Is It Safe to Place a Tibial Intramedullary Nail Through a Traumatic Knee Arthrotomy?

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Abstract

We conducted a study to compare postoperative infection and nonunion rates in tibial intramedullary nails (IMNs) placed through either uninjured knees or traumatic knee arthrotomies (KAs).

We reviewed all adult tibial diaphyseal fractures (n = 1378) treated with an IMN between 1998 and 2010. Fourteen of these nails were placed through a traumatic KA. Each patient in the study group was assigned 4 separate matched controls for comparison. Controls were matched on age, sex, diabetes, smoking, and fracture classification (closed or open with Gustilo-Anderson).

There were no postoperative infections (knee or fracture site) in the traumatic KA group and 2 (3.5%) in the control group (P = .473). One nonunion (7.1%) was noted in the traumatic KA group, and 9 (16%) were noted in the control group (P = .6694).

To our knowledge, this is the first study to report outcomes of placing tibial IMNs through traumatic KAs. In our sample, the practice presented no increased risk either for infection (at the knee or the fracture site) or for nonunion with appropriate surgical debridement.

Tibial diaphyseal fractures are the most common long-bone fractures, and current operative management favors fixation with an intramedullary nail (IMN).[1-3] Because of the poor soft-tissue envelope, there is increased risk for open fractures and therefore infection and nonunion. Overall infection rates range from 0% to 7%,[4-6] with closed tibial nails' reported infection range of 0% to 4.4%,[7-10] and open fracture infection rates varying from 0% to 33% depending on injury severity (**Table I**).[8-18] Similarly, nonunion rates (Gustilo-Anderson classification) range from 0% to 17%.[5,6,14,15]

Tibial shaft fractures occasionally present with ipsilateral traumatic knee arthrotomies (KAs), which can lead to difficulty in surgical decision making. IMN use in this setting is of concern because of possible contamination of the fracture site through the knee. Isolated KAs after standard irrigation and debridement can themselves carry an infection rate of 2.1%.[19] Retrograde nailing of open femur fractures can result in septic knee arthritis in 0% to 1.1% of cases.[20,21] In a recent series, placing retrograde femoral nails through traumatic KAs carried no elevated risk for nonunion, or for infection at the knee or the fracture site.[22] To our knowledge, no prior studies have examined the risk for complications from nailing a tibia through a traumatic KA. We conducted the present study to analyze the postoperative infection and nonunion rates in tibial IMNs placed through traumatic KAs, with comparison to a 4-to-1 (4:1) matched control group.

Materials and Methods

After obtaining approval from our medical center's institutional review board, we retrospectively reviewed all adult (age, >18 years) tibial diaphyseal fractures (Orthopaedic Trauma Association 42) treated with an IMN at a level I academic trauma center between 1998 and 2010. We identified 1378 fractures, and 21 tibial IMNs placed through traumatic KAs. After excluding ballistic injuries and patients without follow-up to clinical union or 12 months, we reviewed the charts of 14 patients with IMNs through traumatic KAs. We recorded patient demographic data, including smoking, diabetes and other systemic diseases, injury mechanisms, injury severity scores, arthrotomy sizes, Gustilo-Anderson fracture classifications, and ipsilateral extremity fractures. Each of the 14 patients was compared to a 4:1 matched control group of 56

Table I. Reported Infection and Nonunion Rates of Open Tibia Fractures

Gustilo-Anderson Fracture Type	Rate, %	
	Infection	Nonunion
I	0-8.9	0-3
II	0-21	0-5
IIIa	5.5-17	0-7.1
IIIb	9-26	0-17
IIIc	16.1-33	—

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Table II. **Patient and Injury Characteristics**

Characteristic	Tibial Nail With Traumatic Knee Arthrotomy	*P*	Tibial Nail Without Traumatic Knee Arthrotomy
No. of Patients	14	—	56
Age, y	Mean, 34.1 SD, 14.4 Range, 18-68	.949	Mean, 33.8 SD, 12.9 Range, 18-66
Injury Mechanism			
Motor vehicle crash	9 (64.3%)	.552	29 (51.8%)
Motorcycle crash	5 (35.7%)	.022	5 (8.9%)
Pedestrian vs automobile	0 (0%)	.331	7 (12.5%)
Fall from height	0 (0%)	1	3 (5.4%)
Other	0 (0%)	.107	12 (21.4%)
Injury Severity Score	Mean, 16.7 SD, 7.8 Range, 9-27	.849	Mean, 16.2 SD, 8.2 Range, 9-38
Fracture Class			
Closed	2 (14.3%)	> .99	8 (14.3%)
Open	12 (85.7%)	> .99	48 (85.7%)
I	1 (7.1%)	> .99	4 (7.1%)
II	4 (28.6%)	> .99	16 (28.6%)
IIIa	5 (35.7%)	> .99	20 (35.7%)
IIIb	2 (14.3%)	> .99	8 (14.3%)
IIIc	—	—	—
Ipsilateral Extremity Fracture			
Foot/ankle	1 (7.1%)	.494	2 (3.6%)
Patella	4 (28.6%)	.212	7 (12.5%)
Femur	8 (57.1%)	.017	12 (21.4%)
Acetabulum/pelvis	2 (14.3%)	.621	5 (8.9%)
Diabetes	0 (0%)	.473	2 (3.6%)
Smoker	2 (14.3%)	.321	18 (32%)

patients from the consecutive series of IMNs placed through intact joints. These controls were matched on age, sex, fracture classification (closed or Gustilo-Anderson), and, whenever possible, diabetes and smoking (**Table II**).

Treatment data were recorded for temporizing management, surgical approach, and nail reaming. Measured clinical outcomes included postoperative infection and nonunion. *Infection* was defined as a case treated with surgical debridement and irrigation at the knee or fracture site. *Nonunion* was defined as a case that required surgical revision. A 2-tailed paired Student *t* test was used to compare continuous variables between the groups, and a 2-tailed χ^2 test with Yates correction was used to compare categorical variables. Statistical significance was set at $P < .05$.

Results

Fourteen tibial IMNs placed through traumatic KAs were compared with 56 matched controls. Main outcome comparisons showed no significant difference in postoperative deep infection or nonunion between the 2 groups (**Table III**). There were no infections in the study group and 2 in the control group, and 1 nonunion in the study group and 9 in the control group. With the groups' data pooled, outcomes were compared across Gustilo-Anderson fracture classes (**Table IV**). Only observations can be made, as the subgroups were too underpowered for conclusions to be drawn.

There were no significant differences in most treatment modalities and demographics, including age, sex, injury severity score, fracture classification, length of follow-up, diabetes, and smoking (**Tables II, III**). Patient injury characteristics varied significantly with respect to motorcycle crashes ($P = .022$) and ipsilateral femur fractures ($P = .017$), both occurring more frequently in the study group.

Discussion

IMN fixation is a favored treatment method for tibial diaphy-

Table III. **Outcome Comparison**

Outcome	Tibial Nail With Traumatic Knee Arthrotomy	*P*	Tibial Nail Without Traumatic Knee Arthrotomy
Follow-up, mo	Mean, 19.28 SD, 13.1 Range, 7-52	.493	Mean, 20.82 SD, 17.64 Range, 6.1-56
Deep infection	0 (0%)	.473	2 (3.5%)
Nonunion	1 (7.1%)	.669	9 (16%)

Table IV. **Pooled Outcomes of Open Fractures Within Gustilo-Anderson Classification**[a]

Gustilo-Anderson Fracture Type	Total n	Deep Infection		Nonunion	
		n	Rate per Class	n	Rate per Class
I	5	0	0%	2	40%
II	20	0	0%	2	10%
IIIa	25	1	4%	3	12%
IIIb	10	1	10%	2	20%

[a]N = 60 (12 study, 48 control).

seal fractures. Other investigators have been concerned about potential contamination from an open fracture site to the knee joint with the passing of instruments and implants back and forth through the medullary canal,[19,20] but to our knowledge, no previous studies have investigated the possibility of contamination from the knee joint to the tibia, potentially leading to further complications, including infection and nonunion.

The overall rate of infection in our study falls within the range of previously reported rates. Twelve of our patients with traumatic KAs also had open tibial shaft fractures, which means they had 2 areas of potential contamination. As would be expected, the infection rate was higher for more severe open fractures. Our nonunion rates were consistent with prior studies as well. With the exception of the nonunion rates for our type I open fractures, the nonunion rates in our sample population were higher for more severe open fractures. The outlier data for the type I open fractures may stem from the small sample size (5) or from the medical comorbidities of nicotine and alcohol abuse reported by the 2 patients with nonunion.

As discussed, most agree on the importance of the Gustilo-Anderson open fracture classification in predicting complication rates, but several studies have also elaborated on several host-specific factors that should be considered in combination with fracture type.[23-25] These include diabetes, age over 80, tobacco use, alcohol use, systemic inflammatory disease, HIV, malignancy, cirrhosis, and immunosuppressive treatment. In the present study, controls were matched on age, tobacco use, and diabetes, and there were no significant differences between the subject groups on these factors. The less common comorbidities were recorded for each subject as well. Owing to the high-energy injury mechanism, our sample was made up of mostly young, healthy adults, and thus our findings of no complications in the 2 patients with diabetes and 2 nonunions in the 20 smokers (10% nonunion, 0% infection) have limited interpretive value. Of the 3 patients with the less common comorbidity of hepatitis C, 1 had a nonunion. In addition, the 1 patient who was a chronic alcoholic had a nonunion.

Our study did not investigate variables that were the focus of prior studies. The effect of reaming, for example, has been greatly debated. Some have theorized that reaming leads to an increase in complications involving the endosteal blood supply,[26] but there is disagreement as to whether outcome is affected.[14,27-29] According to a Cochrane Review, the evidence either way is insufficient.[30] There were no unreamed tibias in our subject sample, and there was not enough of a difference within the cohort with respect to temporization to be able to fairly compare the effect of immediate versus delayed nailing. Other authors have found a higher risk for infection in immediate nailing with skin closure,[23,24] yet our sample included 8 total delayed nails (11% of all subjects), and 3 (33%) were affected by infection or nonunion—a rate higher than that for the sample as a whole. Because only the most contaminated and injured limbs are commonly temporized at our institution, these were likely to already represent a higher complication risk.

The main limitation of our study is its sample size. Despite evaluating almost 1400 tibia fractures treated with IMNs, we identified only 21 with ipsilateral traumatic KAs. In addition, we lost 7 patients to follow-up, which is consistent with several published trauma series and may result from patients with IMNs reaching clinical and radiographic union at a mean of

9 weeks.[18] A prospective randomized study with a plate-fixation arm could be considered for comparison.

Conclusion

This is the first study to investigate tibial IMN placement through traumatic KAs. This series demonstrates the relative safety of placing a tibial IMN through a traumatic KA with appropriate surgical debridement. There is no increased risk for nonunion or postoperative infection at the knee or the fracture site.

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