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Health outcomes of delayed union and nonunion of femoral and tibial shaft fractures

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ABSTRACT

Introduction: Knowledge about the functional consequences of lower limb long bone fractures is helpful to inform patients, clinicians and employers about their recovery process and prognosis. This study aims to describe the epidemiology and health outcomes of femoral and tibial shaft fractures treated at two level I trauma centres, by comparing the differences between patients with delayed union or nonunion and patients with union.

Patients and methods: An analysis of registry data over two years, supplemented with medical record review, was conducted. Fracture healing was retrospectively assessed by clinical and radiological evidence of union, and the need for surgical intervention. SF-12 scores, and work and pain status were prospectively recorded at six and twelve months post injury.

Results: 285 fractures progressed to union and 138 fractures developed delayed union or nonunion. There was a significant difference between the two cohorts with regards to the mechanism of injury, association with multi-trauma, open fractures, grade of Gustilo classification, patient fund source, smoking status and presence of comorbidities. The SF-12 physical component score was less than 50 at both six and twelve months with improvement in the union group, but not in the delayed union or nonunion group. 72% of patients with union had returned to work at one year, but 54% continued to have pain. The difference compared to patients with delayed union or nonunion was significant.

Discussion: Even patients whose fractures unite in the expectant time-frame will have residual physical disability. Patients with delayed union or nonunion have still poorer outcomes, including ongoing problems with returning to work and pain. It is important to educate patients about their injury so that they have realistic expectations. This is particularly relevant given that the patients most likely to sustain femoral or tibial shaft fractures are working-age healthy adults, and up to a third of fractures may develop delayed union or nonunion.

Conclusion: Despite modern treatment, the patient-reported outcomes of lower limb long bone shaft fractures do not return to normal at one year. Patients with delayed union or nonunion can expect poorer outcomes.

Introduction

Femoral and tibial shaft fractures are major limb injuries that can lead to significant physical impairment [1]. Because they usually result from high-energy trauma, delayed union and nonunion are common occurrences of these fractures [2].

Fracture nonunion is a chronic condition associated with pain, and functional and psychosocial disability [3] that has been shown to have a greater negative impact on the quality of life than patients with end-stage congestive heart failure, and patients receiving renal dialysis or chemotherapy for cancer [4,5]. In addition to the considerable economic costs to society [6], delayed fracture healing and multiple surgeries cause patients to have ongoing pain, swelling, stiffness and inability to bear weight in their limb [7].

The assessment of fracture healing using traditional parameters, such as time to union or range of motion for adjacent joints,

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does not necessarily correlate with the patient's experience of their injury or recovery [8]. While patient-reported outcomes have now been studied for several orthopaedic conditions [9–11], review of the literature confirms a paucity of comparable data on fracture nonunion. In particular, a direct comparison of the health status of patients with delayed union or nonunion and with normal fracture healing has yet to be documented. The exact determination of the burden of delayed union and nonunion of lower extremity long bone fractures is important to inform patients and their families, clinicians, employers and insurers about their recovery process and functional prognosis. This could also guide the design of more focused research in this area and provide relevant information to potential funding bodies.

The aim of this study is to describe the epidemiology and health outcomes of femoral and tibial shaft fractures treated at two level I trauma centres, by comparing the differences between patients with delayed union or nonunion and patients with union.

Patients and methods

A retrospective analysis of prospective registry data, supplemented with patient medical record review, was conducted. Patients were selected from the Victorian Orthopaedic Trauma Outcomes Registry (VOTOR) database with approval of the respective hospital ethics committees.

VOTOR includes all patients with orthopaedic injuries admitted to the two level I adult trauma centres in Victoria, Australia [12]. Participants were recruited into VOTOR using an opt-off method of consent, whereby all eligible patients are automatically registered upon admission and given the option to withdraw from the registry at any time [12]. Patients were enrolled in the study from August 2003 to August 2004 and again from February 2005 to July 2006 [12]. The five month gap between the two sample collection periods was due to temporary funding issues with the registry. Femoral and tibial shaft fractures were identified by reviewing the VOTOR database for AO fracture types 32 and 42, respectively. Exclusion criteria included patients who sustained a pathological fracture or whose injury was managed by a non-orthopaedic team [12], fractures with joint involvement, and fractures in a subsequently amputated limb or in a patient deceased less than six weeks post injury. Fig. 1 illustrates the patient inclusion process.

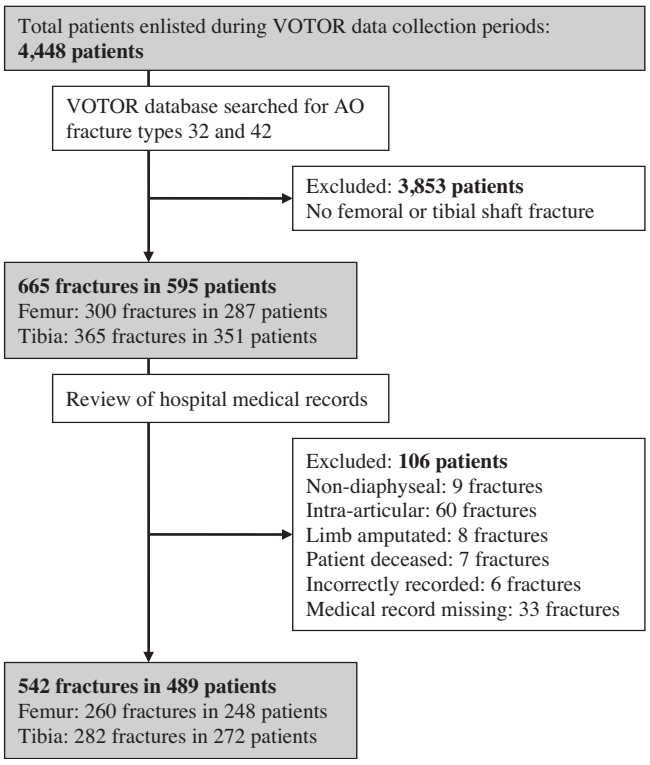

Fig. 1. Flowchart of patient inclusion process.

Fracture healing was assessed by clinical and radiological evidence of union. The indication and timing for surgical intervention was determined by reviewing hospital medical records. Evidence of clinical union included the absence of tenderness at the fracture site and ability to bear full weight on that limb without pain [13]. A fracture was deemed to have evidence of radiological union by the presence of adequate callus bridging the fracture site and disappearance of the fracture line [13,14]. The earliest timing for surgery for delayed healing was set at six weeks post fracture based on common local practice and included nail dynamisation. A fracture was considered to have progressed to nonunion if it required surgical intervention at greater than six months after injury, given that the majority of united fractures should have achieved the aforementioned clinical and radiological milestones. The outcome of a fracture was regarded as unknown if follow-up was for less than twelve weeks or if their clinical and radiological progress were unclear in the patient's records.

Health, work and pain status were prospectively recorded at six and twelve months post injury as part of the VOTOR follow-up protocol [12]. The health status of patients was assessed using the SF-12 [12], which has been tested for reliability [15–18] and validated for use within the Australian population [19] and in trauma patients [20]. Responses from the twelve questions in the self-reported survey are used to calculate a Physical Component Summary (PCS) and a Mental Component Summary (MCS) score which correspond to the physical and mental health status of respondents, respectively [18,21]. Each component is scored between 0 and 100, with higher scores indicating better health [18,21] and a total greater than 50 representing no disability [22].

Patients were also asked whether they had returned to any form of work and whether they still had any pain from their injury [12]. Participants were interviewed by a trained research nurse [12]. Four contact attempts were made before a patient was considered lost to follow-up [12].

Patient demographics and injury details including age, gender, fund source, mechanism of injury, open or closed fracture, and the Gustilo classification for open fractures were retrieved from the VOTOR database. Hospital records were reviewed to determine other injuries and the cigarette smoking status of patients. To categorise other injuries, patients were identified as having sustained an isolated injury or multi-trauma (other than ipsilateral extra-articular fractures of the fibula associated with fractures of the tibia, minor abrasions or lacerations, or loss of consciousness for less than 30 minutes without neurological sequelae) with and without head injury. Head injury was defined as having evidence of traumatic cerebral oedema, diffuse or focal brain injury, or intracranial haemorrhage.

In addition, the Charlson Comorbidity Index [23,24] (CCI) was calculated for each patient using the ICD-10-AM diagnosis codes assigned for that admission. This was utilised as an aggregate measure of a patient's general health.

The data was analysed using the statistical software package, Stata [25]. The p values for the categorical variables were calculated using Pearson's chi-squared and Fisher's exact two-tailed tests. The SF-12 PCS and MCS scores were analysed by linear regression modelling to calculate a correlation coefficient. The return to work and pain status results were analysed by logistic regression modelling to calculate a risk ratio. Multi-variate analysis was employed to account for other variables.