Pravara Med Rev; June 2022, 14 (02), 34 – 41
DOI: 10.36848/PMR/2022/60100.51072

Original article

Prospective study of role of poller screw in interlocking nailing of metaphyseal fractures of tibia

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ABSTRACT

Introduction: Fractures of the metaphyseal part of the tibia are among the common fractures encountered in orthopaedic patients. The stabilisation of fractures of the proximal and distal tibia is associated with a high incidence of malalignment.

Aims and objective: To evaluate the use of poller screws as supplement to fixation of metaphyseal fractures of tibia with intramedullary nails and to describe technique, results and complications of operative stabilization of metaphyseal fractures of tibia treated with intramedullary nails and poller screw.

Material and Methods: This prospective study comprised of 42 patients with metaphyseal fractures of tibia at either proximal or distal end or both [segmental] was carried out between 1st april 2016 and 31 August 2017.

Results: Most patients were in the age group of 18-30 years with male predominance. Most patients had fractured their left tibia. 54.3% of the total subjects had closed fractures and 45.7 % had open fractures. 60% of the total subjects had distal fractures, 34.3% proximal tibia fracture and 5.7% segmental fractures involving either proximal or distal part. Pre-operative period of 25 patients showed anterior angulation with varus to valgus ratio of 2:1, while 8 patients showed posterior angulation with varus and valgus malalignment of 7:1. In the intra-operative period, a single blocking screw was sufficed in 28 patients to achieve reduction (80%) while two blocking screws were used in 7 subjects (20% reduction). Postoperatively twenty nine patients (83%) were in the acceptable range of <5°out of which 22 patients had a varus-valgus deformity of <3° and 9 had a varus deformity of 3-5°. Three patients were malaligned to >5° of deformity. Thirty four patients had an antevertum-recurvatum deformity of either equal to 3or less than 3°, and one patient had >5° procurvatum. Functional outcome was excellent in 6 cases (17%), good in 13 cases (37.1%), satisfactory in 14 cases (21.81%), moderate in 1 (2.9%) and poor in 1 case (2.9%).

Conclusion: Interlocking nailing in proximal & distal metaphyseal tibial fractures remains a challenge because of the disproportionate diameter of the intramedullary canal in the metaphysis. Mismatch between the diameters of the nail and the medullary canal, with no nail-cortex contact, the nail may translate laterally along coronally placed locking screws and increased stress is placed on the locking holes to maintain fracture alignment.

Keywords: Poller Screw, Interlocking Nailing, Metaphyseal Fractures

Introduction

Fractures of the metaphyseal part of the tibia are among the common fractures encountered in orthopaedic practice.As being one of the principal load-bearing bones in the lower extremity, fractures of tibia can cause prolonged morbidity and extensive disability unless treatment is appropriate. Although good results are achieved with closed reduction, casting and functional bracing, biological fixation of tibial fractures is an important advancement in the fracture management in which utmost respect is given to soft tissue and vascularity of bone. It can be done through 3 techniques - splinting with external fixators , intramedullary nails and with the use of plate and screw as pure splints.[1,2]

Interlocking nailing is usually used for diaphyseal fractures but it has also been tried for fixation of metaphyseal fractures of tibia. Unlike intramedullary fixation of diaphyseal fractures of tibia, nailing of metaphyseal fractures with a short proximal or distal fragment is associated with an increase in malalignment, particularly in coronal plane. So to improve nailing the metaphyseal fractures vrious other techniques like blocking screws (poller screw), temporary unicortical

PMR P ISSN: 0975-0533, E ISSN: 0976-0164

plating, percutaneous reduction clamps, and fibular plating have been tried with variable success rates. Thus, the present study was carried out to evaluate the use of Poller screws as a supplement to the fixation of fractures of proximal and distal third of tibia treated with intramedullary nails.

Material and methods

After getting approval from Institutional Ethics Committee (IEC), this prospective study was carried out in the department of orthopaedics, Shyam Shah Medical College & associated Sanjay Gandhi Memorial Hospital, Rewa between 1st April 2016 and 31 August 2017. It included 42 adult patients (above 18years age) with open or closed metaphyseal fractures of tibia (grade 1 and grade 2). Patients with pathological fractures, underlying neuromuscular disorders and congenital bone disorders e.g. osteogenesis imperfecta was excluded from the study.

As soon as the patient presented in the department a primary survey was carried out with recording of the vitals and limb assessment for neurovascular compromise. The fractured part was appropriately splinted. Intravenous fluids & blood transfusion (wherever necessary) and analgesics were given. Analgesics were given to relieve the pain. A detailed history was taken, noting down the mode and severity of trauma including any associated head injury, chest or abdominal injury completing the secondary survey. An appropriate radiogragh of the fractured limb (Anteroposterior and lateral view including proximal and distal joint) was taken to know the site of bone involved and type of fracture. Patient with proximal tibia were in particular advised regarding limb elevation and ice fomentation in the wards. Surgery was delayed in patients with severe swelling and compound injuries till swelling subsided and wound healed. In order to achieve wound healing wound debridement and washing with normal saline and antibiotic solutions wherever necessary was done. The patients who completed the aforementioned criteria were registered and their clinical details were recorded in the history sheet.

Preoperative Planning

After haematological investigations were done, pre anaesthetic check-up was undertaken before posting the patient for surgery. A mandatory prewritten informed consent was taken from relatives.

Preoperative preparation of patients:

Patients were kept fasting overnight before surgery. Adequate amount of compatible blood was kept ready for any eventuality. The whole of the extremity of affected side was prepared. when required a systemic antibiotic, usually a 3rd generation cephalosporin was administered 1 hour before surgery.Intra-medullary nails and cortical screws serving as blocking screws were planned for all patients after their deformity was determined using standard anteroposterior and lateral radiographs before surgery. A preoperative planning for placement of poller screw was tentatively scheduled.

Operative technique

Entry point in proximal metaphyseal tibia fracture in anteroposterior plane is 1cm lateral to midline of tibial plateau and in lateral plane a more proximal and posterior entry was made for fractures of proximal metaphyses, one or two percutaneous blocking screw placement was done depending upon fracture pattern. Anteroposteriorly these screws were inserted in the distal aspect of the proximal segment, just lateral to the central axis of the proximal tibia. The sagittal plane screws were placed in the posterior half of proximal part of tibia.

In distal tibia metaphyseal fractures entry point was made on anterior edge tibial plateau centered over medullary canal in AP view. The blocking screws in case of distal tibial metaphyses was used on the concave side of the deformity close to the fracture in the short fragment.

Mal-alignment after intra-medullary nailing is assessed by Trafton's Recommendation or I.M.P.R.E.S.S Protocol.

Trafton's[3] recommendation for acceptable mal-alignment is

1. less than 5 degrees of varus-valgus angulation,
2. 10 degrees of anteroposterior angulation,
3. 10° of rotation and
4. 15mm of shortening while

I.M.P.R.E.S.S. Protocol[4] defines malunion as

1. >5 degrees varus/valgus,
2. >5 degrees anterior or posterior angulation,
3. >10 malrotation degrees, and
4. >1cm shortening.

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Post Operative Treatment

Postoperative dressing was done on alternate days. After first postoperative dressing knee and ankle joints exercises were started. Partial weight bearing was encouraged for those who had no other associated injuries prohibiting walking. Patients were allowed for touch weight bearing on first post operative day, partial weight bearing for 6-8 weeks then full weight bearing when callus was seen on follow-up X-Rays.

Supervised physical therapy was initiated for thigh strengthening and knee range of motion exercises. Patients were followed up at intervals of 4 weeks in the first 3 months and 3 monthly thereafter.

POST OPERATIVE ASSESSMENT

Radiographic varus-valgus and antevertum-recurvatum were assessed as described below and clinical assessment was done by the Karlstrom-Olerud scoring system.[5]

Radiologic assessment

Immediate post operative x rays were used to assess the mal-alignment in two planes, varus-valgus in the coronal plane and antevertum (procurvatum)-recurvatum in the sagittal plane. The varus valgus angles were calculated on antero-posterior radiographs. Two arbitrary points were taken from the medial most point on the tibia at the knee joint to the medial cortices of the tibia on the proximal fragment, e.g., 2 cm and 5 cm. Similarly, two such points were also taken on the lateral cortices from the lateral most point on the tibia at the knee joint equidistant to the medial points, also at 2 cm and 5 cm. The midpoint of these two points were then joined on the proximal fragment to give the axis of the proximal fragment. Similarly, the axis of the distal fragment was drawn. The two axes intercrossed at an angle, giving the varus-valgus mal-alignment. The valgus angles were noted in positive values and the varus angles in negative values. The antevertum-recurvatum mal alignment is calculated by the two axes, one each of the proximal and distal fragment on the lateral radiographs. Two points on the anterior and posterior cortices are drawn from the knee joint downwards and from the ankle joint upwards. The two axes intercrossed at an angle, giving the antevertum-recurvatum mal-alignment. The antevertum angles were noted in positive values and the recurvatum angles in negative values.

The clinical outcome was assessed according to the Karlström-Olerud scoring system.[5] The overall clinical outcome was graded as Excellent: 33 points, Good: 32-30 points, Satisfactory: 29-27 points, Fair/Moderate: 26-24 points and Poor 23-21 points

Complications

Complications were divided into 2 parts: (1) Due to the Poller screws and (2) those which were related to the nailing. Potentially related complications due to poller screw include mechanical instability leading to nonunion, new fracture lines through the holes for the Poller used, breakage of the Poller screw etc. complications related intra-medullary nail include compartment syndrome, infection, rotational malalignment, breakage of the locking screw and nerve or vascular injuries.

Results

In the present study, most patients were in the age group of 18-30 years with male predominance. Most patients had fractured their left tibia.

In present series, 54.3% of the total subjects had closed fractures and 45.7 % had open fractures.60% of the total subjects had distal fractures, 34.3% proximal tibia fracture and 5.7% segmental fractures involving either proximal or distal part.

On assessing fracture deformity in the pre-operative period, 25 patients showed anterior angulation with varus to valgus ratio of 2:1, while 8 patients showed posterior angulation with varus and valgus malalignment of 7:1.

In the intra-operative period, a single blocking screw was sufficed in 28 patients to achieve reduction(80%) while two blocking screws were used in 7 subjects (20% reduction).

Postoperatively twenty nine patients (83%) were in the acceptable range of <5°out of which 22 patients had a varus-valgus deformity of <3° and 9 had a varus deformity of 3-5°. Three patients were mal-aligned to >5° of deformity.Thirty four patients had an antevertum-recurvatum deformity of either equal to 3or less than 3°,and one patient had >5° procurvatum.

According to Karlstrom–Olerud scoring system, the present study showed that the functional outcome was excellent in 6 cases (17%), good in 13 cases (37.1%), satisfactory in 14 cases (21.81%), moderate in 1 (2.9%) and poor in 1 case (2.9%).

PRE-OPERATIVE XRAY AP & LATERAL VIEW

IMMEDIATE POST OP XRAY USING 2 POLLER SCREW
AFTER 4 MONTH FOLLOW UP

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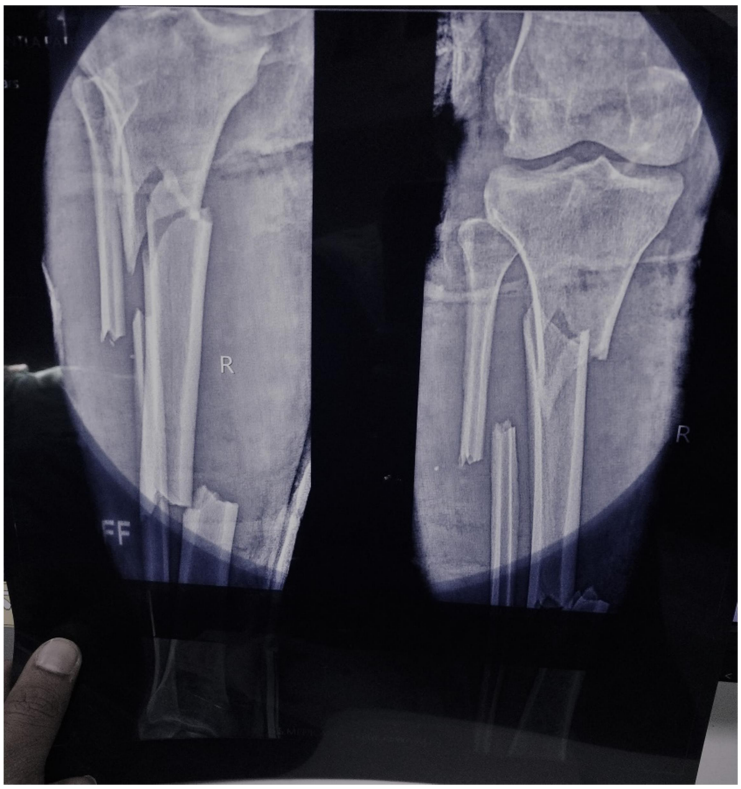
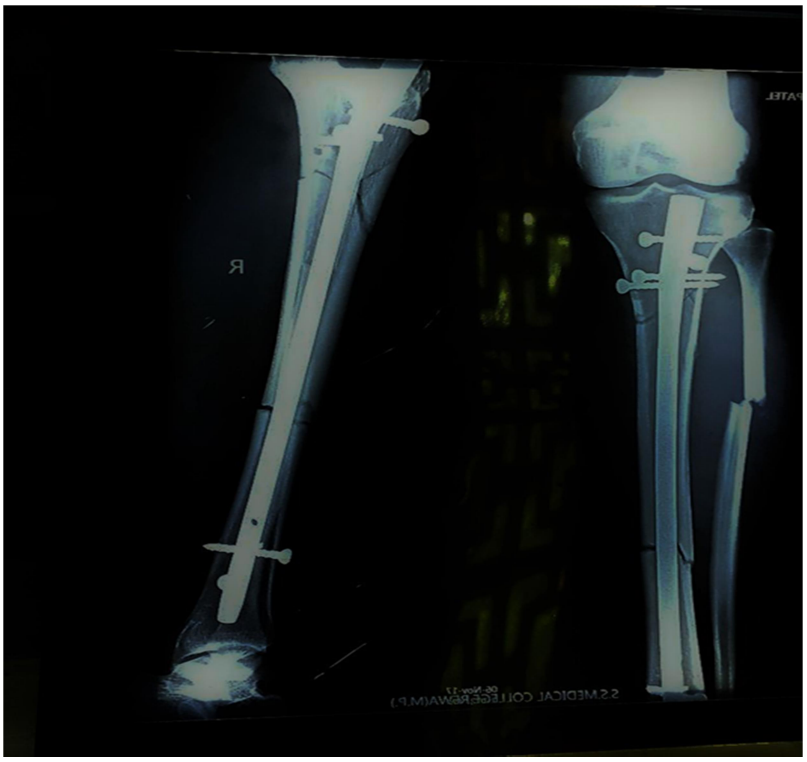
Use of two block screw to correct the mal-alignment of the deformity

PRE-OPERATIVE XRAY AP & LATERAL VIEW SEGMENTAL TIBIA



IMMEDIATE POSTOPERATIVE XRAY USING 2 POLLER SCREW



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AFTER 4 MONTH FOLLOW UP

Discussion

The stabilisation of fractures of the proximal and distal tibia is associated with a high incidence of malalignment.[6-8] This has been attributed to muscular forces which displace the fracture and to instability which results from the play of a nail along the interlocking screws.[9] Contributing factors include poor bone-nail contact in the metaphysis and nails with locking screw holes placed in a single plane. Since the locking screws are usually orientated in the coronal plane, varus-valgus malalignment may follow.

Deformities in the sagittal plane, usually better tolerated, are less common if the fracture is reduced at the time of initial locking. Poller screws, placed adjacent to the nail and perpendicular to the interlocking screw holes, usually in an anteroposterior direction, have been suggested as one possible method for improving the stability of metaphyseal fractures[9,10] and have been described as a reduction tool used to overcome the displacing forces at the time of introduction of the intramedullary nail. The screws functionally decrease the width of the metaphyseal medulla and are particularly useful with nails of smaller diameter.

The unique architecture of the medullary cavity in metaphyses of tibia makes IM nailing difficult. Also, the proximal metaphyses is subjected to deformation by several muscle groups that results in forseeable patterns of displacement. The extensor mechanism causes an apex anterior or procurvatum deformity, which is further increased by the pull of the gastrocnemius. Intramedullary nailing with the knee in hyperflexion further increases this deformity. There is a net a net valgus moment in the coronal plane due to pes anserinus tendon attachmenton the medial aspect of tibia. The large difference between the size and shape of the medullary canal and interlocking nail, the nail itself will have no effect on maintaining an appropriate reduction.[11]There's a high incidence of

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malalignment reported in literature while stabilization of the fractures of proximal and distal tibia.[12] This malalignment is due to muscular forces around the fracture which displaces it.

There are many supplements for achieving and maintaining reduction in metaphyseal fractures of tibia; we studied the role of poller blocking screws with intramedullaey interlock nail in 24 distal tibia fractures, 16 proximal tibial fractures including 2 of them segmental.[15] All the fractures in our series treated by blocking screws,healed with a mean varus-valgus alignment of -0.88^0 and a mean antecurvatum-recurvatum alignment of $1.0.^0$. These results appear to be superior to others reported for the stabilisation of metaphyseal fractures with intramedullary nails. We used single Poller screw in case of 28 patient, and in 7 patients, two poller screws were used. Kulkarni et al[13] used a single Poller screw on the concave side of the deformity in 45 cases in which 2 and 3 Poller screws were placed in 27 and 3 cases respectively whereas Bhangadiya et al[14] used a single blocking screw in 38cases while 2 and 3 blocking screws in remaining 7 and 5 cases respectively.In the present study, all the thirty five patients were minimally followed up to 8 months. The mean union time for the 35 patients was 5.24 months (8-60 weeks). Union time in the study conducted by Krettek et al[1] was 5.4 Month.

Conclusion

Interlocking nailing in proximal & distal metaphyseal tibial fractures remains a challenge because of the disproportionate diameter of the intramedullary canal in the metaphysis. Mismatch between the diameters of the nail and the medullary canal, with no nail-cortex contact, the nail may translate laterally along coronally placed locking screws and increased stress is placed on the locking holes to maintain fracture alignment. This has led to the use of Poller screws for additional blocking during intramedullary fixation of proximal or distal tibial fractures.

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