The treatment of osteonecrosis of the femoral head (FHN) is controversial. It mainly occurs in young patients in whom total hip replacement is best avoided because of an increased risk of revision. The objective of this long-term follow-up study was to evaluate the outcome of intertrochanteric flexion osteotomy as a hip joint preserving operation for FHN.

Over a 19-year period we carried out 70 intertrochanteric flexion osteotomies for FHN in 64 patients. The mean follow-up was 10.4 years (3.0 to 20.3). The overall mean Harris hip score increased from 51 points preoperatively to 71 points postoperatively. Six patients (9%) developed early postoperative complications. A total of 19 hips (27%) underwent total hip arthroplasty at a mean of 8.7 years after osteotomy. The five-year survival rate was 90%. Survival rates of hips in Ficat stage 2 were higher than those in stages 3 or 4. Hips with a preoperative necrotic angle of <200˚ had a better survival probability than those with a necrotic angle >200˚. Our findings suggest that flexion osteotomy is a safe and effective procedure in Ficat stage 2 and 3 FHN, preferably with a necrotic angle of <200˚.

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The treatment of osteonecrosis of the femoral head (FHN) is controversial, mainly because it occurs in young patients between the age of 30 and 50 years.1 Total hip replacement is not the preferred treatment in the young patient because of an increased risk of revision.2 Joint preserving methods of treatment are therefore favoured. Intertrochanteric flexion osteotomy has been described as a joint preserving procedure for FHN.3 The principle of this procedure is to move the osteonecrotic area of the femoral head is turned away from the weight-bearing area by resection of an intertrochanteric segment of bone and flexion of the femoral head.

Patients and Methods

Preoperative assessment and demographic data. Between August 1975 and February 1994, a total of 64 patients underwent intertrochanteric flexion osteotomy for FHN. In 21 the FHN was bilateral and six of these underwent bilateral osteotomies, so that a total of 70 operations are included in this study. There were 54 operations in 49 men, and 16 operations in 15 women. The mean age of the patients at the time of surgery was 38 years (13 to 62). The ratio of left to right hips was 3:2.

Operative technique. For evaluation of the site and extent of the osteonecrotic lesion, we took standard radiographs in
the anteroposterior (AP) and axial planes. The object of the operation was to move the osteonecrotic lesion away from the weight-bearing area. The osteotomy was occasionally combined with other procedures (Table I). There was only one patient with radiological Ficat stage 4, which represents major joint destruction. In the majority of hips, the flexion angle was 30° depending upon the site and extent of the osteonecrotic lesion (Table I).

**Assessment.** For clinical assessment of the outcome of the intertrochanteric flexion osteotomy, we used the Harris hip score. Standard radiographs in the AP and axial planes were used to determine the Ficat stage of osteonecrosis and to estimate the necrotic angle. The necrotic angle was measured by adding together the necrotic angles in the AP and axial radiographs and was subdivided into two subgroups, one with angles ≤200°, and one with angles >200°. Implantation of a total hip arthroplasty (THA) was interpreted as failure of the osteotomy.

**Data acquisition.** Preoperative data were collected from the patients’ notes. The Harris hip score was assessed preoperatively and at the time of follow-up. Joint function, leg length, and the range of movement was documented. A complete history was taken with emphasis on other diseases, alcohol intake, and the use of corticosteroids. The patients’ profession was documented and any change of job or early retirement due to hip disease. The radiographs were assessed and staged preoperatively and at follow-up.

**Statistical analysis.** The chi-squared test was used for the comparison of two categoric values. Wilcoxon’s signed rank test was used for testing parameters preoperatively and postoperatively. Failures were recorded and, using these data, survival probability curves were drawn as performed in comparable studies. Confidence limits for all Kaplan-Meier survivorship estimates were calculated with a confidence level of 0.95. We used the log-rank test to calculate the statistical significance of differences between the Kaplan-Meier survival curves with respect to the Ficat stage or the necrotic angle.

### Results

**Preoperative data.** The presumed risk factors include abuse of alcohol (16 hips, 23%), use of corticosteroids (seven hips, 10%) and pathological fat metabolism (four hips, 6%). One patient had suffered from Caisson disease from diving (two hips, 3%). One patient suffered from SLE and had steroid therapy (one hip). One patient suffered from diabetes (one hip). No risk factor could be identified for the majority of the patients (39 hips, 56%).

The mean age at surgery was 38 years (13 to 62). The male to female ratio was 3.4:1. Men had a mean age of 38 years and women a mean age of 40 years at the time of surgery. Patients who had not undergone THA by the time of follow-up (31 patients; 36 hips) had a mean age of 37 years. Patients who had undergone THA (19 hips; 27%; 18 patients) had a mean age of 40 years at the time of the flexion osteotomy. Seven patients who had undergone unilateral surgery died at a mean of 57 months postoperatively and before follow-up. Five patients did not attend follow-up, and three declined to participate in the follow-up examination (eight patients; eight hips). The mean follow-up period was 10.4 years (3.0 to 20.3).

**Clinical outcome.** For the 32 patients (36 hips) who had not undergone THA, the mean Harris hip score was 51 points preoperatively, and 71 at the time of follow-up (p < 0.01). The 19 hips which underwent THA after flexion osteotomy had a mean Harris hip score of 46 points preoperatively. This was not significantly different from those hips which had not undergone THA. Of the 24 hips with Ficat stage 2 which had not undergone THA, the increase in the mean Harris hip score from 49 to 71 points was not significantly higher than for 12 Ficat stage 3 and 4 hips, which increased from 54 points preoperatively to 71 at follow-up. The mean preoperative pain score was rated at 15 points by the patients who had a THA, not significantly lower than the 18 points awarded by the patients who had not undergone THA. At follow-up, the mean Harris hip score increased significantly to 32 points in the group who had not undergone THA (p < 0.05). In respect of function, the Harris hip score increased significantly from a mean of 26 points preoperatively to 38 at follow-up (p < 0.05). Preoperatively, Ficat stage 2 hips had a mean Harris hip score of 27 points and Ficat stage 3 and 4 hips had a mean score of 30 points. Ficat stage 2 hips had increased to a mean of 37 points, while Ficat stage 3 and 4 hips had risen to a mean of 40; not significantly different. Of the hips which did not undergo THA, preoperatively, in seven (19%) the distance walked was limited to bed and chair only. For seven other hips (19%), the walking distance was unlimited, seven (19%) were able to walk two to three blocks, and 15 (42%) were able to walk six blocks. At follow-up, 26 hips (72%) had an unlimited ability to walk, nine (25%) could walk six blocks, and one

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**Table I.** Overview of the procedure combined with an intertrochanteric flexion osteotomy for patients with FHN

<table>
<thead>
<tr>
<th>Number of hips</th>
<th>Flexion angle in degrees</th>
<th>Varus displacement</th>
<th>Valgus displacement</th>
<th>Bone graft</th>
<th>Core decompression</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>30</td>
<td>14</td>
<td>4</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

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(3%) was able to walk two to three blocks. Two hips, therefore, had a decreased walking distance, seven were unchanged, and 27 had an increased walking distance.

**Joint mobility.** For those hips which had not undergone THA, there was reduced movement of the hip in all planes at follow-up when compared with the preoperative stage (Table II). This was not significant for Ficat stage 2 hips but was significant for Ficat stages 3 and 4.

**Early complications.** Six patients (9%) developed early postoperative complications. These were a superficial wound infection (one), delayed wound healing (one), deep wound infection (one), deep-vein thrombosis (one) and delayed bony union (two hips). One patient with a delayed union underwent a revision procedure.

**Failure.** THA was undertaken in 19 hips (27%) at a mean of 8.7 years after the flexion osteotomy. Of the 31 Ficat stage 2 hips, four underwent THA and 14 of 32 stage 3 hips underwent THA. Seven of 16 patients with alcohol abuse (44%) and eight of 39 hips with idiopathic FHN (20%), underwent THA.

<table>
<thead>
<tr>
<th>Ficat stage</th>
<th>Number of hips</th>
<th>Flexion/extension Preop</th>
<th>Flexion/extension Follow-up</th>
<th>Abduction/adduction Preop</th>
<th>Abduction/adduction Follow-up</th>
<th>External/internal rotation Preop</th>
<th>External/internal rotation Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>24</td>
<td>118</td>
<td>104</td>
<td>52</td>
<td>42</td>
<td>45</td>
<td>34</td>
</tr>
<tr>
<td>3 and 4</td>
<td>12</td>
<td>116</td>
<td>96</td>
<td>45</td>
<td>32</td>
<td>36</td>
<td>25</td>
</tr>
</tbody>
</table>

![Fig. 2](image1.png)

**Fig. 2**
A survival probability curve for 65 hips treated by an intertrochanteric osteotomy (95% CI).

![Fig. 3](image2.png)

**Fig. 3**
Survival probability of an intertrochanteric osteotomy by Ficat stage.
Survival analysis. Of the total of 70 hips, 65 could be included for survival analysis. Five patients did not attend for the follow-up examination. Figure 2 shows the survival curve. After five years, the survival rate was 90%, after ten it was 81%, and after 15 it was 63%. Ficat stage 2 hips achieved a 5-, 10-, and 15-year survival rate of 92%, 87% and 78%, respectively (Fig. 3). For Ficat stages 3 and 4, the survival rates were 88%, 76% and 52%, respectively. Survival rates for Ficat stage 2 hips were significantly higher than for Ficat stages 3 and 4 (log-rank test; p < 0.05).

Hips with a preoperative necrotic angle of $\leq 200^\circ$ had a survival probability of 89%, 89% and 76%, while hips with a preoperative necrotic angle of $>200^\circ$ achieved 90%, 78% and 60% survival probability after five, ten and 15 years, respectively (Fig. 4).

Radiological findings. We examined 32 of the 36 hips which were available for radiological follow-up. Of the 22 hips which had been staged preoperatively as Ficat stage 2, ten remained in stage 2, six were staged as Ficat 3, and six were staged as Ficat 4 at follow-up. Of the ten hips which had been staged preoperatively as Ficat 3, seven remained as stage 3 and three were staged as Ficat 4.

Of 44 hips with a preoperative necrotic angle of $>200^\circ$, 15 (34%) underwent THA. Only four of 21 hips (19%) with a preoperative necrotic angle of $\leq 200^\circ$ underwent THA ($p < 0.05$). Of the nine Ficat stage 3 hips with a necrotic angle $\leq 200^\circ$, three (33%) underwent THA, while 11 (48%) of 23 stage 3 hips with a necrotic angle $>200^\circ$ underwent THA. One (8%) of 12 stage 2 hips with a necrotic angle $\leq 200^\circ$ underwent THA 25 months after the flexion osteotomy, whereas the three of 19 hips (16%) with a necrotic angle $>200^\circ$ underwent THA at a mean of 96 months after the flexion osteotomy. Three stage 3 hips with a necrotic angle $\leq 200^\circ$ underwent THA after a mean of 127 months.

At follow-up, the mean necrotic angle was 238°, significantly larger than the 222° measured preoperatively ($p < 0.05$; n = 33 hips). The mean preoperative necrotic angle of 224° for the hips which underwent THA after the osteotomy (n = 19) was not significantly different to the 222° for those hips which did not (n = 36).

Working capability. In 19 patients (20 hips) of the 32 patients (36 hips) who had not undergone THA at the time of follow-up, FHN and flexion osteotomy had no impact on their working capability. Of these patients, 14 had a largely sedentary job and five had a physically moderately demanding job. At follow-up, 13 patients said they had no work. Six of these patients (19%) had not been working before surgery while two had retired due to age, and five had retired due to their hip disease.

Discussion

The cause of non-traumatic FHN is still widely discussed.11 Local ischaemia is assumed to be the mechanism by most authors.12 Intravascular coagulation has also been suggested.13 Other investigators have proposed that increased intraosseous pressure disturbs the blood supply to the femoral head.14

The young age of patients with non-traumatic FHN strongly suggests that joint-preserving treatment methods should be used.11 The long-term results of THA for FHN are known to be worse than for patients who have other conditions of the hip.5,15 The highest revision rates of THA are found in patients with steroid-induced FHN and FHN associated with underlying bone diseases such as sickle cell disease (59% over a 5.5 year period).16 The mean age of the patients at operation in our study was 38 years (13 to 62), and joint-preserving techniques should clearly be favoured in order to delay the need for THA. We investigated the outcome of intertrochanteric flexion osteotomy as a hip joint preserving procedure.3

The Harris hip score was improved by a flexion osteotomy and was independent of the Ficat stage. The range of movement of the hip was less after a flexion osteotomy for all hips, although this reduction was not significant for stage 2 hips. This, and the poor rate of return to work, may be a drawback of the method. Pain, a major indication for surgery, was improved by the flexion osteotomy. Pain and walking ability also improved in another study of flexion osteotomy.17 In a study on corrective proximal femoral
osteoartrosis, a good to excellent outcome, with an increase in Harris hips score, has also been described. 

The rate of early postoperative complications was 9% in our study, compared with 17% in a recently published study. No complications were reported for a varus osteotomy by Saito, Ohzono and Ono, although only four hips were examined. Nonunion and pseudarthrosis are complications which are specific to this technique.

The rate of failure of a flexion osteotomy in our study was 10% after five years, and 27% for the whole follow-up period. The rate of failure of a flexion osteotomy in a recently published retrospective study was 27% after five years. In other studies, the rates of failure were 37.5% and 24%. Alcohol abuse contributed to a higher rate of failure in our study.

We found an overall five-year survival rate of 90%. The survival rate was 92% for Ficat stage 2 hips and 88% for stage 3 and 4 hips. Schneider et al. reported a five-year survival rate was 92% for Ficat stage 2 hips and 88% for Ficat stage 2A FHN, but not when there is evidence of cystic change in the femoral head on plain radiographs. None of the 11 Ficat stage 1 hips treated with core decompression, while Ficat stage 2 FHN would appear to be an option for core decompression. The authors wish to thank Mrs Bettina Andresen for assistance in designing Figure 1.

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


