Non-vascularised fibular graft as an intramedullary strut for infected non-union of the humerus

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ABSTRACT

Purpose. To review outcomes of 7 patients who underwent revision surgery for infected non-union of the humerus using a fibular graft as an intramedullary strut.

Methods. Records of 7 men aged 29 to 59 (mean, 40) years with humeral diaphyseal infected non-union who underwent fixation using a compression plate and a non-vascularised fibular graft as an intramedullary strut were reviewed. The mean number of previous surgeries was 2.7 (range, 2–4). Three of the patients had active draining sinuses previously. Their C-reactive protein levels were normal and tissue cultures negative. The remaining 4 patients had active draining sinuses. They first underwent implant removal and debridement. Tissue cultures confirmed infection in 3 of them. The mean duration between debridement and the index surgery was 5 (range, 3–10) months.

Results. The mean length of the fibulae harvested was 13 (range, 12–15) cm. All 7 non-unions healed. The mean time to healing was 5.4 (range, 4–8) months. The mean follow-up period was 15 (range, 13–24) months. All patients had weakness of the extensor hallucis longus, which improved to near normal at month 3. There was no donor-site morbidity. Three patients with active infection at presentation underwent repeat surgery. Two of them had wound washouts, and their non-unions went on to heal successfully; one underwent implant removal after union due to an active sinus. Six of the patients returned to their pre-injury activity level, and one endured a brachial plexus injury.

Conclusion. Fixation using a compression plate and a non-vascularised fibular graft as an intramedullary strut achieved good outcome for infected non-union of the humerus despite prior multiple failed surgeries.

Key words: fractures, ununited; humeral fractures; surgical wound infection; treatment failure

INTRODUCTION

Most of non-unions of humeral diaphyseal fractures
are atrophic and usually heal following conventional treatment (open reduction and internal fixation with bone grafting). Management of non-union is challenging, especially in patients with wound infection following multiple failed surgeries and in the presence of scarred, adherent soft tissues, and inadequate bone stock. With the advent of locked compression plates, stabilisation can be achieved in osteoporotic bones. Nonetheless, in severely osteoporotic bones, internal fixation may fail even with locked compression plates. For patients with humeral non-union who also have multiple risk factors for failure of internal fixation, the use of a fibular graft as an intramedullary strut is an alternative. We reviewed outcomes of 7 patients who underwent revision surgery for infected non-union of the humerus using a fibular graft as an intramedullary strut.

**MATERIALS AND METHODS**

Records of 7 men aged 29 to 59 (mean, 40) years with humeral diaphyseal infected non-union (Fig. 1) who underwent fixation using a compression plate and a non-vascularised fibular graft as an intramedullary strut between 2005 and 2009 were reviewed (Table). The mean number of previous surgeries was 2.7 (range, 2–4). Three of the patients had active draining sinuses 6 to 12 months earlier but not at presentation. Their C-reactive protein levels were normal and tissue cultures negative. The remaining 4 patients had active draining sinuses. They first underwent implant removal and debridement. Tissue cultures confirmed infection in 3 of them. In one patient with methicillin-resistant *Staphylococcus aureus*, intravenous teicoplanin for 3 weeks was given. In another with methicillin-resistant *Staphylococcus epidermidis*, antibiotic-impregnated bone cement (4 g of vancomycin mixed with 40 g of cement) was used; 15 beads were made in 2 strings and placed in the wound. Patients were reviewed regularly after debridement. When their C-reactive protein level was normal and the wounds had healed well, the index surgery was performed. The mean duration between debridement and the index surgery was 5 (range, 3–10) months.

The skin was incised through the anterolateral approach, which was modified depending on previous incisions and soft-tissue scarring. Intervening fibrous tissue was excised. The medullary canal was re-established in both fragments. Serial reaming of the proximal and distal fragments was then performed with rigid Kuntscher nail reamers. Bone-holding forceps were used to hold the fragments especially near the fracture site so as to prevent splintering of osteoporotic bone. The length of the fibular graft needed was measured by adding the depth of the last reamer inserted into both fragments. An ipsilateral non-vascularised fibular graft was harvested by a standard technique.

The diameter of the fibular graft was larger than that of the last reamer. An oscillating saw was used to reshape and reduce the diameter of the fibular graft to

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**Figure 1** Infected non-unions of the humeral shaft with failed internal fixation.
1 mm less than the last reamer size. The centre of the
graft was marked. The fibular graft was then inserted
into the proximal fragment, with the distal 4 to 5 cm
exposed. The distal fragment was reduced onto the
fibular graft protruding from the proximal fragment.
Care was taken to avoid fracturing the fibular graft
or distal fragment. Once the distal fragment was
reduced, the fracture site was distracted. The fibular
graft was then pushed into the distal fragment, until
the central mark was at the fracture site. A contoured
4.5 mm narrow dynamic compression plate was fixed
with 4 or 5 bicortical screws proximally and distally.
Axial compression was applied manually prior to
fixation. Autogenous iliac crest bone grafts were
placed around the non-union area. The wound was
then closed. Postoperative drains were retained for 48
hours.

For the 3 patients with positive cultures, specific
antibiotics were given for 6 weeks. For the 4 patients
with no positive culture, antibiotics were given for 10
days until suture removal. An arm sling was used;
plaster immobilisation was avoided. Mobilisation
exercises were started after 2 days. Patients were
followed up every 3 months until bone union.

RESULTS

The mean length of the fibulae harvested was 13
(range, 12–15) cm. All 7 non-unions healed (Figs.
2 and 3). The mean time to healing was 5.4 (range,
4–8) months. The mean follow-up period was 15
(range, 13–24) months. All patients had weakness of
the extensor hallucis longus, which improved to near
normal at month 3. There was no donor-site morbidity.

Three patients with active infection at
presentation underwent repeat surgery. The
duration of antibiotic use after debridement was
suboptimal (usually at least 6 weeks is advocated
for osteomyelitis). At the time of index surgery,
tissue cultures were positive although there was no
macroscopic evidence of infection. A more rigorous
assessment for infection should have been performed
to confirm absence of infection before the index
surgery. Two of them had wound washouts, and
their non-unions went on to heal successfully. The
third patient underwent implant removal after union
owing to an active sinus.

Six of the patients returned to their pre-injury
activity level, and one endured a brachial plexus
injury.

DISCUSSION

Treatment modalities for humeral non-unions include
casting, bracing, compression plating, intramedullary
nailing, and external fixation.7,8 In compression plate
fixation, the screw purchase depends on the quality of
the bone.9 Screw purchase may be inadequate owing
to osteoporosis or previous surgery.10 Although
locked compression plates provide improved pull-out
strength and fixation, implant failure can still occur. The intramedullary fibular graft provides good purchase for screws and adequate fixation. Rigid stabilisation is necessary for non-unions. In one series, 17 of 18 patients achieved bone union after fixation using the fibular allografts and locked compression plates for proximal humeral non-unions. Good outcome was also achieved in 6 patients after fixation with fibular grafts, when those with poor soft tissues and infection were excluded. In selected patients, adequate stability can be obtained with non-locked plates and fibular grafts. In a biomechanical study of fixation using a locked compression plate with and without fibular strut grafting for proximal humerus osteotomy with a gap on the medial side, none of the constructs augmented with the fibular graft failed, as opposed to 6 of 8 constructs not so augmented failed. The fibular graft can increase the pull-out strength even for locked compression plates.

In arthroplasty surgery, >10 neutrophils per high power field in a frozen section is indicative of infection. Non-vascularised grafts have less

Figure 2  (a) An infected non-union of the humeral shaft after 18 months after 4 previous surgeries; (b) one year after fixation showing good bone union.

Figure 3  (a) An infected non-union of the humeral shaft after debridement; (b) 2 years after fixation showing good bone union.
resistance to infection. If infection remains, re-debridement and local antibiotic delivery should be performed. In our study, repeat surgeries could have been avoided if the absence of infection had been confirmed before the index surgery.

In our study, postoperative immobilisation with plaster could be avoided owing to adequate stabilisation after fibular strut grafting. In patients with multiple surgeries, the joints are already stiff. Any further immobilisation leads to more stiffness and suboptimal outcome.

The limitations of this study were its retrospective nature and the absence of functional assessment before and after surgery.

REFERENCES