of the lateral segment (b), group B with less than 50% loss of height of the lateral segment (c) and group C with more than 50% loss of height of the lateral segment (d).

The results also showed that there was a significant correlation between age at the onset of the disease and the arthrographic shape of the femoral head in the fragmentation stage. Younger patients had a greater preponderance of spherical femoral heads and older children a greater degree of deformity.

Discussion

Since the original description of Perthes' disease independently by Legg, Calvé and Perthes in 1910, various authors have suggested certain clinical and radiological features as prognostic indicators. In 1959 O'Garra⁷ proposed the concept of partial or complete involvement of the epiphysis. His group-1 patients who presented with less than 50% involvement of the epiphysis had a good prognosis whereas group-2 patients with involvement of the whole epiphysis had a poorer prognosis. In 1971, Catterall subdivided these two groups into four. To increase the prognostic accuracy he introduced the concept of head-at-risk signs.² Since then many authors have used this classification,⁸⁻¹⁶ but there have been some criticisms. First, the grouping is based on the epiphyseal involvement at the time of maximum resorption. This occurs relatively late and the grouping will appear to change if the classification is applied too early.^{13,15,16} Secondly, there is a poor level of interobserver agreement^{17,18} and groups 2 and 3 are particularly difficult to separate. Fulford et al⁵, in their prospective study, suggested that the final functional result could be predicted more accurately by the arthrographic appearances at initial examination rather than by the Catterall classification.

In 1984 Salter and Thompson³ proposed a return to a two-group classification based on the extent of the subchondral fracture. This can be applied earlier in the course of disease.¹⁹ In their original review, however, only a small percentage of patients' radiographs showed a subchondral fracture. In other studies also, a significant number of patients showed no subchondral fracture.²⁰ We were able to identify a subchondral fracture in only 28 hips (34%) at any stage of the disease.

The Herring classification is based on the involvement of the lateral pillar of the femoral head (Fig. 2) and was found to be useful in predicting Stulberg outcomes at maturity. This classification has been assessed by Ritterbusch et al²⁰ and Farsetti et al,²¹ who found that the measurements were prognostically useful.

We have shown that the lateral pillar grading and sphericity of the femoral head determined by arthrography together with the age of onset of the disease are the most accurate prognostic indicators. The combination of these three factors, which are independently predictive, is a sensitive indicator of the final outcome as defined by the Stulberg grading. All patients in Herring group A had an excellent outcome, except one child who developed Perthes' disease at the age of 7 years 3 months and had a moderately deformed head on arthrography. In group-B

patients, knowledge of the age of the child and the sphericity of the femoral head improved the predictive value. If the child was less than seven years at the onset of symptoms the prognosis was invariably good in this group. All spherical hips in group B had a good outcome (Stulberg 1 and 2). The moderately and severely deformed hips on arthrography resulted in a Stulberg 3 or 4 outcome. In group C cases none of the hips achieved a Stulberg 1 result. The age at onset and the arthrographic appearance did not significantly influence the prognosis in group C which was always associated with a poor outcome.

Involvement of the lateral part of the femoral epiphysis is recognised to lead to established deformity. Kemp and Boldero²² noted that the prognosis was worse when the lateral third of the femoral head was affected. The distinguishing feature between Catterall groups 2 and 3 is involvement of the lateral segment of the head of femur. Similarly, the distinguishing feature in the Salter and Thompson grading³ is the presence (in group A) or absence of an intact, viable lateral margin of femoral epiphysis. It was proposed that an intact lateral epiphyseal margin acted as a supporting column, preventing further collapse and subsequent deformity. Herring et al⁴ also recognised the importance of the integrity of the lateral pillar or segment and graded the height of the column into three groups. Our results support the view that the resorption of avascular bone leads to a critical lack of epiphyseal support.

Our initial treatment is directed towards the reversal of muscle spasm so that the range of hip movement, particularly abduction, is regained. After a period of bed rest and abduction traction, lasting several weeks in some patients, we perform arthrography under general anaesthesia. Four views are obtained. For the lateral view we currently favour a 'frog-lateral' rather than a 'shoot-through lateral' projection. Arthrography allows us to estimate the sphericity of the femoral head to determine the best position for containment and the presence of hinge abduction in deformed hips. At this stage MRI may be valuable; it gives greater definition of the extent of the infarction although it does not show the shape of femoral head any better than arthrography.

Children in Herring group A or group B with no major loss of sphericity have a period of non-weight-bearing using a wheelchair or crutches, depending on their age and capability. A physiotherapist monitors the continued maintenance of hip movement; non-weight-bearing exercise such as swimming and cycling is encouraged. Weight-bearing is increased progressively as the epiphysis begins to recover.

We advise operative treatment for children over six years of age in Herring group C and for those in group B when arthrography shows loss of sphericity. We perform a proximal femoral varus osteotomy (15 to 20°), without excision of a bone wedge so that further shortening of the leg is avoided.²³ Our relative indications for operative treatment include bilateral disease or repeated episodes of

spasm and stiffness during conservative treatment, since these suggest the presence of a more extensive epiphyseal infarct.

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