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Modern Retrograde Intramedullary Nails Versus Periarticular Locked Plates for Supracondylar Femur Fractures After Total Knee Arthroplasty

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ABSTRACT

This study purpose is to analyze outcomes of modern intramedullary (IM) nails with a locked distal screw versus periarticular locking plates for peri-prosthetic supracondylar femur fractures in TKA. Ninety-five consecutive fractures in 91 patients were retrospectively reviewed. Fixation included 29 knees with a retrograde IM nail and 66 periarticular locked plates. Six patients died and 4 were lost to follow-up. There were 2 (9%) nonunions in the IM nail group and 12 non-unions/delayed-unions (19%) in the locked plate group ($P = 0.34$). A mean of 5.0 distal screws was used in locked plates versus 3.8 distal screws in the IM nails ($P < 0.001$). Despite a greater quantity of screws in the distal fragment, the failure rate of locked plating was twice that of IM nail fixation.

Distal periprosthetic femur fractures above total knee arthroplasties are difficult fractures to treat for orthopaedic surgeons. With increasing numbers of total knee arthroplasties performed, this specific complication is becoming more prevalent. The management of these fractures is complicated by several variables, which include osteoporotic bone in the distal femoral metaphyseal region, short distal segments for adequate fixation, surgical exposure and blood loss, nonunion, malunion, and malalignment. Recently, peri-articular locked plating techniques have become popular as the most common fixation method. However, consensus does not currently exist within the orthopaedic community or the peer-reviewed literature to establish which implant, fixation strategy or technique is optimal for a successful treatment outcome.

The purpose of this study is to retrospectively compare the results of modern IM nails with locked distal fixation to periarticular locked plating. Our hypothesis is that the modern nails will have equivalent success to the periarticular locked plates in achieving clinical and radiographic union.

Materials and Methods

Institutional review board approval was obtained from three participating centers. Ninety-five consecutive fractures in 91 patients were identified from the institutional database, between 2001 and 2011, as having undergone fixation of a periprosthetic supracondylar femur fracture. There were 10 orthopedic surgeons that participated in the operative management of the study cohort. Fractures were classified using the Lewis and Rorabeck system and subclassified using the AO/OTA classification system. All fractures in this study were Lewis and Rorabeck type II: displaced fractures with a stable prosthesis [1]. Fixation was performed in 29 knees with a retrograde IM nail with a locked distal screw and in 66 periarticular locked plates.

Patient demographic, intraoperative, and postoperative data were prospectively collected and recorded from the institutional database. Preoperative variables that were retrieved included age, gender, surgical date, femoral component type, ambulatory level, and fracture classification. In addition, medical comorbidities that may affect fracture healing were documented and included diabetes, smoking, thyroid disease, autoimmune disease and osteoporosis. Postoperative variables included clinical outcome, operative time, time to union, time to weight bearing, ambulatory level, as well as the total number of screws used and number of screws used in the distal fragment.

Radiographic analysis was completed using standard AP and lateral knee radiographs. The institutional digital PACS system was utilized for radiographic interpretation. The digital goniometer provided by the PACS software was utilized to analyze pre-operative and post-operative radiographs for angular and translational measurements. The initial postoperative film was analyzed followed by the latest follow-up images available. The highest quality sagittal and coronal images from each time point were used in the radiographic analysis [2,3]. The individual femoral component coronal alignment was measured and recorded from the AP films. The femoral component

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sagittal alignment was measured and recorded from the lateral radiographic projections. For the analysis of the coronal plane the distal femoral valgus angle and translation of the distal femoral fragment were assessed. Selecting a midpoint of the femoral component and the femoral diaphysis, then drawing two parallel lines tangential to the anatomic axis, and measuring the translation distance between these two lines determined the translation measurement (Fig. 1). Clinical and radiographic follow up was obtained until fracture union. Nonunion or delayed union was considered a clinical failure. Multivariate statistical analysis was performed to assess differences in outcomes between groups and variables predictive of nonunion or failure. Differences were considered statistically significant at $P < 0.05$.

Results

Six patients died and 4 patients were lost to follow-up, leaving 85 TKR periprosthetic fractures (22 IM nails, 63 locked plates) with a minimum of 6 weeks follow-up (mean 31.8 weeks, range 6 to 176 weeks) (Table 1). Twenty-five of original 29 fractures in the IM nail group were in knees with cruciate-retaining implant designs and the other four (13.8%) were in posterior-substituting designs with an open box amendable to utilization of an IM nail. Forty-six of 66 original fractures in the locked-plate group were in knees with cruciate-retaining implant designs and the other 20 were in posterior-substituting designs (30.3%). Seventy-one of 85 knees (83.5%) went on to union at an average of 16 weeks. There were 2 (9%) nonunions in the IM nail group and 12 nonunions or delayed unions (19%) in the locked plate group ($P = 0.34$) (Table 2). Eleven of the 12 non-unions/delayed-unions in the locked plate group were in females, and one of the two IM nail group non-unions was a female. There was no difference in time to union between groups ($P = 0.64$). A mean of 5.0 (range, 3–8) distal screws were used in the locked plate group, compared to 3.8 (range, 3–4) distal screws in the IM nail group ($P < 0.001$).

Fig. 1. AP radiograph of healed distal femoral periprosthetic femur fracture above a well-fixed TKA demonstrating the method for measuring distal fragment translation.

Radiographic analysis (Table 3) demonstrated the mean immediate postoperative alignment of the femoral component in the sagittal plane was 0.36°of extension in the locking plate group, which was not statistically different than the 1.05° extension in the IM nail group ($P = 0.7$). At final radiographic follow up, the sagittal femoral flexion changed minimally to mean of 0.2° in the locking plates and 0.26° in the IM nails ($P = 0.9$). The immediate postoperative femoral component anatomic valgus in the coronal plane was measured at a mean of 5.62° valgus in the locking plate group, compared to 6.4° in the IM nail group ($P = 0.7$). At final radiographic follow-up, anatomic coronal alignment changed minimally to a mean of 5.28° valgus in the locked plate group, compared to 6.2° in the IM nail group ($P = 0.7$). Further, "acceptable" coronal femoral valgus alignment was defined as $5^{\circ} \pm 2^{\circ}$ anatomic femoral valgus, which revealed 56% of IM nails and 41% of locking plates fell outside of acceptable alignment at final radiographic follow-up. As might be expected with these devices, the locking plate cohort demonstrated greater immediate postoperative translation (distal fragment translation medially) of 4.7 mm compared to 1.8 mm in the IM nail group ($P = 0.04$) (Table 3); however, at final follow-up there was no statistically significant difference between the study groups in regard to distal femoral fragment translation with means of 5.3 mm translation in the locking plates and 2.4 mm in the IM nail group ($P = 0.1$).

Surprisingly, none of the medical comorbidities were statistically correlated or predictive of failure or nonunion. With respect to ambulatory status, the IM nail group demonstrated an overall lower ambulation level (as indicated by the percentage of patients who use a walking aid) preoperatively compared to the locking plate group ($P = 0.013$), indicating a potential selection bias of the surgeons to use the IM nails in more sedentary and less mobile patients. The mean time to resume full weight-bearing was less in the IM nail group at 9.1 weeks compared to 11.7 weeks in the locked-plate group ($P = 0.01$).

Discussion

Supracondylar periprosthetic distal femur fractures after total knee arthroplasty (TKA) are problematic for the treating orthopedic surgeon. These fractures represent a rare but challenging problem, affecting 0.3% to 2.5% of total knee arthroplasty patients [4,5]. The treatment challenges arise from the typical distal fracture location and poor bone quality, the technical challenges associated with the femoral implant and varying designs, the less than optimal bone biology and the elderly patient population in which these fractures typically occur. It is well reported that these fractures have not responded well to traditional non-locked plating techniques. Moran et al [6] reported satisfactory results in 10 of 15 patients treated with non-locked plates. The authors noted that although better outcomes resulted from operative vs. non-operative treatment for displaced fractures, the complication rate of non-locked plating techniques were substantial.

The results of internal fixation of supracondylar periprosthetic distal femur fractures have been documented, and have almost universally defined union and alignment as their outcome measures. Satisfactory outcomes have been reported with use of both periarticular locked plates and retrograde intramedullary (IM) nail fixation. Ricci et al [7] utilized minimally invasive locked plating techniques in periprosthetic fractures, of which 19 of 22 fractures united with mean follow-up of 15 months. When examining the Less Invasive Stabilization System