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ORIGINAL PAPER

Vancouver type B2 and B3 periprosthetic fractures treated with revision total hip arthroplasty

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Abstract
Purpose Periprosthetic fractures are the fourth most common cause for hip revision and a devastating complication. Our purpose is to report results and quality of life following revision THA for Vancouver B2 and B3 fractures.
Methods This was a retrospective review from January 2000 to November 2012 to identify all revision THA performed for Vancouver types B2 and B3 that had a minimum follow-up of two years. Routine post-operative and radiographic evaluation to assess patient survival, implant failure, complications and quality of life was involved. Statistical analysis was made with the Kaplan-Meier survival curve with 95 % confidence interval and the log rank (Mantel-Cox) test.
Results A total of 76 fractures were included, with an average follow-up 74.4 months. Mean age at the revision surgery was 75.7 years (range, 41–97 years; SD, 12.4). Sixty-six cases were classified as Vancouver B2 and treated with distal fixation stem. Ten cases were Vancouver B3 and a proximal femoral allograft technique was used. The overall five-year Kaplan-Meier survival rate for the patients was 77.9 % (95 % CI, 67.4–88.4), and the ten-year rate was 65.1 % (95 % CI, 51.4–78.8). Five-year Kaplan-Meier survival rate for the implants was 89.6 % (95 % CI, 82.2–97); we presented seven failures. The mean SF-12 mental was 55.1 (range, 31–68; SD, 8.1) and the physical was 37.4 (range, 16–55; SD, 9.4).
Conclusion Mortality rate after periprosthetic fractures is high as compared to other hip surgeries; our Kaplan-Meier analysis showed that it tends to plateau after five years. In our series the failure rate was low and occurred early in the post-operative period.

Keywords Hip revision · Vancouver classification · Periprosthetic fractures

Introduction

Periprosthetic femoral fracture is a devastating complication after total hip arthroplasty (THA). These fractures usually require difficult revision surgery and clinical outcomes are often poor with high mortality rates [1]. Periprosthetic fractures are considered the fourth most common cause for hip revision surgery and account for 9.9 % of hip revisions in the Australian Hip Registry and 7.4 % of hip revisions in The Swedish Hip Registry [2–5].

The incidence of periprosthetic femoral fractures, although variable, is reported to be between 0.1 and 4 % with a higher incidence after revision THA [6–10]. However, it is clear that their incidence has increased over the last decade due to an increase in the number of primary and revision THAs performed, longer longevity of the implants, higher functional demands of the patients, and an increase in elderly patients with osteoporosis receiving THA surgery [6, 7].

Periprosthetic femoral fractures may occur during surgery (intra-operative fractures) that are more frequent with uncemented stems or as a result of post-operative trauma. Post-operative fractures are related to low energy trauma and

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the presence of osteolysis among other risk factors that are detailed in Table 1 [8].

The Vancouver classification is currently the most widely used classification for periprosthetic femoral fractures [11]. This classification has been shown to be reliable and includes the anatomical location of the fracture, the fixation status of the femoral stem, and the quality of bone stock. All of these factors help to determine the definitive fracture management [12]. Generally speaking, if the femoral components are well-fixed (types A, B1 and C) then fracture healing may be achieved either non-operatively or through open reduction and internal fixation (ORIF). On the other hand, revision hip arthroplasty is the treatment of choice for a periprosthetic fracture with a loose femoral component (types B2 and B3) [7, 9, 10].

There is little evidence regarding mid-term results of patients undergoing revision surgery for periprosthetic fractures. The purpose of this study was to report patient survival, implant failure, complications and quality of life following revision surgery for Vancouver B2 and B3 periprosthetic femoral fractures.

Methods

Patient inclusion and data collection

Research ethics board approval was obtained from our institution. A retrospective review of our surgical database from January 2000 to November 2012 was performed to identify all revision hip surgeries performed for periprosthetic fractures that had a minimum follow-up of two years and required revision arthroplasty secondary to a loose stem (i.e. Vancouver B2 and B3). Exclusion criteria were fracture due to tumour disease and history of active or previous periprosthetic infection.

Surgical technique

All the surgeries were performed in a tertiary referral centre by fellowship-trained arthroplasty surgeons with extensive experience in hip revision surgery.

Table 1 Risk factors associated with periprosthetic femoral fracture

Osteolysis / poor bone quality
Minor trauma
Overweight
Malposition of femoral stem
Female
Increased physical activity
Increased periprosthetic stress

The length of the trochanteric osteotomy, the fixation zone of the revision stem in the isthmus of the femur and the size of the modular implant components were templated using full length femoral radiographs. The goal was to obtain a solid press-fit fixation in the isthmus of the femur using the shortest possible modular stem.

The patient was placed in lateral decubitus position and a trochanteric osteotomy was made to the periprosthetic fracture. This surgical approach generally opens the proximal fragment using an extended trochanteric osteotomy to the tip of the fracture and separates the proximal fragment into two pieces. The advantages of this approach are to monitor the zone of distal fixation of the new prosthesis at all times and to easily remove any residual cement. After achieving solid distal fixation of the stem, the proximal fragment is closed around the implanted stem with cerclage wires. This approach has shown good results; however, it is important to minimize soft tissue stripping to maintain blood supply to the bone for fracture healing (Fig. 1) [13, 14].

The acetabular component was checked routinely for any evidence of aseptic loosening, and the femoral bone stock was assessed intraoperatively. An uncemented ZMR (Zimmer Inc., Warsaw, IN, USA) cone type modular stem was used for type B2 cases, and it needed to achieve cortical fixation of at least 3 cm and bypassed the fracture site by a minimum of two outer cortical diameters. In some cases cortical allografts were used in the fracture site to add extra stability. Type B3 cases were commonly treated with a proximal femoral allograft (PFA) technique that has been previously reported (Fig. 2) [15–17].

Post-operative evaluation

Post-operatively the patients were clinically evaluated at six weeks, three months, six months, one year, and then annually. Patients were kept touch-weight bearing for eight to ten weeks using a walker or crutches and then advanced to full weight bearing with one cane that they usually used for six weeks.

Radiographic evaluation included AP pelvic and lateral radiographs of the affected hip that were taken at six weeks, six months, and then annually. The initial six-week post-operative radiographs served as a baseline with which all subsequent radiographs were compared for evidence of migration or loosening of components.

Failure was defined as those stems that required revision surgery and replacement for any reason (including infection). Complications such as superficial infection or dislocation were also recorded.

Patients that were unable to attend the last follow-up appointments were contacted (or their next of kin) to obtain data related to possible complications or date of death. Also, patients without dementia were interviewed using the Medical Outcome Study Short Forms 12 (SF-12) [18].

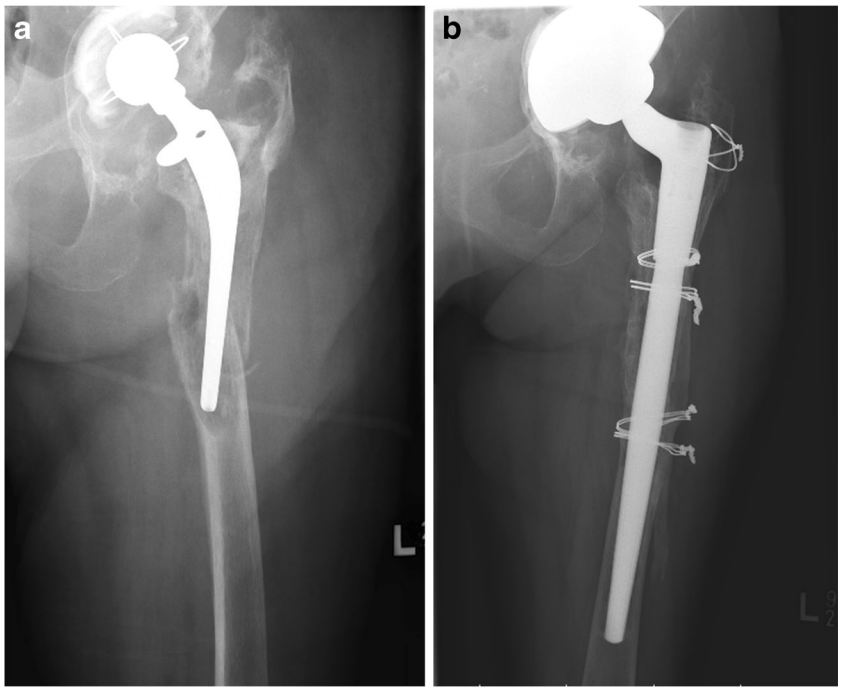

Fig. 1 Vancouver B2 periprosthetic fracture treated with a uncemented distal fixation (ZMR) stem through a trochanteric osteotomy approach. **a** Pre-operative X-rays. **b** Post-operative X-rays

Statistical analysis

SPSS 21 (SPSS Inc, Chicago, IL, USA) was used for data analysis. The Kaplan-Meier survival curve with 95 % confidence interval (CI) was used to assess patient and implant survival. Comparison between curves was done using the log rank (Mantel-Cox) test.

Results

Eighty-one periprosthetic fractures in 81 patients were included in the study. We were unable to locate five patients; therefore, 76 Vancouver B2 and B3 periprosthetic fractures were available for follow-up. Twenty-eight patients (36 %) were male and 48 (74 %) were female. The mean follow-up was 74.4 months (range, 24-167; SD, 42.9). The average age at the time of the revision surgery was 75.7 years (range, 41–97 years; SD, 12.4).

Thirteen fractures (17.1 %) occurred in patients with a pre-existing revision THA. In six cases (7.8 %) the primary cause for the THA was a hip fracture. The acetabular component was found to be loose and revised together with the stem in 24 cases.

Sixty-six cases were classified as Vancouver B2. All of them were treated with uncemented distal fixation stem

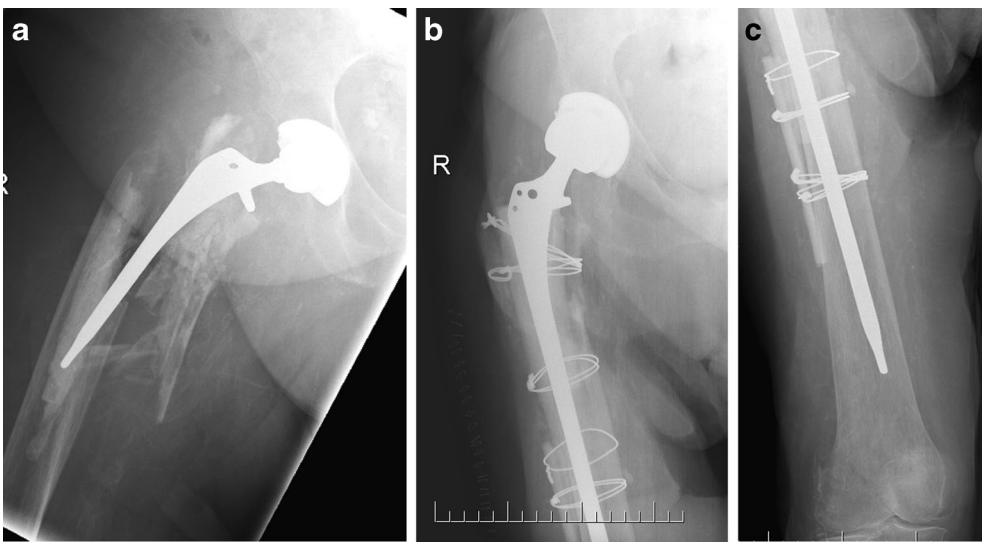

Fig. 2 Vancouver B3 periprosthetic fracture treated with a proximal femoral allograft technique. **a** Pre-operative X-rays. **b** and **c** Post-operative X-rays

(ZMR); additionally 18 were supplemented with cortical allograft. Ten cases were classified as Vancouver B3 and a PFA technique was used in all of them.

The overall five-year Kaplan-Meier survival rate for the patients was 77.9 % (95 % CI, 67.4–88.4) with 35 patients at risk, and the ten-year survival rate was 65.1 % (95 % CI, 51.4–78.8) with ten patients at risk (Fig. 3).

With clinical failure resulting from any cause as the endpoint, the overall five-year Kaplan-Meier survival rate for the implants used was 89.6 % (95 % CI, 82.2–97) with 29 patients at risk (Fig. 4). There was no significant difference between the survival curves regarding the type of treatment (distal fixation stem alone versus distal fixation stem supplemented with cortical allograft or PFA) (p=0.847).

At the time of last follow-up the mean SF-12 mental was 55.1 (range, 31–68; SD, 8.1) and the average SF-12 physical was 37.4 (range, 16–55; SD, 9.4).

We presented seven failures in our series. Five failures were secondary to aseptic loosening of the femoral component. Three of these failures were revised to a new diaphyseal fixation stem (ZMR) and two were revised to a PFA. The remaining two failures were a Vancouver B2 fracture that was revised to a new diaphyseal fixation stem (ZMR), and a deep infection that was treated with a two-stage exchange.

We had eight complications (10 %) that occurred at an average of 11.1 months after surgery (range, 1.5–29.8 months; SD, 11.2) and are detailed in Table 2. We also had three acetabular components with aseptic loosening that required revision and were not considered a failure or complication.

Discussion

As has been previously reported, patients with periprosthetic fractures have increased mortality as compared to other conditions, mainly due to patient characteristics and complex nature of the surgery. Mortality rate after periprosthetic fracture has been reported to be much higher in comparison to patients having revision for aseptic loosening and similar to the mortality rate found after hip fracture [19, 20].

In our series we did not have any deaths within the first 30 days after surgery and only one patient died within the first two months after surgery (1.3 %). Previously, Lindahl et al., based on data from the Swedish National Hip Register, and Fuchtmeier et al. have reported early mortality rates of 1.8 and 1.6 % within the first week and month after surgery, respectively [21, 22]. Our smaller early mortality rate may be the result of smaller patient numbers and because our series only includes type B2 and B3 fractures treated with revision while fractures treated conservatively or with ORIF were excluded.

We had six patients who passed away during the first year after surgery with a mortality rate of 7.8 %. Data from the Swedish National Arthroplasty Register showed a slightly higher one year mortality rate (13.1 %); however, it is important to consider that in his publication Lindhal et al. included all types of periprosthetic fractures with different treatments, including ORIF, and 28 % of the fractures occurred in revision THA [22]. ORIF has been reported to have a higher failure and mortality rate compared to revision hip arthroplasty [23].

Also, Fuchtmeier et al. reported a higher one-year mortality rate. They reported a 12.3 % mortality rate (mean age 75.5 and 17 % of fractures in revision THA) for Vancouver type B2 and

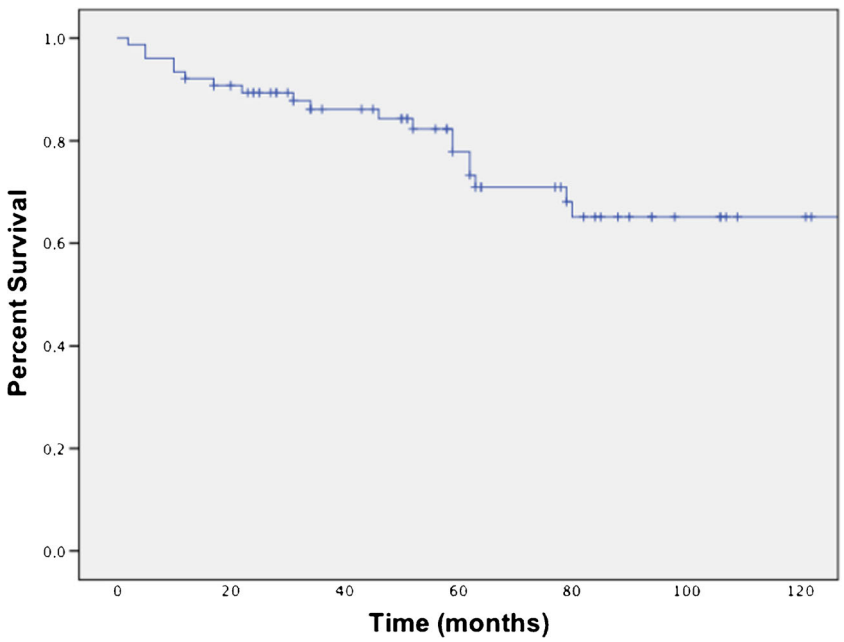

Fig. 3 Kaplan-Meier survival curve for patients after revision total hip arthroplasty (THA) for Vancouver type B2 and B3 periprosthetic fractures

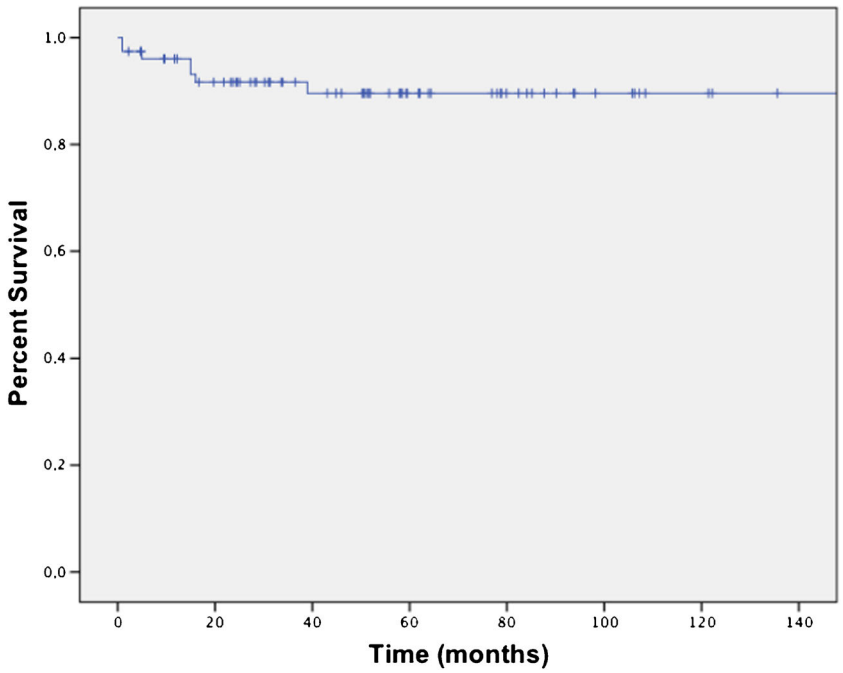

Fig. 4 Kaplan-Meier survival curve (revision for any cause) for revision total hip arthroplasty (THA) due to Vancouver type B2 and B3 periprosthetic fractures

B3 fractures. This finding could be partially explained by the large amount of post traumatic (hip fracture) THA included in their study (23.1 %), which was associated with a significant increase in the mortality and failure rate [21]. While only 7.8 % of patients in our study received their initial THA for hip fracture.

Our Kaplan-Meier analysis showed a 7.5- and ten-year patient survival estimate of 65.1 %. Our patient survival estimate is higher than that reported by Fuchtmeier (52.5 % at 7.3 years) but similar to data from the Swedish National Arthroplasty Registry (64.9 % at ten years). This difference may also be the result of the larger number of hip fractures included in the Fuchtmeier series and by the comorbidity status of the patients rather than the periprosthetic femoral fractures [21, 22].

In our series the implant failure rate was 9.2 % and failures presented early in the follow-up period with six out of seven occurring within 18 months after surgery. Our results are similar to previous reports. If we take into account only the Vancouver B2 and B3 fractures from the Fuchtmeier series they reported a failure rate of 11 % in their patients that were treated with a Wagner, uncemented, distal fixation, monoblock stem. All but one of the failures occurred during the first post-operative year. Also, in concordance with our findings the most common failure was a loose stem [21]. Furthermore, Fink et al. in their series of 32 Vancouver type B2 and B3 fractures treated with a tapered, uncemented, distal fixation, modular stem through an ETO approach, did not present any failure with a minimum follow-up of two years [13]. In contrast, data from the Swedish National Arthroplasty Register showed a revision rate of 18.7 % for Vancouver type B2 and B3. It is important to note that those results come from nationwide data including different types of treatments and surgical expertise [22].

We used the SF-12 to measure health-related quality of life. The SF-12 is a generic health status measure that has been shown to be dependent on age with the absolute score tending to decrease with age. The SF-12 has been previously used for reporting functional outcome after revision THA [24]. It is important to note that patients with a periprosthetic fracture

Table 2 Complications

Type of complication	Number	Treatment
Dislocation	4	Patients A, B and C: closed reduction. No further dislocation
		Patient D: recurrent dislocation revised to constrained liner
Infection	2	Patient A: I&D with head and liner exchange
		Patient B: chronic antibiotic suppression
Periprosthetic fracture	2	Patient A and B: Vancouver type C fracture treated with ORIF

I&D irrigation and debridement, *ORIF* open reduction and internal fixation

represent a distinct subgroup of patients who may have had a well-functioning implant before their injury with high pre-injury SF-12 scores. Thus, the surgical goal for these patients is to return them to their pre-injury functional status. Our SF-12 results were similar to the ones previously reported by Helwig et al. in revision surgery due to periprosthetic infection [25].

Our study has some limitations. First, it is a retrospective series with a relatively small number of patients. Second, it presents the results of periprosthetic femoral fractures treated in a tertiary hospital by experienced arthroplasty surgeons, therefore the outcomes may not be extrapolated. Third, the classification of the periprosthetic fracture in Vancouver type B2 or B3 was done pre- and intra-operatively by the senior surgeon and it could be somewhat subjective. Finally, as periprosthetic fractures usually happen suddenly in previously well functioning implants and many of our patients were transferred from other hospitals, we did not have pre-injury functional or health related scores for many of the patients in this series, therefore a comparison with post-operative scores was not possible.

Conclusion

Mortality rate after periprosthetic fractures is high as compared to other hip surgeries and occurs mainly in the first post-operative year. Our Kaplan-Meier analysis showed that mortality tends to plateau after five years; however, larger numbers with longer follow-up are required. In our series the failure rate was low and occurred early in the post-operative period (within the first 18 months). We believe this was in part due to a standardized surgical protocol. Our preferred method for the treatment of Vancouver type B2 and B3 periprosthetic fractures is revision THA with a modular, uncemented, distal fixation stem.

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