Intertrochanteric osteotomy for avascular necrosis of the head of the femur

SURVIVAL PROBABILITY OF TWO DIFFERENT METHODS

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We have compared different types of intertrochanteric osteotomy for avascular necrosis of the hip and evaluated their performance in the light of improving outcome after total hip arthroplasty (THA). During a period of 14 years we performed 63 flexion osteotomies (partly combined with varus or valgus displacement), 29 rotational osteotomies, 13 varus osteotomies, eight medialising osteotomies and two extension osteotomies. The mean period of follow-up for all 115 operations was 7.3 years (maximum 24.6).

At follow-up, 27 of 29 patients with a rotational osteotomy had already undergone a THA, compared with 36 of 63 after flexion osteotomy. A high incidence of complications (55.2%) was seen early after rotational osteotomy, compared with 17.5% after flexion osteotomy.

For all osteotomies there was a high correlation between the size of the necrotic area and the incidence of failure, which also correlated with the preoperative Ficat and Steinberg stages. Using Kaplan-Meier survivorship analysis, Sugioka’s rotational osteotomy showed a survival probability after five years of 0.26 (95% confidence interval 0.49 to 0.14), and after ten years of 0.15 (CI 0.36 to 0.06). The survival probability for flexion osteotomy was 0.70 (CI 0.83 to 0.59) after five years and 0.50 (CI 0.65 to 0.38) after ten years. The subgroup of flexion osteotomy with a necrotic sector of less than 180° achieved the best survival probability of 0.90 (CI 1.00 to 0.80) after five years and 0.61 (CI 0.84 to 0.45) after ten years.

The indications for intertrochanteric osteotomy for avascular necrosis of the hip have to be addressed critically. Even flexion osteotomy in cases with small areas of necrosis provides only temporary benefit. Rotational osteotomy was associated with a high incidence of complications.

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The treatment of patients with avascular necrosis of the hip remains a challenge. It affects mainly patients in the third to fifth decades of life for whom conservative treatment or joint-preserving surgery should be preferred.1 Bone-marrow oedema and preradiological stages of osteonecrosis can be diagnosed easily and accurately by MRI2-3 allowing early treatment with the aim of complete recovery.4 In stages with radiological signs of osteonecrosis, early treat-ment at least delays, and may prevent, progression to irreversible stages.5 For young patients with osteonecrosis of stages II or III, according to Ficat,6 treatment should provide long-lasting, pain-free and unrestricted activity. The efficacy of differing joint-preserving surgical proce-dures has to compare with the improved outcome after total hip arthroplasty (THA).7-21 In this retrospective study we have evaluated the results of osteotomy in the light of modern arthroplasty, and assessed differences between techniques of osteotomy regarding indications, postopera-tive complications, the clinical outcome and prospects for survival.

Patients and Methods

Between 1975 and 1989 we performed 115 intertrochanteric osteotomies on patients with avascular necrosis of the hip. Flexion osteotomy was undertaken on 63 occasions, combined with some varus displacement in 48 hips and valgus displacement in five. Rotational osteotomy, as described by Sugioka,22 was undertaken in 29 hips. Other techniques were used in smaller groups, for example, varus osteotomy in 13, medialising McMurray osteotomy in eight and extension osteotomy in two.7 For each operation the technique was selected according to the size and site of the osteonecrotic area and an attempt was made to rotate it away from where it would transmit weight. In order to assess the site and extent of the necrosis the following radiographs were taken: standard anteroposterior (AP),
frog-leg, AP in abduction and adduction, and AP in 30° flexion of the hip and with 30° angulation of the tube to show the cranioventral and craniodorsal aspects of the femoral head. The lateral views and the AP view in 30° flexion of the hip gave the most information about the required displacement of the femoral head. Rotational osteotomy was recommended for those patients in whom a conventional flexion osteotomy, with or without additional varus or valgus displacement, was insufficient to rotate the infarct away from the weight-bearing area.

All patients were assessed clinically using the Harris hip score. Plain AP and frog-leg radiographs served to assess the stage of osteonecrosis according to Ficat and Steinberg, Hayken and Steinberg. For clinical practicability the grading into A, B and C was modified by calculating the sum of the necrotic areas in the AP and frog-leg positions (A: <160°, B: 160° to 200°, C: >200°), instead of calculating the percentage of the volume or surface of the femoral head which was involved.

For all patients who underwent secondary surgical procedures, the date and indication for revision were recorded. For deceased patients the date of death was recorded and also the state of the hip at the time of death. Using these data, survival probability curves were drawn according to Kaplan and Meier with revision for any reason taken as the endpoint. Confidence limits for all Kaplan-Meier survivorship estimates were calculated with a confidence interval level of 0.95. Log-rank tests were used to calculate the statistical significance between Kaplan-Meier survival curves with regard to the type of osteotomy or preoperative stage of osteonecrosis. For comparison between the surgical procedures, only the two principal groups (flexion and rotational osteotomies) were included. In order to relate the preoperative stage of osteonecrosis to outcome, all patients were included. A standard statistical software package (S-Plus 2000; MathSoft Inc, Springer-Verlag, Berlin) served for analysis of the data, statistical calculations and preparation of survival curves.

**Results**

**Preoperative data.** We found the same risk factors as those published by other authors with alcohol abuse in 46.2% of patients, hyperlipidaemia in 40.6%, smoking in 26.4% and obesity in 18.9%. Steroid medication had been taken by only 2.8%. The two main groups of rotational and flexion osteotomy showed similar distributions of risk factors: alcohol abuse in 51.7% and 47.6%, hyperlipidaemia in 41.4% and 38.1%, smoking in 24.1% and 23.8%, obesity in 20.7% and 12.7%, and steroid medication 3.4% and 3.2%, respectively. The mean age at the time of surgery was 41.7 years (CI 39.2 to 44.2) for those who had a Sugioka rotational osteotomy and 41.5 years (CI 39.5 to 43.5) for the patients who had a flexion osteotomy.

Assessment of the preoperative radiographs according to Ficat showed that both groups were predominantly stage III (67.9% of rotational osteotomy, 86.0% flexion osteotomy), with depression of the articular surface, but without pronounced narrowing of the joint space. Before surgery Ficat stage-IV necrosis was seen in 32.1% of those with a rotational osteotomy and in 12.3% of those who had a flexion osteotomy. According to the staging of Steinberg et al. stage IV was the most common, being slightly less in patients with a rotational osteotomy (Fig. 1).

Patients who had a rotational osteotomy had a mean preoperative Harris hip score of 57.4 (CI 39.9 to 75.0) compared with 59.6 (CI 54.4 to 64.8) in those who had a flexion osteotomy. In both groups pain was the main indication for surgery rather than functional impairment. For those undergoing rotational and flexion osteotomy, a preoperative value of 15.7 (CI 8.4 to 23.0) and 17.3 (CI 14.4 to 20.2), respectively, was calculated from a possible maximum of 44 points for pain.

The mean follow-up interval, including the time interval until THA in patients needing revision, was 8.1 years (CI 6.6 to 9.7; maximum 24.6) for flexion osteotomy and, because the technique had been introduced later, 4.2 years (CI 2.6 to 5.7; maximum 13.4) for rotational osteotomy. For comparison of both methods this difference is compensated for by calculating the survival probability according to Kaplan and Meier. All patients were assessed both clinically and radiologically. For the 24 patients who were not available for the final follow-up, the date of the last clinical and radiological examination was used to calculate the survival probability. Therefore, all 115 patients were included in this calculation.

At an interval of five years after rotational osteotomy, 21 of 29 patients had been revised to a THA resulting in a survival probability of 0.26 (CI 0.49 to 0.14). After flexion osteotomy, 17 of 63 patients had undergone THA giving a survival probability of 0.70 (CI 0.83 to 0.59). After ten years 24 of the 29 rotational osteotomies (survival probabil-
Survival probability in relation to the preoperative stage of osteonecrosis. Calculating the survival probability according to the method of Kaplan and Meier for all hips, irrespective of the type of osteotomy, we found the following relationship between the extent of the necrotic lesion and probability of survival. After five years patients with a smaller necrotic area (less than 180° as a sum of AP and axial projection) have a survival probability of 0.84 (CI 0.95 to 0.75) compared with 0.39 (CI 0.54 to 0.28) for patients with a preoperative necrotic area greater than 180°. After ten years the survival probability for these two groups was 0.57 (CI 0.74 to 0.44) and 0.31 (CI 0.46 to 0.21), respectively (Fig. 3). This difference between hips with smaller and greater necrotic areas is statistically significant (p = 0.002).

For the subgroup of flexion osteotomy with a necrotic area smaller than 180°, the survival probability was 0.90 (CI 1.00 to 0.80) after five years and 0.61 (CI 0.84 to 0.45)
Fig. 4
Kaplan-Meier survivorship curves for flexion osteotomies, related to the preoperative necrotic area (faint lines represent respective 95% CIs). At the end of the follow-up period seven patients with small preoperative necrotic areas had been lost during follow-up, and ten remained unrevised. Five with large preoperative necrotic areas had been lost and five remained unrevised.

Fig. 5
Kaplan-Meier survivorship curves for rotational osteotomies, related to the preoperative necrotic area (faint lines represent respective 95% CIs). At the end of the follow-up period no patient with a small preoperative necrotic area had been lost during follow-up or remained unrevised. One with large preoperative necrotic areas had been lost and one patient remained unrevised.

Fig. 6
Kaplan-Meier survivorship curves for all osteotomies, related to the preoperative Ficat stage (faint lines represent respective 95% CIs). At the end of the follow-up period 18 patients, in preoperative Ficat stage III, had been lost during follow-up and 16 remained unrevised. No patient in stage IV had been lost or remained unrevised.
after ten years. For necrotic areas greater than 180°, the survival probability was 0.48 (CI 0.72 to 0.33) after five years and 0.36 (CI 0.60 to 0.22) after ten years (Fig. 4). This difference showed borderline significance (p = 0.05).

For rotational osteotomies with a necrotic area smaller than 180° the survival probability was 0.56 (CI 1.00 to 0.31) after five years and 0.22 (CI 0.75 to 0.07) after ten years. For necrotic areas greater than 180° the survival probability was 0.11 (CI 0.41 to 0.03) after both five and ten years (Fig. 5). This difference is not significant (p = 0.17).

Categorising all hips, independent of the type of osteotomy, according to the staging of Ficat, there was a survival probability of 0.61 (CI 0.73 to 0.52) after five years, 0.47 (CI 0.60 to 0.37) after ten years and 0.24 (CI 0.40 to 0.15) after 15 years for Ficat stage-III patients. For stage-IV hips it was 0.33 (CI 0.64 to 0.17) after five years, and 0.05 (CI 0.37 to 0.01) after ten and 15 years (Fig. 6). This difference between Ficat stage-III and stage-IV hips is statistically significant (p = 0.0008). The calculation for Ficat stage-II cases was omitted because the numbers were too small. Categorising all hips according to the staging of Steinberg, there was a survival probability of 1.00 after five years, 0.76 (CI 1.00 to 0.52) after ten years and 0.42 (CI 1.00 to 0.16) after 15 years for Steinberg stage-III hips. For stage-IV hips the survival probability was 0.56 (CI 0.69 to 0.45) after five years, 0.44 (CI 0.58 to 0.34) after ten years and 0.31 (CI 0.45 to 0.21) after 15 years. Stage-V hips had a survival probability of 0.48 (CI 0.77 to 0.30) after five years, 0.27 (CI 0.61 to 0.12) after ten years and 0.00 after 15 years (Fig. 7). The calculations for Steinberg stages I, II and VI were omitted because the numbers were too small. The difference between Steinberg stages III, IV and V regarding survival probability was statistically significant (p = 0.01). Log-rank tests comparing the probability of survival of Steinberg stage-III and stage-IV hips differed at the level p = 0.09, those between stages IV and V at the level p = 0.06, and those between stages III and V at p = 0.002.

Discussion

Bearing in mind the young age of patients who develop avascular necrosis of the hip (the mean age at the time of surgery of our patients was 41.3 years (CI 40.5 to 43.2)), joint-preserving techniques have been preferred in order to delay the need for THA. The outcome after intertrochanteric osteotomy has been compared with the improving results after THA7-21 (Table I). Several authors report rates of revision of less than 10% during similar follow-up periods.8,10,11,14,16,17,19,20 Our five-year rate of failure of 21 of 29 hips (72.4%) after rotational osteotomy fails by comparison. Even the better results after flexion osteotomy with a rate of failure of 27.0% at five years are not satisfactory.

When considering the outcome after surgery for osteonecrosis of the femoral head, most papers which include THA deal with patients whose osteonecrosis is stage III or IV (Table I). The increasing risk of failure with advanced preoperative stages of osteonecrosis, is clearly shown in our study, classified according to both Ficat6 and Steinberg et al24 (Figs 6 and 7). Analysing the early complications related to the surgery, our rate of 55% for complications after rotational osteotomy is not acceptable, particularly as this relates only to major complications. Lesser complications such as postoperative swelling, haematoma, minor wound problems, superficial thrombophlebitis or urinary tract infection, are not considered. This exceeds the 33% rate of major complications published by Saito, Onzono and Ono.27 From these data it may be concluded that the technique of rotational osteotomy is not recommended as a routine intervention. Our results, however, compare well with most other publications concerning this technique,27-35 but without approaching the excellent results of the proponents of the original method.36-43 Retrospectively, it is clear that the technique of rotational osteotomy as described by Sugioka et al36 is demanding, not only in regard to planning and
Table I. Comparisons of intertrochanteric and rotational osteotomies with THA in avascular necrosis of the femoral head

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THA

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*HHS, Harris hip score; ONFH, osteonecrosis of the femoral head stage according to the Japanese Investigation Committee of Health and Welfare
†C, cementless; C+, cemented; C±, hybrid

execution, but, crucially, concerning the preservation of the blood supply by carefully protecting the branches of the medial femoral circumflex artery during exposure, osteotomy and rotation. An additional explanation for poor results after osteotomy, and the high incidence of early complications, may be the earlier mobilisation than was originally proposed. Sugioka et al 81 advised bed rest for five to eight weeks before beginning partial weight-bearing.

Even our complication rate of 17% after flexion osteotomy seems high, and this confirms that this technique is also technically demanding and requires compliance by the patient (non-weight-bearing mobilisation) to avoid failures of fixation. Our rate of failure after flexion osteotomy compares with that in previous series (Table I).

Categorising the survival probability of all osteotomies in relation to the size of the necrotic area (more or less than 180°) which have been previously published, there is a higher incidence of failure in patients who have larger necrotic areas. 31,37,44,45 In our patients, this higher incidence is seen for all forms of osteotomy. The subgroup of flexion osteotomies, with an AP and axial necrotic sector less than 180°, achieved the best survival probability of 0.90 (CI 1.00 to 0.80) after five years and 0.61 (CI 0.84 to 0.45) after ten years. Therefore, flexion osteotomy remains a valuable surgical procedure in those hips with small

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osteonecrotic areas without narrowing of the joint space or flattening of the femoral head. Purely conservative treatment, even in early stages of osteonecrosis, leads to a progression of the disease. Ohzono et al showed radiological progression to collapse of the femoral head after a mean follow-up of five years, especially in patients with a necrotic area located laterally in the femoral head (94%), compared with those with a medial or central lesion (0% to 19%). Aaron, Lennox and Stulberg reported clinical progression of 69% and radiological of 76%, after a mean follow-up of 32 months in early-stage osteonecrosis. Progression in conservatively-treated hips with early stages of osteonecrosis, has been published in MRI-controlled studies.

We have drawn the following conclusions. The size of the necrotic area should be carefully determined preoperatively, since the risk of failure increases with the extent of necrosis. The site and extent of necrosis can be accurately defined using MRI, a method which was not available at the time of our earlier series of intertrochanteric osteotomy. In those patients in whom the size of the necrotic area requires the technically demanding rotational osteotomy, a high incidence of failure after surgery should be taken into consideration. In our patients, the probability of survival after this procedure is poor, with the necessity of a THA after a relatively short period. Even the comparatively better results after flexion osteotomy fail to give the younger patients a lasting functional and pain-free solution. Comparing our results with regard to the incidence of failure after intertrochanteric osteotomy and that after THA in patients with avascular necrosis, the latter has better results in the medium and advanced stages 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


