Periprosthetic fracture of the femur after hip arthroplasty: The clinical outcome using cortical strut allografts

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ABSTRACT

Between 1993 and 1998, 15 patients with periprosthetic fractures of the femur after hip arthroplasty were treated using deep-frozen cortical strut allografts as an adjunct support after internal fixation or revision arthroplasty. According to the Vancouver classification system, there were 7 type B1, 2 type B2, 4 type B3 and 2 type C fractures. Seven patients had severe osteopenia, 10 patients had bone defects between 2 to 7 cm and 2 were associated with infection. Nine patients had internal fixation of the fracture using a compression plate, and 6 had revision arthroplasty using a long-stemmed femoral prosthesis. The average length of the allograft was 13.9 cm. At an average follow-up of 31 months, all the patients had a satisfactory functional result except one who had a leg length discrepancy of 4 cm due to multiple operations. There were no non-unions, malunions or infections. The fractures healed between 10 to 24 weeks (average, 15.6 weeks). In conclusion, a cortical strut allograft associated with internal fixation can be an effective method of treating periprosthetic fractures of the femur after hip arthroplasty.

Key Words: Periprosthetic fracture, cortical strut allograft, revision arthroplasty

INTRODUCTION

Ipsilateral fracture of the femur after hip arthroplasty is an uncommon but serious complication. The outcome of treatment varies according to types of the fracture and modalities of treatment. Nonoperative treatment is recommended by some authors. However, pulmonary complications and thromboembolic disease are potential risks to elderly patients due to prolonged bed rest. Others report a high rate of malunion, non-union and joint stiffness when the fractures were managed with traction. Internal fixation with a compression plate, cerclage wires, an Ogden plate or a nylon plate have been reported with various clinical results. The difficulty of open reduction and internal fixation in osteoporotic bone and around the prosthesis is to achieve adequate screw purchase. This report reviews the clinical outcome of these fractures using cortical strut allografts and internal fixation with or without revision arthroplasty.

MATERIAL AND METHODS

Between December 1993 and August 1998, 15 patients with periprosthetic fractures of the femur after hip arthroplasty were treated using deep-frozen cortical strut allografts as an adjunct support after internal...
fixation or revision arthroplasty. The average age was 61 years (range 31 to 87 years) with ten men and five women. Fractures were classified using the Vancouver classification system. Type A fractures are those situated in the trochanteric region. Type B fractures are those located around or just distal to the stem. Type C fractures are those located well below the stem. Type A fractures are subclassified into Type AG where fractures involve greater trochanter and Type AL where fractures involve lesser trochanter. Type B fractures are subclassified into B1 if the implant is stable, B2 if the implant is loose and B3 if the implant is loose and bone stock around the stem is inadequate. In this series, there were 7 type B1, 2 type B2, 4 type B3 and 2 type C fractures.

Seven patients had severe osteopenia, 10 patients had bone defects between 2 to 7 cm due to comminuted fractures or failed previous osteosynthesis, and 2 were associated with infection. Three patients had 6 previous attempts of osteosynthesis but all failed. Previous hip arthroplasties were primary total hip arthroplasty (THA) in 7, revision THA in 5, bipolar hemiarthroplasty in 2 and Moore’s hemiarthroplasty in 1 patient. Single AO/ASIF 4.5 mm broad dynamic compression plates with an onley cortical strut allograft were used for 9 fractures with a stable implant (7 type B1 and 2 type C) except one who had bicortical allografts to support a large bone defect distal to the stem (total 7 cm including segmental and cortical defects) after 3 failed osteosyntheses (Fig. 3). The graft was usually placed medially to allow purchase of the screws from the lateral compression plate, thus enhancing fixation of the implant if the quality of the bone was inadequate. The remaining 6 patients who had type B2 and B3 fractures were treated with a revision arthroplasty using a long-stemmed femoral component (Corin, Cirencester) and uni or bicortical strut allografts according to the adequacy of the cortical bone stock (Fig. 1 and 2). Unicortical grafts were

![Figure 1](image1.png)  A type B3 periprosthetic fracture of the femur. Note the tip of the stem penetrating out of the femoral cortex.

![Figure 2](image2.png)  Radiograph taken 9 months after revision total hip arthroplasty using long-stemmed femoral prosthesis and bicortical strut allografts showing good incorporation of allografts to host bone. Note comminuted fracture of the lateral femoral cortex.
selected for B2 fractures and bicortical grafts for B3 fractures. The allografts were placed on the surface of the bone where significant bone deficiency was most obvious and fixed to the femur using cerclage wires. All the patients had autogenous iliac bone grafts packed in the fracture site and between the allograft and host femur to enhance bone healing. The average length of allografts was 13.9 cm (from 7 to 20 cm).

Follow-up studies ranging from 14 to 70 months (average, 31 months) were made with all patients. Clinical and radiological evaluations were conducted each visit. Healing of the fracture was defined as their being no radiolucency at the fracture site and no pain clinically. The functional result was evaluated according to the Harris hip rating system.10

RESULTS

All the patients had unions of the fracture between 10 to 24 weeks after surgery (average, 15.6 weeks). There were no malunions or infections, including two patients with preoperative infection. Excellent incorporation of the allograft to the host bone was demonstrated radiographically in almost every case at the final follow-up. Fourteen patients (93%) had an excellent or good result. No one experienced pain in the affected limb. Only one patient had a fair result due to a leg length discrepancy of 4 cm and stiffness of the ipsilateral knee. This patient was a 67-year-old man who sustained a type B1 fracture 5 years after bipolar hemiarthroplasty. Open reduction and internal fixation of the fracture with plate and screws was performed four and a half years previously at another hospital. One and a half years later, a second operation with double plate fixation and iliac autografting was done due to failure of the reduction. However, the second operation resulted in an infected non-union. The causative organism was Staphylococcus aureus. Removal of the implant and debridement followed by external fixation was done at another hospital later. Nine months previously, due to persistent infected nonunion, the patient underwent vascularized fibular grafting. However, removal of an external skeletal fixator due to pin tract infection 8 months later demonstrated failure of bone union (Fig. 3). He was transferred to our institution and underwent open reduction and internal fixation with a compression plate, supplemented with bicortical strut allografts and massive iliac autografts to fill the bone defects. Local gentamicin — impregnated cement beads — were applied to prevent recurrent infection. Protected weight bearing was instructed for 6 months postoperatively. The patient had uneventful bone healing 6 months postoperatively (Fig. 4). However, due to the multiple operations, he had a leg length discrepancy of 4 cm and limited knee motion from 0 to 90 degrees at follow-up.

DISCUSSION

The treatment of periprosthetic fractures of the femur after hip arthroplasty varies according to the location of the fracture and the stability of the femoral component. Johansson et al.12 classified the fractures into three types: Type I fractures occur proximal to the tip of the prosthesis; Type II fractures extend from the proximal portion of the femoral shaft to beyond the distal tip of the prosthesis; Type III fractures are those
that are entirely distal to the tip of the prosthesis. Type I fractures can be treated with conservative methods which include traction or hip spica. However, prolonged bedrest and immobilization in the elderly may be associated with thromboembolic disease, pulmonary complication or joint stiffness. Type II fractures present a formidable challenge to an orthopaedic surgeon. If the stem is loose, revision to a long-stemmed femoral prosthesis is a logical option. If the stem is well-fixed, the results of conservative treatment may be discouraging due to malunion, non-union and subsequent loosening. Open reduction with cerclage wires or screws are not adequate. It is difficult to obtain good fixation of the proximal screws around the stem with conventional plates. A high failure rate up to 52% was reported. The Ogden plate and Parham bands fixation has the advantage of using proximal cerclage fixation of the plate to the femur without violating the femoral cortex. The reported union rates were between 90 to 100%. However, using a finite-element model in a biomechanical study showed that the Ogden plate caused highest tensile stress at the fracture site and stress shielding of the proximal femoral cortex. The nylon plate and cerclage bands devised by Patridge have the advantage of not causing stress shielding or stress risers due to their flexibility. But their mechanical strength is less effective than Parham bands or other titanium cable systems.

The use of a cortical strut allograft in the treatment of a periprosthetic fracture of the femur has been reported. In Chandler’s report, 16 out of 19 fractures around a well-fixed femoral stem had a satisfactory outcome after open reduction and internal fixation using massive cortical allograft struts. There were two non-unions and one malunion. Seventeen patients who had union of the fractures returned to their preoperative status after an average of 4.5 months. Jensen et al. reported only 15 out of 44 fractures with well-fixed stems treated with internal fixation had good clinical results. The main reasons for failure were non-union and subsequent prosthetic loosening. The advantages of using a allograft strut in these situations are as follows: it can be customized to fit the femur, it has a similar modulus of elasticity compared to the host femur, it is a biological material which enhances healing of the fracture, and the healed allograft strut and host femur are stronger in mechanical strength than original bone. In Mihalko’s report, the stress shielding in the proximal femoral cortex is much less in the cortical bone strut model than in the Ogden plate model. The good healing of the cortical allograft to the host bone in revision total hip arthroplasty has been well-documented in clinical studies and animal models by Emerson et al. and Pak et al. also showed 92% of radiographic evidence of graft incorporation using cortical strut allografts in cementless revision total hip arthroplasty. The excellent fracture healing and good functional results of 9 patients with periprosthetic fractures around a well-fixed femoral stem in this report, except the one who had a 4 cm length discrepancy, demonstrate the advantages of the cortical allograft strut in managing these situations.

The treatment of periprosthetic fractures with loose femoral stem is straightforward, that is, revision total hip arthroplasty using a long-femoral stem. However, still some complications such as non-union with subsequent loosening of the prosthesis have been reported. Johannson et al. reported a better clinical result if internal fixation of the fracture is performed simultaneously with revision arthroplasty. The use of bicortical allograft struts in association with a long-
stemmed femoral prosthesis in these fractures is a rational option but has not been reported previously. The bone stocks of the femoral cortex either proximal or diaphyseal are often deficient after loosening which may lead to pathologic fracture with a minor injury. The causes of bone deficiency after failed hip arthroplasty are stress shielding, osteolysis, cortical perforation or windowing for component removal and mechanical loosening. Managing these situations even with a long-stemmed femoral prosthesis is still challenging. The use of morcelized bone grafts does not significantly restore the bone stock. Gustilo reported unfavorable results using morcelized autograft combined with a long-stemmed revision femoral component. In this series, 4 out of 6 fractures associated with loosening of the prosthesis had a significant loss of bone stock. All 6 patients had an excellent fracture healing and good restoration of bone stock after revision using cortical strut allografts and a long-stemmed prosthesis. Therefore, the advantages of using cortical strut allografts in revision total hip arthroplasty with femoral fractures are many, including bone healing enhancement, restoration of bone stock, less stress shielding of femoral cortex and less failure of femoral prosthesis. In conclusion, using cortical strut allografts and internal fixation is a good alternative in treating periprosthetic fractures of the femur after hip arthroplasty with or without loosening.

REFERENCES