TOTAL HIP ARTHROPLASTY AFTER PREVIOUS PROXIMAL FEMORAL OSTEOTOMY

NORBERT BOOS, ROBERT KRUSHELL, REINHOLD GANZ, MAURICE E. MÜLLER

From the Inselspital, University Hospital, Berne, Switzerland

We compared 74 total hip arthroplasties (THAs) carried out after previous proximal femoral osteotomy with a diagnosis-matched control group of 74 primary procedures performed during the same period. We report the perioperative results and the clinical and radiological outcome at five to ten years.

We anticipated a higher rate of complications in the group with previous osteotomy, but found no significant difference in the rate of perioperative complications (11% each) or in the septic (8% v 3%) and aseptic (4% each) revision rates. There was a trend towards improved survival in the group without previous osteotomy (90% v 82%), but this difference was not statistically significant. The only significant differences were a higher rate of trochanteric osteotomy (88% v 14%) and a longer operating time in the osteotomy group.

Our study indicates that THA after previous osteotomy is technically more demanding but not necessarily associated with a higher rate of complications. Furthermore, proximal femoral osteotomy does not jeopardize the clinical and radiological outcome of future THA enough to exclude the use of osteotomy as a therapeutic alternative in younger patients.

Proximal femoral osteotomy is a valuable surgical option in the treatment of a variety of conditions affecting the hip, but some patients will subsequently require total hip arthroplasty (THA). Few substantive data have been published on the techniques, complication rate or outcome of THA performed after previous osteotomy.

Our aim was to evaluate the complications and the clinical and radiological outcome of THA after previous proximal femoral osteotomy and to compare the findings with those in a matched control group without previous surgery.

PATIENTS AND METHODS

We included in the study 74 patients who had had primary THA with a cemented Müller straight-stem femoral component between 1980 and 1984, and who had previously had a proximal femoral osteotomy.

Information from before and during the operation was collected by review of the hospital records, radiographs, and the detailed standardised surgical data sheets which had been prospectively completed by the surgeons for all patients at the time of THA. These contained data on the operative findings, surgical technique, duration of the operation, intra- and postoperative complications, and the surgeon's subjective rating of the difficulty of the procedure. Blood loss was not recorded on these sheets and could not be analysed in our study. Perioperative data were available for all patients. Details of the patients, the diagnosis and the mean preoperative Harris hip score are given in Table I.

The mean interval between osteotomy and subsequent THA was 128 months (1 to 20 years). Seventy-one hips had had previous intertrochanteric osteotomy; 33 were varus (5° to 30°) and 12 valgus (20° to 40°) and in 26 the original operative note was not available. Three patients had a Schanz-type sub/pertrochanteric valgus osteotomy. In 55 patients the internal fixation from the osteotomy had been removed at a separate operation preceding the hip replacement. In the remainder it had been removed at the time of the THA.

Control group. We selected 74 diagnosis-matched cemented THAs in a blinded fashion from a pool of 399 consecutive primary operations performed during the same time period by the same surgeons, including consultants and...
trainees, to comprise the control group. The potential pool of patients was too small to have a control group matched one-to-one for diagnosis, gender and exact age. Details of these patients, the diagnosis and the mean preoperative Harris hip score are shown in Table I.

**Operative technique** (Table II). We performed all THAs through either a transtrochanteric or transgluteal approach with an anterior approach to the hip. If necessary a trochanteric osteotomy was performed to reposition a trochanter which was over-riding the entry point of the femoral canal due to the previous osteotomy, to tension the abductors or to provide necessary exposure. Sixty-five of the hips (88%) after previous osteotomy required a trochanteric osteotomy compared with only ten in the control group (14%). Müller straight-stem femoral implants (Protek, Berne, Switzerland) were cemented into both groups. No long-stem designs were used. The diameter of the femoral head was 22 mm in all 19 patients with congenital hip dysplasia and 32 mm in the remaining 55 patients. The cement was injected from proximal to distal with a cement
syringe. A bone plug was used in only half of the cases (47% and 46%). All acetabular components were cemented (size 40 to 54 mm).

**Follow-up review.** An attempt was made to see each patient for physical examination and radiography at a minimum five-year follow-up. The examiners (NB, RK) collected functional data from each patient using a standard questionnaire and assessed the radiographs independent of the operating surgeons. When it was not possible to see patients, attempts were made to contact each of them by post to obtain fresh radiographs and responses to the questionnaire. Those who had died or could not be located were excluded from the follow-up but were included in the life-table calculation.

Radiological analysis consisted of a thorough review of all serial radiographs after THA. In most patients radiographs were available since before the osteotomy. They were reviewed with regard to technical problems associated with the subsequent THA. Loosening of the femoral component was assessed using the criteria of Harris, McCarthy and O’Neill. Accordingly, definite loosening was defined as component migration including the appearance of a radiolucent line at the stem-cement junction, a cement crack or stem fracture. Probable loosening was classified as a continuous radiolucent zone at the cement-bone interface, surrounding the entire cement mantle. Possible loosening was defined as component migration including the appearance of a radiolucent zone between cement and bone occupying more than 50% but less than 100% of the cement-bone interface. The location of radiolucencies was evaluated using the zonal analysis described by Gruen, McNeice and Amstutz. Migration of the acetabular component was used to define a definitely loose cup. Impending failure was used to describe acetabular components showing a continuous radiolucent line greater than 2 mm thick. The radiolucencies were assessed using the zonal analysis suggested by DeLee and Charnley.

**Statistical analysis.** Differences between the groups were analysed statistically using Fisher’s exact tests ($2 \times 2$), contingency tables ($R \times C$) and the Mann-Whitney tests as appropriate. Life tables were calculated for both the study and control groups. The endpoint for survival of a THA was defined as a revision of the arthroplasty or severe pain and radiological evidence of loosening. None of the patients was excluded in the calculation of the life tables. The survival of THAs in the study and control groups was compared using a log-rank test and the hazard ratio with a 95% confidence interval. The latter estimates the relative death rate in one group, THA after previous osteotomy, relative to that in the other group, primary THA. The level of statistical significance was set at a $p$ value of less than 0.05, two-tailed. The appropriate statistical procedures were performed using StatView 4.02 (Abacus Concepts Inc, Berkeley, California) on a Macintosh computer.

**RESULTS**

A comparison of the data obtained before operation from the study and the diagnosis-matched control group showed no significant difference with regard to gender, type of implant, surgeons and the Harris hip score (Tables I and II). The study group, however, was on average four years younger than the control group ($p < 0.008$). In the study group the operation was rated as difficult or very difficult in 33.8% of the cases compared with 20.3% in the control group ($p < 0.0001$). The operating time in the study group was significantly longer ($p < 0.0002$) (Table II).

**Perioperative complications.** In the study group, there were five fractures during operation; four of them were undisplaced cracks in the proximal cortex which were treated by cerclage wires and one was a proximal fracture treated by lag-screw fixation (Table III). Three minor undisplaced fractures of the calcar in the control group did not require treatment. There were four intraoperative fractures of the trochanter in the control group and one in the study group, all treated by cerclage wires. One rasp perforation of the femoral canal occurred in each group. One case of femoral nerve palsy in the study group resolved completely. The overall rate of perioperative complications was identical in both groups (10.8%). The rate of general medical complications (Table III) was not significantly different ($9.5\% \pm 5.4\%, p < 0.38$) and there were no perioperative deaths.

**Clinical outcome.** In the study group, four patients could

---

**Table III.** Perioperative complications in both groups

<table>
<thead>
<tr>
<th></th>
<th>Study group (n = 74)</th>
<th>Control group (n = 74)</th>
<th>Group differences (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local complications</td>
<td>10.8%</td>
<td>10.8%</td>
<td>1.0</td>
</tr>
<tr>
<td>Undisplaced calcar fractures</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Trochanter fractures</td>
<td>1</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Perforation with rasp</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Femoral nerve palsy</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>General medical complications</td>
<td>9.5%</td>
<td>5.4%</td>
<td>&lt;0.38</td>
</tr>
<tr>
<td>Deep venous thrombosis</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Abdominal</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
not be located and were considered lost to follow-up. Six
had died of unrelated causes before the five-year follow-up;
all were reported to have had well-functioning hips before
death and none had undergone additional hip surgery.
Another patient had had no difficulty with the hip, but had
been unable to walk due to spinal disease and was excluded
from the evaluation of the clinical results. Nine patients had
undergone revision and were excluded from the overall
calculation of the clinical outcome. All the remaining 54
patients had a clinical examination by one of the authors
and completed a self-rating questionnaire. The mean fol-
low-up was 82.6 months (57 to 116). At the latest follow-
up, the mean Harris hip score of the 54 unrevised hips was
87.7 (69 to 100) with a mean improvement of 44.8 (7 to
72).

In the control group, seven patients could not be located
and were considered lost to follow-up. Four had died before
and two after the five-year follow-up. None had problems
related to the THA. Five hips had required revision and
were excluded from the calculation of the overall clinical
outcome. Thirty-three patients had a clinical examination,
while the remaining 23 responded to a questionnaire and
sent radiographs for evaluation. The mean follow-up was
88.0 months (56 to 146). The mean follow-up Harris hip
score of the 56 unrevised hips was 90.1 (48 to 100) with a
mean improvement of 49.4 (9 to 82).

<table>
<thead>
<tr>
<th>Clinical results</th>
<th>Study group (n=74)</th>
<th>Control group (n=74)</th>
<th>Group differences (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients excluded from clinical evaluation (lost to follow-up, died, revised)</td>
<td>20</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Follow-up in months (range)</td>
<td>82.6 (57 to 116)</td>
<td>88.0 (56 to 146)</td>
<td>&lt;0.21</td>
</tr>
<tr>
<td>Harris hip score at follow-up (range)</td>
<td>87.7 (69 to 100)</td>
<td>90.1 (48 to 100)</td>
<td>&lt;0.06</td>
</tr>
<tr>
<td>Improvement in Harris hip score (range)</td>
<td>44.8 (7 to 72)</td>
<td>49.4 (9 to 82)</td>
<td>&lt;0.15</td>
</tr>
<tr>
<td>Radiological results (Unrevised THA at follow-up)</td>
<td>54</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Femoral component*</td>
<td>45</td>
<td>50</td>
<td>&lt;0.42</td>
</tr>
<tr>
<td>No loosening</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looseing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definite</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Possible</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Acetabular component*</td>
<td>48</td>
<td>48</td>
<td>&lt;0.78</td>
</tr>
<tr>
<td>No loosening</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Looseing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Definite</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Impending failure</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Revision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Septic</td>
<td>8.1%</td>
<td>2.7%</td>
<td>&lt;0.28</td>
</tr>
<tr>
<td>Revision THA</td>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Girdlestone arthroplasty</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Aseptic</td>
<td>4.1%</td>
<td>4.1%</td>
<td>1.0</td>
</tr>
<tr>
<td>Femoral component</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Acetabular component</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Both</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Survival at ten years</td>
<td>81.9%</td>
<td>89.9%</td>
<td>&lt;0.23†</td>
</tr>
</tbody>
</table>

* criteria see text
† log-rank test

There were no statistically significant differences
between the study and control groups with regard to fol-
low-up or clinical results (Table IV).

**Radiological outcome.** In the study group, three unrevised
hips had definitely loose femoral components and two had
definitely loose acetabular components according to the
criteria listed above. In the control group, there were six
definitely loose acetabular and three definitely loose femo-
ral components. There was possible loosening of the femo-
ral component in six hips in the study group and in three in
the control group. Four in each group had a radiolucent line
at least 2 mm thick in one of the three DeLee and Charnley
zones. Impending failure of the acetabular component was
diagnosed in four and two hips, respectively. None of the
remaining hips had a complete radiolucent line around the
cement mantle. There were no significant differences in the
rates of radiological loosening between the two groups
(Table IV), but the numbers were too small for statistical
analysis.

Nonunion after trochanteric osteotomy was seen once in
the study and once in the control group, but did not require
revision.

**Revisions.** In the study group, nine hips had been revised at
the latest follow-up, six for infection with a mean interval
of 21.5 months (4 to 35) from the arthroplasty. All infected
hips had negative cultures at the time of the original THA.
One patient with a *Staphylococcus epidermidis* infection was revised at four months. The others were revised for late sepsis more than 12 months after operation. Of these, only one had an identifiable source of contamination, a perianal abscess caused by *Escherichia coli*. The others had no definite source of a haematogenous seeding and, with the exception of one, the infection was caused by *Staphylococcus epidermidis*. Five of the six infected hips had a successful revision THA; the other required a Girdlestone arthroplasty. There was no correlation between the removal of internal fixation at the time of THA and later development of infection. In the control group, two infected hips were revised with a Girdlestone arthroplasty. The septic revision rate was higher in the study group (8.1%) than in the control group (2.7%), but this difference did not reach statistical significance (p < 0.28).

In the study group, one aseptic revision was for a loose acetabular component, one for a loose femoral implant, and in the third for both loose components. There was no correlation between hips with an intraoperative fracture and those subsequently revised for aseptic femoral loosening. In the control group, three hips needed revision for a loose acetabular component. There were no hips awaiting revision for clinical or radiological failure.

**Survival.** Life tables showed a higher rate for survival at ten years in the control group (89.9%) compared with the study group (81.9%), but the difference did not reach statistical significance (p < 0.23) (Fig. 1). The hazard ratio was 1.96 with a 95% confidence interval from 0.68 to 5.53.

**DISCUSSION**

Total hip arthroplasty is the treatment of choice in osteoarthritis of the hip in the older individual. Intertrochanteric osteotomy may play a role in some patients by improving joint congruency, redistributing forces across the hip and improving limb alignment, thus delaying the need for THA.\(^1,3,5,9,18,19\) Little has been written, however, concerning the technical difficulties and outcome of hips which were converted to a THA after a previous femoral osteotomy.

**Technical considerations.** The small numbers involved did not allow a meaningful statistical analysis of the technical problems encountered in our patients and an account of the major difficulties can only be provided in a descriptive manner.

THA after previous intertrochanteric osteotomy can be technically demanding because of the distortion of the proximal femur. After a varus osteotomy the greater trochanter may lie over the axis of entry of the femoral component into the medullary canal. A trochanteric osteotomy will then be required. Both varus and valgus osteotomies may distort the neck-shaft angle and the proximal femur which will influence the selection of femoral size and head/neck offset, as well as collar-calcar contact if a collared implant is used. Rotational changes can affect the anteverision of the femoral component and mask the landmark for femoral insertion. Marked amounts of flexion, extension or medial/lateral displacement, and osteotomies below the intertrochanteric level may sometimes require a proximal femoral osteotomy to realign the bone before insertion of the femoral component. This was not required in any of our series.

Methods of intertrochanteric osteotomy which avoid major distortion of the anatomy are desirable as long as they do not compromise the results of the osteotomy. Such large distortions are less likely to occur with contemporary techniques of osteotomy which do not use wedge resection and employ standard internal fixation according to AO/ASIF principles. An alternative to intertrochanteric osteotomy in patients who have acetabular dysplasia is a periacetabular osteotomy\(^6,9\) which is more technically demanding, but has the advantage of preserving the normal femoral anatomy while, in theory, still allowing the normal insertion of an acetabular component.

Difficulties can occur when the internal fixation is removed at the time of THA. Pressurisation of the cement may be impaired and extravasation of cement from empty screw holes must be prevented. Care must also be taken to avoid fracture due to stress concentration from a rasp or femoral component in relation to holes left by metal implants.\(^6,9\) The removal of internal fixation may be considered once the osteotomy has healed, but must be weighed against the risks and costs of an additional procedure and the period of protected weight-bearing which may be needed after removal. We found no compelling evidence to suggest that early removal of the implant is advantageous for the outcome of subsequent THA.

Remodelling of the proximal femoral canal can take place over many years after an osteotomy and may give a relatively normal radiological appearance. This should not lead the surgeon to overlook changes in the proximal
femoral anatomy, such as blocking of the access to the femoral canal by the greater trochanter or changes in alignment and width of the femoral canal which will prevent the insertion of a straight femoral stem. Major distortions of the proximal femur may need to be addressed at the time of a subsequent THA. Fluoroscopic examination may be required to visualise the maximum angulation present in a distorted proximal femur, and careful preoperative planning with standard radiographs and CT are necessary.

**Complications.** We had anticipated a higher rate of perioperative complications after previous osteotomy. Surprisingly, there was no significant difference in the overall rates in the osteotomy and control groups (10.8% v 10.8%). The higher rate of trochanteric fracture in the control group (5.4% v 1.4%) may be related to the much lower rate of trochanteric osteotomy.

In our series, we had no cases of infection while in hospital and only one early infection, at four months after operation. This rate is lower than might be anticipated, since only 60% of the operations were done in a laminar-flow theatre and less than 10% of the patients received prophylactic antibiotics. While Søballe et al did not encounter any deep infections. Ferguson, Cabenela and Ilstrup reported an infection rate of 3.2% requiring revision. Benke et al reported an infection rate of 8.6%, necessitating the removal of the prosthesis in four cases. This is in line with the general view that infection rates are higher in revision procedures.

We encountered a high rate of late infections (5/74) more than six months postoperatively. The negative cultures at the time of THA suggest that these hips did not have residual infection from the osteotomy. The late presentation is more likely to be due to haematogenous secondary infection rather than primary infection at the time of arthroplasty. The possibility, however, of an occult low-grade postoperative infection presenting late cannot be excluded. We now use prophylactic perioperative antibiotics and patients are provided with instructions regarding lifelong precautions against infection after hip replacement.

**Outcome.** Our study shows that patients who have had a previous osteotomy can achieve considerable clinical improvement after THA. Our results in the study and control groups did not differ significantly as has also been reported by Ferguson et al and Søballe et al.

The most significant and common long-term complication of THA is aseptic loosening, particularly of the femoral component, and this may be higher after previous osteotomy. In a long-term follow-up of 215 hip replacements after previous osteotomy, Ferguson et al reported an aseptic revision rate of 14.9%. They stated that residual cortical defects appeared to be the cause of the loosening in at least four cases. A valid comparison with a primary THA group was not possible, however, since they did not have a control group. Søballe et al studied patients who had had medial displacement osteotomies and reported that aseptic revision rates were similar to those of a control group at the five-year follow-up (0.9% v 1.4%). In our series, the revision rate due to aseptic loosening was identical in the study (4.1%) and control groups (4.1%). In unrevised hips, we found no difference in definitive radiological loosening of the femoral components in the study and control groups using the criteria of Harris et al. The rate of ‘possible loosening’ of the stem was higher in the study group, but not significantly different from that of the control group. Radiological loosening without clinical relevance in our series (16.6%) is similar to the 19.5% reported by Ferguson et al.

Life tables revealed a trend toward decreased survival of the THA at ten years in the osteotomy group (81.9% v 89.9%). Although this difference did not achieve statistical significance, it is possible that with additional time it may do so. The hazard ratio of 1.94 indicates that a THA after previous osteotomy has approximately twice the likelihood of failure at ten years compared with a primary THA, but the confidence interval (0.68 to 5.53), however, is large because of the small numbers. Our data permit only a limited conclusion, but agree with the one other study which reports a ten-year survival rate of 79.4% of THA after previous proximal femoral osteotomy.

We wish to thank Carol Conpland for her help with the statistical analysis. 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**