Survival analysis of hips treated with flexion osteotomy for femoral head necrosis

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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 $<200^\circ$ had a better survival probability than those with a necrotic angle $>200^\circ$. 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 $<200^\circ$.

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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

Fig. 1

The principle of an intertrochanteric osteotomy. The necrotic 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.

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 lesion away from the weight-bearing area (Fig. 1). This method requires a relatively long period of postoperative immobilisation and high patient compliance. The objective of this retrospective follow-up study was to assess the outcome of intertrochanteric flexion osteotomy and to identify predictive factors for its outcome.

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

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

Number of hips	Number of hips with associated procedures				Core decompression
	Flexion angle in degrees	Varus displacement	Valgus displacement	Bone graft	
1	15	1			
3	20	1			
63	30	14	4	5	
3	40			1	1

the anteroposterior (AP) and axial planes. The object of the operation was to move the osteonecrotic lesion away from the weight-bearing area.³ The osteotomy⁴ was occasionally combined with other procedures (Table I). There was only one patient with radiological Ficat stage 4, which represents major joint destruction.⁵ 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.⁶ Standard radiographs in the AP and axial planes were used to determine the Ficat⁵ 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 radiographs⁷⁻⁹ and was subdivided into two subgroups, one with angles $\leq 200^\circ$, and one with angles $> 200^\circ$. 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.¹⁰ 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

Table II. Range of movement and Ficat stage of the 36 hips which had not undergone THA at the time of follow-up

Ficat stage	Number of hips	Mean range of movement (degrees)					
		Flexion/extension		Abduction/adduction		External/internal rotation	
		Preop	Follow-up	Preop	Follow-up	Preop	Follow-up
2	24	118	104	52	42	45	34
3 and 4	12	116	96	45	32	36	25

(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.

Fig. 2

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

Fig. 3

Survival probability of an intertrochanteric osteotomy by Ficat stage.

Fig. 4

Survival probability of an intertrochanteric osteotomy by necrotic angle.

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

osteotomy, a good to excellent outcome, with an increase in Harris hips score, has also been described.¹⁸

The rate of early postoperative complications was 9% in our study, compared with 17% in a recently published study.⁸ No complications were reported for a varus osteotomy by Saito, Ohzono and Ono¹⁹ 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.⁸ In other studies, the rates of failure were 37.5%¹⁷ and 24%.¹⁸ 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 al⁸ reported a five-year survival probability of 70%, a ten-year probability of 50% for flexion osteotomy. They also reported a significantly lower long-term survival probability for Ficat stage 4 hips, when compared with stage 3 hips, after both intertrochanteric flexion and Sugioka's rotational osteotomy.⁸

In our study, the failure rate for necrotic angles of $>200^\circ$ was higher than for those hips with necrotic angles $<200^\circ$. Wagner et al⁹ found that the outcome for FHN declined with necrotic angles of $>200^\circ$. The outcome for those with a necrotic angle of $>250^\circ$ was poor. A survival probability of 90% was reported for flexion osteotomy when the necrotic angle was $<180^\circ$.⁸

Saito et al¹⁹ suggested that intertrochanteric varus osteotomy is a good form of treatment for selected patients with small and shallow areas of necrosis and where the lateral head is intact. Other joint preserving techniques include Sugioka's rotational osteotomy, core decompression and non-vascularised or vascularised fibular grafting.¹⁹⁻²²

A high complication rate of 33% and the need for a highly experienced surgeon for Sugioka's rotational osteotomy, was described by Saito et al.¹⁹ Complication rates of 55%, and a five-year failure rate of 72% have been reported for this technique.⁸ Good results have been reported by its proponents.^{20,23,24}

When considering a flexion osteotomy, the surgeon should bear in mind that if the operation fails joint replacement with a very flexed femur can be technically difficult.

Core decompression has a good outcome when carried out in the early stages of FHN, although poor long-term results have also been reported for both it and non-vascularised bone grafting.^{19,25} Core decompression has been suggested for Ficat stage 1 and 2A FHN, but not when there is evidence of cystic change in the femoral head on plain radiographs.²⁶ None of the 11 Ficat stage 1 hips treated with either core decompression or a vascularised fibular graft needed a THA.²⁷ For stage 2 or 3 hips, the failure rate was significantly higher after core decompression than for hips treated by vascularised fibular grafting.²⁷

Free vascularised fibular grafting for FHN has been reported to improve the Harris hip score.²² No association was found however, between the aetiology and the probability of conversion to THA. In a study of vascularised fibular grafting, the 50-month survival rate was 89% for stage 2 hips and 81% for stage 3 hips.²⁷ The same study found the 50-month survival rate to be 65% for stage 2 hips, and 21% for stage 3 hips after core decompression.

Our findings suggest that an intertrochanteric flexion osteotomy is a safe and effective procedure, preferably for stage 2 but also for stage 3 hips, and with a necrotic angle of $<200^\circ$. In FHN associated with alcoholism, an intertrochanteric flexion osteotomy appears to have a higher failure rate. Ficat stage 1 FHN may be treated by the less invasive core decompression, while Ficat stage 4 FHN would appear to benefit most from a THA.

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References

1. Meyers MH. Osteonecrosis of the femoral head: pathogenesis and long-term results of treatment. *Clin Orthop* 1988;231:51-61.
2. Furnes O, Lie SA, Espehaug B, et al. Hip disease and the prognosis of total hip replacements: a review of 53698 primary total hip replacements reported to the Norwegian Arthroplasty Register 1987-99. *J Bone Joint Surg [Br]* 2001;83-B:579-88.
3. Willert HG, Sarfert D. Treatment of segmental ischemic necroses of the head of femur with intertrochanteric flexion-osteotomy. *Z Orthop Ihre Grenzgeb* 1975;113:974-94.
4. Teinturier P, Levai JP, Collin JP, Terver S. Intertrochanteric flexion osteotomy as an only alternative to total hip arthroplasty in advanced osteoarthritis: a ten-year follow-up. *Clin Orthop* 1982;166:158-61.
5. Ficat RP. Idiopathic bone necrosis of the femoral head: early diagnosis and treatment. *J Bone Joint Surg [Br]* 1985;67-B:3-9.
6. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty: an end-result study using a new method of result evaluation. *J Bone Joint Surg [Am]* 1969;51-A:737-55.
7. Kerboul M, Thomine J, Postel M, Merle d'Aubigne R. The conservative surgical treatment of idiopathic aseptic necrosis of the femoral head. *J Bone Joint Surg [Br]* 1974;56-B:291-6.
8. Schneider W, Aigner N, Pingerra O, Knahr K. Intertrochanteric osteotomy for avascular necrosis of the head of femur: survival probability of two different methods. *J Bone Joint Surg [Br]* 2002;84-B:817-24.
9. Wagner H, Baur W, Wagner M. Joint-preserving osteotomy in segmental femur head necrosis. *Orthopade* 1990;19:208-18.
10. Murray DW, Carr AJ, Bulstrode C. Survival analysis of joint replacements. *J Bone Joint Surg [Br]* 1990;75-B:697-704.
11. Mont MA, Hungerford DS. Non-traumatic avascular necrosis of the femoral head. *J Bone Joint Surg [Am]* 1995;77-A:459-74.
12. Drescher W, Schneider T, Becker C, et al. Selective reduction of bone blood flow by short-term treatment with high-dose methylprednisolone: an experimental study in pigs. *J Bone Joint Surg [Br]* 2001;83-B:274-7.
13. Jones JP Jr. Intravascular coagulation and osteonecrosis. *Clin Orthop* 1992;277:41-53.
14. Wang GJ, Moga DB, Richermer WG, et al. Cortisone induced bone changes and its response to lipid clearing agents. *Clin Orthop* 1978;130:81-5.
15. Stulberg BN, Singer R, Goldner J, Stulberg J. Uncemented total hip arthroplasty in osteonecrosis: a 2- to 10-year evaluation. *Clin Orthop* 1997;334:116-23.
16. Clarke HJ, Jinnah RH, Brooker AF, Michaelson JD. Total replacement of the hip for avascular necrosis in sickle cell disease. *J Bone Joint Surg [Br]* 1989;71-B:465-70.

17. **Gallinaro P, Masse A.** Flexion osteotomy in the treatment of avascular necrosis of the hip. *Clin Orthop* 2001;386:79-84.
18. **Mont MA, Fairbank AC, Krackow KA, Hungerford DS.** Corrective osteotomy for osteonecrosis of the femoral head. *J Bone Joint Surg [Am]* 1996;78-A:1032-8.
19. **Saito S, Ohzono K, Ono K.** Joint-preserving operations for idiopathic avascular necrosis of the femoral head: results of core decompression, grafting and osteotomy. *J Bone Joint Surg [Br]* 1988;70-B:78-84.
20. **Sugioka Y.** Transtrochanteric anterior rotational osteotomy of the femoral head in the treatment of osteonecrosis affecting the hip: a new osteotomy operation. *Clin Orthop* 1978;130:191-201.
21. **Arlet J, Ficat C.** Ischemic necrosis of the femoral head: treatment by core decompression. *J Bone Joint Surg [Am]* 1990;72-A:151-2.
22. **Urbaniak JR, Coogan PG, Gunneson EB, Nunley JA.** Treatment of osteonecrosis of the femoral head with free vascularized fibular grafting: a long-term follow-up study of one hundred and three hips. *J Bone Joint Surg [Am]* 1995;77-A:681-94.
23. **Sugioka Y, Katsuki I, Hotokebuchi T.** Transtrochanteric rotational osteotomy of the femoral head for the treatment of osteonecrosis: follow-up statistics. *Clin Orthop* 1982;169:115-26.
24. **Sugioka Y, Hotokebuchi T, Tsutsui H.** Transtrochanteric anterior rotational osteotomy for idiopathic and steroid-induced necrosis of the femoral head: indications and long-term results. *Clin Orthop* 1992;277:111-20.
25. **Schneider W, Breitsenseher M, Engel A, et al.** The value of core decompression in treatment of femur head necrosis. *Orthopade* 2000;29:420-9.
26. **Bozic KJ, Zurakowski D, Thornhill TS.** Survivorship analysis of hips treated with core decompression for nontraumatic osteonecrosis of the femoral head. *J Bone Joint Surg [Am]* 1999;81-A:200-9.
27. **Scully SP, Aaron RK, Urbaniak JR.** Survival analysis of hips treated with core decompression or vascularized fibular grafting because of avascular necrosis. *J Bone Joint Surg [Am]* 1998;80-A:1270-5.