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THE EARLY OUTCOME OF SURGICAL TREATMENT OF CLOSED TIBIAL DIAPHYSEAL FRACTURES BY CLOSED REAMED INTRAMEDULLARY LOCKED NAIL

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ABSTRACT

Background: Tibial diaphyseal fractures are one of the most common long bone fractures encountered by orthopedic surgeons, treated by different modalities, the use of intramedullary nailing which has gained acceptance but it still a challenging procedure. **Objective:** To find out the early outcome of treating tibial diaphyseal fractures with intramedullary nail system and assess the advantages and complications associated with the use of tibial locked nailing. **Patients and Methods:** A total of 50 patients with closed tibial diaphyseal fracture were treated with closed intramedullary interlocking nail at Al-Jumhoori teaching hospital from January 2019 to June 2020, with regular follow-up for 6 months. The patients were evaluated clinically and radiologically for fracture union and complications, functional outcome was assessed using Johner and Wruhs criteria. **Results:** Of the 50 patients, 35(70%) were males and 15(30%) were females. The mean age of the patients was (38.02±14.28). Average time to union was 20.52 weeks Wound infection was developed in 3(6%) of patients. Most common complication was anterior knee pain which was found in 13(26%) of cases. The overall functional outcome was excellent and satisfactory in 80 % of cases. **Conclusion:** Intramedullary interlocking nail is a reliable and effective treatment for most closed tibial diaphyseal fractures with good biological stabilization, short term outcome and minimal complications.

KEYWORDS: Closed tibia fracture, Locked intramedullary nail.

INTRODUCTION

Among all the bones in the body, the one that is considered to be most commonly fractured is the tibial bone.[1] Due to its relatively subcutaneous location, it is exposed to frequent injuries.[2] This factor along with a poor blood supply makes the treatment challenging.[3] Because of the high prevalence of complications associated with tibial fractures, management is often difficult and the optimum treatment method remains controversial. Management of the fractured tibia requires the widest experience, greatest wisdom and the best of clinical judgment in order to choose the most appropriate treatment for a particular pattern of injury.[4] Among the various modalities of treatment such as conservative gentle manipulation and use of short leg or long leg cast, open reduction and internal fixation with plates and screws, intramedullary fixation including intramedullary nails, and interlocking intramedullary nails with or without Reaming, and External fixation techniques, surgeon should be capable of using all these techniques and must weigh advantages and disadvantages of each one and adapt the best possible treatment.[5] The best mode of management should be determined by considering the morphology of the fracture, the amount of energy imparted to the extremity, the mechanical characteristics of the bone, the age and general conditions of the patient, and most importantly the status of the soft tissues.[6] Three important factors to be considered for the better outcome of the management of tibial fractures are prevention of infection, the achievement of bony union, and the restoration of function.[6] Immobilization in a plaster cast has been used most commonly in the past, but it does not always maintain the length of the tibia and it leaves the wound relatively inaccessible.[6] Open reduction and internal fixation with plates and screws has yielded unacceptably

high rates of infection. This method may be selected with more severe or local injuries associated with displaced intra articular fractures of knee and ankle.[7] External fixation, considered the treatment of choice by many traumatologists, has the disadvantages of bulky frames and frequent pin tract infections, non-unions, and mal-unions.[7] Intramedullary nailing, locked or unlocked has become an attractive option since image intensifier has made closed intramedullary nailing possible. Nail is a load sharing device and is stiff to both axial and torsional forces. Closed nailing involves least disturbance of soft tissue, fracture haematoma and natural process of bone healing as compared to other forms of internal fixation.[8] The history of intramedullary nailing for the treatment of long bone fractures is long and storied.[9] During the mid-1800s through the first decade of the1900s, most of the work in intramedullary nailing appear to revolve around the use of ivory pegs.[10] During World War II, Gerhard Küntscher is credited with the first use of an intramedullary rod, also known as an intramedullary nail (IM nail) or Küntscher nail without proximal or distal fixation for soldiers with fractures of the femur.[11] The exuberance that accompanied the advent of compression plating for tibias and femurs in the 1960s quickly diminished in the 1970s and, thus, a renewed interest in refining closed nailing techniques appeared. While there was certain progress as far as nail design and materials is concerned during the 1990s; the major advancements came with the expansion of indications for unreamed and reamed intramedullary nailing.[11] Design achievements of the 1990s included the introduction of new titanium nails, cephalo-medullary devices such as the Gamma nail, and retrograde supracondylar intramedullary nails such as the Green- Seligson-Henry nail.[11]Although stainless steel was used for older IM nails, titanium has several advantages, including lower mechanical failure rates and improved biocompatibility.[12] Initially intramedullary tibial nails were reamed nails. They were unlocked nails and maximum stability was gained from broad contact between the nail and the endosteal surface of the tibia. This was facilitated by reaming the endosteal surface so that a large diameter nail, often measuring 14 mm or 15 mm, could be inserted. With the introduction of locked nailing, stability was radically improved but concern was expressed about the effects of reaming on the endosteal blood supply.[13] However there was a considerable debate about the advantages and disadvantages of reaming particularly as research indicated that reaming increased the periosteal blood flow.[14] The original Küntscher nail was designed in the form of a slotted clamping sleeve. Its introduction into the reamed medullary cavity stabilizes the fragments by creation of radial and longitudinal stresses. Interfragmentary compression was only possible for axial loading and was only applicable to particular types of fracture in the diaphyseal midthird. Torsional deformities were not addressed.[15] Modern intramedullary implants that are cannulated nails with a correspondingly small diameter can be inserted in both reamed and unreamed technique. The choice of a suitable intramedullary procedure should provide maximum possible stability and cause minimal damage to the blood supply. According to AO principles, intramedullary nailing is a method of internal splinting of the diaphysis that leads to relative stability at the fracture site. The fracture heals by way of callus formation.[15]

PATIENTS AND METHODS

This prospective case series study was carried out at Al-Jumhoori teaching hospital from January 2019 to June 2020. A total of 50 patients, 35 are males and 15 females were selected according to inclusion and exclusion criteria. Adult aged from 20 to 60 years, Closed transvers and short oblique diaphyseal tibia fractures and Duration of fracture (less than 2 weeks) were included in this study, while Open fracture, Pathological fracture and Patients with chronic debilitating disease or alcoholic and those refused to participate or not completed the duration of follow up of the study were excluded from this study. After fitting in the inclusion criteria of the admitted patient, a thorough history was elucidated, physical examination performed and investigation carried out. Verbal and written consents were taken from each patient before participation in the study. Specially designed questionnaire was constructed for the purpose of data collection for each patient and followed up after two weeks, six weeks, three months and six months postoperatively. The collected data included socio-demographic characteristics, site of injury, mechanism of injury, operative time, time to union and any post-operative complications. All the patients were sent for pre-operative investigations including complete blood count, viral screen test (HIV,HBS,HCV and COVID 19). The patient was operated under spinal anesthesia or general anesthesia, Prophylactic intravenous antibiotic injection was used for all patients which was 3rd generation cephalosporin (ceftriaxone one vial 50 mg/kg intravenous) with respect to any associated drug allergy in every patient, within 1hour before anesthesia, for patients had allergy to cephalosporin group and they received aminoglycoside (gentamicin injection 6 mg/kg/day single dose only) instead. The patient was placed in supine position. The injured leg was positioned on a radiolucent adjustable “A” frame with the knee bent at 90 degrees and the leg draped free Fig. (1), Intraoperative fluoroscopy is brought in from the opposite side. Radiographic visualization of the tibia, with true anteroposterior and lateral views of the knee, tibial shaft, and ankle must be obtainable. Vertical patellar tendon splitting incision of about 5 cm long was made over the skin extending from center of the inferior pole of the patella to tibial tuberosity Fig. (2),


Fig. (1): Knee bent at 90 degrees and the leg draped free. Fig. (2): Longitudinal incision.

The curved bone awl was used to breach the proximal tibial cortex in a curved manner. The awl should be aligned parallel to the tibial crest Fig. (3) Image intensification can be used to confirm the starting point. The starting point must be just medial to the lateral tibial spine Fig. (4), After insertion of the awl, a T-handled reamer with distal anterior curve is inserted into the tibia Fig. (5). The reamer is positioned in line with the crest of the tibia and force on the distal reamer tip is directed anteriorly to maintain the reamer in the canal. The reamer is then removed and a ball tip guide wire is inserted into the tibial diaphysis Fig. (6). Appropriate manual traction and manipulation is then undertaken to align the tibia and allow the guide wire to pass across the fracture site and into the distal tibia. Care must be taken to place the ball tip into the center of the plafond on both the anteroposterior and lateral fluoroscopic views to maintain proper alignment of the tibia while reaming Fig. (7). Sequential reaming is then done in 0.5 mm increments, and over reaming by about 1 - 1.5 mm. is probably indicated. Preoperative templating may be done from radiographs to ensure that the appropriate nail size is present in the operating room but the definitive nail length is measured from the guide wire Fig. (8).


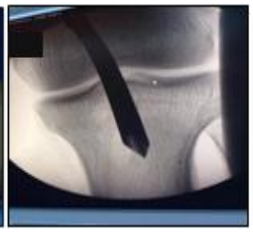
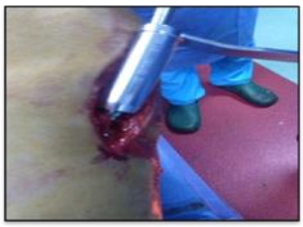


Fig.(3) Fig.(4) Fig.(5) Fig.(6)

Fig. (3) The awl is parallel to tibial crest. Fig. (4) Confirmation of starting point. Fig. (5) T- handled reamer Fig. (6) A ball tip guide wire is inserted.


Fig.(7) Fig.(8)

Fig. (7) The ball tip into the center of the plafond. Fig. (8) Nail length is measured from guide wire.

The nail is mounted on a handler and inserted into the tibia over the guide wire Fig. (9). Once the nail is inserted, fluoroscopic checkup of the overall alignment and position of the fracture and the nail should be done Fig. (10). We use one or two proximal cross screws, these are inserted through percutaneous incisions using the proximal cross screw locking jig Fig. (11). Image intensifier is used to insert the distal cross screws using a freehand technique Fig. (12 a,b). If the fracture site is distracted, the distal screws can be inserted first and then used to reduce the distal fragment to the proximal one.

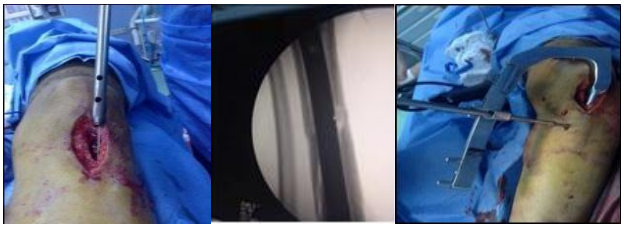

Fig. (9) Fig. (10) Fig. (11)

Fig. (9): Introduction of tibial nail. Fig. (10): Fracture reduction check up by fluoroscopy Fig. (11): Proximal screw locking jig.

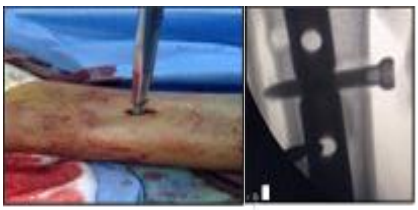

Fig. (12 a,b)

Fig. (12 a,b): Insertion of distal screws (free hand technique).

Postoperative care Active knee, ankle and toe mobilization is started when patient recovers from anesthesia. All the patients in our series were allowed non weight bearing standing on the 1st post op day except in 2 patients who had associated upper limb fractures. Antibiotics were continued for 3-5 days and sutures were removed on the 11th or 12th postoperative day. partial weight bearing with crutches walking/walker was commenced depending upon the type of fracture, rigidity of fixation, and associated injuries. Further follow up was done at six weeks, three months and six months postoperatively Fig. (13), and each patient was assessed clinically and radiografically according to the standard performa, The study was approved by the scientific council of orthopedic surgery of the Arab board for medical specializations and permission was obtained from directorate of the health of Mosul (DOH). A verbal and written consent were obtained from each participant before being enrolled in the study. Data were analyzed using statistical package for social science (SPSS) version 19 computer software. Chi-square test was used to compare between proportions. P value ≤ 0.05 was considered statistically significant.

Fig. (13): Pre and post-operative x ray.

RESULT

A prospective case series study was performed on 50 patients with closed tibial shaft fracture presented to the orthopedic department of Al-Jumhoori teaching hospital. Follow up evaluation was performed on the patients in time period from January 2019 to June 2020. The current study included patient with a mean age of 38.02 years ±14.28 SD. The study included 35(70%) male and 15(30%) females with male to female ratio of 2.33: 1. Transverse fracture was found in 32(64%)of fractures while short oblique fracture was found in 18(36%)of the study sample. The current study revealed that 19 (38%) of patients had middle third tibial fracture, proximal third fracture was found in 17 (34%) of patients while distal third fracture was found in 14 (28%) of patients. Regarding mechanism of injury, the present study revealed that 27 (54%) of patients were subjected to RTA, 18 (36%) of patients had history of fall from height, while only 5 (10%) of patients had history of sport injury(contact) Table 1.

Table 1: Socio-demographic characteristics of patients in the study sample.

Variable	No.	%
Age(yrs.) mean ± SD 38.02±14.28		
Gender		
Male	35	70.0
Female	15	30.0
Type of fracture		
Transverse	32	64.0
Oblique	18	36.0
Level of the fracture in tibial shaft		
Proximal	17	34.0
Middle	19	38.0
Distal	14	28.0
Mechanism of injury		
RTA	27	54.0
FFH	18	36.0
Sport(contact)	5	10.0
Total	50	100.0

The results of study revealed that the mean operative time was 103:34 minutes ± 20.44SD. The present study showed that the minimum time to union was 17 weeks while the maximum time was 36 weeks, the mean time to union of the study sample was shown to be 20.52 weeks ± 3.59 SD. Table 2.

Table 2: Operative time & time to union of the study sample.

Operative time in minutes	No.	%
Operative time(min) mean ± SD 103.34±20.44		
≤90	15	30.0
>90	35	70.0
Duration period of union of fractures		
Time to union(weeks) mean ± SD 20.52±3.59		
≤20 weeks	28	56.0
>20 weeks	22	44.0
Total	50	100.0

Regarding complications Table 3, the result of the study showed that 1 (2%) of the 50 patients developed superficial infection (entry site) which was treated by daily dressing and oral antibiotics for one week and 2 (4%) of cases developed deep infection which was treated by debridement and culture specific antibiotics for about six weeks. Anterior knee pain was found in 13 (26%) of cases at three months which was decreased to 6 (12%) at six months follow up. Passive and active movements of the knee joint was begun in the immediate postoperative periods, return of functional range of movements in the knee was measured at six months postoperatively and it was <80% of the range of normal side in all patients but one who needs physiotherapy . The result of the current study showed that two (4%) of the patients developed delayed union Fig. (14).

Fig. (14): Delayed union.

Table 3: Complications seen during treatment in the study sample.

Variable	No.	%
Infection		
Superficial	1	2%
Deep	2	4%
Anterior knee pain		
3 months	13	26%
6 months	6	12%
Knee range of motion		
≥80%	49	98%
>80%	1	2%
Delayed union	2	4%

According to Johner and Wruhs method the results of the study showed that 19(38%) of cases had excellent results, good results were shown in 21(42%) of patients. Fair results were shown in10 (20%) of cases. There was statistically significant difference p<0.001 between excellent and good results regarding return to previous functional activities or not, table 4.

Table 4: Distribution of no. and percentage of the assessment by Johner and Wruhs' method for the study group for return to previous activitiesor not.

Variable	Over all		Returned		Did not returned		P value
	No.	%	No.	%	No.	%	
Excellent	19	38	19	66.7	-	-	<0.001
Good	21	42	7	33.3	14	58.3	
Fair	10	20	-		10	41.7	
Poor	0	0	-		-		
Total	50	100.0					

DISCUSSION

Intramedullary nailing of closed tibial shaft fractures has been associated with high rates of radiographic and clinical success, but the use of this procedure hasn't become widely accepted for distal metaphyseal fractures.[16] The mean age of cases in the present study was 38.02 years ±14.28 SD. Other studies had similar age distribution as of this study. Signer and Kllan.[17] had

an average of 36 years in their study of 43 tibial fractures. The present study revealed that 35(70%) of patients were male and 15 (30%) of patients were females. This goes with the study conducted by Bonatus et al [(18)] which showed a sex distribution of 52(73%) men and 19(27%) women in their study. The current study revealed that the major mechanism of injury was road traffic accidents, accounting for 27(54%) of cases, those who sustained fracture after a fall were 18(36%) patients and 5(10%) of cases sustained fracture due to sport injury. This goes in hand with the study conducted by Bonnevialle et al.[19] on 38 patients studied there were 25(65%) motor vehicle accidents, 8(22%) falls and 5(13%) sports accidents. The current study revealed that the mean operative time was 103:34 min ± 20.44 SD which is slightly longer than that in a study conducted by Yu T et al.[20] which was 91.9 min; this may be due to more experience with IM system by them. The present study revealed that 48(96%) of cases got union within 26 weeks postoperatively. This is comparable to the study conducted by Court- Brown et al.[21] which showed union rate of 95%. The mean time to union in the current study was 20.52 weeks which goes with study conducted by Bone et al.[22] in his analysis which showed mean time to union of 19 weeks. But it was longer than that observed in a study conducted by Al alqawy et al.[23] which was 13.2 weeks. The present study revealed that 1(2%) of cases developed superficial infection and 2(4%) of cases developed deep infection. This is comparable with the results obtained by Al alqawy.[23] who observed an infection rate of 7% in his series on 56 patients. While it was higher than the infection rate observed by Shuler [(24)] which was 1%.This may be attributed to a better sterilization technique used by Shuler. Out of the 50 patients, 13(26%) had knee pain at three months which was decreased to 6(12%) at six months. This goes in agreement with Al alqawy.[23] in his study where he observed a moderate knee pain in his series in about 26.7% whereas Court-Brown.[21] reported that knee pain was worse in younger patients and frequently required nail removal. In this study 1(2%) of cases reported restricted knee range of motion at six months postoperatively which necessitated physiotherapy, this is comparable to the result observed by Habernek.[25] who showed a restriction in knee range of motion in 1.8% of cases. The results of the study revealed that 2(4%) of cases developed delayed union, but at last both of them got union within 36 weeks. The results are higher than that reported by Toivanen.[26] where he reported 0% of delayed union in his comparative study in 2002. Karladani et al.[27] reported 20% delayed union in his study which is higher than that in the present study. According to Johner and Wruhs criteria, the present study showed that the majority (80%) of cases showed excellent and good results, fair results were showed in (20%) of cases. Furthermore, there was statistically significant difference $P < 0.001$ between excellent and good results regarding return or not to the previous activities. This is comparable with the results observed by Nascimento et al.[28] in their study where 76.7% of the cases showed excellent and good results. Limitation of our study was relatively small sample size, short period of the study and a single center experience.

CONCLUSIONS AND RECOMMENDATIONS

The study has proved that reamed intramedullary locked nailing is a good option for treatment of most closed tibial shaft fractures. Patients treated with intramedullary locked nailing can return to their past usual activities in a reasonable time without assistance. It is familiar procedure with minimal complications that lead to union in almost all cases. The current study follow up period is relatively short, longer period of follow up and larger sample of patients are necessary to study the overall results and complications in more details.

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