CASE REPORT

Novel use of a trabecular metal spacer in the treatment of a long-standing ulnar fracture non-union

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SUMMARY

The use of trabecular metal (TM) implants in spine and joint surgery is well documented. However, their use has yet to be reported as an alternative to either allograft or autograft in the management of fracture non-unions. We present our experience in using a TM implant for treating a patient with a long-standing ulnar fracture non-union. Excision of devitalised bone resulted in a 17 mm defect which the TM implant was used to infill. The defect was then bridged with a locking plate. At 2-year clinical and radiographic review, bony union and a pain-free return to full function was noted. In this case, the use of a TM implant avoided the morbidity associated with an iliac crest autograft.

BACKGROUND

Ulnar shaft fractures are notoriously slow to unite and have a higher risk of non-union (2%–10%) than many long bone fractures.^{1 2} This is thought to occur as a result of the dynamic effects of the forearm muscles during supination and pronation of the forearm.^{3 4} Non-union is particularly problematic because its disabling effects may be seen at the elbow and wrist, as well as the forearm.

While treatment with an above-elbow cast may be considered in undisplaced fractures, open reduction and internal fixation (ORIF) is the treatment of choice where displacement is noted.⁵ Complication rates are low,⁶ with postoperative union rates reported at between 88% and 98% and satisfactory functional outcome achieved in 92% of cases.^{7 8}

Risk factors for non-union include fracture complexity (degree of comminution, damage to surrounding tissue), poor bone quality, patient age, comorbidity, smoking and inadequate surgical technique.⁹

Non-unions are traditionally treated with a revision ORIF using bone graft.² Union rates in such cases are reported at between 95% and 100%, but are associated with a suboptimal outcome in 15% of cases.^{6 7}

CASE PRESENTATION

A righthand dominant man in his mid-50s presented with increasing pain on the ulnar aspect of his right mid-forearm following a fall onto his outstretched arm. The pain was such that he was now unable to continue his work as a manual labourer. He gave a history of a Monteggia fracture,¹⁰ sustained 23

years earlier, following a road traffic accident. He had undergone ORIF with a dynamic compression plate. However, since the surgery he had complained of persisting low-grade discomfort at the fracture site with certain activities. Clinical review and radiographs 9 years previously demonstrated a non-union at the fracture site but no further intervention was undertaken. He had a body mass index of 25 kg/m² and was not diabetic although had a history of heavy smoking.

Examination indicated no concerns regarding infection. Due to discomfort, both supination and pronation of the forearm were reduced by 25% compared with the contralateral side. He had a palpable radial pulse and normal radial, median, ulna and interosseous nerve function. Elbow and wrist movements were full but uncomfortable.

INVESTIGATIONS

Radiographs showed an established atrophic non-union of an ulnar fracture, with a loose plate held proximally and distally with screws (*figure 1*). There was also moderate osteoarthritis of the elbow joint.

A CT scan was not organised as the non-union was clearly displayed on the plain film radiographs and was consistent with both the clinical history and examination.

TREATMENT

Following a fully informed discussion concerning the risks and benefits of various treatment options, the patient opted for the use of the trabecular metal (TM) spacer in place of bone autograft. It was highlighted that this would be a novel procedure and the particular risks and benefits were outlined in detail.

He underwent a revision ORIF of the fracture non-union. The old scar was excised. There were no signs of infection either at time of surgery or on the tissue samples sent for culture. Intraoperatively, an unstable fibrous non-union with moderate bony resorption was confirmed.

Following plate removal the interposed fibrous tissue and devitalised bone were excised (*figure 2*). Bone quality was noted to be poor, with eburnated non-bleeding bone even after excision of the non-union. Excision was carried out to a maximum gap of 17 mm, to allow insertion of the TM spacer (Spinal System Trabecular Metal TM VBR-S size 11×14 mm, 17 mm height; Zimmer, Warsaw,

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Figure 1 Pre-op plain film radiographs showing the ulnar fracture non-union.

Indiana) (figure 3). Decortication, by feathering the bone ends with an osteotome, was performed prior to the insertion of the TM spacer.

A universal locking plate was applied as a bridging construct with four screws placed either side of the fracture. Compression was applied across the fracture site with two non-locking screws.

OUTCOME AND FOLLOW-UP

Postoperatively, he was allowed full flexion and extension of his wrist and elbow but was advised to limit supination and pronation for 6 weeks.

At 5-week follow-up, he was generally comfortable with only slight wrist discomfort. Power grip testing however caused significant discomfort.

At 9-week follow-up, he was more comfortable, and pleased with his arm and hand function. Radiographs confirmed bony bridging across the TM implant, and at 10 weeks postoperatively he was back to his work as a manual labourer (figure 4).

Figure 2 Intra-op removal of devitalised bone.

Figure 3 Trabecular metal implant in situ.

At 18 weeks postoperatively, he had grip strength equivalent to his non-dominant hand. He reported no pain and radiologically there was good evidence of bone surrounding the implant.

He had a final review at 2 years postoperatively and had no functional deficit of his upper limb with radiological evidence of complete bony bridging across the implant (figure 5).

DISCUSSION

The ideal bone graft should possess the characteristics of: (1) osteointegration (ability to bond to bone), (2) osteoconduction (ability to support bone growth over its surface), (3) osteoinduction (ability to induce differentiation of pluripotent stem cells).

Figure 4 Postoperative plain film radiographs showing bony bridging across the implant.

Figure 5 : Two-year postoperative plain film radiographs showing complete bony bridging across implant.

from surrounding tissue to an osteoblastic phenotype), and (4) osteogenesis (ability to form new bone due to osteoblasts within the graft material).¹¹ There are a range of bone graft options available.

Autologous (or autogenous) grafting involves using bony tissue obtained from another region in the patient's own skeleton. Most commonly this is harvested from the iliac crest, but other donor sites include the femur, tibia and os-calcis.¹² Autologous bone grafting for diaphyseal forearm fracture non-unions has reported union rates of 97%–100% and satisfactory functional outcome rates of 69%–94%.^{6,9} However, it is not without complications and these include donor site infection and/or pain, nerve damage and donor site fracture.^{6,12}

Vascularised bone grafts (VBG) are a form of autograft harvested either with the donor vascular supply, or anastomosed with the blood supply at the transplant site. These are commonly obtained from the fibula, ribs and iliac crest.¹² VBGs for forearm fracture non-unions have reported union rates of 100%, and satisfactory functional outcome rates of 100%.¹³ VBGs are often reserved for complex, refractory cases due to significant disadvantages including: sacrifice of other limb arteries, and the need for technical microvascular expertise.^{1,14}

Synthetic bone graft involves the use of calcium compounds such as tricalcium phosphate in place of harvested bone tissue.¹⁵ While they overcome some of the potential morbidity they do not possess the ideal graft characteristics of osteoinduction and osteogenesis.¹¹ As such, they are often combined with recombinant human growth factors or autograft.¹⁶ This makes for a more costly process, with a benefit profile not necessarily superior to autografts or allografts.

Allograft (or homologous bone graft) is harvested from skeletons of other individuals in the same species. The harvested bone is irradiated before storage and as such does not have the

characteristics of osteogenesis.¹⁵ Allograft is mainly used in cases involving significant bony defect, due to the inherent limitation of available autologous graft.¹⁷ Allografts for forearm fracture non-unions have reported union rates of 92%–100%, and satisfactory functional outcome rates of 69%–75%.^{18,19} Possible allografting complications include: transplant site infection, donor site infection and non-union.^{18,19}

TM implants are a biomaterial made from the metal tantalum, with mechanical properties and morphology similar to trabecular bone.¹⁹ Their porous structure allows tissue ingrowth, providing a framework through and around which host bone and vascular tissue may freely grow.²⁰ Bone may eventually fully unite around the implant, further reinforcing its stability.²⁰ While TM implants may not possess osteoinduction and osteogenesis, they do offer the ability to interpose a mechanically strong spacer or strut, without the attendant morbidity associated with the use of autograft or allograft.

The use of TM implants as a viable bone graft alternative in hip, spine, knee and ankle surgery has been well documented. In hip surgery, TM implants (without using bone graft) have been shown to be no less inferior to traditional implants when managing acetabular defects and pelvic discontinuity during acetabular revision arthroplasty.²¹ In spine surgery, TM implants without graft have shown satisfactory fusion rates and clinical outcomes in both cervical corpectomy and lumbar interbody fusion surgery.²² In knee surgery, TM implants have shown comparable results in total knee arthroplasty when compared with cemented implants, particularly in the young and active population.²³ In ankle surgery, TM implants have been used successfully as a bone graft alternative in arthrodesis, with early reports also suggesting encouraging results from use in total ankle replacement.²⁴

The spinal fusion implant used in our patient was chosen for this case on the principle that it is designed to facilitate fusion between two bony ends separated by a large distance. Based on this principle, the novel use of the implant facilitated the bony union required in an acceptable interval of time, allowing

Patient's perspective

I was a little apprehensive about having the procedure done beforehand, but since it has been done I no longer have to suffer any pain, and have had very little discomfort at all.

All this means is that I can continue to work without any discomfort at all. I am also grateful I never had to have a bone graft taken from my hip as I have heard this can be very painful.

I would like to say that I am very grateful to Dr Norton and to all the staff who have ultimately given me my life back 'pain free'.

Learning points

- ▶ Trabecular metal spacers may offer an alternative to bone graft for managing long bone non-unions where a defect is present.
- ▶ Trabecular metal spacers have the advantage of no attendant donor site morbidity.
- ▶ In this case, the patient returned to heavy manual work within 10 weeks.
- ▶ Further trials comparing trabecular metal spacers to bone graft are needed.

function to be restored. In our patient, stability, range of motion and full pain-free function were restored with moderated exercises postoperatively.

In this case report, we described how the utilisation of a TM spacer led to excellent radiological, functional and patient satisfaction outcomes, in the management of a chronic ulnar fracture non-union. To our knowledge, the use of TM spacers in managing such long bone pathology has not been previously described in the literature. We would suggest that consideration of TM augments in the management of such non-unions has merit. We acknowledge however that a case report is limited in its inability to generalise to a larger cohort. As such, further randomised trials comparing TM implants to bone graft are warranted.

Contributors OOO and JSHG planned, drafted and modified the initial manuscript. RGM and MRN were the operating surgeons and were involved in revisions of the manuscript. All authors are accountable for the article submitted.

Competing interests None declared.

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