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Original Research Article

Intramedullary Nail supplemented with Poller screws for proximal and Distal 1/3rd shaft tibial fracture

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Abstract:

Introduction: The most frequent fracture of a long bone is a tibial shaft fracture. The aim of therapy for a shaft tibial fracture is to maintain the length of the initial fracture, accomplish union, and restore both axial and rotational alignment. Fractures of the proximal and distal 1/3rd of the tibia's shaft have higher rates of malunion. The preferred method of managing diaphyseal fractures of the lower limb, however, is intramedullary (IM) nailing. Aim: To evaluate the functional and radiological outcomes of IM nail supplemented with Poller screws for proximal and distal 1/3rd shaft tibial fractures.

Materials and Methods: From May 2020 to November 2021, a prospective, interventional study was carried out at thecollege name. The study included a total of 30 fracture patients between the ages of 18 and 60. For the treatment of the proximal and distal 1/3rd shaft tibial fractures in all participants, IM nails were additionally combined with Poller screws. Ten instances had open fractures (grade I or II according to Gustilo Anderson's complex tibia fracture classification), while twenty cases had closed fractures. Patients were checked on at three weeks, then every six weeks till union. KarlströmOlerud's functional evaluation standards were used to assess patients.The IBM Statistical Package for the Social Sciences (SPSS) software version 23.0 was used to statistically evaluate the data.

Results: In this study, there were 20 (33.3%) females and 40 (66.7%) males, indicating a male predominance. It was found that 40% of the patients were between the ages of 41 and 50. The patients' median age was 34.12 ±5.9 years. According to KARLSTRMOLERUD'S FUNCTIONAL EVALUATION, 36 patients (n=60) in the current study had excellent outcomes, followed by 16 (26.7%) patients who had good outcomes, and 4 (6.7%) patients who had both satisfactory and moderate outcomes. Postoperative complications included shortening of the leg, of which two patients experienced a 0.5 cm shortening, four patients experienced a 10° loss in ankle dorsiflexion, three patients experienced a loss of knee flexion (two patients experienced a loss of 20° flexion and one patient experienced a loss of 15° flexion), six patients experienced a loss of subtalar movement (two patients experienced a 10° inversion loss, three patients experienced a 5° inversion loss, and one patient.

Introduction

The most frequent fracture, which affects about 4% of the elderly population, is a fracture of the tibia's shaft. These fractures are caused by mechanisms with both low and high energy [1]. The goal of therapy for a shaft of tibia fracture is to maintain the length of the initial fracture while achieving union and correcting both axial and rotational alignment. Additionally recommended [2–5] are early patient mobilisation, pain-free weight bearing, and functional range of motion of the knee and ankle joints. The most prevalent cause of proximal tibia fractures, which are those that extend from the articular surface up to 1.5 times the medial to lateral width of the articular surface, is high-velocity trauma. Operative management is preferred because there is a risk of malunion, nonunion, or joint stiffness with conservative management. Higher malunion rates were noted [6], and fractures of the proximal and distal thirds of the tibial shaft continue to be difficult to treat. 5-11% of tibial shaft injuries are non-articular fractures of the proximal portion of the tibia [1]. These fractures typically lead to apex anterior and valgus deformities along with malunion. Similar to this, treating displaced extra-articular fractures of the distal tibia with residual varus, valgus, recurvatum, or procurvatum might be challenging. The distal fragment's tiny size can make it challenging to maintain reduction and implant an appropriate distal locking fixation, with center-centre nail placement crucial in both the proximal and distal pieces [1]. The objectives of surgical management include early functional range of motion of the knee and ankle, establishment of length and rotation, and correction and maintenance of sagittal and coronal alignment. However, intramedullary (IM) nailing is the method of choice for the surgical management of lower limb diaphyseal fractures and is also a treatment option for metaphyseal fractures. The requirement for subsequent treatments to establish union and an increase in malalignment, particularly in the coronal plane, are linked to nailing metaphyseal fractures with a short distal fragment. Due to the long lever arm, metaphyseal enlargement, and epiphyseal-metaphyseal fixation issues, the'standard' practise of IM nailing has limitations in the treatment of metaphyseal fractures, making the reduction and controlling angulation of the shorter bone fragment technically challenging. This might be a result of a misplaced entrance site or a combination of shifting muscle forces and lingering instability [7]. In metaphyseal fractures, a number of treatments have been suggested, including percutaneous reduction clamps, fibular plating, temporary unicortical plating, and blocking screws (Poller screws), to improve the fixation of the nail. Krettek first introduced the "Poller screw" in 1999, which was a metal device similar to those used to block or direct traffic, to prevent axial abnormalities in proximal or distal third tibia fractures after IM nailing. The Poller screw narrows the medullary canal in the metaphyseal area, which makes it easier for the intramedullary nail to fit snugly. As a result, the bone-implant architecture is more stable [7-9]. The proximal and distal third tibial shaft fracture in the metaphyseal region, which was stabilised with locking intramedullary nails and Poller screws, had a significant amount of axial malalignment. Muscular forces that shift the fracture and create instability were the root cause of this [10]. For the repair of long bone fractures, there are few papers that compare the clinical efficacy of Poller screw augmentation to that of IM nail alone. Therefore, the purpose of the current study was to assess how well proximal and distal 1/3rd shaft tibial fractures treated with IM nailing and Poller screws.

Materials and Methods

After receiving approval for the current prospective, interventional study from the institutional research ethics committee via letter number (317-2020), it was carried out at the department of orthopaedics at the college in question from May 2020 to November 2021. The study subjects provided their informed consent. The sample population consists of 40 men and 20 women (a total of 60 fractures) between the ages of 18 and 60 who had IM nailing with Poller screws augmentation for proximal and distal 1/3rd shaft tibial fractures. Twenty patients had open fractures, while the majority (n=40) of the patients had closed fractures.

Inclusion Criteria

The study comprised patients between the ages of 18 and 60 who had closed fractures of both bone legs or open fractures in the proximal and distal thirds of the tibia according to Gustilo Anderson classification 2 [1].

Exclusion Criteria

Patients with proximal tibial fracture fragments less than 7 cm as well as those with displaced fractures along the proximal and distal tibial intra-articular fracture lines were excluded. The study excluded patients with thrombocytopenia and open fractures of both bone legs according to Gustilo Anderson classifications 3A, 3B, and 3C as well as individuals with severely comminuted fractures. Study Methodology The knee was held in a semi-extended posture during the procedure on a comfortable knee rest. Under fluoroscopic guidance, a poller screw was placed on the side opposite the deformity's apex, along the concave border in both the anteroposterior (AP) and lateral views. By using a bone awl, a high entry point was created following patellar tendon retraction at midline. Following the passage of the guided wire to the centre and a fluoroscopic assessment of its position in the AP and lateral views, sequential reaming was carried out. Slowly, while dealing with the Poller screws, a reamed nail of the proper length and diameter was inserted. The nail was locked from both the proximal and distal sides. Poller screws remained in place. Patients were mobilised after surgery on the first postoperative day. Quadriceps exercises, both static and dynamic, were used as part of the physical treatment. Partial weight-bearing (15 to 20 kg) was permitted for six to eight weeks. Depending on the radiographic evidence of bone union and the absence of pain, weight-bearing was then gradually increased.The first follow-up was conducted on the twenty-first day, and after that, one was conducted every six weeks until the union was accomplished. Patients were assessed using the functional evaluation criteria listed in Table 1 by KarlströmOlerud [11,12].

Table 1: Karlström-Olerud's scoring criteria

Parameter	3 points	2 points	1 point
Pain	None	Slight	Severe
Difficulty in walking	None	Moderate	Severe limping
Difficulty in climbing stairs	None	With help	Unable
Difficulty in the sports activity	None	Some sports	Unable
Occupational limitation	None	Moderate	Unable
Skin	Normal	Different colour	Ulcer/fistula
Deformity	None	Mild	Significant
Varus/valgus	0	1-5	>5
Ante/recurvatum	0	1-3	>3
Muscleatrophy (cm)	<1	1-2	>2
Shortening of the leg (cm)	<1	1-2	>2
Movement loss in the knee (°	<10	10-20	

Movement loss in the ankle (°)	<10	10-20	>20
Subtalar movement loss (°)	<10	10-20	>20

Based on the above criteria, points were awarded and tallied to produce the following scores: a score of 36 excellent 35-33: acceptable 32–30 points: acceptable 30 to 27 points: moderate 26–24 points: abysmal From the postoperative X-ray, alignment and deformity were estimated, and the degree of varus/valgus and antecurvatum/recurvatum malalignment was then determined. Varus and antecurvatum angulation were symbolised as positive (+) values. Valgus and recurvatum were symbolised as negative (-) values.

Statistical Analysis

The data was entered in the form of a data matrix in Microsoft Excel® and statistically analysed using IBM Statistical Package for the Social Sciences (SPSS) software version 23.0. Paired t-test were used for comparing mean values.

Results

In this study, there were 20 (33.3%) females and 40 (66.7%) males, indicating a male predominance. It was found that 40% of the patients were between the ages of 41 and 50. The patients' median age was 34.12 ±5.9 years(table 2).

Table 2: Age wise and gender wise distribution of subjects.

Age group (years)	Male n (%)	Female n (%)
10-20	0	0
21-30	12(30)	4(20)
31-40	10(25)	4(20)
41-50	16(40)	8(40)
51-60	2(5)	4(20)
61-70	0	0

The closed reduction approach was used on each subject. Of the 30 cases, 18 required the placement of one more Poller screw to cure the deformity. 38 patients presented within the range of 15 weeks, followed by 20 patients in the range of 16–20 weeks, and only two patients had delayed union >20 weeks. The mean time for fracture union was 16.232.49 weeks. According to KARLSTRMOLERUD'S FUNCTIONAL EVALUATION, 36 patients (n=60) in the current study had excellent outcomes, followed by 16 (26.7%) patients who had good outcomes, and 4 (6.7%) patients who had both satisfactory and moderate outcomes. When compared to the preoperative mean value of +9.01°, the residual mean varus alignment postoperatively was +1.37°. Residual mean valgus malalignment postoperatively was -1.55° when compared to the preoperative mean value of -11.26° (Table 3).

Table 3: Preoperative and postoperative comparison of mean angulation of varus and valgus deformities.

Deformity	Time	N	Mean	SD	t-test	p-value*
Varus deformity	Preoperatively	34	8.06	3.36	7.23	0.001
	Postoperatively	34	1.37	2.2		
Valgus deformity	Preoperatively	26	11.22	3.4	8.78	0.001
	Postoperatively	26	1.65	2.03		

p-value <0.05 was considered statistically significant

Prior to surgery, the mean total varus/valgus deformity was 10.234.32°, and it was 1.432.1° after surgery. According to statistics, there was a significant difference between the two (p-value 0.005) (Table 4). In the current study, 50 patients had valgus and varus following surgery with a mean of 5°, and 10 individuals had both.

Table 4: Comparison of mean angulation of varus/valgus deformities (combined) preoperatively and postoperatively.

Deformity	Time	N	Mean	SD	t-test	P value
Varus/ valgus	Preoperatively	60	10.23°	4.32	11.400	0.001
	Postoperatively	60	1.43°	2.1		
	At union	60	1.63°	2.371		

In comparison to the preoperative mean value of +6.16°, the postoperative mean antecurvatum angulation was +0.14°. In comparison to the preoperative mean value of -7.23°, the postoperative mean recurvatum angulation was -0.21° (Table 5). Preoperatively, there was a 6.225.5° total mean antecurvatum/recurvatum deformity; postoperatively, there was a 0.25.56° difference (Table 6).

Table 5: Measurement of antecurvatum and recurvatum deformities.

Deformity	Time	N	Mean	SD	t-test	P value
Antecurvatum (positive)	Preoperatively	34	6.16	5.23	3.403	0.001
	Postoperatively	34	0.14	0.34		
	At union	34	0.14	0.34		
Recurvatum (negative)	Preoperatively	26	7.23	7.43	3.32	0.005
	Postoperatively	26	0.21	0.65		
	At union	26	0.21	0.65		

Table 6: Comparison of total antecurvatum/recurvatum deformities (combined) preoperatively and postoperatively

Deformity	Time	N	Mean	SD	t-test	P value
Antecurvatum/ recurvatum Deformity	Preoperatively	26	6.22°	5.5	6.43	0.001
	Postoperatively	26	0.25°	0.56		
	At union	26	0.25°	0.56		

Postoperative complications included shortening of the leg, of which two patients experienced a 0.5 cm shortening, four patients experienced a 10° loss in ankle dorsiflexion, three patients experienced a loss of knee flexion (two patients experienced a loss of 20° flexion and one patient experienced a loss of 15° flexion), six patients experienced a loss of subtalar movement (two patients experienced a 10° inversion loss, three patients experienced a 5° inversion loss, and one patient

Table 7: Postoperative complications of the procedure.

Complication	Present	Percentage
Shortening of leg	4	6.6%
Movement loss in the knee (in degree)	6	10%
Movement loss in the Ankle	8	13.33%
Muscle wasting	12	20%
Subtalar movement loss	12	20%

Discussion

66.7% of the participants in the current study were men, compared to 33.3% of the women. The patients in the current study had a mean age of 34.12 5.9 years. Male predominance was also noted in a study by Kulkarni SG et al., with 71.4% of patients being male [13]. Males outnumbered girls by a ratio of 83.3%, according to Kumar A et al., 2020 [14]. In 2020, Hussain T et al. found that 57.1% of tibial shaft fracture patients were male [15]. Closed fractures were present in 66.7% of the patients. The incidence of grade I and II fractures was demonstrated by Kumar A et al. in their study [14].

In the current study, a total of 20 patients—10 of whom were in grades I and II—were included. In this study, there were 26 cases of varus and 34 cases of valgus. The preoperative range for varus to valgus malalignment is +14 to -20°, and the postoperative range is +8 to -7°, with only ten (16.6%) instances having >5° postoperatively. Preoperatively, out of a total of 75 cases, 30 were varus, 10 were neutral, and 35 were valgus in a research by Kulkarni SG et al. [13]. Varus to valgus angles range from +24 to -11o. Only one patient acquired a varus malalignment of +7°, while the majority of the cases, 74, had less than 5° of varus or valgus deformity after surgery. In a different research project by KumarA et al., postoperatively, three patients had >5° varus deformity and 10 patients had 7° [14]. In the present study, ten patients had varus and valgus >5°, and 50 patients had <5° after surgery.

In a research by Kulkarni SG et al., the range of antecurvatum to recurvatum deformity was +8 to -17o [13]. In postoperative cases, there was no deformity in 65 cases and a deformity of 4 to 9 degrees in 7. Preoperatively, there were 75 cases; of those, 28 had recurvatum, 40 had procurvatum, and 17 had a 0° deformity. The antecurvatum to recurvatum deformity range in the current study ranges from +19 to -27o. None of the patients exhibited a deformity greater than 3o after surgery. Similar findings to those of the current study were found in Kulkarni SG et al.'s study [13]. Similar to the current study, 32 postoperative cases in a study by Hussain T et al. had 0°, two had 0-3°, and one had 4° [15].

Table 8: Antecurvatum/recurvatum deformity [13,15]

Study	Preoperative Range	Antecurvatum(+)/recurvatum(-) deformity		
		Postoperatively		
		0	0-3	>3
Present study	+19 to -27º	90%	10%	0%
Kulkarni SG et al., [13]	+8 to -17º	86.7%	9.3%	4%
Hussain T et al., [15	+7 to -16º	91.4%	5.8%	2.8%

In the current study, 6.6% of patients had shortening of the leg, 13.33% and 10% had mobility loss in the ankle and knee, respectively, while 20% of patients had muscular atrophy and subtalar movement loss. Two patients had prolonged antibiotic treatment for a superficial skin infection (oozing purulent discharge from the distal locking skin suture site). No complications were found in a research by Bhangadiya R that dealt with Poller screws [16]. After the removal of the nail, screw, and radiographic union in 60 cases. All patients reported full quadriceps strength, no flexion deformity, and no ligamentous instability. Five patients experienced pain in the anterior knee joint following surgery, and two others experienced superficial infections. These complications were managed by debriding the area's tissue and putting antibiotic-impregnated beads into the affected areas. As a postoperative consequence, anterior knee joint pain was described in eight individuals by Kulkarni SG et al. and superficial infections in four patients. Both conditions were treated by local debridement and the insertion of antibiotic-impregnated beads [13]. Guo J et al. found that enhancing IM nailing with Poller screws resulted in a faster rate of fracture healing when compared to IM nailing alone, reporting nonunion in 0% of cases, malunion in 3%, and the requirement for further surgical treatments in only 3% of instances[17]. The study was completed by all of the patients, and the functional evaluation criteria used by Karlström-Olerud to assess the functional outcome produced findings that supported the findings for radiological and clinical indications of union.

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