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Comparative Study of Management of Acute Tibial Shaft Fracture with Intact Fibula Using Interlocking Nail With and Without Primary Fibulectomy

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Abstract:

Isolated Tibial shaft fractures with intact fibula are common injury accounting for about 20-22% of tibial diaphyseal fracture with high rate of, delayed union, and non-union. To assess the efficacy of primary partial fibulectomy in treatment of isolated tibial shaft fractureThis study was conducted on 40 patients who had isolated tibial shaft fracture with intact fibula in adults divided in to 2 groups.Group I (20 cases): was treated by combind primary partial fibulectomy and interlocking nail.Group II (20 cases): was treated by interlocking nail without primary partial fibulectomy between May 2018 and Septemper 2021. in Benha university hospitals. Results in this study were assessed according to the criteria given by the Association for the Study and Application of the Methods of Ilizarov (ASAMI score) All Fractures in group I united at an average duration of 17.6 weeks while in group II the average duration of union was 23.5 weeks. There is astatistically high significant difference in the union time (P- value = 0.0010**).Non union was observred in 2 cases in group II, one case with hypertrophic non union managed by partial fibulectomy and one case with atrophic non union managed with partial fibulectomy and bone graft. Primary Partial fibulectomy has proved to be a reliable procedure to successfully manage acute tibial shaft fracture with intact fibula and overcome problems encountered in bone healing as delayed union and non union.

Keywords: Isolated Tibial shaft fractures, intact fibula, Primary Partial fibulectomy.

1. Introduction

Isolated Tibial shaft fractures with intact fibula are common injury accounting for about 20-22% of tibial diaphyseal fracture. The incidence of open fractures is approximately 25 % of all tibial shaft fractures. Their severity varies greatly from a low-energy closed undisplaced fracture that unites uneventfully to an open high-energy fracture that is difficult to treat and may result in permanent sequelae for the patient with functional disability, chronic pain or even amputation [1].

A direct, high-energy injury mechanism "considered to be associated with sports or motor vehicle accidents" causes the majority of isolated tibial shaft fractures in younger patients.These injuries frequently result in a displaced fracture pattern as well as significant soft tissue damage. A bending mechanism causes a spiral or oblique fracture, and occasionally a "abutterfly fragment" in sports-related injuries. Indirect, torsional, low-energy injuries are common in elderly individuals. Although these mechanisms normally result in a spiral, nondisplaced fracture pattern with minimal soft tissue damage, in patients with osteoporotic bone, more complex patterns can occur[2]. Conflicting views have been expressed concerning the effect of an intact fibula on a fracture of the tibia, some authors believe that an intact flbula contributes to stability at the fracture site and promotes union. In contrast, other authors believe

that the intact fibula allows lateral angulation and loss of contact of the bone ends with higt rates of delayed union and non union[3].The aim of this study was to assess the efficacy of primary partial fibulectomy in treatment of isolated tibial shaft fracture with intact fibula.

2. Patient and methods

This study was conducted on 40 patients who had isolated tibial shaft fracture with intact fibula in adults divided in to 2 groups.Group I (20 cases): was treated by combind primary partial fibulectomy and interlocking nail.Group II (20 cases): was treated by interlocking nail without primary partial fibulectomy between May 2018 and Septemper 2021. in Benha university hospitals, Orthopedic & Spine hospital in Shebin El- Kom teaching hospital after approval of the ethical committee of the hospital, a written consent was taken from every patient before participation in the study. The Inclusion Criteria included Acute tibial shaft fracture with intact fibula,Adult after closure of tibial physis and.Closed fracture or open grade I or II.The Exclusion Criteria included Fracture with intra-articular extention ,Highly comminuted fractures, Pathological fractures and.Associated ipsilateral lower limb fractures. Preoperative evaluation included a thorough history taking and a thorough clinical examination of the affected limb. Fractures, skin abrasions, burns, ecchymosis, and skin tenting of the surrounding skin and soft tissueswere all recorded and documented .Upon initial presentation, open fractures were identified, and adequate tetanus updates and antibiotics were started.A thorough neurovascular examination was carried out and recorded. In these patients, there was a high suspicion of an associated compartment syndrome, and repeated clinical examinations were performed.

Radiological examination was done using standered trauma survey for high energy injury including cervical, thoraco-lumber x-ray, chest and pelvis x-ray and abdomino-pelvic ultrasound.Anteroposterior and lateral view of affected leg including knee and ankle joints.

2.1. Surgical technique

Position the patient was supine with the knee flexed on a radiolucent table with C-arm of an image intensifier set up opposite to the surgeon. Fracture reduction and reamed intramedullary interlocking nail were done using conventional techniques till distal locking screw insertion.partial fibulectomy was done at mid third of the fibula in group I only.A skin incision was made just

behind the fibular shaft about 15 cm above the lateral malleolus. The internervous plane lying between the peroneal muscles, supplied by the superficial peroneal nerve, and the flexor muscles, supplied by the tibial nerve.

The plane between the peroneals and the soleus began to emerge after deep surgical dissection.A longitudinal incision was made from the periosteum of the fibula to the bone. Muscles originating from the fibula have fibers running distally from proximal to distal toward the ankle. As a result, they were stripped from proximal to distal. To complete the fibular dissection, the interosseous membrane was removed from proximal to distal. Following complete exposure of the fibula, a 2.5 cm fragment was removed from the fibula.Excision of less than 2.5 cm of the fibula may allow the fibula to heal before the tibial union, whereas resection of an excessive length of fibula may cause instability at the tibial fracture site, necessitating the use of a long cast for an extended period of time.

Care must be taken during cutting and removing the osteotomized fibular segment because the peroneal artery and veins lie just behind it and are vulnerable to injury. Before closure, to assure hemostasis; a suction drain was used in some cases. then wound closure was done. Proximal interlocking was performed by placing a single proximal screw in the proximal dynamic hole of the nail.Dynamic locking allows impaction of the fracture (controlled dynamisation). Tissue Closure was done first parapatellar arthrotomy,patellar tendon, subcutaneous and skin closure.

Fig. (1) Excision of 2.5 cm segment from fibula

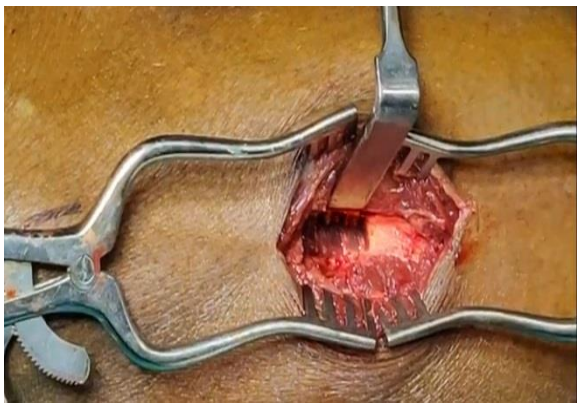

Fig. (2) fibulectomy site.

2.2Postoperative care and rehabilitation:

Toe-touch for four weeks in all patients followed by partial weight bearing when early radiological evidence of healing was noticed then full weight bearing was allowed. Patients was assessed in the out-patient clinic every 2 weeks till union appeared in x-ray and then every one month till sound union occurred. Time to union, knee and ankle range of movement, limb alignment, and any complications were recorded.

Outcomes: The Association for the Study and Application of Methods of Ilizarov "ASAMI score"criteria wase used to evaluate the results of this study, which included both radiological and functional scoring systems.

3.Results:

This study comprised 40 patients with acute tibial shaft fracture with intact fibula in adults (33 male and 7 females). In group I:The mean age of the patients was 36.5 years (range 22 to 55 years, SD 9.66). 13 patients had closed fractures and 7 had open fractures. [Table 1]

Table (1) Demographic data of present study.

Item		Group I	Group II
Age		22-57y(mean **36.5y**) SD **9.66**	23-55y(mean **38.3y**) SD **9.13**
Gender	**Male**	16	17
	Female	4	3
Side	**right**	12	9
	left	8	11
level	**Mid shaft**	14	12
	Distal	6	8
Mode of injury	**High energy**	14	16
	low energy	6	4
Open or closed fracture	**Closed**	13	16
	open	7	4
Type of open fracture	**I**	5	2
	II	2	2

In group II:The mean age of the patients was 38.3 years (range 23 to 57 years, SD 9.13) The right side was affected in 21 patients (52.5%), while the left side in 19 patients(47.5%).16 patients had closed fractures and 4 had open fractures. Most common cause was Road traffic accidents(RTA) or fall from height (30 cases) accounting for 75% followed by self fall, direct blow or workplace injuries(25%).

Patients were followed up for an average of 11 months (range 7–15 months). All Fractures in group I (with fibulectomy) united at an average duration of 17.6 weeks (range 14–21 weeks) while in group II (without fibulectomy) the average duration of union was 23.5 weeks (range 18–29 weeks). There is astatistically high significant difference in the union time (P- value = 0.0010**), duration of full weightbearing (P- value = 0.037711*) and time to return to work (P- value = 0.002437**) between group I and group II of patients. [Table 2]

There is astatistically significant difference in the union time according to age, gender and the level of fracture site between group I and group II . [Table 3]

Table (2) Observation after Intervention (inweeks)

	Group I		Group II		
	mean	**SD**	**mean**	**SD**	**P value**
Duration to partial weight bearing	9.3	0.79	12.2	0.85	0.02728*
Duration to full weight bearing	13.4	1.03	16.6	1.12	0.037711*
Duration to return to work	16	1.37	21.3	1.45	0.002437**
Time of union	17.6	2.41	23.5	2.47	0.0010**

*** significant value** **** highly significant value**

Table (3) Mean Time to union (in weeks).

		Mean Time to union(in weeks)		
		Group I	**Group II**	**P value**
Age	**< 40y**	15.3 weeks	20.7weeks	0.001653**
	> 40y	18 weeks	24 weeks	0.001194**
Gender	**male**	16 weeks	20.3 weeks	0.012074*
	female	17.2 weeks	22.5weeks	0.005522**
Level of fracture	**Mid shaft**	18.5 weeks	23.5 weeks	0.006522**
	Distal	16.7weeks	20.6weeks	0.023926*

*** significant value** **** highly significant value**

Non union was observred in 2 cases in group II, one case with hypertrophic non union managed by partial fibulectomy and one case with atrophic non union managed with partial fibulectomy and bone graft. One case with delayed union in group II which heal

without intervention at 29 weeks by enhanced walking exercise. Superficial infection was observed in 3 cases of group I and one case of group II managed with simple debridement and antibiotics according to culture and sensitivity test.

Pre-operative x ray

2 weeks postoperative

7 months postoperative

Fig. (3) Isolated tibial fracture with intact fibula treated by interlocking nail and primary partial fibulectomy.

4. Discussion

The Association for the Study and Application of Methods of Ilizarov "ASAMI score"criteria was used to evaluate the results of this study, which included both radiological and functional scoring systems. [4].

Radiologically, in (group I) , 17 patients have excellent results with bone union, no infection, good alignment in all planes. 3 patients have good results with bone union and superficial infection . In (group II),16 patients have excellent results,one has good results, one has fair results and 2 have poor results with nonunion. Functionally, in (group I) 18 patients have excellent results (active , No limping. Good range of knee and ankle joints and no reflex sympathetic dystrophy) , 2 patients have good results (active with moderate limp and stiffness of ankle joint<10o dorsiflexion). In(group II), 15 patients have excellent results , 3 have good results, one has fair and one has poor results.

There is alarge debate regarding the effect of intact fibula on the healing process of acute tibial shaft fracture. ***Ranganath et al*** conducted a study of 30 patients with isolated tibial diaphyseal fractures (closed fractures, Type I open fractures, and Type II open fractures) were operated with closed intramedullary interlocking nailing. 7 out of 30 cases went for delayed union which is around 23%. 4 cases

went for non union. He stated that, the main difficulties encountered in the orthopaedic treatment of leg fractures with intact fibula are reduction of the tibial fracture and the high rate of varus malunion, delayed union and nonunion [5].

Madhukar et al conducted a study of 12 patients with isolated tibial diaphyseal fractures were operated with closed intramedullary interlocking nailing. The delayed union was seen in 6 (50%) cases out of which 4 united readily with fibular osteotomy/partial fibulectomy and 2 patients were diagnosed with non-union. He stated that, Fracture tibia with intact fibula are more proven for union-related problems when compared to both bone leg fracture. Partial fibulectomy is an effective intervention in the management of delayed union in isolated tibia fracture[6]. Evren AT et al, conducted a study of 12 patients with isolated tibial diaphyseal fractures were operated with closed intramedullary interlocking nailing. The non union was seen in 3 (25%) cases, Malalignment was observed in one patient (8.3% of cases) [7]. Balaji, et al, conducted a study of 51 patients with isolated tibial diaphyseal fractures 33 closed and 18 open fractures had been operated with intramedullary interlocking nailing. Delayed union occurred in 6 patients (4 open fractures) and non union occured in 3 patients (2 open fractures) [8]. Madhuchandra et al conducted a study of 28patients with isolated tibial diaphyseal fractures were operated with closed intramedullary interlocking nailing He stated that intact fibula in tibial diaphysis fractures treated with intramedullary nailing will not affect rate of union, or lead to loss of reduction, non-union, or malunion[9]. Burçin Karslı et al, conducted a study of 27patients with isolated tibial diaphyseal fractures were operated with closed intramedullary interlocking nailing. He stated that An intact fibula can shorten the healing time; however, it does not have any effect on angulation rates[10].

The majority of researches attribute the increased rate of non-unions in isolated tibial diaphyseal fractures to the intact fibula[11]. The effects of intramedullary nailing and partial fibulectomy on fracture loading were studied using a tibial shaft fracture model.Biomechanical testing was performed on cadaveric lower extremities that were implanted with strain gauges. Only the proximal locking screws were used to place a nonreamed nail into each tibia.Each specimen was tested in six different ways: intact tibia, intact tibia with nail, fractured tibia with nail removed and fibula intact, fractured tibia with nail and fibula intact, fractured tibia with nail and partial fibulectomy, fractured tibia with partial fibulectomy and nail removed. In the intact tibia the anterior cortex was in relative tension compared with the posterior cortex. This tension was raised after transverse fracture of the tibia.and insertion of the nail enhanced anteromedial and anterolateral compressive strains while decreasing posterior strains. The strain patterns were unaffected by doing a partial fibulectomy with a nail in the fractured tibia.These findings support the presence of relative

anterior tension in the intact tibia and show that this anterior tension increases following transverse fracture. The use of an intramedullary nail or a partial fibulectomy increased anterior compressive loading.The clinical success achieved with these treatment modalities could be due to this loading modification. [12].

Nonunion rates range from 1 to 17 percent in cases of isolated tibial diaphyseal fractures. The fibula bears 6–15% of the weight of the lower extremity.Because one of the fundamental features in the healing process is a natural cyclical application of weight bearing forces across the fracture, an intact fibula appears to interfere with the healing of an isolated tibial fracture by inhibiting efficient compression at the fracture site. [13]. After review of literature and according to authers knowledge, this is the first study that evaluate the effect of primary partial fibulectomy in treatment of acute tibial shaft fracture with intact fibula. Acomparative study was done between management of acute tibial shaft fracture with intact fibula using interlocking nail with and without primary partial fibulectomy in 40 patients divided in to 2 groups and the results were very satisfactory according to the criteria given by the "Association for the Study and Application of the Methods of Ilizarov". All fractures in fibulectomy group healed at areasonable duration average 17.6 weeks (range 14–21 weeks) witout delayed union or non union with acceptable alignment in the coronal and sagittal planes. Functionally, all patients were active with no limitation of knee or ankle motion with early return to their daily activity without any problems at the fibulectomy site.

5. Conclusion

Primary partial fibulectomy is technically easy procedure and can be performed by less-experienced surgeons without any problems at the fibulectomy site . it creates optimal mechanical environment by allowing axial compression at the fracture site So bone healing is greatly enhanced. Primary Partial fibulectomy has proved to be a reliable procedure to successfully manage acute tibial shaft fracture with intact fibula and overcome problems encountered in bone healing as delayed union and non union. Closed intramedullary interlocking tibial nailing combined with primary partial fibulectomy should be added to the algorithm for the treatment of isolated tibial diaphyseal fractures as a simple, easy, rapid, and inexpensive method to treat this type of tibial fracture with very good outcome as regard decreasing time to union and decreasing rate of delayed union and nonunion.

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