A paired study of Perthes' disease comparing conservative and surgical treatment

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We performed a paired study of mature patients with Perthes' disease to compare the radiological results after treatment between conservatively- and surgically-treated groups. One patient was selected from each group to create the pairs for this study. Each pair was strictly matched for gender, body mass index, age at onset, stage at the first visit, necrotic area and radiological at-risk signs and each was assessed by comparing the values of six radiological measurements.

Eighteen pairs (36 hips) fitted the criteria. The radiological measurements which showed a statistically better result in the surgical groups were Mose's method, the acetabular-head index and leg-length discrepancy. There were no statistical differences in the slope of the acetabular roof and the articulo-trochanteric distance. Four hips in the conservative group were in Stulberg class II, five in class III and nine in class IV. In the surgical group, 13 were in Stulberg class II, four in class III and one in class IV.

We conclude that surgical treatment improved the sphericity of the femoral head and provided greater acetabular cover, but did not reform the acetabular roof.

It was noteworthy that a greater leg-length discrepancy and a smaller articulo-trochanteric distance were not seen in the surgical group. Our study suggests that surgical treatment is preferable in patients with severe Perthes' disease.

There is considerable controversy regarding the use of conservative or operative treatment in Perthes' disease. One of the reasons is that the patients selected for each treatment group are dissimilar particularly with regard to the severity of the disease. Comparative studies in the past have been carried out using simplistic and varying guidelines.¹⁻⁶ A satisfactory comparison between conservative and surgical treatment should involve patients who are matched for severity of the disease, gender, physique, age at onset, stage at the first visit, necrotic area and radiological signs. Such an attempt has not been previously undertaken.

Our aim was to compare the radiological results at maturity in matched pairs of patients with Perthes' disease, treated either by a uniform conservative or an operative method.

Patients and Methods

We selected only unilateral patients for our study. A total of 163 patients were reviewed of whom 136 were male and 27 female. The right side was affected in 68 hips and the left in 95. All were mature at the last follow-up. The conservative group consisted of 135 patients who

had been treated before 1985 by a Tachdjian-type orthosis, which is a trilateral socket hip abduction orthosis. The surgical group consisted of 28 hips which had been treated by femoral varus osteotomy between 1990 and 1995, in accordance with our protocol. This protocol had been created by one of the authors (MK) in 1987⁷ based on a long-term follow-up of the conservative group.

The protocol had three categories based on the following factors: age at onset, the Catterall classification⁸ and signs of severe subluxation and/or a metaphyseal cyst. Severe subluxation and a metaphyseal cyst were indicated by a difference in the teardrop distance of more than 3 mm between the affected and unaffected sides, and a diffuse cyst on the antero-posterior view. The categories were possibly poor, probably poor and definitely poor. Surgical intervention (varus femoral osteotomy) was undertaken in patients classified as possibly poor with persistent limitation of movement of the hip, particularly if there was less than 30° of abduction, or for all patients in the probably and definitely poor groups. The desired post-operative femoral neck-shaft angle was approximately 100°.

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Table I. Details of the 18 pairs of patients

Number of pair	Body mass index*		Age at onset (yrs + mths)		Stage	Catterall group ⁸ (III or IV)	Head-at-risk sign	
	Cons	Surg	Cons	Surg			Subluxation	Metaphyseal cyst
1	15.9	17.7	9+1	9+6	Necrotic	III	+	+
2	15.1	15.4	8+4	8+5	Initial	III	+	+
3	16.2	16.8	10+0	10+6	Necrotic	III	+	+
4	16.5	15.9	7+0	7+2	Necrotic	III	+	+
5	15.3	15.2	6+9	7+6	Necrotic	III	+	+
6	15.5	16.9	8+4	8+3	Initial	III	+	+
7	14.8	15.1	6+3	6+6	Initial	III	+	+
8	16.2	15.8	8+1	8+5	Necrotic	III	+	+
9	17.3	16.2	7+1	6+7	Necrotic	IV	+	+
10	17.3	16.4	10+9	10+1	Regenerative	III	+	+
11	18.2	17	9+8	9+0	Initial	III	+	+
12	17.6	15.8	8+1	9+0	Necrotic	III	+	n/a
13	16.5	15.6	8+6	8+7	Necrotic	III	+	n/a
14	16.7	18.1	8+1	8+1	Necrotic	III	+	+
15	17.9	16.5	8+5	8+8	Necrotic	III	+	+
16	18.5	17.9	10+1	10+4	Necrotic	III	+	n/a
17	17.8	17.1	11+0	10+6	Regenerative	III	+	n/a
18	17.1	16.8	11+3	11+0	Initial	III	+	+
Mean	16.7	16.5	8+8	8+9				

* cons, conservative; surg, surgery

Table II. Radiological findings in the 18 pairs*

Number of pair	Mose ⁹ (mm)		AHI (%)		SAR (°)		ATD (mm)		LLD (mm)		Stulberg ¹¹ classification	
	Cons	Surg	Cons	Surg	Cons	Surg	Cons	Surg	Cons	Surg	Cons	Surg
1	10	8	64.4	75.8	-15	-18	2	10	3	14	IV	IV
2	6	3	74.0	66.3	0	0	5	8	12	8	III	III
3	6	0	67.1	82.6	0	-5	13	5	15	2	III	II
4	3	0	68.7	80.0	0	-3	3	-8	11	5	III	II
5	2	0	82.1	84.7	0	-10	-2	-2	23	5	II	II
6	6	0	74.0	77.4	0	1	5	5	12	0	III	II
7	4	2	75.6	78.9	0	0	1	-2	18	14	IV	II
8	3	2	72.0	82.4	0	-12	-7	-9	11	9	IV	III
9	10	2	65.0	82.8	-14	-3	6	11	22	4	IV	III
10	10	8	64.4	86.8	-15	-16	2	5	3	10	IV	III
11	10	0	61.2	87.4	-20	0	-2	5	20	13	IV	II
12	2	1	78.2	92.4	0	0	0	3	21	15	II	II
13	1	2	77.8	72.7	2	-7	6	3	3	5	II	II
14	4	1	72.5	88.2	0	-8	3	3	13	3	IV	II
15	2	1	76.5	82.9	2	-5	5	8	15	3	II	II
16	3	2	83.9	65.6	2	-15	2	-5	7	12	III	II
17	8	1	68.4	80	0	0	6	-2	5	8	IV	II
18	4	0	70	79.4	-5	3	2	5	12	5	IV	II
Mean	5.2	1.8	72.0	80.4	-3.5	-5.4	2.8	2.4	12.6	7.5		
Median	4.0	1.0	72.3	81.2	0.0	-4.0	2.5	4.0	12.0	6.5		

* AHI, acetabular head index; SAR, slope of acetabular roof; ATD, articulothoracic distance; LLD, leg-length discrepancy; cons, conservative; surg, surgery

One patient was selected from each treatment group to create the pairs for our study. Each pair was matched for gender, sex, body mass index within ± 2 , age at onset, the stage at the first visit (the initial, necrotic or regenerative), Catterall group (III, IV, head-at-risk), and severe subluxation and/or a metaphyseal cyst. Catterall group III was evaluated more strictly by measuring the epiphyseal height from a lateral radiographic view. Heights which were less than 75% of the epiphysis of the normal side were classified as group III. At follow-up each pair was assessed radiologically by Mose's method,⁹ by measurement of the acetabular-

head index (AHI), the slope of the acetabular roof (SAR),¹⁰ the articulothoracic distance (ATD) and the leg-length discrepancy (LLD) and by the classification of Stulberg, Coopermann and Wallensten.¹¹ The measurements in both the conservative and surgical groups were performed on radiographs taken between the ages of 16 and 20 years.

Statistical analysis. We used the Wilcoxon signed-rank test (Statistical Analysis System, Cary, North Carolina). The results were expressed as the mean with the 95% confidence interval (CI) and the median. A p value of <0.05 was considered to be significant.

Fig. 1a

Fig. 1b

Fig. 1c

Plain radiographs of a seven-year-old boy (pair 4) in the conservative group with Catterall classification III and positive signs of subluxation and a metaphyseal cyst showing a) anteroposterior (AP) and b) lateral views and c) the same patient at the age of 19 years when classified as Stulberg class III.

Fig. 2a

Fig. 2b

Fig. 2c

Radiographs of the paired surgical patient (pair 4) at 18 years of age showing a) a more spherical femoral head and classified as Stulberg class II, b) the AP and c) lateral views at onset.

Results

Eighteen pairs fitted the criteria. All were male. The most frequent stage at the first visit was the necrotic or fragmentation stage. Seventeen pairs were classified as Catterall group III and one as group IV. Subluxation and a metaphyseal cyst were seen in 14 pairs, and subluxation alone in four (Table I).

The results of the radiological measurements are given in Table II. The findings were significantly better for the surgical group compared with the conservative group for Mose's method ($p = 0.0003$), AHI ($p = 0.0096$), and LLD ($p = 0.0234$).

No statistical difference was seen between the conservative and surgical groups in the SAR ($p = 0.245$) and ATD ($p = 0.886$). The mean confidence intervals (CI) and median

for the difference of each variable in each pair were 3.4 mm (2.0 to 4.8) and 2.5 mm for Mose's method, -8.4% (-13.8% to -3.0%) and -10.9% for the AHI, 1.9° (-2.2 to 6.0) and 2.0° for the SAR, 0.4 mm (-3.9 to 4.7) and 0.0 mm for the ATD, and 3.7 mm (1.0 to 6.4) and 6.0 mm for the LLD. Stulberg's classification showed that good results were more frequent in the surgical group than in the conservative group with better results in 12 pairs, the same result in six pairs and no worse results for any pair. Four hips in the conservative group were in Stulberg's class II, 5 in class III and 9 in class IV, while in the surgical group 13 were in class II, 4 in class III and 1 in class IV (Table II).

Pair presentation

Pair 4. The radiographs at presentation of a seven-year-old patient in the conservative group showed Catterall group

Fig. 3a

Fig. 3b

Radiographs of a patient aged six years and seven months (pair 9) in the surgical group in Catterall group IV with positive signs of subluxation and a metaphyseal cyst showing a) AP and b) lateral views.

Fig. 4a

Fig. 4b

Fig. 4c

Radiographs of the paired conservative patient (pair 9), with the same classification and at-risk signs showing a) AP and b) lateral views and c) Stulberg class IV.

III with positive signs of subluxation and a metaphyseal cyst (Figs 1a and 1b). At 19 years of age the patient was classified as Stulberg class III with 3 mm by Mose's method and 68.7% of AHI (Fig. 1c). The radiograph of the paired surgical patient aged 18 years showed a more spherical femoral head (0 mm by Mose's method) and better acetabular cover (80.0% of AHI) and was classified as Stulberg II (Fig. 2a). The appearance of this hip at onset is shown in Figures 2b and 2c. The LLD was 11 mm in the conservative patient and 5 mm in the surgical one. Neither patient had a positive Trendelenburg sign, in spite of the high greater trochanter. However, the SAR was slightly better in the conservative patient (0°) than in the surgical patient (-3°).

Pair 9. Both patients in this pair were classified as Catterall group IV. The surgical patient had initially been treated by a Tachdjian orthosis, followed by a varus femoral osteotomy because of radiological deterioration (Fig. 3). Radiographs for the conservative patient also had the same risk

signs (Figs 4a and 4b). The results for this pair were quite different. The conservative patient was classified as Stulberg class IV (Fig. 4c) and the surgical patient as Stulberg class III (Fig. 5). The femoral head in the surgical patient was more spherical (2 mm by Mose's method) and well covered by the acetabulum (82.8% of AHI), compared with 10 mm by Mose's method and 65% AHI in the conservative patient.

Discussion

The extent of the necrotic area and head-at-risk signs are generally accepted as two of the most influential factors affecting the prognosis in Perthes' disease. In our study, a modified form of Catterall's classification was used to assess the patient's prognosis. For this, the amount of viable bone and the height of the femoral head on the lateral view were measured in the necrotic or fragmentation stage and any head-at-risk signs were identified in the femoral head.

Fig. 5

A radiograph of the surgical patient classified as Stulberg class III (pair 9).

Herring et al¹² reported the lateral pillar classification in which the height of the lateral part of the epiphysis (lateral pillar) is estimated during the fragmentation stage. It has been widely accepted because of its simplicity and reproducibility. However, Lappin, Kealey and Cosgrove¹³ have suggested that the Herring grade often changes with time, especially in the early stages of the disease. We therefore decided not to use this method of classification.

The indications for surgical treatment in Perthes' disease remain controversial despite several reports comparing the results of conservative and surgical treatment.¹⁻⁶

In our study by using matched pairs of conservatively and surgically treated patients we have tried to obtain a more rigorously controlled comparison between the two groups. We included only patients classified at presentation as Catterall group III and IV.

Lloyd-Roberts et al⁴ stated that containment by femoral osteotomy was the treatment of choice in patients with at-risk signs provided that severe deformity had not already occurred. However, their study of three groups, an osteotomy, an untreated, and an uncontained treated group was based on a simplistic standard of patient selection and only excluded Catterall group-I patients. Marklund and Tilberg⁵ compared conservative treatment in one institute and surgical treatment in another with differing guidelines of treatment. Lahdes-Vasama et al³ compared the outcome between conservative and surgical groups in terms of the femoral sphericity, acetabular cover and acetabular direction. However, they selected patients for both groups by using only the classification A or B described by Salter and Thompson.¹⁴ Randomised or simple mass studies do not allow us to make an accurate judgement of the correct choice of treatment. The use of carefully matched pairs of conservatively and surgically-treated patients in our study

may help to resolve this important issue which has long been discussed without any general consensus.

Some authors have reported that the most important factor for the long-term prognosis is the sphericity of the femoral head.^{9,11,15} In our study sphericity of the head measured by Mose's method and the AHI, which reflects acetabular congruity were significantly better in the surgical group. Lecuire¹⁶ has stated in a follow-up study of more than 50 years that normal or flattened spherical heads present few problems, but irregular or very irregular heads are associated with a poor result. There was no statistical difference in SAR or ATD between the groups.

Weiner, Weiner and Riley¹⁷ recommended a post-operative femoral varus angle of more than 105°. Heikkinen and Puranen¹⁸ suggested that 100 to 110° of varus were optimal for obtaining good containment of the femoral head in the acetabulum. We usually performed osteotomies with about 40° of varus which resulted in a neck-shaft angle of approximately 100°. It is generally thought that a femoral varus osteotomy produces a higher position of the greater trochanter, with a greater LLD than conservative treatment. However, our results do not support this belief, in terms of the ATD and LLD. The value of the ATD in both treatment groups did not show a statistical difference ($p = 0.886$). The value of the LLD showed a statistically better result for the surgical group ($p = 0.0234$) contrary to our expectations. This suggests that even in the conservative group, a considerable loss of epiphyseal height had occurred, resulting in poor values for the ATD and LLD. Yrjönen¹⁵ reported that the incidence of LLD was similar in conservative and surgical groups. The results of our study suggest that femoral osteotomy does not cause increased LLD in patients with Catterall group-III disease compared with conservative treatment. Clinically the higher position did not give rise to a Trendelenburg phenomenon in either group.

We conclude that surgical treatment can improve the sphericity of the femoral head and provide greater acetabular cover than conservative treatment. However, the SAR was not affected. A greater degree of LLD and a smaller ATD were not seen in the surgical groups. Our study suggests that surgical instead of conservative treatment is preferable for patients with severe Perthes' disease.

Although only 18 strictly matched pairs (36 hips) were included in our study, the results suggest that varus femoral osteotomy is better than conservative treatment in patients with severe (Catterall group III or group IV) Perthes' disease.

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