Injury, Int. J. Care Injured 45 (2014) 1091–1094

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Comparing Femoral Version After Intramedullary Nailing Performed by Trauma-Trained and Non-Trauma Trained Surgeons: Is There a Difference?

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ARTICLE INFO

Article history:
Received 30 June 2013
Received in revised form 30 November 2013
Accepted 21 January 2014

Keywords:
Femoral version
Intramedullary nail
Femur fracture
Fellowship trained

ABSTRACT

Introduction: As with some procedures, trauma fellowship training and greater surgeon experience may result in better outcomes following intramedullary nailing (IMN) of diaphyseal femur fractures. However, surgeons with such training and experience may not always be available to all patients. The purpose of this study is to determine whether trauma training affects the post-operative difference in femoral version (DFV) following IMN.

Materials and Methods: Between 2000 and 2009, 417 consecutive patients with diaphyseal femur fractures (AO/OTA 32A-C) were treated via IMN. Inclusion criteria for this study included complete baseline and demographic documentation as well as pre-operative films for fracture classification and post-operative CT scanogram (per institutional protocol) for version and length measurement of both the nailed and uninjured femurs. Exclusion criteria included bilateral injuries, multiple ipsilateral lower extremity fractures, previous injury, and previous deformity. Of the initial 417 subjects, 355 patients met our inclusion criteria. Other data included in our analysis were age, sex, injury mechanism, open vs. closed fracture, daytime vs. nighttime surgery, mechanism of injury, and AO and Winquist classifications. Post-operative femoral version of both lower extremities was measured on CT scanogram by an orthopaedic trauma fellowship trained surgeon. Standard univariate and multivariate analyses were performed to determine statistically significant risk factors for malrotation between the two cohorts.

Results: Overall, 80.3% (288/355) of all fractures were fixed by trauma-trained surgeons. The mean post-operative DFV was 8.7° in these patients, compared to 10.7° in those treated by surgeons of other subspecialties. This difference was not statistically significant when accounting for other factors in a multivariate model ($p > 0.05$). The same statistical trend was true when analyzing outcomes of only the more severe Winquist type III and IV fractures. Additionally, surgeon experience was not significantly predictive of post-operative version for either trauma or non-trauma surgeons ($p > 0.05$ for both).

Conclusions: Post-operative version or percentage of DFV >15° did not significantly differ following IMN of diaphyseal femur fractures between surgeons with and without trauma fellowship training. However, prospective data that removes the inherent bias that the more complex cases are left for the traumatologists are required before a definitive comparison is made.

Introduction

Femoral shaft fractures are the most common long bone fracture encountered by orthopaedic surgeons today, and locked intramedullary nailing (IMN) is the treatment of choice for these injuries. [1,2] The goals of operative management include restoring native length, alignment, rotation, and difference in femoral version (DFV) of the fractured femur. Femoral version is a proxy for femoral rotation, and represents the angle between the femoral

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0020–1383/$ – see front matter © 2014 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.injury.2014.01.024

neck and posterior femoral condyles in the axial plane, and ranges from -4 to 35° in healthy individuals.[3] Achieving the operative goals can be challenging for the treating orthopaedic surgeon, including those trained in trauma surgery, and the generalist alike, given the high incidence of postoperative malrotation. [4,5] Specifically, matching native version has proven especially problematic, as up to 43% of operated femoral shaft fractures had a difference in femoral version (DFV) of over 10° from the uninjured side. [6–8] On average, in uninjured individuals, the DFV is 4°, and only 5% of healthy people have a DFV over 11°. [9] Torsional deformities may result in difficulties with such demanding activities as running, sports, and managing stair climbing. [7] Clinically significant malrotation after femoral fractures appears to occur with a DFV of ≥ 15°, as confirmed by Jaarsma et al. to occur in 28% of femur fracture patients in their series. [7] Malrotation has been shown to alter normal knee joint biomechanics, affecting contact pressures in the tibiotalar and patellofemoral joints. [10–12]

In a retrospective analysis of malrotated femur fracture patients, Liodakis et al. were unable to identify risk factors for malrotation, and showed that version was not affected by surgeon experience, among other factors. [13] As with some procedures, subspecialty training may affect clinical or technical outcome. [14–16] Given the ubiquity of these injuries, it is our goal in this study to identify whether post-operative DFV differs between surgeries performed by those with and without trauma fellowship training.

Materials & methods

Between 2000 and 2009, 417 consecutive patients with diaphyseal femur fractures (AO/OTA 32A-C) were treated via IMN. All operations were performed at an academic level 1 trauma center. Inclusion criteria for this study included complete baseline and demographic documentation as well as pre-operative films for fracture classification and post-operative CT scanogram (per institutional protocol) for version and length measurement of both the nailed and uninjured femurs. Exclusion criteria included bilateral injuries, multiple ipsilateral lower extremity fractures, previous injury, and previous deformity.

Of the initial 417 subjects, 355 patients met our inclusion criteria. Patients were treated by one of 4 trauma fellowship-trained surgeons or 11 non-trauma surgeons. Institutional protocol dictated that one of the following methods was used to determine rotation for all fractures in which it could not be assessed intra-operatively by cortical alignment due to comminution: (1) Pre-operatively, the contour of the lesser trochanter was noted fluoroscopically with the ipsilateral patella facing directly anterior. This saved image was then used in order to match a similar lesser trochanteric contour on the injured femur. If the fragment is excessively externally rotated, the lesser trochanter appears smaller and more concealed behind the femoral shaft. If it is internally rotated, the lesser trochanter is brought into view and appears larger than on the uninjured side; or (2) modification of the quantitative measurement published by Tornetta et al.[8] Post-operative femoral version of both lower extremities was measured on CT scanogram by an orthopaedic trauma fellowship trained surgeon based on previously published methods.[17] The post-operative rotation of the nailed side was compared to that of the uninjured side, and our primary outcome measure was the difference in femoral version (DFV) between the two. Regardless of fellowship training, we also sought to find any association between surgeon experience and DFV. "Experience" was calculated as the number of days that had elapsed between the end of the surgeon's fellowship training and the day of the operation. Other data included in our analysis were age, sex, injury mechanism, open vs. closed fracture, daytime vs. nighttime surgery, mechanism of injury, and AO and Winquist classifications. Surgeries were classified as having been performed during the daytime if initiated between 7:00 AM and 6:59 PM.

Standard descriptive statistics, including mean and standard deviation (SD), were used to report baseline and demographic data. Univariate, followed by stepwise, multivariate regressions were used to test for associations between all of the previously listed independent variables (including trauma training and experience) and our primary outcome variable (DFV). We were then interested in seeing if there was any change in our results when only the more comminuted Winquist types 3 and 4 were examined separately. Accordingly, we created new regression models that included all of the same aforementioned independent variables, but only Winquist type 3 and 4 fractures. Statistical significance was defined as $p < 0.05$. All statistical analysis was performed with SPSS 20.0 (IBM Corp., Armonk, NY).

Results

Of the 355 patients included in this study, the majority were treated by trauma-fellowship trained orthopaedic surgeons (81.9%, Table 1). Between the two cohorts, there were no statistically significant differences in age, gender, or rate of open fractures (Table 1). Complete demographic data can be found in Table 1. There were no statistically significant differences between AO and Winquist injury classifications between fractures treated by trauma surgeons versus those treated by others, providing an appropriately similar comparison in regards to operative difficulty (Table 2).

The mean post-operative DFV in patients treated by trauma-trained surgeons was 8.71° (SD 7.12) compared to 10.71° (SD 8.07) in those treated by surgeons of other subspecialties (Table 3). This difference was not statistically significant when accounting for age, sex, injury mechanism, open vs. closed fracture, daytime vs. nighttime surgery, mechanism of injury, and AO and Winquist classifications in a multivariate model ($p > 0.05$). The same statistical trend was true when analyzing outcomes of only the

Table 1
Patient Demographics*

		Trauma	Non-Trauma
N		267 (81.9%)	59 (18.1%)
Age (mean ± SD)		31.9 ± 14.0 y	29.3 ± 11.7 y
Sex	*Male*	222 (83.1%)	48 (81.4%)
	Female	45 (16.9%)	11 (18.6%)
Open fractures		35 (13.1%)	9 (15.3%)
Nighttime surgery		65 (24.3%)	14 (23.7%)
Mechanism:	*MVA*	122 (45.7%)	25 (42.4%)
	Fall	25 (9.4%)	10 (16.9%)
	Pedestrian struck	36 (13.5%)	2 (3.4%)
	Crush	9 (3.4%)	0 (0%)
	Gunshot	48 (17.9%)	14 (23.7%)
	Motorcycle accident	25 (9.4%)	6 (10.2%)
	Assault	2 (0.7%)	2 (3.4%)

* $p > 0.05$ for all comparisons

Table 2
Comparing injury severity between the two cohorts.*

		Trauma (n = 267)	Non-Trauma (n = 59)
AO type:	*32A*	141 (52.8%)	26 (44.1%)
	32B	76 (28.5%)	22 (37.3%)
	32 C	50 (18.7%)	11 (18.6%)
Winquist type:	*1*	136 (50.9%)	26 (44.1%)
	2	38 (14.2%)	9 (15.3%)
	3	53 (19.9%)	17 (28.8%)
	4	40 (15.0%)	7 (11.8%)

*$p > 0.05$ for all comparisons