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Cable plate fixation for Vancouver Type-B1 periprosthetic femoral fractures-Our experience and identification of a subset at risk of non-union

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ABSTRACT

Introduction: Management of periprosthetic femoral fractures is challenging. Vancouver classification is universally accepted for fracture description and management algorithm. Guidelines for the treatment of type B1 fracture is open reduction and internal fixation. The difficulty involved in managing this group is evidenced by the array of treatment options described in the literature.

Methods: Thirty two patients with Vancouver type B1 fracture treated with osteosynthesis using cable plate (between 2007 and 2015) were reviewed retrospectively. There were 21 females and 11 males with an average age of 81yrs (56–96 years). The average follow-up was 21 months. All patients were reviewed clinically and radiologically until fracture united or patient re-operated. Postoperative protocol followed was six weeks toe touch weight bearing, 6 weeks partial weight bearing and then full weight bearing if there was no displacement. Post-operative radiographs were evaluated for fracture union. Statistical analysis was done using contingency tables with Fishers exact test and a p-value < 0.05 for significance.

Results: In twenty four patients fracture union was achieved. Non-union was recorded in four patients. Comparing the different fracture patterns all non-unions occurred in the fractures which were short oblique or transverse at the cemented stem tip ($p = 0.001$). Fractures were more common in female patients and associated more with the uncemented femoral stems, but it was not associated with increased rate of non-union ($p = 0.68$). All failed osteosynthesis were revised successfully using long stem prosthesis. Two patients died within 2 months, one patient died within 4 months, one patient was lost to follow-up.

Conclusion: Transverse or short oblique periprosthetic fractures around tip of cemented femoral stems can have high failure rates with just internal fixation. Revision arthroplasty may be the preferred option if possible otherwise may need to supplement fixation with cortical onlay graft. We should consider subcategorising Vancouver type B1 periprosthetic fractures into groups based on the pattern and fracture level in relation to the femoral stem.

Introduction

With the rising number of hip arthroplasties performed every year, the reports of periprosthetic femoral fractures after total hip replacement have shown increasing incidence over time. Reports from the Swedish Hip registry mentioned of 0.64% [1]. Mayo clinic registry reported 1.1% in 23,980 primary THR (1969–99) & 4% in 6349 revision THR. Hence the incidence of these fractures varied between 0.5% and 2% for primary total hip arthroplasties but can be high as 4% following revision procedures [2]. Risk factors for peri-prosthetic fractures include osteoporosis, mal-aligned stems, incomplete cement mantle, osteolysis due to wear of the bearing surfaces and stress shielding.

The Vancouver classification is universally accepted worldwide for fracture description based on site, stability of implant and quality of bone. It can act as a guide with a management algorithm. There are other variables guiding the decision making which include patient co-morbid factors, intra-operative findings, surgeon preferences and logistics. The guidelines for the treatment of type B1 fracture according to the Vancouver classification is open reduction and internal fixation. Type B is one of the commonest [3,6]. Abdel et al. in their epidemiological study [19] for 40 year experi-

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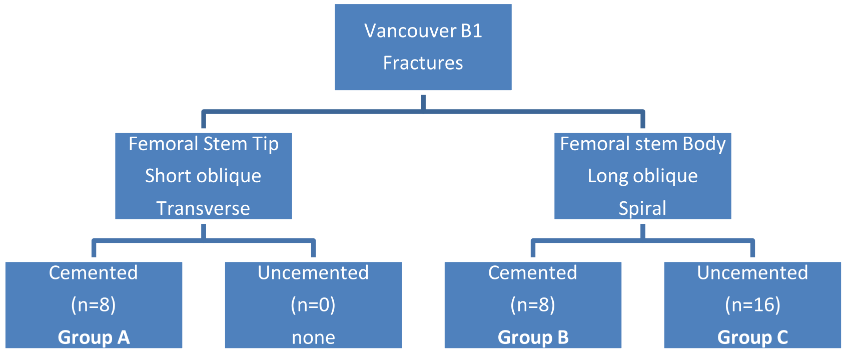

ence of 5417 revision total hip arthroplasties mentioned that most common was Vancouver B1 (31%). In another study [20] for 32 644 primary total hip arthroplasties Abdel et al. noted a Cumulative risk of post-operative peri-prosthetic femur fracture was 3.5% at 20 years.

Treatment of the inherently unstable Vancouver type-B1 peri-prosthetic femoral fractures is especially challenging. Proper evaluation and planning is essential for a successful outcome. The complications associated with the treatment of peri-prosthetic femoral fractures have been increasingly recognised and reported. The difficulty involved in the management of femoral peri-prosthetic fractures around a well fixed implant (Vancouver Type B1) is evidenced by the variety of treatment options described in the literature, which focus mainly on open reduction and internal fixation, with or without allogeneic strut graft or revision arthroplasty procedures. Radiological assessment only may be insufficient for analysing the stability of the femoral stem and appropriate classification into this group may be difficult.

There is a lack of consensus regarding the best operative fixation strategy and needs more clarity. There is lack of data from prospective well designed randomised control studies for the different methods. Several authors have reported a union rate ranging from 33% to 100% with different surgical techniques.

We studied the outcomes and complications of open reduction internal fixation with lateral cable plates without the use of strut bone grafts in Vancouver Type B1 fractures.

Patients and methods

In our retrospective consecutive case series (Level 4 evidence) we had thirty-two patients who had Vancouver type B1 peri-prosthetic femoral fractures treated with cable plate fixation from 2007–15. There were 21 females and 11 males with an average age of 81 years (Range 56–96 years) at the time of the index procedure. Sixteen fractures occurred around primary uncemented femoral stems and 16 occurred around femoral cemented stems. All the patients sustained isolated injuries after a low energy fall. The duration from primary procedure to fracture averaged 8 years (range 2 months-18 years).The operations were performed with laminar flow using extended lateral approach. None of the operations were performed with use of minimally invasive techniques. Fracture reduction was under direct vision and fluoroscopy assisted. Lateral cable plate fixations were utilised without strut allografts or other types of bone grafts. The plate (Zimmer Cable-Ready Bone Plate) was fixed proximally with cables and/or cerclage wires, and distally with screws.

Patients were evaluated clinically and radiographically until signs of union. Stability of cementless stems was assessed according to criteria of Engh et al. [4], stability of cemented stems according to criteria of Harris et al. [5]. Fracture union was defined as the ability of the patient to weight bear fully with or without aids and to have evidence of callus bridging the fracture on both antero-posterior and lateral radiographs. The average duration of follow-up for 28 patients was 18 months (range, 8–27 months). Broadly we subdivided our patients with Vancouver B1 fractures into three subgroups depending on the fracture pattern and site. One(Group A) having patients with transverse or short oblique fractures around femoral stem tip (all with this pattern were with cemented femoral stems) Fig 1–3, second(Group B)with long oblique, spiral type fractures around body of femoral stems Fig 4 and subdivided them depending on the mode of stem fixation. Statistical analysis was done with contingency tables using Fishers exact test and p-value < 0.05 to indicate significance.

The rehabilitation protocol included early mobilisation toe touching on the involved side for six weeks, if there is no change of alignment on radiographs and absence of pain the patients were progressed to partial weight bearing for another six weeks, after which if there was no pain or change in alignment they were allowed to fully weight bear.

Results

Fracture union was achieved in twenty-four patients uneventfully at an average of 6 months (range 4–13 months). All except two of these had long oblique or spiral fractures around the body. Four fractures failed to unite, with a failure of the plate construction occurring at seven, eight, ten and twelve months post-operatively. All four patients had short oblique or transverse fracture around the cemented stem tips. Two patients were non-compliant with the post-operative protocol of restricted weight bearing. All four patient patients were revised successfully using long stems prosthesis that allowed immediate weight bearing. One among them had an interim revision to locking plate fixation which also failed. Varus alignment of the stem of less than 15° was noted in three fractures, but none progressed and all three fractures united.

In the group with B1 fractures around cemented femoral stems there were 15 patients available as one was lost to follow-up. Union was achieved in eleven patients in this group. The fracture pattern in the four patients with non-unions in this group was short oblique or transverse around the femoral stem tip. Considering patients with all femoral stem types (un-cemented & cemented) all non-unions were with the pattern of short oblique or transverse fracture ($p = 0.002$). Using the Fisher's exact test to compare the fracture patterns and non-union in cemented femoral stems, all non-unions were with short oblique/transverse fractures around the femoral stem tip area($p = 0.03$). Fractures were more common in female patients and associated more with the uncemented femoral stems, but it was not associated with increased rate of non-union ($p = 0.68$).

One (Group C) patient had deep wound infection that needed debridement and removal of metalwork, this patient was known to

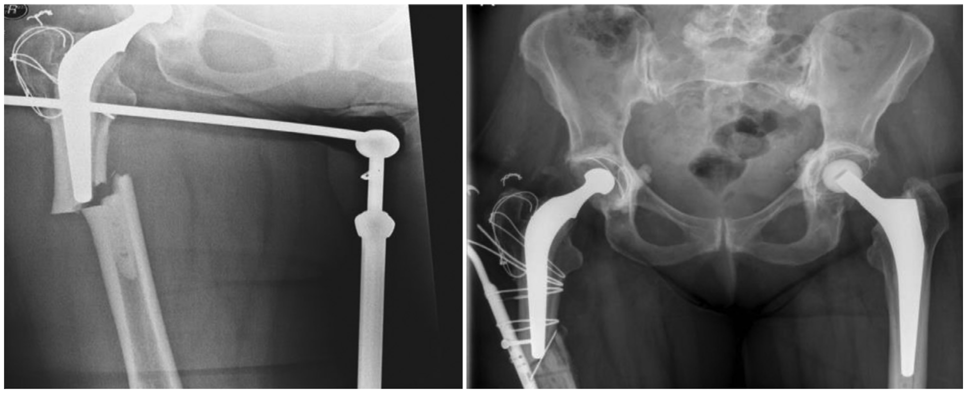

Fig. 1. (a). Transverse fracture at the tip of cemented stem, (b). Non-union after cable plate.

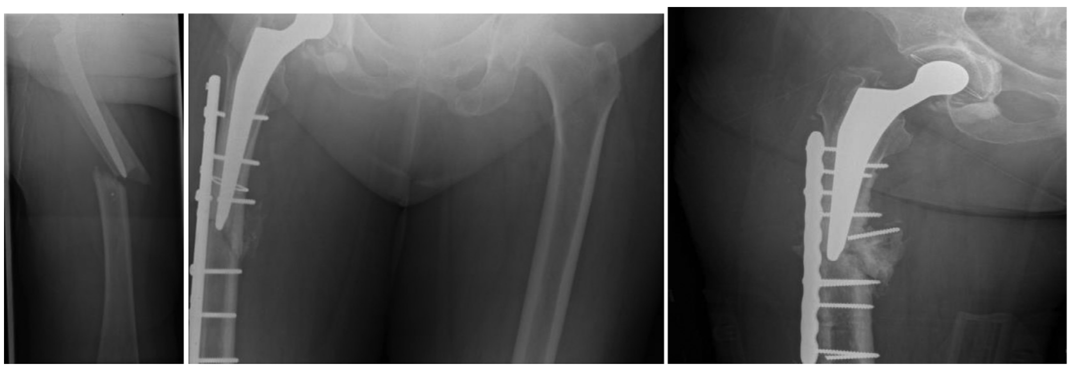

Fig. 2. (a). Transverse fracture at the tip of cemented stem, (b). non-union after cable plate, (c). Non-union after revision to locking plate.

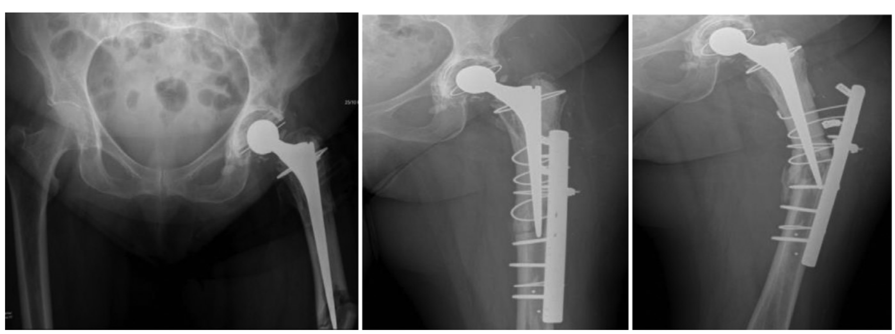

Fig. 3. (a). Short oblique fracture at the tip of cemented stem. (b). Cable plate fixation. (c). Non-union at 8 months.

suffer from lung cancer and died within four months after fracture fixation. The other two (Group C) patients who died within two months of surgery were suffering from multiple co-morbidities, one had bowel cancer.

Discussion

In our series we noticed a trend for failure of plate construct in short oblique and transverse fractures around tip of cemented stems. In this group there is already loss of endosteal healing potential, small contact area for fracture healing and high shear forces in comparison with long oblique or spiral patterns around the body of the implant. All long oblique and spiral fractures in our series united with use of single lateral cable plate. Reports focusing on only one fracture pattern (Vancouver type B1) are scarce.

In a critical analysis of studies reporting locking plate fixation Graham et al. [10] made the conclusion that outcomes could be improved if the fracture site was left free of locking screws, preserving the soft tissue envelope, addition of cortical strut grafts and if stability cannot be achieved with fixation then long stem revision can be considered to achieve axial stability. The loss of endosteal healing potential and soft tissue stripping required for the placement of plates and wires could have played an important role in the failures in these series.

In a systematic review Dehghan et al. [13] compared the most commonly used fixation strategies for these fractures and found that compared with cable plate and compression plate systems, locking plates had a significantly higher rate of non-union (3% vs. 9% $p = 0.02$) High failure rates with locking plate fixation of B1 fractures (6/14) were reported by Buttaro et al. [14]. In contrast Stoffel et al. [15] in a systematic review showed there was 11.9 times higher risk for non union with non locked plating compared with locked plating (although included all Vancouver fracture patterns).These represent Vancouver B1 fractures to be a unique group having varied results with different fixation strategies [7–9,21].

One multicentre report included only forty fractures from over a four year period, using strut grafts alone in half of the patients and strut grafts with plate fixation in the other half and reported

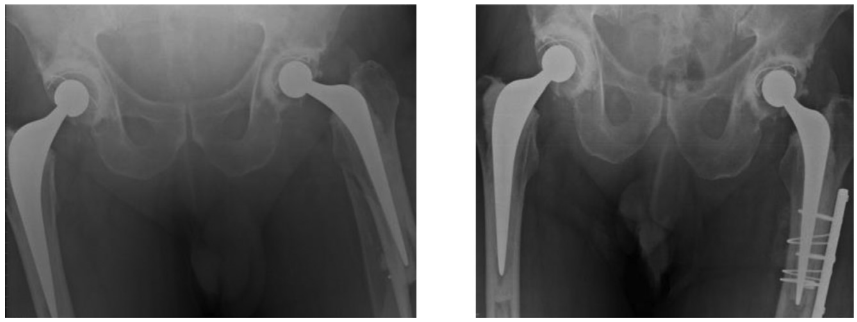

Fig. 4. (a). Long oblique fracture at the body of cemented stem, (b). united with relatively short plate.

98% union [11]. The disadvantages of strut grafts are their high cost, limited availability, increased risk of infection, and potential for transmitting disease. In addition, remodelling occurs subsequent to the initial incorporation of the strut graft, and this leads, in turn, to biomechanical weakness during the first 4 to 6 months following grafting. Meanwhile another series of forty one patients from a trauma centre over a two years period were treated by lateral plating only using biological fixation methods without strut or any other types of grafting, reported 100% union [12]. Ricci 2005. Long stem revision arthroplasty by-passing the fracture for transverse fractures at stem tip was recommended by Hernandez and Holck [16], as they were unstable with slow healing potential. They also mentioned if it was not an option then adding a cortical strut graft would be useful to improve the mechanical stability with preferred site being anteriorly which reduces the soft tissue stripping.

Previous studies have focussed on fixation strategies, addition of strut grafts, postoperative regime etc. Our experience shows that we should consider subcategorising Vancouver type B1 periprosthetic fractures into fractures around the body of the stem and fractures around the tip of the cemented stem. The subcategory of fracture around body of the stem could be treated by long lateral plate using biological fracture fixation techniques. Meanwhile, in the second sub-category of short oblique or transverse fractures around the tip of the cemented stem, plating may need augmentation with strut grafting to minimize stress concentration. We noticed that most of the patients in our series are frail elderly patients who are struggling to comply with the post-operative protocol of toe-touching or partial weight bearing for three months. Meanwhile all the patients that were revised to long stem prosthesis did very well with immediate post-operative weight bearing and this option should be considered whenever feasible especially when it is possible to revise the stem without the need to revise a well fixed cup.

We had three patients with multiple comorbidities, who died within four months after peri-prosthetic fracture (9% mortality). This is comparable with a study by Young et al. 2008 [17] which compared 232 peri-prosthetic femoral fracture patients with matched patients who underwent total hip revision; they found a higher 6 month mortality rate (7.3% vs. 0.9%, $p < 0.001$).Bhattacharyya and associates 2007 [18], Reported a 1 year mortality rate of 11% in patients treated operatively for periprosthetic femoral fractures.

Limitation of this study include the small number of patients, short-term follow-up, and a lack of a control group of patients treated with strut grafting in addition to lateral plating for transverse fractures around tip of cemented stem.

Conclusion

Our experience shows it will be a good idea to consider subcategorising Vancouver type B1 periprosthetic fractures into two groups, firstly fractures around the body of the stem and secondly transverse or short oblique fractures around the tip of a cemented stem. In the second group addition of strut bone graft should be considered if feasible otherwise long stem revision arthroplasty should be the preferred option.

Declaration of Competing Interest

No conflict of interest.

Acknowledgment

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