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Distal Fracture Fragment Malrotation in Patients of Diaphyseal Tibial Fracture with Intramedullary Nailing

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Abstract

Background: Rotational malalignment after intramedullary tibial nailing is a very frequent finding which is rarely addressed in any orthopaedic studies. Development and progression of degenerative changes in knee and ankle joints may be an undesirable consequence especially due to rotational mal malalignment. The purpose of this study is to determine tibialmalrotation in cases of diaphyseal tibial fractures with intramedullary nailing.

Materials and Methods: Seventy patients (62 males and 8 females) with tibial diaphyseal fracture were included in this study. The mean age of the patients was 28.5 ± 12.5 years. All fractures were manually reduced and fixed using standard intramedullary nailing technique.Bilateral limited computerized tomography was used to measure the tibial rotational malalignment. A differencegreater than 10° is defined as malrotation between both tibia.

Results: 21 (30%) patients had malrotation of more than 10°. in 8 cases malrotation was greater than 15°. Good orexcellent rotational reduction was achieved in 60 % of the patients. There was no statistically significant relation between AO tibialfracture classification and fibular fixation and malrotation of greater than 10°.

Conclusions: we need a precise method to evaluate the rotational malrotation intraoperatively to prevent the problemConsidering the high incidence rate of tibialmalrotation following intramedullary nailing.

Keywords: closed intramedullary nailing, rotational malrotation, plumb line

Introduction

Fractures oftibia diaphysis area are among commonlong bone fractures.[1] Treatment inthese cases is to attain rapid union with acceptableaxial and rotational alignment, while initial bone lengthis preserved.[2] Several studies have shown superior outcomes and less complication associated with that tibial nailing compared to those obtained with openreduction and internal fixation (ORIF), external fixation,or nonoperative treatment in case of closed stable orunstable fractures.[3,4] Also, for most open tibial shaft fractures intramedullary (IM) nailing isthe most common method of fixation.[5] Closed techniques using indirect reductionin an injured limb can be challenging and cause higherrates of malalignment.[6]Tibialmalrotation is the anatomical twist of the proximalversus distal articular axis of the tibial bone in the transverse plane around the longitudinal axis.[7,8] Any change in the tibial torsion, either

in the internal or inthe external direction, is considered a malrotation and can be seen after fixation of the tibial shaft fractures by closed IM nailing.[4,9]Rotational malalignment after IM tibial nailing is rarely specifically addressed and most clinical studies havemeasured axial malalignment using plain radiography. There is not enough accurate information about theincidence and severity of tibialmalrotation after IMnailing.[4,6-8]In many studies, tibial malrotation has been measuredclinically and the incidence is reported to be 0–6%;[6] whereassuch incidence is reported to be 22–36% by using othermeasurement methods such as computerized tomography(CT) scanning.[4,9]To date, several methods have been described to measuretibial torsion,[4,6,8-12] and CT scan is the investigation ofchoice with good inter- and intra-observer reliability andrepeatability.[4]The purpose of this study was to determine the incidenceand severity of tibialmalrotation using CT scan in aconsecutive series of patients who underwent closed reamedIM nailing for diaphyseal fractures. To our knowledge, thereis only few similar previous study not sufficient to draw conclusion that has assessed tibialmalrotation in a consecutive series of patients.[4]

Materials and Methods

This study was performed from december 13, 2019 to June 30,2019. A total of 70 patients (62 males and 8 females)with tibial mid-diaphyseal fractures, who were admittedand underwent closed IM nailing, were enrolled in thisstudy consecutively. Exclusion criteria were fresh or old contralateral tibial fracture, previous ipsilateral tibial fracture, ipsilateral proximal or distal tibial fracture, fractures extendingto knee or ankle joints, multiple trauma, and pregnancy. Thestudy was approved by the ethical committee and a writtenconsent form was signed by all the patients.All of the fractures were manually reduced and operatedwithin 7 days. Under spinal or general anesthesia, and insupine position, the fractures were fixed by the parapatellar approach. The fractures were stabilized with two interlockingscrews on each side of the fracture. All of the operationswere performed by the same surgeon.A limited (few cuts) bilateral CT scan imaging wasperformed before each patient was discharged. A standardmethod similar to previous studies was used to determinetibial torsion.[4,6,7,9] In supine position, both legs were gentlystrapped together to minimize the movement. CT scanimages were prepared from 3–4 axial cuts in the proximaland 3–4 axial cuts in the distal part of tibia. Proximal cutswere taken 2–3 mm above the proximal tibiofibular jointand distal cuts were taken just proximal to the tibiotalararticulation. The proximal reference line is a line drawn as tangent to posterior tibial cortex in the cut just proximalto the fibular head. The distal reference line is a line thatconnects the tibial and fibular centers in the cut just proximalto the tibial plafond. The torsion angle is the angle betweenperpendicular lines to two reference lines.The unaffected side was used as the control. Malrotationwas defined as torsional difference greater than 10° betweenthe fractured and unaffected sides. Positive values wereconsidered as external rotation and negative values asinternal rotation. The intra-observer reliability determinedin a pilot study was 0.75 approximately

Results

The mean age was 28.5 ± 12.5 years (range 17–60 years).37 cases had injured their right tibia and 33 cases hadinjured their left tibia. Based on the AO (ArbeitsgemeinschaftfuerOsteosynthesefragen) fracture classification, 34 fractureswere AO type A, 24 AO type B, and 12 AO type C. All fractureswere closed. 55 fractures were caused by motor vehicleaccident, 10 by falling from a height, and 5 were theresult of fights. In all cases, tibial fracture was associated withfibular fracture. However, fibula was

not fixed in 58patients.In 10 cases, fibula was fixed by plate and screws. All these10 cases had very distal tibialfractures. The mean torsional difference between the two tibiae was8.2 ± 5.3° (23° external rotation to 18° internal rotation).21 (30%) patients had malrotation of more than 10°.Malrotation was greater than 15° in 9 (11.6%) cases. Basedon the classification described by Johner and Wruhs,[13] theresults were excellent (0°–5°) in 27, good (6°–10°) in 21, fair(11°–20°) in 19, and poor (>20°) in 3 cases. In other words, good or excellent rotational reduction was achieved in 70%of the patients. In the current study, we did not find anystatistically meaningful relation between AO classificationand fibular fixation, with malrotations greater than 10°($P<0.05$) [Table 1].

Discussion

To date, there is no clear definition of tibial torsion in the literature.[9]Mikulicz and Le Damany defined it as arotation of the proximal versus the distal articular axis inthe transverse plane,[10] which is currently used by severalauthors. Torsional malalignment following closed IM nailing for tibial fractures has been reported in several studies.[4, 7, 9]However, the incidence and severity of tibial malrotation after IM nailing is not well documented. Also, definition ofan acceptable range of deformity is contradictory.[4] Usually,shortenings greater than 1 cm and angular or rotationaldeformities greater than 10° are considered to be malunion.[4]Malrotations after using the locked tibial nails are rarelyreported.[7]It is believed that rotational malalignment(>10˚) ofthe lower extremity can affect knee and ankle jointsbiomechanics and consequently leads to developmentand progression of degenerative changes.[14] Some studieshave documented the clinical association betweentorsional malalignment of tibia and osteoarthritis of kneeand ankle, patellofemoral instability, patellar compressionsyndrome, pes planus, and gait abnormalities.[4,6,8,9,15] Anyof these conditions can seriously decrease the qualityof life.[4,6] Also, two separate studies by Puno et al. and Jend et al. reported that tibial malalignment is associated with poor functional outcomes.[8,16] Despite these reports, there are several other studies that found no or poor correlation between malunion and osteoarthritis. Vander Schoot et al.[17] and Bonnevialle et al.[18] demonstratedthat there was no correlation between tibialmalrotation and arthrosis. Probably the lack of a reliable and standard technique forclinical or radiographic assessment of tibial torsion contributes to the difficulty of accurately detecting this condition.4Velazcoet al.,[19] Court‐Brown et al.,[20] and Puno et al.[16] reported 0, 3,and 1 cases of clinically detected malrotation after tibial IM nailing in groups of 50, 125, and 51 patients, respectively. Alhoet al. defined rotational malalignment as a difference greaterthan 15° between normal and injured tibiae, and reported two cases with malrotation after IM nailing of 93 tibial fractures.[21]Williams et al.,[22] Krishan et al.,[23] Freedman and Johnson,[24]O'Dwyer et al.,[25]Pintore et al.,[26]Lambiris et al.,[27] and Tuet al.[28] also reported similar findings. In a study of 21 patientswith closed tibial shaft fractures treated with unreamednailing, Krettek et al. reported 15% clinically detected malrotation.[29]Detecting tibial malrotation clinically is very difficult and occultproblems in many patients may lead to underestimationof the extent of the problem. In 1949, Hutter and Scott described the radiographic method using X‐rays to measurethe torsion11 which is a more accurate method compared toclinical investigation. Since then, several techniques have beendescribed. In 1980, Jakob et al. described a method using CTscanning.10 Jend et al. proposed a similar method in 1981.[8]Currently, CT is the gold standard for quantifying the torsionwith excellent accuracy, and good inter‐ and intra‐observerreliability and repeatability.[4, 8, 10, 30] there are few studies which measured tibial malrotation following IM nailing. Prasad et al. measured tibial torsionin 22 patients with tibial diaphyseal fractures treated with closed IM nailing. They found a difference of 8° or greater in8 (36%)

patients.[9] In a study by Bonnevialle et al., torsionalabnormalities and length discrepancies after diaphyseal tibial fractures were measured in 89 patients using the CTscanning method. They found that in 73% of the patients,the rotational alignment in fractured and intact limbs wasthe same, but the mean difference between injured andintact limbs in the remaining 27% of patients was 6.84°.[18]Also, Poluski et al. determined the incidence and severityof torsional malalignment in 25 consecutive patients with tibial shaft fractures who underwent reamed IM nailing Jafarinejad, et al.: Malrotation following intramedullary nailing in tibial fractures315 Indian Journal of Orthopaedics | May 2012 | Vol. 46 | Issue 3CT scan. Their results revealed a mean absolute differenceof 6.7° between injured and uninjured tibia. They foundfive cases with more than 10° malrotation.[4]In the presentstudy, we found 18 (30%) patients with malrotation of more than 10°. Incidence of tibial malrotation in our studyis similar to that reported in previous studies. These findingssuggest that current methods of intraoperative assessment of tibial torsion are not efficient, and it is crucial to developnew methods for accurate intraoperative measurement. Clementz and Magnusson described a method for measuring tibial torsion intraoperatively using fluoroscopy.They compared the rotational alignment of the knee in atrue anteroposterior view with that of the ankle in a truemortise view.[12] Although, they have shown good accuracyand repeatability of this method, there is no report ofpractical use of this technique yet. We believe that our study had an acceptable samplesize, but it was performed during a short period of time. A clinical and biomechanical long term followup studyon the malrotated group would be helpful to improveour insight about the effects of tibialmalrotation on thepatient's gait and quality of life.

Conclusion

Tibial malrotation following IM nailing is a commonfinding. Postoperative CT scanning is the gold standard formeasurement of the torsion, but the need for a method toevaluate the torsion intraoperatively is greatly felt. In thisway we will be able to prevent malrotation and subsequent knee and ankle joint degeneration.

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