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An Outcome Analysis to Determine the Uses of Poller Screw in Treatment of Displaced Proximal and Distal Shaft Metadiaphyseal Fractures of Tibia Treated With Intramedullary Nailing

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Abstract

Purpose: Study to determine the uses of the Poller screw in treatment of displaced proximal and distal shaft metadiaphyseal fractures of tibia treated with intramedullary nails.

Methods: 50 metadiaphyseal tibia fractures (proximal 35 and distal 15) were studied out of which 46 were freshly displaced fracture, 3 were delayed union and one was malunion. 40 males and 10 females aged 20 to 60 years (mean 35 years), all underwent treatment with small diameter intramedullary nails were poller screws were used as tool for reduction. 90 % fractures were caused by road traffic accidents. 45 were closed and 5 were grade I and II open fractures. Outcome of study was evaluated using AOFAS (100 points) ANKLE-HINDFOOT SCALE for ankle and RASMUSSEN'S FUNCTIONAL SCORE SYSTEM for knee.

Results: Healing occurred in all 50 cases out of which, 47 cases united in mean period of 4.1 (range 3-9) months. 2 cases underwent non-union which was overcome with bone grafting eventually and one was mal-united. Full range of knee movement (0^{o} – 130^{0}) was attained in 45 cases and 4 cases attained flexion of 0^{0}- 110^{0} and full range of ankle dorsiflexion movement (0^{0}-30^{0}) was attained in 47 cases and 2 case attained ankle dorsiflexion movement of 0^{0} to 20^{0}. According to RASMUSSEN'S FUNCTIONAL SCORE SYSTEM for knee, results were EXCELLENT in 41 cases, GOOD in 5 cases, FAIR in 2 cases AND POOR in 1 case, while as per AOFAS ANKLE-HIND FOOT SCALE score was improved from preoperative 30 to 55 (mean 46.8) to postoperative 91 to 98 (mean 95.6) which remained same after a mean follow up of 28.9 months. Postoperatively 49 cases had knee < 4^{0} varus or valgus malalignment and only one case developed varus of $+8^{0}$ while 48 cases had ankle < 5^{0} of varus or valgus alignment and 2 cases developed varus of $+9^{0}$. 45 cases exhibited no deformity, 3 had deformity of < 3^{0} and 2 cases developed deformity in range of 4^{0} to 10^{0} in knee, while in ankle 44 cases had no deformity, 4 cases had deformity of < 4^{0} and 2 cases developed deformity of 5^{0} to 11^{0}.

Conclusion: Poller screw can be used as a tool for obtaining and maintaining reduction while treating displaced proximal and distal shaft fractures with intramedullary nailing.

Keywords: Poller screws; Reduction tool; Intramedullary nailing; Tibia fractures; Outcome study

Introduction

Tibial fractures are the most common long bone fracture and occur at a frequency of about 26 fractures per 100,000 population per year [1,2], of which extraarticular metadiaphyseal proximal third fractures account for 5 to 11 percent [3] and distal third fractures account for less than 7% of all tibial fractures [4,5]. The intramedullary nailing of metadiaphyseal fractures with a short proximal or distal fragment is associated with an increase occurrence of malalignment, particularly in the coronal plane, because of inaccurate entry point or both to the displacing muscular forces and residual instability [1,2] in comparison to nailing of diaphyseal fractures of the tibia. Also owing to large difference between the size of the implant and the metadiaphyseal diameter with the absence of nail-metadiaphyseal cortex contact, there is increase the risk of malalignment, as the nail may translate along the interlocking screws, due to the play between the screws and the nail holes. This problem can be solved by the use of blocking screws or Poller screws [6–9], which can be used as tool to obtain, maintain reduction and alignment of fracture and maintain fixation of intramedullary nailing [3,10]. Poller screws decrease the width of the medullary cavity, guide and physically block the nail in the centre of the widened metadiaphyseal area, and increase the mechanical stiffness of the bone implant construct [11]. Thus our aim is to analyse and study outcome of the poller screw

used as tool for reduction in treatment of displaced proximal and distal shaft fractures of tibia treated with small diameter intramedullary nails.

Materials and Methods

We studied 40 males and 10 females (n = 50) aged 20 to 60 years (mean 35 years) metadiaphyseal tibia fractures, who underwent treatment with intramedullary nailing were poller screws used as tool for reduction, between period June 2010 and July 2013. Out of this 50 metadiaphyseal tibia fractures, 35 were proximal one third (Figure 1) and 15 were distal (Figure 2). 46 were freshly displaced fracture, 3 were delayed union and one was malunion. 90 % of fractures were caused by road traffic accidents. 45 were closed and 5 were grade I and II open fractures. The fractures were classified by AO classification as A (n=38), B (n=7), and C (n=5), and soft tissue injuries in open fractures (n=8) were classified using Gustilio Anderson Classification [12].

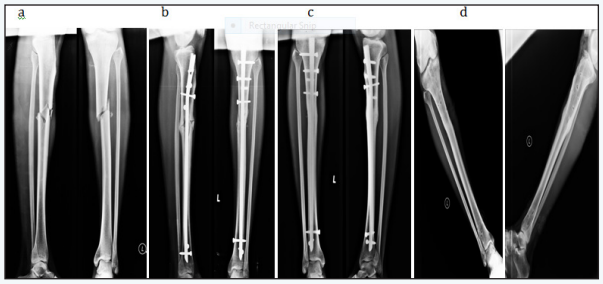

Figure 1: Radiographs showing anteroposterior and lateral views of a) proximal one third shaft tibia fracture. b) Fractured treated by nailing with poller screw which is used as tool for obtaining reduction and alignment. c) Alignment and callus formation at 6 months. d) After nail removal.

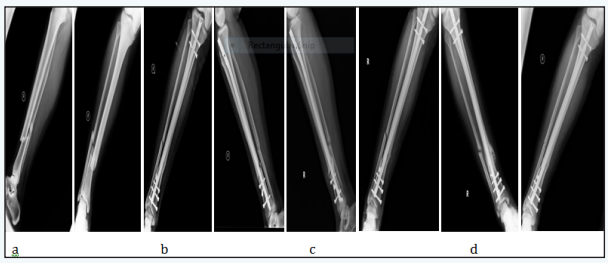

Figure 2: Radiographs showing anteroposterior and lateral views of a) distal one third shaft tibia fracture. b) Fractured treated by nailing with poller screw which is used as tool for obtaining reduction and alignment. c) Alignment and callus formation at 6 months. d) bone union seen.

Patient with intra articular fractures of proximal and distal tibia, non displaced and those who were treated conservatively, and who were medically unfit were excluded from the study. Some of the patients had associated injuries like humerus, forearm, metacarpal, ribs, femur and posterior malleolus fracture but they didn't affect the treatment and the study.

The patient included in study had mean length of the proximal fragment 88 ± 25 mm (30 to 125) and that of the distal fragment 65 ± 40 mm (30 to 120). The mean length of the fracture was 73 ± 60 mm (40 to 290). The patient was operated within 48 hrs of injury in 43 and was delayed in 7 patients (mean delay, 72 hrs). Poller screws were selected for use by the surgeon for the following reasons: 1) to obtain reduction during insertion of the nail; 2) to maintain alignment or to improve the stability of the bone-implant complex.

The patient selected was treated with titanium solid nails with a high bend of 110 near its proximal tip, of the diameter 9 mm (most common) and 10 mm. Cortical screws of 3.5 or 4.5 mm were used as blocking or poller screws during nail insertion to obtain and maintain reduction. The blocking screw was placed on the concave side of the deformity. In 38 cases, a single blocking screw was placed while in remaining 7 and 5 cases, 2 and 3 blocking screws were placed respectively.

Intra-operatively, the patient was positioned on fracture table with knee kept in a semiextended position on a well-padded knee rest [13]. Temporary Poller wires were fixed on the opposite side of the apex of deformity in both anteroposterior and lateral views under image intensifier guidance. Parapatellar incision was taken and a high entry point was taken with an awl after slightly retracting the patellar tendon at midline. A high bend unreamed nail of appropriate size was inserted slowly and negotiated with the Poller wires obtaining reduction and achieving the correct alignment. The nail was locked in a semi-extended position. Poller wires were then exchanged with permanent cortical screws to maintain the reduction.

Postoperative mobilisation with partial weight bearing (15 to 20 kg) and Static and dynamic quadriceps exercises was started on day two and were continued for 6 to 8 weeks. Subsequently, weight bearing was increased gradually, according to decreasing symptoms pain and increasing radiographic evidence of bone union.

Patients were evaluated using AOFAS (100 points) ANKLE-HINDFOOT SCALE for ankle and RASMUSSEN'S FUNCTIONAL SCORE SYSTEM for knee during follow up at interval of 6 to 8 weeks for a year and 6 monthly thereafter. Alignment and deformity was calculated by drawing the anatomic axis of tibia in both proximal and distal fragments on radiographs. The degree of varus/valgus and procurvatum/recurvatum were then calculated. Varus and procurvatum angulations were expressed as positive values, and valgus and recurvatum as negative values. Fracture healing was defined as the patient's ability to bear full weight without pain and support, along with callus seen bridging in 3 of 4 cortices on radiographs.

Complications considered were those related complications included mechanical instability, non-union, occurrence of new fracture through the Poller screws site, nail breakage or friction

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due to damage by the drill and breakage of the Poller screws. Neurovascular or tendon injury was considered related, while all other complications which were not related to poller screw, but were related to the fracture or intramedullary nail such as anterior knee joint pain, compartment syndrome, infection, rotational deformity, breakage of the locking screw and neurovascular injuries, present before insertion of the Poller screws were considered.

Results

Bone union was achieved in all 50 cases. 47 cases united in mean period of 4.1 (range 3-9) months. 2 cases had non-union which was treated with bone grafting eventually and one was mal-united.

After the mean follow up of 28.9 (20 – 33) months, full range of knee movement (0^{o} – 130^{0}) was attained in 45 cases and 4 cases attained flexion of 0^{0}- 110^{0} and full range of ankle dorsiflexion movement (0^{0}-30^{0}) was attained in 47 cases and 2 case attained ankle dorsiflexion movement of 0^{0} to 20^{0}. According to RASMUSSEN'S FUNCTIONAL SCORE SYSTEM for knee, results were EXCELLENT in 41 cases, GOOD in 5 cases, FAIR in 2 cases AND POOR in 1 case, while as per AOFAS ANKLE-HIND FOOT SCALE score was improved from preoperative 30 to 55 (mean 46.8) to postoperative 91 to 98 (mean 95.6) which remained same after a mean follow up of 28.9 months.

Postoperatively 49 cases had knee < 4^{0} varus or valgus malalignment and only one case developed varus of $+8^{0}$, whereas compared to 30 cases of varus, 15 cases of valgus, and remaining 5 cases of neutral alignment (range of varus to valgus was $+26^{0}$ to -13^{0}). Similarly postoperatively,45 cases exhibited no deformity, 3 had deformity of < 3^{0} and 2 cases developed deformity in range of 4^{0} to 10^{0}, as compared to 33 cases of procurvatum,12 cases of recurvatum, and 5 cases of no deformity.(range of procurvatum to recurvatum deformity was $+10^{0}$ to -19^{0}).

While 48 cases had ankle < 5^{0} of varus or valgus alignment and 2 cases developed varus of $+9^{0}$, compared to 32 cases of varus, 10 cases of valgus and remaining 8 cases of neutral alignment (range of varus to valgus was + 23^{0} to -14^{0}). Similarly postoperatively, 44 cases exhibited no deformity, 4 had deformity of < 4^{0} and 2 cases developed deformity in range of 5^{0} to 11^{0}, as compared to 35 cases of procurvatum, 9 cases of recurvatum, and 6 cases of no deformity. (range of procurvatum to recurvatum deformity was $+12^{0}$ to -18^{0}).

No complications related to poller screw were noted. Nail removal with screws was done in 30 cases after radiographic union of bone. All cases had achieved full quadriceps strength, with no ligamentous instability or flexion deformity. Postoperative complications included anterior knee joint pain (n=5) and superficial infections (n=2), which was treated with local debridement and use of antibiotic impregnated beads.

Discussion

There's a high incidence of malalignment reported in literature while stabilisation the fractures of the proximal and distal tibia [12,14-16]. This malalignment is due to muscular forces around the fracture which displaces it [14]. Also because of poor bone-nail contact in the metadiaphysis and nails with locking screw holes placed in a single coronal plane, instability results due to play of a nail along the interlocking screws [17], causing varus-valgus malalignment.

In 1994, Krettek et al. [6,8] described the clinical application of blocking screws, termed 'Poller screws', as a tool for the prevention of axial deformities of proximal and distal fractures of the tibia during intramedullary nailing. The same technique described here for the tibia has been used for the femur [7,9]. They act via a 3-point fixation principle. They prevent and counteract the forces generated by muscles at the fracture site during insertion of nail [8] and decreases the width of metadiaphysis and prevent the play of nail [3]. Poller screw are placed at right angle to the interlocking screw holes, usually in an anteroposterior direction, beside the nail close to apex of deformity (CORA) [3], improve the stability of metadiaphyseal fractures [8,9] and enables control of angular deformities [10].

Conclusion

Poller screws can increase the primary stability of distal and proximal metaphyseal fractures after nailing and can be used as effective tool for obtaining reduction in cases of malalignment and/or instability [10]. In our study, final results were similar to those reported in previous studies [3,10,18], but here we concluded the following uses of the Poller screw,

- Used blocking screws
- Good, easy and effective means of obtaining fracture reduction.
- Help in maintaining alignment of fracture fragment in case of proximal and distal extraarticular Metadiaphyseal fractures
- When applied during insertion of nail, they help in guiding the nail centrally.
- Reduces soft tissue injuries during fracture reduction.
- tool for obtaining reduction in cases of mal alignment and/or instability
- Easy to use by surgeon without much effort.
- Cost effective and reduces the operative procedure time.

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