Impaction bone grafting in revision hip surgery

A HIGH INCIDENCE OF COMPLICATIONS

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We have reviewed retrospectively 68 revisions of the femoral component in arthroplasties of the hip in 65 patients, using impaction bone grafting, at a median of three years (1 month to 6 years). We employed the cemented Exeter X-Change technique in 36 patients and the uncemented Bi-Metric allografting method in 32. The 37 bone defects were grade 3 or grade 4 on the Endo-Klinik classification.

The Mayo hip score improved from a mean of 32 (SD ± 18) to 62 (SD ± 15). Most (25) of the 34 complications occurred in grade-3 and grade-4 defects; nine were intraoperative diaphyseal fractures and eight fractures of the greater trochanter. All the fractures united.

The risk of intraoperative fracture was prevented by supporting the bone with wires in 16 hips, with reinforcement mesh in 18 and by a plate in six. Early migration of the stem of more than 10 mm during the first year indicated rotational instability; it occurred in three cases.

In difficult revision cases with large defects of the femoral bone, bone-impaction techniques carry a high risk of complications.

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The aim of impaction grafting with allogeneic bone is to reconstruct the bone stock. Slooff, Schimmel and Buma introduced the concept of using this procedure with cement in the proximal femur. The technique became more common when Gie et al. introduced special instruments for revision operations. They demonstrated the incorporation-substitution of impacted cancellous allografts and repair of the surrounding cortical bone. Use of a porous-coated stem was introduced by Retpen and Solgaard (personal communication, 1991).

Patients and Methods

Between 1993 and 1995, we revised 68 hips in 65 patients using impaction bone-grafting of the proximal femur. There were 37 women and 28 men with a median age of 71 years (40 to 88). One surgeon operated on 30 hips and assisted in 16. Another operated on 17 hips and assisted in five. There were nine other surgeons involved. The diagnosis at the primary operation was primary or secondary osteoarthritis in 52 patients, developmental dysplasia of the hip in seven, rheumatoid arthritis in five and avascular necrosis of the femoral head in one. In 62 hips the operation was for aseptic loosening. Resection arthroplasty was carried out in five hips for infected total hip replacement and in one because of dislocation of the prosthesis. There were 32 first revisions and 36 further procedures. The bone defects were graded according to the Endo-Klinik classification as follows: grade 1, radiolucent lines around the upper half of the cement mantle; grade 2, generalised radiolucent zones, endosteal erosion and widening of the medullary cavity; grade 3, expansion of the upper femur; and grade 4, gross destruction of the upper two-thirds of the femur.

We used the Exeter X-Change (Howmedica International Ltd, London, UK) bone-impaction technique with cement fixation of the standard stem (Fig. 1) in 36 patients. In 21 a long Bi-Metric stem (Biomet Inc, Warsaw, Indiana) and in 11 a Head-Neck stem (Biomet, Inc) (Fig. 2) were used. These Biomet prostheses have collared, titanium-alloy stems, porous-coated proximally. In Retpen and Solgaard’s technique, cancellous bone grafts are packed into the medulla corresponding to the upper half of the stem.

The method of impaction allografting was chosen during the operation according to the bone defects seen on the radiographs. In patients with wide cavitary proximal defects we chose the Exeter X-Change technique; in those with solid cortical continuity from the proximal part of the femur down through the diaphysis, the Bi-Metric allograft method was preferred. When a segmental defect of the calcar extended below the lesser trochanter (18 cases) a
Metal reinforcement mesh was used as advocated by Gie et al.\(^3\) In 16 hips, cables were utilised to secure the calcar region, and a plate was employed in six. No strut allografts were used. We used a mean of two (1 to 5) allograft femoral heads per operation.

Patients were mobilised on the first postoperative day.
Touch weight-bearing was allowed for two to three months, followed by a gradual return to full loading. Radiographs were taken annually and the Mayo hip score, assessed before and after operation, was used to monitor progress. The need for a further operation was considered as a failure of the method and the follow-up was then discontinued.

Radiological methods. Bone defects were assessed on anteroposterior radiographs by an independent observer (JL). Subsidence of the femoral stem was measured by the first author (JP) and by an independent radiologist (MY), who did the measurements twice. Displacement was measured from a position on the prosthesis to a reproducible landmark on the bone (n = 45) or to the tip of the greater trochanter (n = 16). In seven hips there were no reliable reference points for measurements. The median follow-up was three years (1 month to 6 years).

Results
Radiological evaluation showed that the bone defects were assessed as grade 1 in eight hips, grade 2 in 22, grade 3 in 25 and grade 4 in 13. No significant difference was observed between cemented and cementless arthroplasties (Table I). The defects in the Head-Neck Biomet subgroup were marginally more severe than those in the Bi-Metric patients. No bone fractures were seen in the direct proximity of the wire, mesh or plate reinforcement. Nine diaphyseal fractures occurred during surgery (Table II). In 15

![Fig. 3a](image1)
![Fig. 3b](image2)
![Fig. 3c](image3)
![Fig. 3d](image4)

Cemented Lubinus hip revision in a 66-year-old man eight years previously. Radiographs show a) a grade-4 defect in the femoral shaft, b) a postoperative film after cemented impaction grafting with an Exeter prosthesis, c) a fracture of the femur near the tip of the prosthesis four months after revision and d) a postoperative film after fixation with a Dall-Miles plate and wire.
Table III. The number of hips and the amount of subsidence (mm; SD) which occurred for the three stem groups

<table>
<thead>
<tr>
<th></th>
<th>Exeter</th>
<th>Bi-Metric</th>
<th>Head-Neck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidence in mm (SD)</td>
<td>1.5 (3.5)</td>
<td>2.3 (2.8)</td>
<td>7.5 (11.2)</td>
</tr>
<tr>
<td>Number of hips affected</td>
<td>30</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Subsidence in mm (SD)</td>
<td>0.7 (3.8)</td>
<td>2.8 (4.2)</td>
<td>8.2 (12.8)</td>
</tr>
<tr>
<td>Number of hips affected</td>
<td>19</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>Mean</td>
<td>2.7 (7.1)</td>
<td>2.7 (3.5)</td>
<td>5.6 (10.9)</td>
</tr>
<tr>
<td>Subsidence in mm (SD)</td>
<td>31</td>
<td>19</td>
<td>11</td>
</tr>
</tbody>
</table>

patients, additional fixation was required because of bone defects or fractures. There were six fractures after revision which required further surgery; three were diaphyseal (Fig. 3) and three affected the greater trochanter. All fractures united. In total, 13 reoperations were carried out (19%), six because of fractures. The femoral defects had been graded 3 or 4 in ten patients who had reoperation. Most (25) of the 34 complications (Table II) occurred in grade-3 and grade-4 defects. Postoperative dislocation of the endoprosthesis occurred in four patients. There were three infections, two of them deep. All were treated by operation and the infection subsided. In four hips a further revision ended the follow-up, in three because of rotational instability with massive subsidence (>10 mm) (Figs 1 and 2) and in one because of fracture of a proximal femur. There was one case of fatal pulmonary embolism.

During the period of follow-up the overall mean subsidence was 3 mm (0 to 36). In the Exeter group the mean subsidence was 2.7 mm (SD 7.1), in the Bi-Metric group 2.7 mm (SD 3.5) and in the Head-Neck group 5.6 mm (SD 10.9). There was no significant difference in subsidence between the cases in which cemented and uncemented techniques were used (Table III).

The Mayo hip score improved from 32 (SD 18) to 62 (SD 57) during the period of follow-up. There was no significant difference in outcome between the Exeter and the Bi-Metric techniques.

Discussion

Impaction bone grafting is a technique for managing femoral revisions with extensive bone defects.1-3 Cemented and cementless techniques have been used. Our choice between these alternatives depended on the hypothesis that in un cemented fixation a good proximal cortex gives sufficient fixation for the stem provided that a three-point fixation is possible,5 whereas with the cemented procedure the impacted neomedullary canal gives the stability. No major difference in outcome has been found between these techniques.

The high incidence of complications cannot be explained simply by the learning curve since 47 of the 68 hips were operated on by two orthopaedic surgeons. An increased number of complications encountered in patients in the latter part of the series suggests a broadening of the indications for this technique.

In the past we reserved these revision procedures for expanded lesions such as grade-3 and grade-4 bone defects in order to restore bone stock. We had many complications (Table II) and analysed their causes. A retrospective radiological analysis showed that we had more severe defects than Gie et al7 who had three defects of grade 1, 40 of grade 2, 13 of grade 3 and none of grade 4 (p < 0.001, chi-squared test). In our series, most of the complications (25 of 34) occurred in grade-3 and grade-4 defects and most of the reoperations (10 of 13) were carried out in these groups. It remains uncertain whether these methods of impaction grafting are suitable for use in large bone defects.

In a difficult revision with extensive defects the risk of intraoperative fracture is high. The impaction forces are powerful and temporary plate support may prevent fracture even in cases in which it is not planned to be permanent. Some of our intraoperative fractures may have been prevented by more liberal use of such support. In cases in which wires, meshes or plates had been placed in the proximal femur, complications seem to have been prevented. Three postoperative diaphyseal fractures indicate that the plate support was needed permanently, more often than was practised. A defect near the tip of the stem is particularly dangerous.

Analysis of the grades of defect4 shows that the Exeter and Bi-Metric stems were used in defects of similar severity. The long Exeter stems were not available and the Head-Neck model was preferred in grade-3 and grade-4 defects based on the idea that its more extensive upper part would give extra support. The bone packing, however, remained inadequate as indicated by the amount of subsidence (>10 mm), the cause probably being poor three-point fixation in a defective cortex resulting in impaired incorporation of grafted bone. In the study of Eldridge et al7 late subsidence was not seen. The results of the cemented and uncemented techniques were similar in our patients. The large number of complications in patients with grade-3 and grade-4 defects suggests that this procedure is only useful as an adjunct in large defects. A longer period of observation is required to show differences between the techniques. An improved design of the stem is needed to provide better stability in large bone defects.
The impaction grafting technique must be carried out with precision. Restoration of the bone stock remains the great advantage.\textsuperscript{1,2} The size of a bone defect as seen on pre-operative radiographs is easily underestimated and the surgeon should be prepared to change technique during the operation. When the impaction grafting technique is chosen, the femoral diaphysis may require reinforcement.\textsuperscript{8,9} Alternatively, a long stem with a distal intramedullary support should be chosen,\textsuperscript{9} with or without impaction bone grafting.

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