Injury, Int. J. Care Injured 43 (2012) 1154–1158

Contents lists available at SciVerse ScienceDirect

Injury

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

Long-term functional outcome following intramedullary nailing of femoral shaft fractures

Mostafa el Moumni *, Emma Heather Voogd, Henk Jan ten Duis, Klaus Wilhelm Wendt

Department of Traumatology, University Medical Center Groningen, Groningen, The Netherlands

ARTICLE INFO

Article history:
Accepted 6 March 2012

Keywords:
Femur
Femoral fractures
Intramedullary nailing
Health questionnaire
Functional outcome
Patient-reported outcome measures

ABSTRACT

Background: The management of femoral shaft fractures using intramedullary nailing is a popular method. The purpose of this study was to evaluate the long-term functional outcome after antegrade or retrograde intramedullary nailing of traumatic femoral shaft fractures. We further determined predictors of these functional outcome scores.

Methods: In a retrospective study, patients with a femoral shaft fracture but no other injuries to the lower limbs or pelvis were included. A total of 59 patients met the inclusion criteria. Functional outcome scores (Short Musculoskeletal Functional Assessment (SMFA), Western Ontario and McMaster University Osteoarthritis (WOMAC) index, Harris Hip Score (HHS) and the Lysholm knee function scoring scale) were measured at a mean of 7.8 years (±3.5 years) postoperatively. The Visual Analogue Scale (VAS) was used to determine pain complaints of the lower limb.

Results: The range of motion (ROM) of the hip and knee joints was comparable between the injured and uninjured leg, regardless of the nailing technique. Correlation between ROM and the final outcome scores was found to be fair to moderate. Even years after surgery, 17% of the patients still reported moderate to severe pain. A substantial correlation was observed between VAS and the patient-reported outcome scores. The most significant predictor of functional outcome was pain in the lower limb.

Conclusions: Our findings suggest that the ROM of hip and knee returns to normal over time, regardless of the nailing method used. However, pain in the lower limb is an important predictor and source of disability after femoral shaft fractures, even though most patients achieved good functional outcome scores.

Antegrade and retrograde intramedullary nailing are the popular methods used in the management of femoral shaft fractures. Disadvantages of antegrade nailing of the femur include the risk of injury to the hip abductors or its nerve supply,[1] the risk of heterotopic ossification about the hip[2,3] and implant-related pain.[4] These complications can be avoided using retrograde nailing. This technique has been advocated in cases of polytrauma; ipsilateral pelvic, acetabular, tibial and femoral neck fractures; bilateral femur fractures; and obese and pregnant patients.[3–8] Retrograde nailing involves a transarticular approach and may result in complications of the knee, including infection, damage to the articular cartilage and persistent knee pain.[3,4,9]Multiple studies of both techniques have demonstrated comparable union rates and low rates of infection and malunion.[3,4,10–13] Only a few studies have investigated the functional outcome of patients undergoing intramedullary nailing of femoral shaft fractures. In these reports, the main focus has been postoperative muscle testing. These studies suggest that musculoskeletal deficits may last for years.[14–16]

The purpose of this retrospective cohort study was to evaluate the long-term functional outcome after intramedullary nailing of traumatic femoral shaft fractures by using one generic and three disease-specific patient-reported outcome measures. We further determined predictors of these functional outcome scores.

Materials and methods

In this retrospective study, patients with a traumatic femoral shaft fracture AO/OTA (Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association) type 32 A–C were included. Between January 1996 and December 2007, 158 patients were treated with antegrade and 95 patients with retrograde intramedullary nailing. All nails were inserted without reaming. The patients were evaluated with clinical and radiological examinations at 6 weeks, and at 3, 6, 9, 12 and 18 months postoperatively. Data from serial clinical and radiographic examinations were reviewed by two authors (MEM and EHV).

* Corresponding author at: Department of Traumatology University Medical Center Groningen, Hanzeplein 1, BA 13, 9700 RB Groningen, The Netherlands. Tel.: +31 50 361 28 76; fax: +31 50 361 17 45.
E-mail addresses: m.el.moumni@chir.umcg.nl (M. el Moumni), e.h.voogd@student.rug.nl (E.H. Voogd), h.j.ten.duis@chir.umcg.nl (H.J. ten Duis), k.w.wendt@chir.umcg.nl (K.W. Wendt).

0020–1383/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.injury.2012.03.011

We enrolled only adult patients, aged between 18 and 65 years. Additional inclusion criteria were a minimal follow-up of 1 year, and a healed fracture. Only patients with a femoral shaft fracture but no other injuries to the lower limbs or pelvis were included. Exclusion criteria were a pathologic fracture, bilateral femoral fractures, insufficient follow-up data and a history of previous trauma to the lower limbs. This study was approved by our institutional review board, and all patients included in the study gave their informed consent.

Once included and contacted, the patients were invited for a follow-up visit. Parameters that were retrieved included age, sex, mechanism of injury, associated injuries, injury severity score (ISS), side of fracture, AO/ATO type of fracture, location (proximal, middle or distal third) of fracture, degree of soft-tissue injury, in-hospital complications, used nail and method (antegrade or retrograde nailing). Range of motion (ROM) was measured by a goniometer using the neutral-0-method. Angular malalignment was measured radiographically and was defined as $>10^{\circ}$ angulation. Rotational malalignment was determined clinically and defined as $>10^{\circ}$ malrotation. Axial malunion was present if limb length discrepancy was present of >2 cm.

We defined non-union as failure of clinical and radiological healing at 1 year. The clinical criteria to define a healed fracture were the absence of pain or tenderness at the fracture site with weight bearing. Radiographic criteria used to assess healing of the fracture were defined as cortical bridging callus on at least three of the four cortices on the anteroposterior and lateral radiographs.

Patient-based functional outcome assessment was obtained with four functional outcome questionnaires. The Short Musculoskeletal Functional Assessment (SMFA) is a validated general functional outcome measure used to assess outcome for a variety of musculoskeletal disorders.[17] The SMFA consists of the dysfunction index, which has 34 items for the assessment of patient function, and the Bothersome index, which has 12 items for the assessment of how much patients are bothered by functional problems. The score is a dysfunction measure in which 0 indicates normal function and 100 reflects maximum dysfunction. The Harris Hip Score (HHS) is a disease-specific test used to provide an evaluation system for various hip disabilities and methods of treatment.[18] This observational assessment tool gives a maximum of 100 points and the items include pain (44 points), function (47 points), ROM (5 points) and deformity (4 points). A total HHS below 70 points is considered a poor result, 70–80 fair, 80–90 good and 90–100 as excellent. The (Dutch) Western Ontario and McMaster University Osteoarthritis Index (WOMAC)[19,20] is a disease-specific, self-administered health measure developed to study patients with arthritis of the hip or knee. The index contains the domains of pain, stiffness and physical function. We calculated standardised total scores and subscores for pain, stiffness and function, all potentially ranging from 0 (worst score) to 100 (best score). Originally designed for assessment of ligament injuries of the knee, the Lysholm knee score[21] has been used for a variety of knee conditions.[22,23] The Lysholm knee score, a disease-specific health measure, evaluates functional disability of the knee using the items instability (25 points), pain (25 points), locking (15 points), swelling (10 points), stair climbing (10 points), squatting (5 points), limp (5 points) and the use of support (5 points). The overall score ranges from 0 (worst score) to 100 (best score). The visual analogue score (VAS; 0–10 cm) is used to determine pain in the lower limb (0 = none, 1–3 = mild, 4–6 = moderate and 7–10 = severe).

Statistical methods

Categorical variables were summarised as frequencies. Continuous data were expressed as mean and standard deviation. Mann–Whitney test was used to evaluate differences with regard to the functional outcome scores between dichotomous variables. Differences between the injured and uninjured leg were analysed using Wilcoxon signed-rank test. Spearman's correlation coefficient was used to assess the association of continuous variables (age, ISS, ROM of the hip and knee and VAS) with the patient-reported functional outcome questionnaires. According to the method of Landis and Koch[24] correlation coefficients of 0–0.20 represent slight agreement, 0.21–0.40 fair, 0.41–0.60 moderate, 0.61–0.80 substantial and >0.80 almost perfect agreement. A two-tailed p-value of <0.05 was considered significant.

In order to account for possible confounding with other variables, we also performed a multivariable linear regression analysis, using the forward method. The number of explanatory variables that can be included in the multivariable linear regression analysis is limited by the sample size of this study. Instead of entering all potential explanatory variables, we selected only those that were either significant or nearly significant ($p < 0.10$) in the bivariate analysis.

Results

Of the 79 patients who met the study criteria, 16 patients could not be contacted, three were unwilling to participate and one died during follow-up. Thus, 59 (75%) were available for final evaluation with an average time to follow-up of 7.8 years (see Table 1). The antegrade- and retrograde-treated patients were comparable with regard to age, sex, mechanism of injury, associated trauma, ISS, side of fracture, number of open fractures and AO/OTA type of fracture. The incidence of complications did not differ between these patients, and there were no cases of infection. At the time of union, there was no patient with an angular or rotational malalignment of $\geq 10^{\circ}$. An angular deformity between 5 and 10° was seen in seven patients (five antegrade and two retrograde nails). None of the patients had a limb length discrepancy of >2 cm.

The ROM of the hip of the injured leg was comparable to the uninjured leg (Table 2), regardless of the nailing technique used. The mean knee flexion of the affected leg was similar to the unaffected leg ($p = 0.21$). However, the mean knee flexion in the antegrade group was 143° and in the retrograde group 132 ($p = 0.012$). Extension deficit of more than 5° was observed in only one patient (retrograde group).

The scores on the patient-reported outcome measures are presented in Table 3. Between the two nailing groups, there were

Table 1
Patient and injury characteristics.

	Antegrade group, $n = 40$	Retrograde group, $n = 19$	p-Value
Time to follow-up (months)[a]	100 (46)	82 (30)	0.073
Male/female	28/12	17/2	0.19
Mean age (years)[a]	34 (12)	37 (11)	0.26
Side (R/L)	23/17	8/11	0.40
Cause			0.085
Traffic	33	19	
Other	7	0	
Injury severity score[a]	15 (9.3)	13 (5.3)	0.27
Associated injuries			0.16
Head	16	4	
Spine	2	2	
Thorax	7	7	
Abdomen	5	1	
Upper extremity	12	7	
Open fractures	4	2	1.0
AO/OTA type			0.26
A	24	8	
B	14	8	
C	2	3	

[a] The values are given as the mean with the standard deviation in parentheses.