

Current management of tibial shaft fractures

A survey of 450 Canadian orthopedic trauma surgeons

Jason W Busse¹, Emily Morton², Christina Lacchetti¹, Gordon H Guyatt¹, and Mohit Bhandari¹

¹Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, and ²the Canadian Memorial Chiropractic College, Toronto, Ontario, Canada

Correspondance JWB: j.busse@utoronto.ca

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Background and purpose Strategies to manage tibial fractures include nonoperative and operative approaches. Strategies to enhance healing include a variety of bone stimulators. It is not known what forms of management for tibial fractures predominate among Canadian orthopedic surgeons. We therefore asked a representative sample of orthopedic trauma surgeons about their management of tibial fracture patients.

Methods This was a cross-sectional survey of 450 Canadian orthopedic trauma surgeons. We inquired about demographic variables and current tibial shaft fracture management strategies.

Results 268 surgeons completed the survey, a response rate of 60%. Most respondents (80%) managed closed tibial shaft fracture operatively; 47% preferred reamed intramedullary nailing and 40% preferred unreamed. For open tibial shaft fractures, 59% of surgeons preferred reamed intramedullary nailing. Some surgeons (16%) reported use of bone stimulators for management of uncomplicated open and closed tibial shaft fractures, and almost half (45%) made use of this adjunctive modality for complicated tibial shaft fractures. Low-intensity pulsed ultrasound and electrical stimulation proved equally popular (21% each) and 80% of respondents felt that a reduction in healing time of 6 weeks or more, attributed to a bone stimulator, would be clinically important.

Interpretation Current practice regarding orthopedic management of tibial shaft fractures in Canada strongly favors operative treatment with intramedullary nailing, although respondents were divided in their preference for reamed and unreamed nailing. Use of bone

stimulators is common as an adjunctive modality in this injury population. Large randomized trials are needed to provide better evidence to guide clinical decision making regarding the choice of reamed or unreamed nailing for tibial shaft fractures, and to inform surgeons about the actual effect of bone stimulators. ■

Background

Of all long-bone fractures, those of the tibia are the most common (Heckman and Sarasohn-Khan 1997). The National Center for Health Statistics has reported an annual incidence of 492,000 fractures of the tibia and fibula in the United States (Russell 1996). Tibial fractures are susceptible to complications (Geerts et al. 1994, Turen et al. 1995, Watson et al. 1995, Wells et al. 1995) including nonunion, a complication that approximately 50,000 North Americans suffer from each year (Sarmiento et al. 1995).

Surgeons use several strategies to manage tibial fractures—ranging from nonoperative to operative—as well as adjunctive strategies designed to accelerate healing and reduce rates of nonunion. Current practice in management of tibial shaft fractures by Canadian orthopedic surgeons is uncertain. We present the results of a brief survey designed to explore current management of tibial shaft fractures by Canadian orthopedic trauma surgeons.

Methods

Development of questionnaire

Consulting surgeons, epidemiologists, and the previous literature informed our development of an English-language questionnaire to examine surgeons' preferences and practices in the management of tibial shaft fractures. 3 orthopedic surgeons and 2 epidemiologists participated in the development of the questionnaire. Because a previous report had shown that closed-ended questions result in fewer incomplete questionnaires than open-ended formats (Griffith et al. 1999), we framed the response options in one of two ways: either with Likert scales or with nominal (yes-no) scales. Canada is a bilingual country (the official languages being English and French). In order to facilitate administration of our survey in both languages, we prepared a French version which we tested using a back-translation (Brislin 1986).

Respondents indicated their age, number of years in practice (< 5 years, 5–10 years, 10–20 years, or > 20 years), the number of open and closed tibial shaft fractures they treated each year (0–20, 20–40, or > 40), and their type of practice environment (level-1 trauma, level-2 trauma, or other). A level-1 trauma center was defined as receiving tertiary referrals only, whereas a level-2 trauma center was defined as receiving primary or secondary referrals. Respondents expressed their preference for managing both open and closed tibial shaft fractures, and also stated what surgical fixation device they preferred.

We asked surgeons if they made use of bone stimulators for either uncomplicated or complicated open or closed tibial shaft fractures, and what type of bone stimulators they used—if any. A complicated fracture was defined as presenting with nonunion, delayed union, or malunion, whereas an uncomplicated fracture was described as having none of these features. Respondents also indicated what they would consider a clinically important acceleration in healing attributed to a bone stimulator, in order to justify use of this modality.

Administration of questionnaire

We identified all 753 surgeons who were members of the Canadian Orthopaedic Trauma Association as of January 2005, by acquiring a mailing

list from this organization. In the same month, we administered a 15-question survey to 450 members who were selected using a computer-based random number generator. Orthopedic surgeon's offices in French-speaking areas of Canada were contacted by phone before survey administration to inquire about their preferred language, and they were provided with a French version of the questionnaire if they requested it. In total, 14 surgeons' offices requested a French version of our survey. We were particularly interested in powering our analysis to explore nonoperative management of low-energy tibial shaft fractures in preparation for designing a feasibility trial. Our sample size was based on the assumption that at least 20% of surgeons surveyed would manage closed tibial fractures nonoperatively. Our sample size was determined according to the following formula: $N = (Z\alpha / w) 2p(1 - p)$ where Z is z-value (1.96 for 95% confidence interval), w is the confidence interval, expressed as a decimal ($0.05 = \pm 5$), and p is the percentage picking a choice, expressed as a decimal ($0.2 = 20\%$). According to our calculation, approximately 250 completed questionnaires would allow meaningful analysis. Based on our previous surveys of orthopedic surgeons, we anticipated a 60% response rate (Bhandari et al. 2003, 2005, Leece et al. 2006), which required administration of 450 surveys.

We sent the surveys by fax. Participants were provided with a disclosure letter describing the intent of the survey, and explicit instructions that they could choose not to complete the survey and could fax the cover page back after checking a box indicating that they did not wish to participate. 3 and 6 weeks after the initial mailing, we re-faxed the questionnaire to all non-responders who had not indicated that they did not wish to participate. Individual responses remained confidential, and our local ethics review board approved the study.

Statistics

We summarized categorical and dichotomous variables with percentages. We developed a priori hypotheses regarding potentially important predictors of surgeons' preferences in the treatment of tibial shaft fractures. These variables were number of years in practice and type of practice environment.

We performed multivariable logistic regression analysis to evaluate associations between years in

Table 1. Frequency and types of tibial shaft fractures presenting for care (n = 267 respondents)

Number per year	Closed n (%)	Open n (%)
0–20	169 (63)	265 (99)
20–40	88 (33)	2 (1)
> 40	10 (4)	0

practice and type of practice environment, and outcome variables including surgeons' preferred surgical implant for operative management of tibial fractures and use of bone stimulators. We report the odds ratio (OR) and 95% confidence intervals (CIs) for each significant variable in the analysis. While alternate measures, such as the risk difference or relative risk, enjoy greater ease of interpretation, the OR has several statistical advantages (Walter 2000).

We asked respondents to indicate the minimally clinically important reduction in radiographic healing time (1, 2, 4, 6 weeks, or other) attributable to a bone stimulator that would justify their use in management of tibial shaft fractures. We performed multivariable linear regression analysis to evaluate associations between the number of years in practice and practice environment on responses. We report the unstandardized regression coefficient (b) and 95% CI for each significant variable in the analysis. The regression coefficient represents the slope of the regression line—the amount of change in the y-axis due to a change of 1 unit on the x-axis. Each survey question is graded on a Likert scale and the value of b represents the change in response score.

Results

Characteristics of respondents

Surgeons returned 354 of 450 surveys, a response rate of 79%. 86 respondents returned the cover page only and indicated that they did not wish to participate in the survey. 268 surgeons returned completed surveys, a completed response rate of 60%. 94% of respondents (251 of 268) were male and 63% had been in practice for more than 10 years. 29% practiced in level-1 trauma centers and

Table 2. Preferences in the operative management of tibial shaft fractures (n = 258 respondents)

Choice of implant	Closed ^a n (%)	Open ^b n (%)
Nailing with reaming	120 (47)	152 (59)
Nailing without reaming	104 (40)	62 (24)
Plate	21 (8)	18 (7)
External fixator	1 (<1)	19 (7)

^a 2% (n = 6) stated that they used "another" type of implant, and 2% (n = 6) stated that they do not usually manage closed tibial shaft fractures operatively.

^b 3% (n = 7) stated that they used "another" type of implant.

61% were in level-2 trauma centers; 10% indicated "other" practice settings. Closed tibial shaft fractures were more commonly managed than open (Table 1).

Preferences for management of tibial shaft fractures

80% of respondents managed closed fractures operatively, most of them making use of intramedullary nailing (Table 2). A minority of surgeons preferred plating to nailing, and this preference was associated with a greater number of years in practice (OR = 2.2; 95% CI: 1.3–3.8). Intramedullary nailing was also the implant of choice for management of open fractures (Table 2), and again, use of plating was associated with a greater number of years in practice (OR = 2.5; 95% CI: 1.3–4.7).

16% of respondents sometimes used bone stimulators for uncomplicated closed fractures, or uncomplicated open fractures. 45% "often" (n = 5), "sometimes" (n = 12), or "rarely" (n = 28) used bone stimulators for complicated closed fractures. 43% "often" (n = 5), "sometimes" (n = 14) or "rarely" (n = 24) used bone stimulators for complicated open fractures. Among the 45% of surgeons who reported using bone stimulators, 21% favored low-intensity pulsed ultrasound, 21% favored electrical stimulators, and 3% favored "other" bone stimulators. Neither years in practice nor practice environment was associated with use of bone stimulators.

When asked what they would consider a clinically important reduction in tibial shaft fracture healing time, as facilitated by a bone stimulator, 80% of respondents answered that 6 weeks would

Table 3. Recommendations in common orthopedic teaching textbooks regarding conservative management of tibial fractures

Reference	Recommendations
Whittle 1998	“Closed treatment with casting or functional bracing is an effective method of treating many tibial shaft fractures”
Latta et al. 1998	“Since many fractures have minimal displacement, nonoperative treatment is the choice for these....The majority of ...tibial fractures have excellent outcomes when treated nonoperatively...”
Lang 2000	“As a general rule, low energy and minimally displaced tibial fractures can be successfully treated with closed reduction and cast immobilization, with transition to a fracture brace”
Chapman 2001	“[C]losed reduction and application of a plaster cast is the most commonly used method for treating fractures of the tibial and fibula”
Lang 2002	“[C]losed reduction and casting is the treatment of choice for most low-energy and many mid-range energy fractures”

be clinically important. Greater number of years in practice was associated with considering a larger reduction in radiographic healing time to be clinically important ($b = 0.10$; 95% CI: 0.02–0.19).

Discussion

Summary of findings

Our survey of Canadian orthopedic trauma surgeons revealed that a large majority manage closed tibial shaft fractures operatively. For surgical management of closed or open tibial shaft fractures, the preferred approach is intramedullary nailing, with large preference split between reamed or unreamed nailing. A substantial proportion of Canadian orthopedic surgeons (45%) currently make use of bone stimulators as part of their management strategy for at least some tibial shaft fractures. Their choice of bone stimulators is divided equally between low-intensity pulsed ultrasound and electrical stimulators. Most respondents (80%) would consider a reduction in healing time, due to a bone stimulator, of 6 weeks to be clinically important.

Strengths and limitations

The strengths of our study include a comprehensive sampling of surgeons with an interest in caring for trauma patients, and a good survey response rate for healthcare professionals (79% responded and 60% provided completed surveys). Our results, however, have limited generalizability to orthopedic surgeons outside the Canadian Orthopaedic Trauma Association.

Current evidence and recommendations for management of tibial shaft fractures

Current recommendations for the management of open tibial shaft fractures support operative care (Giannoudis et al. 2006, Okike and Bhattacharyya 2006) and a recent international survey identifying surgeons' preference for intramedullary nailing over other fixation devices (Bhandari et al. 2001) is consistent with our findings. However, there remains considerable variation in practice patterns among orthopedic traumatologists over the choice of reamed or unreamed intramedullary nailing for tibial fractures (Bhandari et al. 2001), and although a recent systematic review has found higher non-union rates associated with unreamed nailing (Forster et al. 2005), that review was based on only 3 trials that had important methodological weaknesses. Treatment allocation was not adequately concealed, outcome assessors were not blinded, and often the dropouts and the withdrawals from the study were not reported. Our finding that most Canadian orthopedic surgeons are now managing closed tibial shaft fractures surgically is more surprising. Many commonly used orthopedic teaching textbooks recommend nonoperative management of closed tibial shaft fractures (Table 3), and the 2 most recent systematic reviews on this topic were unable to find any advantage of operative over non-operative management (e.g. casting) (Littenberg et al. 1998, Coles and Gross 2000).

The relatively common use of low-intensity pulsed ultrasound was lower than suggested by a previous, smaller survey (Busse and Bhandari 2004). However, the evidence for clinical efficacy

of either of the most commonly used bone stimulators, low-intensity pulsed ultrasound or electrical stimulation, is limited (Busse et al. 2002, Pickering and Scammell 2002). Neither has clearly demonstrated the minimal clinical effect in acceleration of 6 weeks for radiographic fracture healing that most of our respondents would consider clinically important. Surgeons may use bone stimulators to heal nonunions, and there is some preliminary evidence to suggest a possible effect (Sharrard 1990, Nolte et al. 2001, Simonis et al. 2003).

Contributions of authors

JWB, MB, and GHG were involved in the conceptualization and design of the study. JWB, EM, and CL performed all data collection. JWB conducted the statistical analysis. All authors revised the manuscript and approved the final version. JWB is the guarantor.

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