Intramedullary Nailing Versus Locked Plate for Treating Supracondylar Periprosthetic Femur Fractures

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abstract

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The objective of this study was to compare retrograde intramedullary femoral nailing with supracondylar locked screw-plate fixation for the treatment of periprosthetic femur fractures following total knee arthroplasty. Time to union and full weight bearing were the primary study outcomes, with perioperative blood loss, need for transfusion, need for revision surgery, and infection being the secondary outcomes.

A retrospective review of 63 patients who sustained Rorabeck Type II periprosthetic femoral fractures was undertaken. Patients were pooled from 3 academic institutions between 2001 and 2009. Patients eligible for the study were identified from the electronic medical record using an IDX query of International Classification of Diseases 9 and Current Procedural Terminology codes for fixation of femur fracture with intramedullary implant or plate and screws. In the series, 35 patients were treated with intramedullary femoral nailing and 28 with a locked screw-plate. The 2 groups were compared for radiographic union at 6, 12, 24, and 36 weeks. At 36 weeks, radiographic union was significantly greater in the locked screw-plate group. Time to full weight bearing was not significantly different. A greater perioperative transfusion rate was observed in the locking plate group, but it also had an overall lower rate of reoperation, for any reason, compared with the intramedullary femoral nailing group. The results support the use of a laterally based locked plate in the treatment of Rorabeck type II distal femur periprosthetic fractures.
Supracondylar fractures of the femur following a total knee arthroplasty (TKA) are an increasing challenge for orthopedic surgeons. The incidence of periprosthetic fractures following primary TKA reported in the current literature is between 0.3% and 2.5%.[1,2] The majority of these fractures occur in the setting of low-energy falls that result in a distal femur fracture.[3] These fractures can be difficult to manage, and factors, such as the stability of the prosthesis and the quality and amount of bone available for fracture fixation, need to be considered when planning treatment. Typically, patients with a TKA periprosthetic fracture also have fairly severe osteopenia.[4]

Multiple treatment options exist for periprosthetic supracondylar femur fractures, including fixed angle implants (such as fixed angle plates and plates with locking screws), retrograde intramedullary nails, or a reconstruction prosthesis (such as a distal femoral replacement), in cases of severe comminution and bone loss.[5] The use of intramedullary nails vs locking plates is debated because both treatment options have been successfully described in the literature.[5-10] However, few series have compared the 2 treatment modalities. In the largest combined series looking at this question, Herrera et al[11] performed a systematic review of 415 fractures in 29 published case series and found that intramedullary nailing was associated with lower nonunion, secondary infection, and fixation failure rates compared with conventional and locking plate techniques.

Recently, fixed angle locked plating techniques have improved the success of plate fixation in the distal femur, especially in the setting of osteoporotic bone, and their use in periprosthetic fractures has been reported throughout the literature.[12,13] Biomechanical evidence supports the use of locked plates in the distal femur when compared with other conventional plating systems (Condylar Buttress Plate and Dynamic Condylar Screw; Synthes, West Chester, Pennsylvania).[14] In addition, newer and less invasive plating systems minimize the periosteal stripping and soft tissue disruption, which helps preserve soft tissue attachments and blood supply to the femur.[15,16]

The purpose of this study was to compare the use of fixed angle (locking) plates and intramedullary nails for the treatment of Rorabeck Type II periprosthetic fractures above a TKA. Due to the infrequency of these fractures and the paucity of literature that exists regarding this topic, the authors performed a multicenter study to increase the study size and decrease surgeon or institution bias with regard to treatment. The hypothesis was that locked plating techniques offer an advantage over intramedullary nailing when it comes to bony union for patients who sustain this fracture type.

Materials and Methods

Patients eligible for the study were identified from their electronic medical record. An IDX query of International Classification of Disease 9 (996.44) and Current Procedural Terminology codes for fixation of femur fracture with intramedullary implant or plate and screws (27519, 27506, 27507, and 27511) for patients seen between 2001 and 2009 was performed at 3 academic institutions. The treating surgeon at each institution was noted. In total, 8 surgeons were involved in the series (6 fellowship-trained arthroplasty surgeons [A.M., S.M.] and 2 fellowship-trained trauma surgeons [J.P.]). The medical records and images were then identified for review in accordance with the institutional review board protocol, which was submitted and obtained for this study.

The inclusion criteria for this study were closed fractures of the femur above a nonstemmed, well-fixed total knee prosthesis. Therefore, fractures were classified as Rorabeck type II (displaced fractures with a stable prosthesis).[17] In addition, a minimum 36-month follow-up was required for inclusion and evaluation. Exclusion criteria were patients in which fracture fixation was not performed with an intramedullary nail or a laterally based locking plate, intraoperative fractures at the time of TKA implantation, segmental fractures of the ipsilateral femur (including ipsilateral head, neck, pterychanteric), open fractures, previous infection of TKA, or evidence of neoplastic lesion or process. After inclusion and exclusion criteria were applied, 63 patients remained in the study.

Fracture fixation was divided based on method of fixation: laterally based locking plate or retrograde intramedullary nail. The primary outcome of interest was time to union. The treating surgeon made this distinction based on radiographic and clinical records. Radiographic healing was defined by the attending orthopedic surgeon as cortical continuity in 3 of 4 cortices, as seen on orthogonal anteroposterior and lateral radiographs. In addition, the radiographs could not show signs of hardware loosening or failure. This determination was confirmed by reviewing the attending radiologist’s report. Time to full weight bearing was also measured using the charted notes and radiographs available for interpretation. Both the intramedullary nail and locking plate groups were partial weight bearing with an assist device immediately postoperatively. Progression to full weight-bearing status was directed by the treating surgeon based on radiographic and clinical data.

Patient data included sex, age, body mass index, date of TKA, date of fracture, and fracture descriptors, such as degree of initial displacement and location of fracture. Perioperatively, the total operating room time and the need for postoperative blood transfusion were recorded. Complications, such as infection, nonunion, or a need for revision surgery, were also noted.

Demographics were analyzed descriptively. Data were analyzed using a nonparametric statistical analysis. All statistics were calculated with SPSS version 15.0 software (SPSS, Inc, Chicago, Illinois).
RESULTS

The 2 patient populations were similar with regard to age and body mass index (Table). Thirty-five patients underwent periprosthetic fracture fixation with an intramedullary nail and 28 with a laterally based locking plate. Mean patient age was 69.5 years for the intramedullary nailing group and 68.3 years for the locked plating group. A total of 44 women and 19 men were included in the study; 26 women and 9 men were in the intramedullary nailing group and 18 women and 10 men were in the locking plate group. Average age of the knee prosthesis at the time of presentation for periprosthetic fracture repair was 77.3 months for the intramedullary nail group and 112.4 months for the locking plate group. Average body mass index was 31.3 kg/m² for the intramedullary nail group and 28.4 kg/m² for the locking plate group.

At 6 weeks postoperatively, both groups had similar rates of healing, with 1 patient in each group showing radiographic union (P = .51). Healing rates were also similar at 12 weeks postoperatively, with 15 fractures in the intramedullary nail group and 11 fractures in the locking plate group showing radiographic union (P = .8). At 24 weeks postoperatively, a trend was found in favor of locking plate fixation, with 24 fractures displaying union compared with 24 fractures in the intramedullary nail group (P = .09). At 36 weeks postoperatively, radiographic union was significantly higher in the locking plate group, with 24 fractures displaying union compared with 24 fractures in the intramedullary nail group (P = .05). Despite this difference in union rate and time to union, the time to full weight bearing (without assist devices) for both groups was not significantly different, with an average of 12.4 weeks for the intramedullary nail group and 11.5 weeks for the locking plate group (P = .54).

For secondary outcomes, differences were noted between the groups. Only 8 patients in the retrograde intramedullary nail group required a blood transfusion (P = .02). Operative time was significantly greater for the locking plate group, with an average time of 155.3 minutes compared with 113.0 minutes for the intramedullary nail group (P < .01; 95% confidence interval, −74.85 to −9.68). Patients in the intramedullary nail group required revision surgery more often (14 patients) compared with those in the locking plate group (4 patients) (P = .05). The causes for revision surgery in the intramedullary nail group were 1 infection, 8 nonunions, 1 refracture, 3 hardware breakages, and 1 revision arthroplasty following fracture repair. The cause for all 4 revisions in the locking plate group was infection.

DISCUSSION

Supracondylar periprosthetic femur fractures are an increasing complication in orthopedics because the number of TKAs performed continues to increase. Early treatment consisted of conservative treatment with closed reduction, traction, and casting. However, the increased complication rate, including prolonged hospital stays, venous thromboembolism,
muscular atrophy, and delayed union, has shifted the focus to operative fixation.\(^1\)\(^,\)\(^2\)\(^,\)\(^20\) The goals of fracture fixation—restoration of limb length, alignment, rotation, and early mobilization—remain the priority in approaching these injuries.\(^13\)\(^,\)\(^21\)\(^,\)\(^23\) Thus, the debate for fracture treatment has shifted to the best operative modality.

The type II fractures described by Rorabeck\(^1\) involve a stable prosthesis with a displacement of the fracture greater than 5 mm or angulation greater than 5°. In most cases, these fractures require surgical intervention because of the high rate of progressive displacement, malalignment, and potential nonunion. In addition, surgical fixation allows for early knee mobilization and range of motion.\(^22\) Time to fracture union, full weight bearing, and return to baseline activities helps define successful treatment for patients and surgeons.

The current findings suggest that the locked plate fixation technique fares better than intramedullary nail fixation for the treatment of these fractures. Comparing the postoperative radiographs and clinical records for these 2 populations at 6, 12, 24, and 36 weeks postoperatively, the authors found that the course of fracture healing was accelerated in patients who underwent locked plate fixation. The trend to earlier union was first identified \(^24\) but became significant at 36 weeks postoperatively \((P=.09)\) but became significant at 36 weeks postoperatively \((P=.05)\). As such, the use of locking plates affords patients an improved time to full recovery. The significant increase in operative time and need for blood transfusion that accompanies plate fixation seems to argue against the use of locking plates retrograde intramedullary nails, but this may be offset by the significantly lower rate of reoperation in the locking plate group.

Many previously published studies have shown favorable results with the use of locked plating techniques for these types of fractures. In a series of 27 patients, Ebraheim at al\(^24\) found that 89% of patients went on to union within an average time of 4.5 months. Even more impressive is the literature that supports the use of the Less Invasive Stabilizing System (LISS) locking plate system, which has been shown to have 100% union in studies by Kregor et al.\(^25\) Wick et al.\(^26\) and O’Toole et al.\(^27\) At 36 weeks postoperatively, the current authors showed that 26 (93%) of 28 of patients achieved bony union with the locked plating technique; this was significantly higher than the 25 (71%) of 35 of patients treated with intramedullary nails. A recent follow-up study of 23 patients who sustained a periprosthetic femur fracture above a TKA showed that all fractures had healed by 14 weeks with 2 delayed nonunions, no nonunions or infections, and an average knee range of motion of 102°.\(^28\) The authors of this study emphasized the distinct advantage over intramedullary nails, which would require adequate bone stock for the placement of the interlocking bolts.\(^28\) The current authors agree with this advantage, and have decreased concerns of having to introduce intramedullary nails around a possible closed-box or stemmed TKA implant, possible pulmonary fat microemboli from nail placement, or inadequate bone stock needed for interlocking screws.

The obvious disadvantage of locked plating techniques seen in the current study arises from the longer operative times and the increased need for perioperative blood transfusion (an indirect measure of blood loss). Bezwada et al\(^2\) found average surgical time for retrograde intramedullary nails to be 45 vs 74 minutes for open reduction and internal fixation, as well as significantly greater intraoperative blood loss in the open reduction and internal fixation group compared with in the intramedullary nail group (450 vs 100 cc, respectively) \((P<.05)\). The current authors found similar results, with only 8 patients in the intramedullary nail group requiring blood transfusion vs 15 patients in the locking plate group \((P=.02)\). In addition, the current authors found that the average surgical time was 113 minutes in the intramedullary nail group vs 155.3 minutes in the locked plate group \((P<.01)\). However, newer techniques in plating have advanced to help minimize these risks.

In a study comparing locked plating techniques with intramedullary nails and more traditional plating techniques (dynamic condylar plates and dynamic compression plates), Large et al\(^6\) found favorable outcomes in the locked plating group. The study noted locked plating techniques to have an approximate 10-minute average decrease in operative time and a statistically significant decrease in mean estimated blood loss by approximately 277 cc \((P=.03)\) compared with other modalities of fixation.\(^5\) Another study by Hou et al\(^29\) found lower operative times and blood loss in favor of locked plating over intramedullary nails. With the advent of submuscular technique, decreased periosteal stripping, and implant design for better preservation of periosteal blood supply seen in fracture plating, the current authors believe that these trends are more likely to continue in contrast to the results described in their study.

Currently, the largest study comparing operative techniques for periprosthetic fractures was a large systematic review performed by Herrera et al.\(^11\) The authors compared intramedullary nails and locking condylar plates with traditional (non-locking) plates. They found that the risk of nonunion was reduced by 87% with intramedullary nails compared with traditional plates. In addition, the likelihood of a secondary surgical procedure was also reduced by approximately 70% when using intramedullary nails. They also found a 57% decrease in the nonunion rate with locked plating compared with conventional plating, with a 43% decrease in the need for additional surgery.\(^11\) The current authors similarly found a lower rate of reoperation when fractures were treated with a locking plate. However, unlike Herrera et al,\(^11\) the current series revealed a significantly...
higher reoperation rate in the intramedullary nail group compared with the locked plate group (P = .05).

Limitations of this study include its retrospective nature and lack of randomization. Given the overall low numbers of these types of fractures, the authors compiled data from 2 different institutions and 8 different surgeons. Of these institutions, the breakdown in intramedullary nails vs the locked plate technique varied considerably. Institution 1 performed 5 intramedullary nail and 6 locked plate fixations, institution 2 performed 15 intramedullary nail vs 4 locked plate fixations, and institution 3 performed 15 intramedullary nail vs 18 locked plate fixations. Surgeon familiarity with either procedure and trends within each institution (ie, more trauma training vs more arthroplasty training) could influence the choice of fracture fixation. In addition, no validated clinical scores were used to assess the patients at each point in their follow-up, which could yield more information on their postoperative function. Given the relative infrequency of periprosthetic supracondylar fractures around TKAs, collection of a large series of patients, without performing a systematic review, has challenged investigators. To the authors’ knowledge, this is the largest direct comparison of retrograde intramedullary nails and modern locking plates used in periprosthetic TKA fractures to date.

The authors believe that the use of locking plate technique affords patients a faster time to fracture union and, accompanied by the lower rate of reoperation, provides patients with a quicker time to rehabilitation and recovery. In addition, the use of the fixed angle locking plate overcomes the potential disadvantages seen with retrograde intramedullary nails, such as compatibility with the preexisting knee prosthesis, difficulty with osteopenic bone, and achievement of adequate distal femoral fixation. The data provided herein provide a framework for other institutions to compare their outcomes with both techniques as to guide their fixation strategy. The data also reveal the need for a prospective study comparing these 2 treatment modalities and compilation of a larger series to evaluate the current treatment modalities for what will become a more common fracture type encountered by orthopedists.

CONCLUSION

Supracondylar fractures of the femur following a TKA are becoming a common injury seen in the orthopedic field. The current debate for fixation of these fractures in patients who have a stable prosthesis has evolved into a comparison of locked plating vs intramedullary nailing. The authors found that the use of a laterally based locked plate in the treatment of Rorabeck type II distal femur periprosthetic fractures offers patients a significantly faster time to union with less need for revision surgery. With the continued development of a minimally invasive locked plating technique, it is expected that the use of locked plating will become more common and afford patients quicker recovery.

REFERENCES


