FRACTURES ABOUT THE HIP

Tapered fluted modular titanium stems in the management of Vancouver B2 and B3 peri-prosthetic fractures

J. T. Munro, B. A. Masri, D. S. Garbuz, C. P. Duncan

From University of British Columbia, Vancouver, British Columbia, Canada

Tapered, fluted, modular, titanium stems are increasingly popular in the operative management of Vancouver B2 and selected B3 peri-prosthetic femoral fractures. We have reviewed the results at our institution looking at stem survival and clinical outcomes and compared this with reported outcomes in the literature. Stem survival at a mean of 54 months was 96% in our series and 97% for combined published cases. Review of radiology showed maintenance or improvement of bone stock in 89% of cases with high rates of femoral union. Favourable clinical outcome scores have been reported by several authors. No difference in survival or clinical scores was observed between B2 and B3 fractures. Tapered stems are a useful option in revision for femoral fracture across the spectrum of femoral bone deficiency.

Cite this article: Bone Joint J 2013;95-B, Supple A:17–20.

Peri-prosthetic femoral fractures remain a common cause for re-operation following total hip replacement (THR) and account for 5% to 10% of revisions internationally.¹⁻⁴ The Vancouver classification can guide surgical decision making following peri-prosthetic fracture.⁵ Revision is most commonly indicated after type B2 fractures, where the stem is loose but there is good bone stock, and type B3 fractures, in which the stem is loose and bone stock is poor. Tapered, fluted, modular, titanium (TFMT) stems are well-suited in managing such cases if the bone loss is not so severe that segmental replacement of the proximal femur with a circumferential allograft, or segmental replacement prosthesis, is required. The fracture can be used to expose and extract the previous stem and remove cement. The intact distal femur is then directly visualised, allowing preparation for the seating of the tapered region of the stem. A proximal body segment of appropriate height and offset is then selected to restore limb length and tissue tension. The intact distal femur is then directly visualised, allowing preparation for the seating of the tapered region of the stem. A proximal body segment of appropriate height and offset is then selected to restore limb length and tissue tension. The proximal bone is wrapped around the construct and secured with wires or cables. A strut allograft may be used to support the stem in cases of severe bone deficiency. This is the so-called ‘distally fixed scaffold’ technique⁶ (Fig. 1).

Several authors have reported good outcomes for TFMT stems used in revision THR with cohorts including all causes for revision.⁷⁻¹¹ Few however have published results dealing specifically with patients presenting with Vancouver types B2 or B3 peri-prosthetic fractures. We present clinical and radiological outcomes of Vancouver B2 and B3 peri-prosthetic fractures revised with TFMT stems at our institution and a review of results published in the literature to date.¹²⁻¹⁶

Patients and Methods

We conducted a retrospective review of 55 patients who presented to our institution with a Vancouver B2 or B3 peri-prosthetic fracture between February 2000 and February 2010, managed with one of two TFMT stems.¹⁷ The Revitan (Zimmer, Warsaw, Indiana) stem has a 2° taper and a reinforced junction to reduce the risk of stem breakage, and was used for cases in which > 4 cm of femoral diaphysis was available to achieve a distal fit. The ZMR (Zimmer) has a 3.5° taper and was used for fractures when < 4 cm of diaphysis was available to achieve a distal fit. When < 2 cm of diaphyseal bone remained to obtain distal fit, more complex techniques were considered. Our study included 38 patients with B2 and 17 with B3 fractures. All previous radiographs were obtained and hospital notes reviewed for surgical data and complications. Eight patients died leaving a final group of 47 including 30 B2 fractures and 17 B3 fractures available for follow-up at a mean of 54 months (24 to 143).

The mean age at surgery was 71.9 years (44 to 93) and at follow-up it was 76.2 years (47 to 96). Radiographs were reviewed for subsidence, femoral union and changes in femoral bone stock according to the system of...
Patients completed a standardised quality of life (QOL) outcome tool that included the Oxford hip score,\(^\text{19}\) the Western Ontario and McMaster Universities osteoarthritis index (WOMAC),\(^\text{20}\) the Short-Form 12 (SF-12)\(^\text{21}\), the hip and knee arthroplasty satisfaction questionnaire \(^\text{22}\) (used to assess patient satisfaction with pain relief and functional ability), and the University of California, Los Angeles (UCLA) activity score.\(^\text{23}\) We conducted a review of orthopaedic literature published in English from 1980 to the present day using the Medline and PubMed databases for studies specifically reporting outcomes for TFMT stems in the management of peri-prosthetic fractures. We identified five studies reporting outcomes for TFMT stems used exclusively for Vancouver B2 and B3 peri-prosthetic fractures.

### Results

In our series, only two stem revisions were required (4%). One was revised for loosening after subsiding > 10 mm and another for deep infection. This compares favourably with the cumulative 3% survival reported in the literature (Table I).

Complete sets of imaging were obtained in 38 of our patients. Subsidence was observed in nine (24%) but only two subsided > 10 mm, including one of the failures. Bone stock at final follow-up was classified as type A\(^\text{18}\) (diminished) in only 11%, with type B (unchanged) in 63% and type C (increased) in 26%. We observed one asymptomatic fracture nonunion in a 63-year-old female with a B3 fracture around a primary cemented stem. Her bone stock was augmented with an allograft strut and at eight-year follow-up this had bonded proximally and distally.

Patient QOL scores were obtained for 28 patients (16 B2 and 12 B3) in our cohort. There was no significant difference in mean scores between those with B2 or B3 fractures. Overall mean WOMAC global score was 76, with mean function score 75 and pain score 83 (normalised to a range of 0 to 100 with 0 being the worst and 100 being the best).

### Discussion

TFMT stems have demonstrated good performance over the short to medium term in the management of femoral peri-prosthetic fracture. They have excellent survival and radiological results with superior QOL outcomes when compared with cementless fixation.\(^\text{24}\) Surgeons have a choice of revision systems. Springer, Berry and Lewallen\(^\text{25}\) reviewed 118 cases revised for peri-prosthetic femoral fractures.
TAPERED FLUTED MODULAR TITANIUM STEMS IN THE MANAGEMENT OF VANCOUVER B2 AND B3 PERI-PROSTHETIC FRACTURES

VOL. 95-B, No. 11, NOVEMBER 2013

Implant systems included cylindrical, non-modular cobalt–chromium (CNCC) stems, long cemented stems, tumour prostheses and allograft composites (APC). All performed well, however B3 fractures were managed either with APC or TFMT, due to concerns about CNCC implants subsiding. This problem has been reported for CNCC stems used in severe femoral bone loss. Levine et al reviewed 17 cases managed with a mix of stem designs. All performed well and they did not see evidence of non-union associated with use of the fracture as an osteotomy. CNCC stems have been shown to have inferior QOL scores, when directly compared with TFMT stems.

When combining outcomes from reported series (Table I), the cumulative femoral stem revision rate for a total of 212 cases (124 B2 and 88 B3) was 3% (seven stems). Of these failed stems, four (2% overall) were revised for loosening and three for deep infection. The known deep infection rate was 3%, with the majority treated with stem retention and antibiotic suppression. Although the mean follow-up periods ranged from 54 to 67 months (18 to 144), Mulay et al did not report this data. Berry followed a small cohort of eight patients for only 18 months. Reported union rates ranged from 91% to 100% with healing within six to 12 months after revision. In our series 30 fractures occurred around cemented stems and 25 around cementless. Most series reported similar proportions but none found an increased risk of nonunion based on previous stem type. Type B3 fractures have not been associated with higher rates of non-union. Onlay strut allograft was used to support the implant where there was severe bone deficiency in 14 B3 fractures (Fig. 2). Images were available for 11 of these and eight demonstrated incorporation into the host femur. Reported incidences of subsidence varies across reported series from 2% to 71%. In the majority of cases, excluding failures, subsidence was < 12 mm.

In eight patients, re-operations were required (15%) in addition to the two requiring stem revision. Three acetabular components were revised, and two supracondylar femoral fractures required plate fixation. Intra-operative fracture did not occur in any of our cases, but were observed by others and these did not typically require intervention (Table I). All authors report a similar rate of complications for similar reasons. This should be expected in complex cases in patients who have associated medical comorbidity and poor bone stock.

There were no reported differences in survival, complication rate or clinical scores between B2 and B3 fractures in any of the studies. QOL scores for the two groups were not significantly different in our study; however 19 patients were unable to complete the questionnaires. In a review of TFMT stems used in revision for aseptic loosening with severe bone loss, Van Houwelingen et al found survival at five years was 94%, although this did decrease to 84% at ten years due to stem breakage. We have continued to use allograft struts in severe bone deficiency when the proximal stem is unsupported, and the original modular stem designs are no longer in use at our centre. Our practice now is to use a non-modular design in most cases, or one with enhanced taper junction strength, if modularity is desirable. We have adopted the more recently introduced ZMR-XL (Zimmer, Warsaw, Indiana) system with a strengthened modular junction, but only use this in large femurs, as it can
result in removal of excessive bone in smaller patients. Excepting Abdel et al, none of the other case series used allograft without apparent detriment to survival over the medium term. TFMT implant fracture has been associated with stems < 19 mm in diameter used in patients with body mass index > 25 kg/m². 11, 12, 24 Our study found that bone stock was preserved or increased in 89% of cases. This is in contrast to CNCC stems that tend to stress–shield. Richards et al found loss of bone in 42% of cases managed with these stems.

Continuing follow-up will demonstrate the long-term outcome for TFMT stems and their efficacy in the management of peri-prosthetic fractures. We believe that these systems are a very attractive revision option, regardless of bone deficiency.

The author or one or more of the authors have received or will receive benefits, including royalties or license fees, or direct or indirect commercial interest from a commercial party related directly or indirectly to the subject of this article. In addition, benefits have been or will be provided to a charity or public benefit organisation with which one or more of the authors are associated.

This paper is based on a study which was presented at the Inaugural 2012 Current Concepts in Joint Replacement® – A Short Course held in conjunction with the 7th International Congress of the Chinese Orthopaedic Association in Beijing, China, 16th November.

References