SCIENTIFIC ARTICLE

The outcome of antegrade intramedullary nail fixation of traumatic diaphyseal fractures of the femur in a tertiary care trauma center in Sri Lanka

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Abstract

Introduction

We evaluated the outcome, functional recovery, and complications of intramedullary nailing for fractures of the femoral shaft fractures.

Methods

A prospective observational study was conducted at the National Hospital of Sri Lanka. Patients with isolated femoral shaft fractures undergoing intramedullary nailing were followed up prospectively to assess the factors associated with better functional recovery (measured by Harris Hip Score (HHS) and Western Ontario and McMaster University osteoarthritis index (WOMAC)).

Results

Of 46 patients, the median age was 40(IQR=26-59) years. Majority had simple (n=34,73.9%), closed (n=39,84.8%) fractures while seven (15.2%) had Gustilo Type I open fractures. Surgery was performed at a median of 9.5(IQR=6-14) days after the injury. Approximately two-thirds of the patients required reamed nailing (n=30,65.2%). Three patients developed surgical site infections. X-rays obtained at four months demonstrated features of non-union in 13(28.3%). Leg length discrepancy (LLD) was present in 16(34.8%), and rotational deformity in one patient. Full and partial weight-bearing at six weeks was achieved in six and 23 patients respectively while 17 patients were unable to bear weight. The median HHS and WOMAC at four months were 66.5 and 36, respectively. Patients with proximal or distal diaphyseal fractures, female patients and those with full weight-bearing six weeks showed the best WOMAC index.

Conclusion

Proximal or distal diaphyseal fractures, female sex and ability to bear weight at six weeks post-surgery were associated with better functional outcomes at four months postoperatively. Surgeons should be mindful of the limitations of resource-poor settings which could affect the surgical outcomes.

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Introduction

Antegrade or retrograde nailing is the gold standard treatment for diaphyseal fractures of the femur [1, 2] which enables the patient to have early active joint mobility, early weight-bearing, excellent union rates and minimal risk of surgical site infections [2]. Locked intramedullary (IM) nailing with reaming provides better healing conditions even in comminuted fractures compared to un-reamed femoral nailing, femur plating or external fixation [3]. However, patients undergoing antegrade IM nail fixation for diaphyseal fractures of the femur show significant negative functional outcomes in a time-dependent manner [4]. Persistent hip pain, joint stiffness, limited walking distance, and difficulty climbing stairs due to pain and limp is often reported [2, 5]. The leg length discrepancy (LLD) is often associated with IM nailing in segmental and comminuted fractures of the femur,[6] which contributes significantly to poor outcomes [7, 8].

Knowledge of surgical outcomes and functional recovery trends is imperative to strategize clinical management and optimize cost-effectiveness [9]. For an instance, decisions on the choice and timing of surgery, rehabilitation protocol, timing of initial weight bearing and nail removal could be made based on functional recovery patterns, which are variable in different populations [10-12]. Given the diverse cultural norms, high patient load and limited facilities in the surgical centres in developing countries [13, 14], there is a necessity for customized feasible and cost-effective management protocols to achieve reasonable clinical outcomes. Nonetheless, prospective studies to examine the clinical outcomes of intramedullary nailing for femur shaft fractures in developing countries are sparse, and the reported prevalence of the said complications is controversial [15]. Moreover, the factors associated with better clinical outcomes are not well established. Therefore, our objective was to determine subjective and objective outcomes, functional recovery patterns, and complications of antegrade intramedullary nailing for femoral shaft fractures at the National Hospital of Sri Lanka.

Materials and methods

An Institutional Review Board-approved prospective observational study (AAJ/ETH/COM/2021) was conducted in adults (age >18 years) with AO type 31A1, 31A2, 31A3 and 32B2 unilateral single femoral diaphyseal fractures who underwent reamed and unreamed intramedullary nail fixation antegrade in three orthopaedic units at the National Hospital of Sri Lanka (NHSL) from April 2019 to April 2020. Patients with AO type 32B3 and 32C fractures (complex patterns: fragmented wedge fractures and multi-fragmentary), distal diaphyseal fractures with supracondylar extension, proximal diaphyseal fractures with trochanteric extension, ipsilateral neck and shaft fractures, and segmental fractures were excluded from the study. Patients who had open fractures with a Gustiolo 1b or higher score, pathological fractures, other associated musculoskeletal or systemic injuries, history of surgical interventions to lower extremities or previous deformity causing functional disability were also excluded.

Fifty-six consecutive patients who met the criteria were invited to the study. Of them, eight were referred to local hospitals for follow-up and two patients defaulted clinic visits, allowing a total of 46 patients to be analyzed in this study. All patients underwent antegrade reamed or unreamed intramedullary nailing through stranded piriformis entry with both dynamic and static proximal locking. Surgeries were performed by second/third-year registrars or senior registrars under the supervision of consultant orthopaedic surgeons. Surgeries performed by medical officers were excluded from the study. The patients were followed up at six weeks, three months and four months post-operatively, and details of hip and knee joint pain thigh/fracture site pain, limp and torsional problems were recorded. The pain was assessed using the 'pain subscale' of the Harris Hip Score (HHS) (see below for details) [16]. The passive range of motion at the hip joint and knee joint were examined, and the limb length discrepancy was determined by measuring the distance between the anterior superior iliac spine and the medial malleolus. Hip and knee joints were placed at 900 flexion and the rotational malalignment was measured by a goniometer. All the above-mentioned measurements were obtained by a single observer (third-year registrar in orthopaedic surgery) three times and the arithmetic mean was calculated. Postoperative radiographs were used to identify evidence of callus formation and possible heterotrophic calcifications at the end of four months. Radiograph assessment was performed by a third-year registrar in orthopaedic surgery under the supervision of a consultant orthopaedic surgeon. The hip function was objectively assessed using HHS four months after surgery. The HHS is a valid and reliable questionnaire [17, 18] which is frequently used to evaluate pain and disability of the hip joint following intramedullary nailing for femoral shaft fractures [5]. HHS is scored from 0 to 100 in four domains: pain (44 points), level of functioning during daily activities (47 points), presence of deformity (4 points) and range of motion of the joint (5 points). A total HHS below 70 points is considered poor, 70-80 fair, 80-90 good, and 90-100 excellent outcome [19]. Western Ontario and McMaster University osteoarthritis index (WOMAC) was used to assess the postoperative functional outcome four months after the surgery [20]. WOMAC has been used extensively to assess the hip and knee functions in patients with lower limb osteoarthritis, lower limb fractures and joint replacement studies [20]. WOMAC is scored from 0 to 96 in three domains: pain (20 points), stiffness (8 points) and physical function (68 points) where lower scores reflect a better functional outcome.

IBM SPSS version 26 and GraphPad Prism 8 were used for data analysis. Continuous data were presented as the median and interquartile range (IQR) unless specified. Mann-Whitney U and Kruskal Wallis tests were used to compare continuous data between two and multiple groups respectively. $P<0.05$ was considered significant.

Results

The median age of the patients was 40 (IQR=26-59) years. Male to female ratio was 1.7:1. The majority had sustained simple (n=34, 73.9%), closed (n=39, 84.8%) fractures while seven (15.2%) had Gustilo type 1 open fractures. Mid-shaft fractures (n=29, 63.0%) were found more frequently than distal (n=13, 28.3%) and proximal (n=4, 8.7%) shaft fractures. The surgery was performed at a median of 9.5 (IQR=6-14) days after the injury. Approximately two-thirds of the patients had reamed nailing (n=30, 65.2%). Spinal anaesthesia was the commonest mode of anaesthesia (n=24, 52.2%), followed by general (n=17, 37.0%) and combined spinal epidural (n=5, 10.9%) anaesthesia. The median duration of the surgery was 195 (IQR=140-240) minutes. All the patients received three doses of intravenous Cefuroxime 1.5 g 8 hourly.

Three patients developed surgical site infections; two superficial and one deep tissue infection. The latter healed after two debridements of the wound. At six weeks post-operatively, 18 patients complained of anterior hip and thigh pain whereas 28 patients complained of anterior knee pain in addition to hip and thigh pain. A leg length discrepancy (LLD) was present in 16 (34.8%), with a median value of 1.25 (0.5-1.5) cm. A 360-degree rotational deformity was found in a patient at six weeks postoperatively and revision surgery was performed. X-rays obtained at four months showed evidence of early callus formation in 33 (71.7%) while 13 (28.3%) showed nonunion features. Static screw removal was performed in nine (19.6%) patients. Full and partial weight bearing at six weeks was achieved in six and 23 patients,

respectively, while 17 patients were kept non-weight bearing. At four months of follow-up, 25 (54.3%), 15 (32.6%) and four (8.7%), respectively, complained of pain at the fracture site, hip and knee. Furthermore, knee stiffness was present in three (6.5%) patients. The median HHS and WOMAC at four months were 66.5 (59.0-72.3) and 36 (21-73), respectively.

Mid-shaft fractures were associated with poor WOMAC scores compared to proximal and distal fractures [W=10.763, p<0.005]. Patients with full weight bearing at six weeks [W=21.051, p<0.001] and female patients [U=350.5, p<0.05] showed the best functional outcomes as measured by the WOMAC index. While the site of fracture [W=6.803, p<0.05] and the weight-bearing status at 6 weeks [W=23.409, p<0.05] were associated with the HHS score at 4 months, the sex of the patient showed no significant associations with the HHS. Furthermore, reamed versus unreamed fixation, closed versus open (Gustilo 1) fractures, the timing of surgery and age of the patients were not associated with HHS or WOMAC scores.

Discussion

Although the incidence of femur shaft fractures in Sri Lanka is unknown, it has become a considerable burden for the young and old. Being a leading tertiary care hospital in the country, the National Hospital of Sri Lanka manages a high patient load with femur fractures every year. In this study, we evaluated the clinical outcomes of IM nailing for fractures of the femur shaft in our unit over a period of one year.

The surgery was performed at a median of 9.5 (IQR=6-14) days after the injury where none of the patients received early fixation (<24h post-injury). Delayed fixation is reported to be associated with high in-hospital morbidity and mortality [21, 22]. However, given the limited resources, it is nearly impossible to offer early fixation for isolated femur shaft fractures in our setting. The median operating time of our study (195 minutes) was also comparatively longer than the reported durations for antegrade nailing (71 to 116 minutes) [2, 23-25] probably due to poor resources such as the limited availability of the C arm for surgeries. However, the rate of surgical site infections (3 out of 46) was comparable to the previous studies [23, 24].

The reported time to the union for antegrade nailing is approximately three months (98 days) [2]. Conceivably, 70% of our cohort showed radiological evidence of healing in four months following surgery. Of 13 patients with X-ray evidence of nonunion at four months, nine underwent dynamization by static screw removal. The majority (12) of the patient with delayed or non-union had reamed nailing while only one patient had un-reamed nailing. He was offered exchange nailing at 4 months, which is an excellent option for aseptic nonunion [26] due to its higher union rates and better comparable healing times compared to dynamization [27].

LLD is a common complication after IM nail fixation for comminuted fractures [6]. In our study, LLD was only present in 16 patients (34.8%), with a median of 1.25 cm. The majority of them had comminuted fractures (75.0%) resulting in shortening of the affected limb. Braton et al. reported 12 shortenings of more than 1 cm in a review of 203 fractures [28] demonstrating that routine use of static screws can avoid dramatic limb shortening [28]. Herscovici et al. reported that, despite being a common complication, most LLDs are less than 1.5 cm and functionally irrelevant [6]. None of the patients with minor LLD was offered corrective surgery due to the high patient load in our setting; instead, LLD of 15mm to 20mm started weight bearing with a shoe raiser. The rotational deformity occurs frequently after IM nailing, and, fortunately, will not always cause complaints. We report a 360-degree rotational deformity in a patient that was corrected in revision surgery. Braten et al reported an incidence of 20.90% of torsional deformity (>150) in 110 patients who had IM nailing for femur fracture but only 3.3% needed corrective surgery [28].

The study demonstrated a reasonable functional recovery four months after surgery in terms of HHS (a median score of 66.5), which is comparable to the HHS reported in an Indian study (68.67) four months after the antegrade nail standard piriform approach [29]. Many studies suggest early weight bearing can be allowed almost immediately after the surgery in stable fractures [28]. Arazi et al reported that patients with comminuted diaphyseal femur fracture who were treated with statistically locked reamed intramedullary nailing found no major complications following early weight bearing within 1 to 2 weeks after the surgery apart from slight bending of locking screws [30]. Here, we report early weight bearing 6 weeks after the surgery, [W=23.409, p=.000] was associated with a better functional outcome with higher HHS at four months after the surgery.

Pain in the hip joint, knee joint or thigh is the commonest complaint after IM nailing, which might result in adverse consequences such as delayed weight bearing, poor fracture healing, joint stiffness and poor compliance in postoperative physiotherapy. Pain could be due to the nail itself, the locking screw, heterotopic bone formation at the entry site or a soft tissue scar [28]. In a study by Braten et al., 30% of the patients reported hip pain and 54% complained of thigh pain at the end of four months of recovery, while twenty-one (45.5%) claimed that pain avoided them from having required weight bearing and joint range of movement [28].

Patients who complained of thigh pain after four months of surgery had radiological evidence of proximal or distal locking screws that impinged on soft tissues or were thin with clinically prominent distal screw heads. Prominent proximal and distal locking screws, especially when they are not fully inserted or when there is little overlying subcutaneous tissue lead to significant distal locking site pain [31, 32]. Therefore the careful selection of the length of the locking screw is essential to avoid protrusion and irritation of soft tissue [31]. Although in the Sri Lankan context it is not routine practice to remove IM nails, current evidence encourages such practice, especially in younger patients with significant pain [28].

In conclusion, proximal or distal diaphyseal fractures, female sex and ability to bear weight at six weeks post-surgery were associated with better functional outcomes four months after intramedullary nailing for femur shaft fractures. However, ante-grade IM nailing of the femur is associated with significant hip and fracture site pain within four months of surgery which can result in unsatisfactory post-operative recovery and rehabilitation. Surgeons should also be aware of the limitations of resource-poor settings that could affect surgical outcomes.

All authors disclose no conflict of interest. The study was conducted in accordance with the ethical standards of the relevant institutional or national ethics committee and the Helsinki Declaration of 1975, as revised in 2000.

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