Acta Orthop. Belg., 2007, **73**, 332-338

ORIGINAL STUDY

Impaction allografting revision for B3 periprosthetic femoral fractures using a Mennen plate to contain the graft : A technical report

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We prospectively evaluated the long-term results of a technique using the Mennen plate to contain impacted allograft and support cemented Exeter stem revision fixation for the treatment of three B3 periprosthetic femoral fractures (PFFs). Three patients with a median age of 77 years were followed-up for a median of 84 months. In all cases the stem bypassed the distal fracture line by a median length of 85 mm (median ratio over femoral diameter = 2.13). The median postoperative Charnley-Merle d'Aubigné-Postel score for pain, function and range of movement was 5, 3 and 6 respectively. Impaction allografting revision could be used for B3 PFFs when the stem bypasses the most distal fracture line by at least two ipsilateral femoral diameters. The Mennen plate can aid to contain the impacted allograft and to maintain fracture reduction and short term stability thereafter, but the long stem is necessary for long-term stability and healing.

Keywords : periprosthetic femoral fracture ; Mennen plate ; impaction bone grafting.

INTRODUCTION

Periprosthetic femoral fractures (PFFs) are technically demanding to treat, particularly Vancouver type B3, which are associated with an unstable stem and inadequate bone stock (*4*). Type B1 fractures (stable stem and good bone quality) are frequently managed successfully with open reduction and plate fixation (*30*). The paraskeletal clamp-on plate introduced by Mennen has been used in the past for the treatment of PFFs with variable results (*1, 18, 25, 27, 32*). With a few reports of being successful (*17, 27, 32*), overall it has been associated with reports of mechanical failure, nonunion and malunion (*1, 18, 25*).

Kligman *et al* (*17*) reported on the use of Mennen plates in conjunction with strut allograft for revision arthroplasty using cemented or uncemented prostheses. The authors demonstrated satisfactory results in 11 out of 12 patients with an average follow-up of 3.5 years. They concluded that the Mennen plate increases the strength of the femur,

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No benefits or funds were received in support of this study

preventing fractures during reaming and hip reduction, and allows space in between the plate and the femur for allografting, therefore, not compromising the periosteal blood supply.

Impaction femoral allografting has shown encouraging results when used in conjunction with cemented stem revision (*8, 9, 23, 24*). Previously reported experience, on the use of femoral impaction allografting in the management of Vancouver type B2 and B3 PFFs, has demonstrated favourable results (*31*). There are several ways to contain allografts within a deficient femur when reconstructing the bone using the impaction grafting technique. Special meshes are readily available and are malleable to close cortical defects with the use of cables or wires around them (*31*). Strut allografts can also contain defects and provide structural support (*13, 31*). Impaction revision for the treatment of Vancouver type B3 fractures is even more challenging. In addition to reconstructing the deficient femur from within out, the maintenance of fracture reduction is required up until the insertion of a long stem, which is likely to provide internal stability to the construct.

In the current report, we present our experience of a technique, using impaction allografting revision to a cemented Exeter stem for the treatment of three type B3 PFFs. A Mennen plate was employed instead of a mesh to facilitate fracture reduction and to contain the impacted allograft.

PATIENTS AND METHODS

Clinical data

Three patients, with 3 Vancouver type B3 PFFs, were prospectively studied. Cemented or uncemented revision of the acetabular component was considered when there was aseptic loosening (table I). All three patients underwent fracture stabilisation with impaction allografting revision to a cemented long Exeter femoral component and a Mennen plate was used to contain the graft and maintain fracture reduction prior to stem insertion. The demographics, stem length and ipsilateral femoral diameter were recorded. The length of the stem bypassing the most distal fracture line was also measured and its ratio over the ipsilateral femoral diameter was calculated. Healing time (radiological and clinical), Charnley-d'Aubigné-Postel hip score (table II) (*7*) at the latest follow-up, and related complications were documented in all patients (table III). No case was missed to follow-up.

Operative technique

A long posterolateral incision (posterior hip approach) was made by either incorporating or excising the previous scar. Before incising the hip capsule, the hip was aspirated for histological examination in order to rule out infection. The criteria used for the suspicion of infection was $> 10^5$ neutrophils per high power field (HPF), 10^4 to 10^5 organisms per HPF, or identification of organisms on Gram staining. If there was infection the procedure was abandoned for a two stage revision.

The fracture site provided access for removal of the prosthesis and previously applied cement. The fracture was then reduced over a phantom femoral stem and temporarily reduced with the application of a Mennen plate. Strut grafts were not used in any of the patients. Fresh frozen femoral heads, screened for transmissible disease during donation and after six months, were used for preparation of the graft. Two sizes of bone chips were prepared. Bone chips of 2-4 mm in size, generated through Noviomagus bone mill (A-one, Medical BV, Nijmegen, The Netherlands), were used for distal canal impaction, and large 5-10 mm chips were used for impaction in the proximal more capacious femur.

Table I. — Demographics and operative data (IG : impaction grafting)

Patient	Age	Sex	Side	No Previous operations	Prosthesis In situ	Vancouver Classification	Stem Revision	Acetabular Revision	IG	Strut	Length of Stem Bypassing Fracture	Femoral Diameter	Ratio Bypass Diameter
1	80	f	r	2	McKee	B3	y	y	y	n	90 mm	32 mm	2.81
2	77	m	l	3	Exeter	B3	y	y	y	n	85	40	2.13
3	72	f	l	1	McKee	B3	y	y	y	n	32	29	2.10
Median	77										85	32	2.13

y = yes, n = no.

Table II. — Charnley-Merle d'Aubigné-Postel score

Category
A = patient fit for age except for affected hip
B = both hips affected but patient otherwise fit for age
C = patient has inbuilt limitations other than from hips (ra = rheumatoid arthritis)
Pain
0 = intense and permanent
1 = severe, even at night
2 = severe on walking, prevents all activity
3 = tolerable, limiting activity ;
4 = mild with activity, rest relieves
5 = slight pain, less with activity
6 = no pain
Function
0 = cannot walk
1 = only with crutches
2 = time and distance very limited without sticks
3 = 1 hour with stick, very difficult without
4 = long time with stick : short without + limp
5 = without stick but slight limp
6 = normal
Movement
Total range of movement of hip joint = flexion + abduction + adduction + internal rotation + external rotation – any fixed deformity
1 = 0° – 30°
2 = 31° – 60°
3 = 61° – 100°
4 = 101° – 160
5 = 161°– 210°
6 = >210°

Before starting impaction, the canal was occluded distally by using a threaded plug attached to a guide wire. If the required position laid beyond the isthmus, it was skewered with a percutaneous wire. The packing of distal and proximal allograft bone chips was then performed over a central guide wire by using appropriately sized distal impactors and proximal phantom stems included in long stem impaction instruments (Stryker-Howmedica Osteonics, Caen, France). Distal impaction was continued until the level of the chips reached the level of the tip of the phantom impactor. The canal was then filled and repetitively impacted with the slap hammer attached to the phantom impactor until the neo-endosteum was formed. Antibiotic Simplex bone cement (Howmedica, Auckland, New Zealand) was then pressurised into the neo-endosteum. Cemented Exeter (Stryker-Howmedica- Osteonics, Caen, France) polished, collarless tapered stems were used in all cases. A wingless Exeter stem centraliser was fitted to the end of the stem before insertion. The Mennen plate was left *in situ*.

Postoperative management

Postoperatively, patients were advised restricted weight bearing for three months. They were followed-up clinically and radiologically for 6, 12, 26, 52 weeks and on a yearly basis thereafter to assess fracture healing. Radiological union was defined as cortical continuity on both the anteroposterior and lateral radiographs with external formation of callus. Clinical union was defined as pain-free full weight bearing, or with occasional pain that did not compromise daily activities, or walking with or without aids.

RESULTS

Two female and 1 male patients with a median age of 77 years (range : 72 to 83) are reported. The median follow-up time was 84 months (range : 72 to 96). The median number of previous operations was 2. One patient had Exeter and two had McKee cemented prostheses *in situ* at the time of fracture.

Table III. — Outcome measures

Patient	Healing Clinical (months)	Healing Rad/cal (months)	Follow-Up (months)	Score Category	Score Pain	Score Function	Score Movement	Stem Alignment (degrees)	Non Union	Mal Union	Infection	Revision
1	8	8	96	B	6	6	6	ne	n	n	n	n
2	6	6	84	B	4	2	3	ne	n	n	n	n
3	10	10	72	C(ra)	5	3	6	ne	n	n	n	n
Median	8	8	84		5	3	6					

n = no, ne = neutral, ra = rheumatoid arthritis

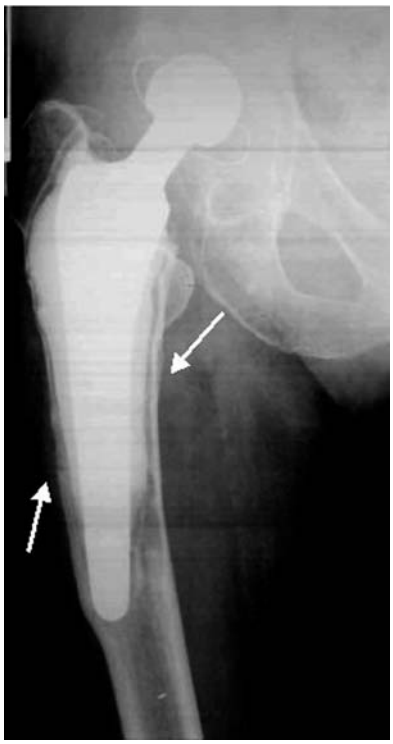

Fig. 1. — B3 periprosthetic femoral fracture : Arrow indicates proximal fracture line.

Fig. 2. — Immediate post operative radiograph : Impaction grafting revision to a long cemented Exeter stem and a Mennen plate. The acetabular component was also revised.

No infection was encountered in any of the cases therefore we proceeded with one stage revision fixation. Cemented acetabular component revision was performed simultaneously without any bony augmentation in all three patients due to aseptic loosening. The median femoral diameter was 32 mm. In all 3 cases, the stem bypassed the most distal fracture line by a median length of 85 mm. The median ratio of the latter measurement over the ipsilateral femoral diameter was 2.13. Overall median healing both radiologically and clinically, was 8 months (range : 6 to 10). There was no incidence of infection in any case. The overall Charnley-d'Aubigné-Postel score (table II) at the final follow-up revealed 2 type "B" and 1 type "C" patients (table III). At the latest review, the median hip score for pain, function and range of movement was 5, 3 and 6 respectively (table III) (figs 1, 2, 3 and 4).

DISCUSSION

In this report we present the long-term follow-up results from a technique using long cemented stem impaction revision and a Mennen plate as an adjunct to contain the graft for the treatment of Vancouver type B3 PFFs. We have found that a Mennen plate can sufficiently contain the impacted allograft while maintaining fracture reduction during the vigorous impaction allografting technique. However, long-term stability and overall fracture healing relies entirely upon the long intramedullary revision stem, without which the Mennen plate is unable to withstand displacement forces, leading to eventual failure.

Fig. 3. — 2 years and 6 months follow-up : Healing and < 1 mm stem subsidence, the Mennen plate remains in place.

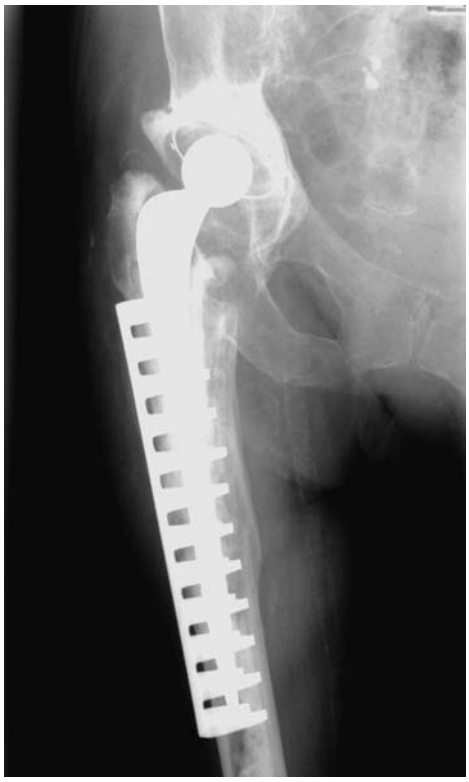

Fig. 4. — 6 years and 7 months follow-up : Healing and remodelling of impaction grafting.

Vancouver type B3 PFFs are not that uncommon ; however, they are very challenging to treat (*30*). There are four consecutive important parameters to consider when treating type B3 PFFs. Firstly, the reduction of the fracture ; secondly, the reconstruction or replacement of the deficient femur ; thirdly, the revision of the stem ; and finally, the fixation of the fracture (*11*). Currently, several available uncemented femoral components can potentially address all the latter issues together ; however, they require intact diaphyseal bone for distal fixation and rely on their coating (hydroxyapatite or metal mesh or beads) for proximal femoral bone regeneration (*26*). Proximal femoral allograft replacement is an option for relatively young patients (*13, 14*) carrying the risk of low or no graft incorporation to the host bone (*22*) while for the low demand elderly patients, prosthetic proximal femoral replacement remains a valid solution and reduces the operative time (*16*).

Maintaining fracture reduction while reconstructing and revising the femur with cemented impaction allografting is difficult and can usually be achieved using cables, wires and various plates. Earlier reported experience with cemented revision and impaction femoral allografting, demonstrated that PFFs were five times more likely to unite if a long instead of a short stem was used (*31*). The major advantage of this technique compared to the uncemented stem option is that it provides an immediate biological reconstruction of the proximal femur, with better load distribution, not

necessarily relying on intact diaphyseal bone (*2, 3, 5, 6, 15, 20, 21, 28, 33-35*). However, since impacted allograft requires at least one year to incorporate and remodel (*6, 19, 29*), a long revision stem (bypassing the most distal fracture line) is required to offer stability at the fracture site in the short-term (*31*). In addition, an extra-medullary fixation device is occasionally useful to augment intramedullary long stem stability and in case of impaction allografting to contain the graft (*31*).

We used the Mennen plate to grossly transform a bone-deficient proximal femur into a contained receptacle for the packing of bone chips without compromising the periosteal blood supply due its low contact profile. Kligman *et al* (*17*) reported the revision impaction of deficient proximal femurs with the use of Mennen plates and strut grafts with success. They found that Mennen plate shortened the time required for impacted bone graft incorporation and speculated that it was the result of preserving the periosteal blood supply.

In our cases, revision impaction allografting with a long stem bypassing the most distal fracture line by at least two ipsilateral femoral diameters and a Mennen plate to contain the graft, lead to uneventful healing. Biological augmentation and mechanical support of B3 fractures is of paramount importance for eventual healing. Morselised graft used in the impaction grafting technique may be replaced by viable bone to eventually reconstruct the deficient proximal femur (*2, 3, 5, 6, 10, 15, 19-21, 28, 29, 31, 33, 34*). Using the clamp-on Mennen plate as an aid only, to contain the graft and to maintain short term fracture reduction allowed a long stem insertion to provide intramedullary stability and healing in the long-term.

Acknowledgements

We would like to thank Z. Gamie for the technical support.

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