Predicting Vancouver Types B1 and B2 Periprosthetic Fractures of the Femur

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Abstract

Background: Periprosthetic fractures of the femur after primary total hip arthroplasty (THA) can be complex and difficult injuries to treat. Because of the increased prevalence of THA, an overall increase is anticipated in the incidence of this complication. Vancouver types B1 and B2 periprosthetic femur fractures (defined as fractures around or just below the stem, with well-fixed and loose femoral stems, respectively) are particularly challenging to accurately classify and thereby treat owing to the difficulty in interpreting stability of stems on initial radiographs. To determine whether the method of stem fixation (ie, cement or press fit) may be a predictor of types B1 and B2 fractures, we performed a PubMed search and independently assessed data from 11 studies with 293 patients.

Methods: Studies were included that provided individual patient data (ie, fracture type, method of stem fixation, and stability of stem at the time of revision procedure). Only patients with Vancouver types B1 and B2 fractures were included. Statistical analysis was performed using a random-effects model, estimated with a restricted maximum likelihood method.

Results: A total of 59 and 92 cemented stems were found to be loose and well fixed, respectively (39% and 61%, respectively; n = 151). A total of 17 and 63 uncemented stems were loose and well fixed, respectively (22% and 78%, respectively; n = 80). The overall estimate of the odds ratio was 0.96 (95% confidence interval, 0.86–1.06).

Conclusions: Our findings suggest that fixation method of stems cannot significantly predict the likelihood of having Vancouver types B1 and B2 fracture patterns.

Introduction

Periprosthetic fractures of the femur are relatively uncommon complications, with occurrence rates between 0.1% and 3.5% after primary total hip arthroplasty (THA). Patient mobility and level of activity after THA have increased notably in the past decade. This and the growing number of THA performed for treating the aging population of the United States have resulted in an increasing incidence of periprosthetic fractures noted in recent studies. These fractures are typically classified using the Vancouver system, which is based on the radiographic characteristics of fractures and stability of the femoral stem. In particular, Vancouver types B1 and B2 fractures are defined as fractures around or just below the stem, with a femoral stem that is well fixed (type B1) or loose with healthy proximal bone stock (type B2). Differentiating between types B1 and B2 fractures is critical because each is treated using different methods. Type B1 fractures can typically be treated with open reduction and internal fixation (ORIF) while leaving the femoral stem in place. Type B2 fractures, on the contrary, require a revision of the femoral stem. These two procedures may necessitate different setup of the surgical suite, instrumentation, and operative techniques.

Both Vancouver types B1 and B2 periprosthetic fractures involve complex fracture patterns, and thus the status of stem fixation can be difficult to predict before intraoperative treatment. Risks of re-fracture and stem failure have been associated with treatment of type B1 fractures and attributed to initial misinterpretation of stem stability. In identifying well-fixed or loose stems and thereby successfully categorizing type B1 or B2 fracture, respectively, multiple studies have explored the use of radiographic techniques, other imaging methods, and revision THA instead of ORIF when the classification remains uncertain.
Because of the challenges in confirming stem stability in Vancouver types B1 and B2 fractures, surgeons must increasingly plan ahead of the treatment to confirm availability of implants and operating room staff to treat either fracture pattern. As such, a reliable radiographic indicator for stem loosening may provide invaluable data to successfully prepare for and treat these fractures. We conducted a meta-analysis of studies on periprosthetic femur fractures after THA and included data on method used for stem fixation. We hypothesized that fixation method would significantly correlate with loosening of the stem in types B1 and B2 periprosthetic fractures of the femur.

Methods

In this meta-analysis, a total of 292 articles were initially identified by searches of PubMed with Boolean modifiers of “periprosthetic femur fracture,” “Vancouver classification,” “Vancouver B fractures,” and “cemented versus uncemented stem.” Clinical research with humans and supplemental references used in prominent studies were included. We excluded case reports, duplicate titles, and studies without individual patient data on whether the stem was cemented or uncemented, Vancouver fracture type, and stability of the stem at the time of revision treatment. After further excluding patients with fractures classified as Vancouver types A, B3, and C, we found that data for 231 patients in 11 articles met the inclusion criteria. No study directly addressed our hypothesis and compared cementation status to stem loosening (Table 1).

A meta-analysis of the odds ratio was applied to use of cemented and uncemented stems, with regards to being well fixed or loose, in which patient sample size and heterogeneity were considered. The analysis was based on a random-effects model using restricted maximum likelihood. All 11 of the studies were included in the random-effects model for computing the odds ratio. Calculations were performed using R version 3.0.1 (The R Foundation, Vienna, Austria).

Results

Vancouver types B1 and B2 fractures were noted in 155 (67%) and 76 (33%), respectively, of the 231 included patients. A total of 59 (39%) and 92 (61%) of the cemented stems (n = 151) were loose and well fixed, respectively. A total of 17 (22%) and 63 (78%) of the uncemented stems (n = 80) were loose and well fixed, respectively. Results of statistical analysis using the random-effects model produced an overall estimate of odds ratio at 0.96 (95% confidence interval, 0.86–1.06; Figure 1).

Method of treatment used was available for 166 patients (72%). Of these, a total of 101 patients (60%) underwent ORIF without revision of the femoral stem, and well-fixed stems or type B1 fractures were noted in 90 (89%). Fifty-four patients (32%) underwent a revision procedure for stem fixation. Eleven (6.6%) of the patients were treated with nonoperative management or traction for 6 weeks.

<table>
<thead>
<tr>
<th>First author</th>
<th>Total (included)</th>
<th>Year published</th>
<th>Country of research</th>
<th>Topic or conclusion</th>
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<tbody>
<tr>
<td>Grammatopoulos†</td>
<td>21 (20)</td>
<td>2011, Injury</td>
<td>UK</td>
<td>Collarless stems in VB2</td>
</tr>
<tr>
<td>Zuurmond†</td>
<td>71 (40)</td>
<td>2010, Injury</td>
<td>Netherlands</td>
<td>Complications in operative treatment</td>
</tr>
<tr>
<td>Bryant‡</td>
<td>10 (10)</td>
<td>2009, Injury</td>
<td>USA</td>
<td>Fixation with ORIF for treating VB1</td>
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<tr>
<td>Holley§</td>
<td>99 (45)</td>
<td>2007, HSS J</td>
<td>USA</td>
<td>Vancouver-based treatment algorithm</td>
</tr>
<tr>
<td>van der Wall*</td>
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<td>2005, Int Orthop</td>
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<td>Argentina</td>
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<td>2006, J Bone Joint Surg Br</td>
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<td>2005, Acta Orthop</td>
<td>UK</td>
<td>ORIF with dynamic compression plates for treating VB1</td>
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<td>Cooper*</td>
<td>6 (5)</td>
<td>2009, HSS J</td>
<td>USA</td>
<td>Early VB2 fractures with non-cemented stems in preoperative morphology</td>
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<tr>
<td>Leonidou*</td>
<td>27 (19)</td>
<td>2013, Injury</td>
<td>Greece</td>
<td>Poor bone quality and high fracture angle in fracture patterns</td>
</tr>
<tr>
<td>Moloney*</td>
<td>58 (41)</td>
<td>2014, Arch Orthop Trauma Surg</td>
<td>USA</td>
<td>ORIF and stem lengths in predicting VB1 re-fracture rates</td>
</tr>
</tbody>
</table>

USA, United States of America; UK, United Kingdom; VB2, Vancouver type B2 fractures; ORIF, open reduction and internal fixation; VB1, Vancouver type B1 fractures.

*Preferred method of fixation of the stem (ie, coating or using collared prosthetics) was not available for most studies and thus was not used to determine the authors’ classification of the stem as loose or well fixed.
injury. Furthermore, the Vancouver classification, which was originally described for fractures about cemented stems, was applied to both cemented and uncemented stems in our study. Finally, we estimated our statistical confidence interval after the presence of empty data sets to compare the studies.

We did not find a statistically significant correlation between stem fixation method (ie, cemented or uncemented) and whether the stem was well fixed or loose in treating the periprosthetic fracture around or just distal to the femoral stem. Our findings support the use of intraoperative assessment of stem stability as the more reliable method to confirm a diagnosis of Vancouver types B1 or B2 periprosthetic femur fractures, and the results also reinforce the notion that a surgeon must be prepared to treat both fracture types if otherwise uncertain. Further research into risk factors and predictors for stem stability in periprosthetic femur fractures is needed to help surgeons in effectively planning treatment of these complex fractures.

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Conflict of Interest

The authors report no conflicts of interest.

References