Original Article

Comparison of functional and radiological outcomes of lower third closed tibia fractures treated by nail VS plate osteosynthesis

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Objective: To determine the functional and radiological outcomes of lower third tibia closed fractures fixed by nail or plate osteosynthesis.

Methodology: This randomized controlled trial included 20 patients presenting with closed fracture lower third tibia in Al-Kindy teaching hospital, Baghdad, Iraq. The patients were divided as every other one into two equal groups; group I had fractures fixed by 3.5 mm locked plate and group II by intramedullary locking nail. We followed all patients for 24 weeks to assess surgical complications, fracture union, alignment and functional outcome based on Knee society score (KSS).

Results: The mean union time in both groups was 10.2 ± 1.48 and 9.3 ± 1.77 weeks, respectively (p = 0.003). Mean KSS in both groups has no significant difference (p = 0.002). Mean union time in females in the group I was higher than that of males with a significant difference (p = 0.045). In contrast, the mean KSS in males was significantly different (p = 0.017) than females. The age of the patients correlated with union time in both groups.

Conclusion: Both methods are good option for fixing distal lower tibia fracture regarding the union time. No significant difference was noted in both groups in the functional outcome. Female fixed by plating may have a delay in union time and lower functional score than male.

Keywords: Lower third tibial fracture, intramedullary nailing, plating osteosynthesis, Knee society score.

INTRODUCTION

Tibial fractures are usually closed one whileopen types account for 23.5%, spiral fractures (AO-type 42-A1) account the higher percentage reaching 34%,with incidence from 16.9 to 22 per 100 000 patients annually.[1] Soft tissue state is paramount important with the assessment of the neurovascular state including the compartment syndrome.[2] Closed tibia fractures with minimum soft tissue injury are usually managed conservatively, although external skeletal fixator can be used as a temporary or definitive technique of fixation.[3]

Operative fixation of the tibia fractures by plate and screws is frequently relatedto postoperative infection, dueto meager soft tissue covering, thus plate fixation is commonly kept for metaphyseal fractures when difficult to control by IMNs.[4] We can reduce the plating tibia complications by using minimally invasive percutaneous plate osteosynthesis and thus minimal affect with the fracture biology similar way to that of IMN. Other disadvantages of plate fixation as compare with IMN is delay weight bearing after surgery due to plate metal fatigue as it load-sharing devices.[4]

Locked intramedullary nailing is usually regarded as the best method for fixing closed unstable tibia shaft fractures despite some relative contraindications like knee arthrodesis, knee arthroplasty, tibia deformity, or narrowing tibia canal < 7 mm, with control rotation stability by two sets of screws fixation above and below to the fracture.[5]

The common complications of IMN are anterior knee pain, delayed union, mal-union, non-union, nail or screws failure, and infection.[6] Malalignment commonly in distal third tibia fractures, because the metaphyseal flare does not give a comfy endosteal adequately with low cortical nail contact. IMN doesn't affect the periosteal blood supply, permits load bearing postoperatively, minimal soft tissue dissection, and is thus regarded as the standard method for fracture shaft tibia.[7] The aim of this study was to determine the functional and radiological outcomes of lower third tibia closed fractures fixed by nail or plate osteosynthesis.

METHODOLOGY

This randomizes control comparative prospective study was done in the orthopedic unit at Al-Kindy Teaching Hospital, Baghdad. The study was approved by the Al-Kindy College of Medicine and all patients gave written informed consent. The study included patients with isolated closed distal third tibia fractures (fractures more than 5 cm from the ankle mortise) during the period from October 2020 to April 2022. We included patients ages between 18 – 45 years old from both sexes, closed

isolated distal third tibia extraarticular fracture 43-A. While open, pathological, multiple, bilateral, previous fractures, or fractures associated with vascular injury were excluded from the study.

On admission to the emergency department, patients were evaluated through history, physical examination, and radiologically by AP and lateral view X-rays for the entire leg. For all patients, the limb was immobilized by applying a back slab above the knee joint with an elevation of the limb and observed for compartment syndrome.

A total of 20 patients were divided randomly every other one into 2 groups. Group I: 10 patients the fractures fixed by plate osteosynthesis and Group II: 10 patients fixed by an intramedullary locking nail. The surgical procedure is done under general or spinal anesthesia according to anesthetist's decision after patient assessment. A single dose of prophylactic antibiotic was given within 1 hour before surgery.

We followed our patients for six months for the assessment of clinical function (pain with standing and walking, range of motion, stiffness, and daily activity achievement), fracture union and alignment by AP, and lateral radiographic imaging of the entire tibia with the knee and ankle joints at 2,6, 12 and 24 weeks. In the group I, partial weight-bearing began after 10 – 12 weeks, while in group II started after 2 – 3 weeks. The radiological union appears within 8 – 12 weeks in both groups (dynamization of the nail was done after radiological appearances of the callus). Functional outcome was measured at the final follow-up based on Knee society score (KSS).[8] Union occurred after 10 weeks in both groups by clinical examination and radiological assessment.

Statistical Analysis: Data were analyzed by SPSS version 25 and Microsoft Excel 2016 using descriptive statistics. Continuous variables are expressed and mean and standard deviation (SD) and analyzed with Student t-test. Binomial variables are expressed as frequency and percentage and analyzed with Chi square. Pearson's correlation was used to explore the possible correlation between age of the patients and union time and KSS in each group. In this test, the correlation coefficient (r) value ranges from -1 to +1, which indicates negative and positive correlation, respectively? A $p<0.05$ was considered statistically significant.

RESULTS

Mean age of patients in the plate osteosynthesis group (group I) was 29.2 ± 9.5 years (range 18 – 45) which did not differ significantly (p = 0.460) from that of the intramedullary nail group (group II) mean age of 26.7 ± 4.52 years (range 19 – 32). Males represented 80% and 90% of patients in plate osteosynthesis and intramedullary nail groups, respectively with no significant difference (p = 0.531). In the plate osteosynthesis group, 60% of injuries were due to MVA while 40% were due to FFH. On the other hand, 80% of injuries in the intramedullary nail group were attributed to MVA, and the other 20% were due to FFH (p = 0.628) (Table 1).

According to radiological findings, the mean union time in the plate osteosynthesis group was 10.2 ± 1.48 weeks (range 8 – 12) compared with 9.3 ± 1.77 weeks (range 7 – 12) in intramedullary nail groups with no significant difference (p = 0.232). Mean KSS in the plate osteosynthesis group was 76 ± 6.14 (range 65 – 85) which was comparable to that of the intramedullary nail group (mean 79 ± 7.0, range 65 – 90) with no significant difference (p = 0.322) (Table 1).

Mean union time in females in the plate osteosynthesis group was 12.0 – 0.0 weeks, which was higher than that of males (9.75 ± 1.28 weeks) with a significant difference (p = 0.045). While the mean KSS in males in the plate osteosynthesis group was 78.13 ± 4.58 compared with 67.5 ± 3.54 in females with a significant difference (p = 0.017). Although, females had higher KSS scores than males in the intramedullary nail group (90.0 ± 0.0 vs. 77.78 ± 6.18) the difference was not significant (p = 0.700). On the other hand, the mechanism of injury seems to have no significant impact on union time or KSS score (Table 2).

In the plate osteosynthesis group, age had a strong positive correlation with union time (r = 0.844, p = 0.003) and strong negative relation with KSS score (r = -0.836, p = 0.003) as shown in Table 3. In the intramedullary nail group, age had also a strong correlation with union time (r = 0.833, p = 0.003).

Table 1: Dermatological distribution with union time and KSS.

Group	Gender		Mech.		Mean Age	Union Time Weeks	KSS
	Male	Female	MVA	FFH			
I	80%	20%	60%	40%	29.2 ± 9.5	10.2 ± 1.48	76 ± 6.14
II	90%	10%	80%	20%	26.7 ± 4.52	9.3 ± 1.77	79 ± 7.0

Table 2: Association of gender and mechanism of injury with union time and KSS score.

Variable	Plate Osteosynthesis (Group I)		Intramedullary Nail (Group II)	
	Union Time (Weeks)	KSS	Union Time (weeks)	KSS
Gender				
Male	9.75 ± 1.28	78.13 ± 4.58	9.56 ± 1.67	77.78 ± 6.18
Female	12.0 – 0.0	67.5 ± 3.54	7.0 ± 0.0	90.0 ± 0.0
p-value	0.045	0.017	0.154	0.097
Mechanism of injury				
MVA	9.67 ± 1.51	76.67 ± 7.53	9.5 ± 1.77	78.13 ± 6.51
FFH	11.0 ± 1.55	75.0 ± 4.08	8.5 ± 2.12	82.5 ± 10.61
p-value	0.174	0.700	0.507	0.461

MVA: Motor vehicle accident, FFH: falling from a height

Two patients in group I presented with hardware irritation during ankle plantar flexion and dorsiflexion, and one patient with superficial wound infection during follow-up. This patient was treated conservatively with a twice-daily dressing and parenteral antibiotic with one g of ceftriaxone twice daily for one week then the infection resolved.

In group II, two patients presented with anterior knee pain during full flexion of the knee joint, these patients were treated conservatively with an oral non-steroidal drug (diclofenac sodium 50 mg twice daily). There was no malunion, delay union, or hardware failure during the period of follow-up. Statistically, there was no significant difference in both groups regarding the complications.

Table 3: Correlation of age with union time and KSS score.

Variable	Plate Osteosynthesis Group I		Intramedullary Nail Group II	
	r	p-value	r	p-value
Union time	0.841	0.003	0.833	0.003
KSS	-0.836	0.002	-0.450	0.192

DISCUSSION

The mean age of our patients was 29.2 ± 9.5 years in the plate osteosynthesis group and 26.7 ± 4.52 years in the intramedullary nail group, which was similar to Majid et al[9] and lower than Al-Sharaa et al,[10] with male predominance, similar to above studies. MVA was the dominant causes of this fracture in our study followed by FFH, which is similar to Majeed et al[9] and Al-Sharaa et al.[10]

No significant difference in fracture shaft tibia regarding the union time and functional score when fixed by plate osteosynthesis or IMN in our study. In a Turkish study, Seyhan et al,[11] found no statistically significant difference in union time, malunion, and nonunion rates in two groups. In Saudi Arabia, Ali et al,[12] a study on 60 patients reported no significant difference between both techniques in union time or functional score. Both techniques were found to be useful and effective, and preoperative planning is the keystone to deciding which implant is chosen, similar result obtain by Guo et al.[13]

A meta-analysis[14] included 10 randomized controlled trials with a total of 782 patients and found no significant variation in both methods of fixation in terms of radiation time, return to work, union time, or functional scores. Another meta-analysis including 16 studies with a total of 1140 patients reported no significant difference in both methods in the functional score and union time.[15] Almost similar results were reported by other studies.[16]

On the other hand, some clinical trials reported superiority for one method over the other. Yang et etl,[17] reported a significantly shorter union time in the nail fixation group than the plating group. Similarly, a meta-analysis showed a higher rate of mal-union in the nail group.[18] However, this study included a relatively high number of older studies, and different nail design and surgical procedure techniques. However, improvement of the mechanical stability can be improved by insertion many screws distally.

These variations among different studies could be explained by the fact that union complications related several factors other than implant alone, like opened fractures, soft tissue injury, bone loss, infection, smoking, and fixing the fibula fracture or not.[19] Furthermore, different studies use different functional

scores and this may have an impact on the outcome of each study.

Many previous studies reported a variation in the incidence of complications between the two methods. Joveniaux et al,[20] reported about 29% patients developed complications in the PO patients' group. In another study, there were statistically significant complications in PO as compared with IMN groupsin deep and superficial infections and soft-tissue irritation and authors attributed the delicate blood supply and thin soft-tissue coverage of the tibial to rendering this area susceptible to wound problems.[21]

Another study confirmed that IMN may be chosen to PO for fixing distal tibial metaphyseal fracture due to lesser incident infection postoperatively infection.[22] IMN treatment could be an advantage in fixing the distal tibial fracture due to minimal vascularity and soft tissues disruption and stimulates the callus formation by micro-motion action.[20]

A study performed in the USA,[23] recorded a late infection incidence of 15% in patients with PO fixation for distal tibial fractures, and about half of the patient's plate was detached due to skin impingement. Another problem associated with PO was implant irritation, due to the great contour of anatomically tibia plates.[24] In fixing the distal tibial metaphyseal fracture, IMN is associated with several complications like mal-reduction and mal-union,[17] with a high percentage of mal-union than percutaneous locked plate.[22]

This difference between the present study and other studies is mainly attributed to the small number of patients in our study which limits the statistical comparison. The rate of wound complications depends on numerous additional factors apart from the surgical procedure including the general condition of patients, skin contamination, surgical theater room, and the length of the operation.[16] Regional variation similarly plays a role in this regard. In a geographical analysis stratified by region, Yu et al,[15] showed that, in non-Asian areas, no difference significantly in both methods of fixation in the rate of infection, may be present other factors affect the outcome results.

In our study, females and older ages had a significant association with delayed union time and lower KSS. Clinical studies evaluating differences in fracture healing according to gender aresomewhat rare and outcomes are difficult to interpret, because of other encouragement factors, like degree of soft tissue injury, type of fracture, body mass index of the patients, and degree of osteoporosis.

This study has many limitations. First, the sample size was small, which cannot allow the generalization of the results. Second, limited period of follow, up which could not permit evaluation of long-term complication and return to work.

CONCLUSION

The intramedullary nailing and plating osteosynthesis are good option for fixing distal tibial fractures regarding the union time, also there is no significant difference in the functional outcome measure by KSS. Female gender treated with plating osteosynthesis may have a delay in union time and lower functional score compared with males.

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