Outcomes of Surgical Management of Supracondylar Periprosthetic Femur Fractures

Nicholas F. Matlovich, MD, Brent A. Lanting, MD, MSc, FRCSC, Edward M. Vasarhelyi, MD, MSc, FRCSC, Douglas D. Naudie, MD, FRCSC, Richard W. McCalden, MD, FRCSC, James L. Howard, MD, MSc, FRCSC

Original Article

ABSTRACT

Background: Fracture location is an important consideration in managing supracondylar periprosthetic femur fractures. The outcomes of locked plating and intramedullary (IM) nail fixation were therefore compared based on fracture location, being above or at/below the total knee arthroplasty (TKA) flange.

Methods: Fifty-seven patients were identified from surgical records as being treated for supracondylar periprosthetic femur fracture with either a locking plate (n = 38) or IM nail (n = 19). Based on fracture location, either above or at/below the TKA flange, both groups were assessed for time to full weight bearing, time to radiographic union, number of postoperative complications, subsequent surgery, transfusion requirements, as well as range of motion, pain, and instability at most recent follow-up. Radiographs were reviewed to assess fracture alignment with comparisons made immediately post-operative to most recent.

Results: Mean follow-up for IM nail and locking plate fixation was 13.9 and 15.6 months, respectively. There was no statistical difference between groups in the mean time to fully weight bear, the incidence of postoperative pain, range of motion, use of gait aids, time to full radiographic union, or the overall radiographic alignment of a healed fracture (P > .05). Comparison based on fracture location yielded similar outcomes. Nonunion was only demonstrated in the IM nail cohort, particularly for fractures below the TKA flange (n = 2).

Conclusion: The use of either IM nail or locking plate fixation for supracondylar periprosthetic fractures provides comparable clinical outcomes. Caution is recommended in using IM nails for fractures below the flange where limited fixation may increase the risk of nonunion.

© 2016 Published by Elsevier Inc.

The treatment of periprosthetic supracondylar femur fractures adjacent to a total knee arthroplasty (TKA) remains a difficult challenge for orthopedic surgeons. Factors such as implant stability, the quality and quantity of metaphyseal bone available for fixation, and complexity of fracture pattern play a significant role in management [1,2]. The use of both retrograde intramedullary (IM) nails and more recently locked plating has been successfully described in the literature. However, a consensus has not yet been achieved in establishing an ideal treatment strategy [3-9].

Traditionally, locked plating has been favored for low supracondylar fractures due to difficulties in achieving distal fixation with IM nails and controlling varus collapse [5,10-13]. However, there are no studies to date that directly compare the 2 modalities on the basis of fracture location. Therefore, the goal of our study is to examine the clinical and radiographic outcomes for fixed-angle locking plates and IM nail fixation for the treatment of supracondylar periprosthetic femur fractures both above and at/below the TKA flange.

Methods

Following ethics approval from our institutional review board (IRB), institutional billing codes were reviewed between January
2005 and May 2013. Fifty-seven patients were identified from surgical records as being treated for supractlylar periprosthetic femur fracture with either a locking plate (n = 38) or IM nail (n = 19). A total of 6 fellowship-trained arthroplasty surgeons treated the study cohort. The Rorabeck classification system was used in identifying fracture types, where type I indicates a nondisplaced fracture with a stable implant, type II a displaced fracture with a stable implant, and type III a displaced fracture with a loose component. All fractures within the study were Rorabeck type II, which served as the main inclusion criteria. All fractures were closed injuries and surrounded a nonstemmed, cemented prosthesis. A cruciate-retaining implant was present in 1 case for the IM nail group and 2 for the locking plate cohort, with the remaining implants being posterior stabilized. All patients treated with an IM nail who had a posterior-stabilized implant had an open box design.

Fractures were further subclassified based on the location of the fracture being either above (high) or at/below (low) the TKA flange (Fig. 1). In all cases, either a long retrograde IM nail or a locking plate extending greater than 3 cortical diameters beyond the fracture site was used. Exclusion criteria consisted of an unstable implant, fracture managed with a distal femoral replacement prosthesis, fracture treated with revision TKA, or fracture which involved a potential neoplastic process.

A retrospective clinical chart review was conducted for demographic data, including age, sex, and time at latest follow-up. Primary outcome measures were obtained including time to full weight bearing, range of motion (ROM), chronic pain, patient subjective instability, and dependency on gait aids. Secondary outcome measures including postoperative complications such as infection, revision surgery, and need for transfusion were also recorded.

Radiographic analysis was used for time to union which was correlated with patient records and determined by a member of the research team who did not perform the surgical procedures. Union was defined as continuity between at least 3 of 4 cortices as visualized on anteroposterior and lateral radiographic images. Deviation from the anatomic axis was also calculated from radiographs at latest follow-up to evaluate coronal and sagittal alignment. A comparison between immediate postoperative and latest follow-up radiographs was made to assess for loss of reduction. The institutional digital PACS (Picture Archiving and Communication System) system was used with Centricity Radiology RA1000 build 2051372-035.

All data were analyzed for statistical significance (P < .05) using SPSS version 17 software (SPSS Inc, Chicago, IL). Mann-Whitney U test was completed for nonparametric data. Student t-test and analysis of variance were used for grouped parametric data where appropriate.

Results

A total of 55 of the initial 57 patients were reviewed. One patient died on postoperative day 5 due to congestive heart failure, and 1 patient died on postoperative day 111 after remaining in hospital due to a complicated intensive care unit stay. Both groups were similar with regard to age, sex, and length of follow-up (Table 1). Mean follow-up after fracture fixation for the IM nail and locking plate cohorts was 13.9 and 15.6 months, respectively.

Clinically, there was no statistical difference found in the mean time to fully weight bear between locked plate fixation and IM nailing, irrespective of fracture location (Fig. 2). Cumulatively, all patients were fully weight bearing postoperatively at 15 weeks. ROM was also comparable, with the locked plating group achieving $2.5^\circ \pm 6.7^\circ$ of extension and $102.9^\circ \pm 11.0^\circ$ of flexion and the IM nail cohort achieving $0.3^\circ \pm 1.2^\circ$ extension and $101.8^\circ \pm 16.7^\circ$ flexion ($P = .88$ and $P = .81$, respectively). This did not vary with fracture location. Patients treated with IM nail fixation demonstrated a significantly higher incidence of subjective instability (17.6% vs 0%, $P = .04$); however, this did not translate into a difference in the requirement of gait aids ($P = .81$). In addition, the incidence of chronic postoperative pain in the locked plating group was 22.2%, which was similar to that found in the IM nail group (22.7%, $P = .94$).

Radiographically, there was no statistical difference in the time to union between locked plating and IM nail fixation regardless of fracture location ($P = .64$). There were 2 cases of nonunion in the IM nail group, both of which belonged to the low fracture subcohort. The time to union for the remaining fractures is depicted in Figure 3. Alignment in the sagittal and coronal planes was also similar between groups ($P = .76$ and $P = .84$, respectively), as was the mean change in alignment between initial postoperative and latest follow-up radiographs ($P = .79$).

The reoperation rate was found to be higher in the IM nail group: 26.3% vs 2.7%, respectively, which included 1 infected nonunion, 1 aseptic nonunion, and 3 cases of hardware irritation. There was no difference in the incidence of infection or reoperation due to infection between the groups. Perioperative blood transfusion, however, was more common in the locked plating group, with 2 of 35 patients requiring transfusion (5.6%) compared to none in the retrograde IM nail cohort.

![Fig. 1. (A) Preoperative anteroposterior and lateral radiographs demonstrating a Rorabeck type II fracture above the flange of a TKA. (B) Preoperative anteroposterior and lateral radiographs demonstrating a Rorabeck type II fracture at/below the flange of a TKA. TKA, total knee arthroplasty](image-url)
Table 1
Patient Demographics Based on Treatment Cohort.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Locked Plating (N = 36)</th>
<th>IM Nail (N = 19)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>75.7 ± 11.2</td>
<td>75.4 ± 9.2</td>
<td>.59</td>
</tr>
<tr>
<td>Follow-up (mo)</td>
<td>15.6 ± 12.6</td>
<td>13.9 ± 15.7</td>
<td>.48</td>
</tr>
<tr>
<td>Sex (M:F)</td>
<td>9:27</td>
<td>3:16</td>
<td>.24</td>
</tr>
<tr>
<td>High fracture*</td>
<td>25</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Low fracture*</td>
<td>11</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

IM, intramedullary; M, male; F, female.

* High fracture and low fracture refer to fracture above and at/below the TKA flange, respectively.

Discussion

Periprosthetic supracondylar femur fractures remain a difficult challenge for orthopedic surgeons. Multiple surgical and nonsurgical treatment modalities have been described, including splinting, casting, locked plating, retrograde IM nailing, revision arthroplasty with stemmed prosthesis, and distal femoral replacement [14-18]. It is well reported that patients managed nonsurgically are subject to increased complications such as malunion, nonunion, deep vein thrombosis, functional decline, and extended hospital stays [9,10,15,16]. Consequently, much of the research in recent years has been directed at operative fixation. Studies published by Figgie et al [1] and Moran et al [19] have shown less than favorable outcomes for conventional plating techniques, and as such, modern interest has focused on both locking plate and retrograde IM nail technology. However, the paucity of literature that currently exists has led to a lack of consensus within the orthopedic community regarding optimal treatment strategies. As the number of TKAs performed continues to increase, it is expected that so will the incidence of supracondylar periprosthetic fracture. Therefore, it follows that there is a need to help unify the literature to clarify direction for treating surgeons.

The present study suggests that overall outcomes for the treatment of supracondylar periprosthetic fractures using either a locking plate or retrograde IM nail are comparable. There was no difference in time to full weight bearing, functional ROM, or need for gait aids, irrespective of fracture location. This parallels the results of several recent studies [19-21]. Meneghini et al [22] have previously shown a decreased time to full weight bearing in patients treated with an IM nail. However, their cohort had a high proportion of patients using gait aids preoperatively, suggesting a possible selection and treatment bias secondary to lower activity status. Interestingly, although the present study did not show a difference in the use of gait aids postoperatively, there was a higher percentage of patients with subjective instability when treated with an IM nail (17.6% vs 0%). This was not found to be accountable by differences in postfracture alignment, pain, or age. Unlike a recently published study by Horneff et al [20], the present study did not demonstrate a statistically significant advantage for locked plating with regard to time to radiographic union. This also held true when analyzing union based on fracture location. Streubel et al [3] have previously compared the outcomes of locked plating supracondylar periprosthetic fractures above and below the TKA flange and found similar results. The present study is the first to report an analogous comparison using IM nails. Comparable to several recent studies, radiographic alignment in the coronal and sagittal plane did not differ between the groups and there was no significant loss of reduction at latest follow-up [3,21].

The overall complication rate was found to be higher in the group treated with IM nail fixation. There were 2 cases of nonunion in the IM nail group and none in the locking plate group. Both cases of nonunion in the present study involved fractures below the TKA flange, indicating a potential influence of fracture location. While IM nails aim at promoting fracture healing by preserving local fracture biology, small distal fracture segments may lead to increased motion and poorer fracture stability. Although the reoperation rate of the IM nail group was also higher than that of the locked plating group, 3 of the 5 cases involved removal of a distal locking screw due to hardware irritation. Conversely, transfusion rates were higher in the locked plating group which has previously been attributed to extensive soft tissue exposure and longer operative times [11,21]. Transition to less-invasive surgical approaches may serve to offset this disadvantage. Collectively, differences in complication rate between the 2 groups may be secondary to the main limitations of this study, which includes a retrospective design and relatively small sample size.

The present study demonstrates comparable clinical outcomes with the use of either IM nail or locking plate fixation for the management of supracondylar periprosthetic fractures. This is irrespective of whether the fracture exists above or below the TKA.
flange. However, caution should be exercised in using IM nails for fractures below the TKA flange as limited fixation may increase the risk of nonunion. Future studies involving prospective comparisons with larger cohort size will help strengthen the current literature and afford treating surgeons important direction in managing these complex fractures.

References