ISSN: 0975-833X

*Availableonlineathttp://www.journalcra.com*

*International Journal of Current Research*
*Vol. 11, Issue, 05, pp. 4116-4120, May, 2019*

**DOI: https://doi.org/10.24941/ijcr.35678.05.2019**

**INTERNATIONAL JOURNAL OFCURRENTRESEARCH**

## REVIEW ARTICLE

# TREATMENT OF PAEDIATRIC TIBIAL SHAFT FRACTURE WITH TITANIUM ELASTIC NAILS

**[1*]Dr. Neeraj Mahajan and [2]Dr. Arti Khurana**

[1]M.S Orthopaedics, Lecturer, GMC Jammu
[2]M.D Radiodiagnosis, Consultant Radiodiagnosis, J&K Health Services

**ARTICLEINFO**

*Article History:*
Received 09th February, 2019
Received in revised form
06th March, 2019
Accepted 28th April, 2019
Published online 30th May, 2019

*Key Words:*
Paediatric, Tibial Fracture,
TENS, Complications.

**Corresponding author:*

**ABSTRACT**

**Background:** Conservative treatment by closed reduction and cast application is the gold standard treatment for tibial shaft fracture in children. Surgical intervention is required in tibial shaft fractures associated with multiple long bone fracture, head injury, unstable tibial fracture, compound tibial fracture, failed closed reduction and cases of compartment syndrome. Titanium elastic nails (TENS) are the ideal implant for paediatric tibial fractures as it maintains alignment and rotation without causing damage to open physis. **Method:** The present study was conducted in Department of Orthopaedics GMC Jammu on 25 patients presenting with tibial fractures. Paediatric tibial fractures were fixed with two titanium elastic nails through proximal tibia preserving the physis. **Results:** Twenty five patients were treated with TENS. There were 14 male and 11 female. Commonest mode of injury pattern is road traffic accident. Nail prominence and skin irritation is the commonest complication encountered in 4(16%) patients, delayed union 2(8%), malunion1(4%) and infection at entry portal 1(4%) patient. Evaluation of the results were done were by Flynn criteria. In 17 (68%) patients excellent results were seen, 8 (32%) patients satisfactory results were seen and poor result was not seen in any patient. **Conclusion:** Titanium elastic nail achieve satisfactory results in management of paediatric tibial fractures in which surgery is indicated. TENS is the treatment of choice in children with compound fractures or soft tissue injuries as it allows rapid healing of tibial fracture with minimal complications.



***Citation: Dr. Neeraj Mahajan and Dr. Arti Khurana.*** **2019.** "Treatment of paediatric tibial shaft fracture with titanium elastic nails", *International Journal of Current Research*, 11, (05), 4116-4120.

## INTRODUCTION

Conservative treatment by closed reduction and cast application is the gold standard treatment for majority of tibial shaft fracture in children. Surgical intervention is uncommon in paediatric tibia fracture. Surgical intervention is required in tibial shaft fractures associated with multiple long bone fracture, neurovascular injury, head injury, unstable tibial fracture, compound tibial fracture, cases of compartment syndrome and failed closed reduction due to excessive shortening, angulation and malrotation at fracture site (Shannak AO 1988). Rigid intramedullay nailing is not possible in paediatric patients owing to open physis and narrow canal diameter. External fixation may be option for those unstable fracture requiring surgical intervention but it is associated with several complications like infection, refracture, malunion, delayed union and non union (Kubaik *et al.,* 2005). TENS has gained widespread popularity in nailing of paediatric long bone fractures because of low complications, closed technique, physeal sparing, fracture haematoma preservation (Carey *et al.,* 1996, Flynn *et al.,* 2001, Metaizeau, 2004). The objective of this study is to evaluate the functional outcome of paediatric tibial fractures treated with TENS.

## MATERIALS AND METHODS

A prospective study was done on 25 children with tibial shaft fracture treated operatively with TENS. Inclusion criteria include patients with tibial diaphyseal fracture with compartment syndrome, multiple long bone fracture, floating knee injuries, polytrauma patients, head injury patients, unstable fractures, grade I or II compound fractures, failed closed reduction in which adequate alignment cannot be maintained. Tibial fractures in children less than 5 and more than 14 years, grade III compound fractures, fractures treated with cast with acceptable alignment, fractures with severe comminution, severe osteopenia, massive bone loss, osteogenesis imperfecta, congenital pseudoarthrosis of tibia and fractures within 4cm of knee joint or within 3cm of ankle joint were excluded. All patients were operated under general anaesthesia. The appropriate size of nail was calculated by using Flynn formula i.e. nail diameter = 0.4 x narrowest diameter of medullary canal. The nail was precontoured to C shape configuration for intramedullary three point fixation. The tip of the nail was bent to 45 degree for easy passage through fracture site. The metaphyseal entry points were marked to avoid proximal physis.

1A.

1B.

**Figure 1. (A&B): X ray showing failed closed reduction of tibial fracture**

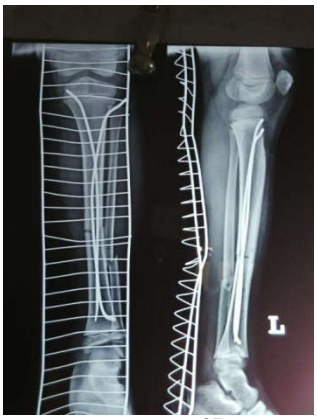
2A.

2B.

**Figure 2 (A&B) : X ray of tibial fracture operated with TENS**

3A

**Figure 3 : 3A Xray showing fracture of tibial diaphysis**



3B

**3B X ray showing fracture treated with TENS**

**Figure 4. Xray showing union of fracture after treatment with TENS**

**Table 1. Distribution of the patients according to age (n=25)**

| Sex | No. of Patients | Percentage |
|---|---|---|
| Male | 14 | 56 |
| Female | 11 | 44 |

**Table 2. Distribution of the patients according to limb involved (n=25)**

| Limb involved | No. of Patients | Percentage |
|---|---|---|
| Right | 15 | 60 |
| Left | 10 | 40 |

**Table 3. Table showing mode of injury**

| Injury pattern | No. of patients | Percentage |
|---|---|---|
| Road traffic accident | 14 | 56 |
| Fall from height | 7 | 28 |
| Sports injury | 4 | 16 |

**Table 4. Table showing tibial fracture pattern**

| Fracture pattern | No. of patients | Percentage |
|---|---|---|
| Transverse | 14 | 56 |
| Oblique | 7 | 28 |
| Spiral | 4 | 16 |

**Table 5. Complications after surgery**

| Complications | No of patients | Percentage |
|---|---|---|
| Nail prominence & skin irritation | 4 | 16 |
| Delayed union | 2 | 8 |
| Malunion | 1 | 4 |
| Infection at entry portal | 1 | 4 |
| Limb shortening | 0 | 0 |
| Limb lengthening | 0 | 0 |

**Table 6. Surgical indications for TENS**

| Surgical indications | No of patients | Percentage |
|---|---|---|
| Failed closed reduction | 10 | 40 |
| Grade I or II compound fracture | 9 | 36 |
| Polytrauma | 3 | 12 |
| Head injury | 2 | 8 |
| Unstable tibial fracture | 1 | 4 |

The starting point for nail insertion is 1.5–2.0 cm distal to the physis, sufficiently posterior in the sagittal plane to avoid injury to the tibial tubercle apophysis. A longitudinal 2 cm incision is made on both the lateral and medial side of the tibia metaphysis just proximal to the desired bony entry point. Using a haemostat, the soft tissues are bluntly dissected down to bone. Based on preoperative measurements, an appropriately sized implant is selected.

A drill roughly 0.5 cm larger than the selected nail is then used to open the cortex at the nail entry site; angling the drill distally down the shaft facilitates nail entry. Both nails are then inserted through the entry holes and advanced to the level of the fracture site. Under fluoroscopic guidance, the fracture is reduced in both the coronal and sagittal planes, and the first nail is advanced past the fracture site. If proper intramedullary position of the nail distal to the fracture site is confirmed on anteroposterior and lateral views, then the second nail is tapped across the fracture site. Both nails are advanced until the tips lie just proximal to the distal tibial physis. Fluoroscopy is again used to confirm proper fracture reduction as well as nail position.

Around 1cm of nail was left outside the cortex proximally for removal, however unburied portion of nail was not bend to minimize soft tissue irritation and bursitis at entry site of nail. It is important that both nails are of same size to avoid differential loading in opposite cortices which may lead to angular deformity .The two incisions for nail entry are closed in a layered fashion, and the wounds are well padded with gauze. Patients were immobilized postoperatively by long leg slab for 6 weeks. Partial weight bearing was started at 6 weeks when there was evidence of bridging callus. Full weight bearing was postponed till complete union of fracture. Signs of complete union include callus formation on atleast 3 out of 4 planes and fading of fracture lines on radiographs. Patients were evaluated at 2 weeks, 6 weeks, three months, six months and one year after surgery to observe alignment of fracture, any infection, delayed union, non union, range of knee motion and union time for fracture. Frontal and saggital plane angulations were assessed on anteroposterior and lateral plain radiographs obtained immediately postoperatively and at last follow up. At last follow up limb length discrepancies were assessed using long standing films between the injured and uninjured sides. Treatment outcome were evaluated based on TEN outcome scoring system (Flynn et al 2004).

## DISCUSSION

Majority of paediatric tibial shaft fracture can be treated with closed reduction and casting. Surgical intervention is required in tibial shaft fractures associated with multiple long bone fracture, neurovascular injury, children with head injury or cerebral palsy, fractures with floating knees, unstable tibial fracture, compound tibial fracture, cases of compartment syndrome and failed closed reduction due to excessive shortening, angulation and malrotation at fracture site (Griffet *et al.,* 2011, Mark G Swindells *et al.,* 2010, Kubiak *et al.,* 2005, Sankar *et al.,* 2007). Methods commonly used for operative treatment include percutaneous metallic pins or bio absorbable pins, external fixators, open reduction and internal fixation with plating, flexible intramedullary titanium or stainless steel nails and in some cases intramedullary Steinmann pins (Vallamshetla *et al.,* 2006, Salem *et al.,* 2006, O' Brien *et al.,* 2004). Rigid intramedullary nailing is not possible in paediatric patients owing to open physis and narrow canal diameter.

External fixation may be option for those unstable fracture requiring surgical intervention but it is associated with several complications like infection, refracture, malunion, delayed union and non union.(Kubaik *et al.,* 2005). The best implant to treat the tibial or femoral fractures in children should be a load sharing device which maintains length and alignment until appearance of callus at fracture site while allowing early mobilization without endangering the tibial physis at entry point (Buechsenschuetz *et al.,* 2002).Titanium elastic nails achieve biomechanical stability from the divergent "C" configuration which creates six points of fixation and allows the construct to act as an internal splint ( Ligier *et al.,* 1985). This is in contrast to Enders nails that achieve stability from nail stacking and canal fill. Titanium nails provide stable and elastic fixation, allowing for controlled motion at the fracture site which results in healing by external callus. TENS balances the forces between two nails in medullary canal acting in opposite direction. The nails must assume double 'C' shaped construct and diameter should be 40% or more of narrowest diameter of medullary canal to achieve the appropriate balance.

**Table 7. TEN outcome scoring**

| | Excellent result | Satisfactory result | Poor result |
|---|---|---|---|
| Leg length discrepancy | <1.0 cm | <2.0cm | >2.0 cm |
| Malalignment | 5 degrees | 10 degrees | >10 degrees |
| Pain | None | None | Present |
| Complications | None | Minor & resolved | Major &lasting morbidity |

**Table 8. Table showing results in our study**

| Results | No. of patients | Percentage |
|---|---|---|
| Excellent | 17 | 68 |
| Satisfactory | 8 | 32 |
| Poor | 0 | 0 |

Nails should have entry at same level both medially and laterally and have similar smooth curves (Pardeep *et al.,* 2014, Gamal El- Adal *et al.,* 2009). O'Brien T et al. 2004 previously reported a series of 16 children with tibial shaft fractures treated with TENS, with a mean follow-up of 17 months. All patients in their series went on to radiographic healing by an average of 9 weeks; No patients had greater than 10° of angular deformity at final follow-up, and no clinically significant leg length discrepancies resulted from treatment. Similarly, Goodwin RC et al. 2005 reviewed 19 patients with tibial shaft fractures treated with TENS After a mean follow-up of 13 months, all achieved union. Two patients had angular deformities in excess of 10°, and one child developed a clinically insignificant physeal arrest. Kubiak *et al.* 2005 in their study compared external fixation with elastic intramedullary nailing for pediatric tibial shaft fractures, they observed superior functional outcomes and patient satisfaction in the cohort treated with TENS. The union time was significantly shorter in the TEN group (mean 7 weeks) compared to the external fixation group (mean 18 weeks). Complications were rare, although most patients complained of irritation over the proximal ends of the flexible nails.

Commonest complication related to TENS is the nail prominence and skin irritation at the entry portal. There were 4 (16%) cases of nail prominence, skin irritation or bursa formation in our study. Prominence of nail leads to complications like superficial/deep infection, skin erosion, bursitis, effusion, knee joint stiffness, reoperation for cutting nail or nail advancement and premature implant remove thereby increasing risk of refracture (Shital N Parikh et al 2012). The worst complication is extension of infection leading to diaphyseal osteomyelitis (Lascombes, 2009). For tibial TENS or elastic stable intramedullary nail Sankar et al 2007 advised to keep 1.5 cm of nail outside bony cortex. It should be parallel to the proximal metaphysis and one should not bent the protruded portion of nail. There were 2 (8%) cases of delayed union and no case of non union. When no callus is seen after 12 weeks after surgery it is labelled as delayed union and no osseous healing at 6 months after surgery it is assumed as non union. Infection at the fracture site after TENS because of compound injury leads to delayed union or non union. Shrivastava AK et al 2008 observed 5 case of delayed union and 2 cases of non union in open tibial fracture fixed with TENS. There was 1 (4%) case of malunion in our study. Eventhough malalignment is not so common in tibia fracture fixed with TENS, Goodwin RC et al 2005 reported 2 cases with angular deformity of 10 degrees each. No major complication were encountered but minor complications like bursa and irritation at site of nail entry 4(16%) cases and infection at the entry portal in 1(4%) case were noted in the study. Results were graded by Flynn JM et al 2004 criteria as excellent,satisfactory and poor. In our study we achieved excellent result in 17(68%) cases, satisfactory results in 8(32%) cases and no poor result.

## Conclusion

Titanium elastic nail achieve satisfactory results in management of paediatric tibial fractures in which surgery is indicated. TENS is the treatment of choice in children with compound fractures or soft tissue injuries as it allows rapid healing of tibial fracture with minimal complications. TENS has gained widespread popularity in nailing of paediatric long bone fractures because of low complications, closed technique, physeal sparing, fracture haematoma preservation.

## REFERENCES


Buechsenschuetz KE., Mehlman CT., Shaw KJ., Crawford AH., Immerman EB 2002. Femoral shaft fractures in children: Traction and casting versus elastic stable intramedullary nailing. *JTrauma.,* 53- 5:914-21.

Carey TP., Galpin RD. 1996. Flexible intramedullary nail fixation of pediatric femoral fractures. *Clin Orthop.,* 332:110–118.

Flynn JM., Hresko T., Reynolds RA., Blasier RD., Davidson R., Kasser J. 2001. Titanium elastic nails for pediatric femur fractures—a multicenter study of early results with analysis of complications. *J Pediatr Orthop*., 21(1):4–8.

Flynn JM., Luedtke LM., Theodore J., Ganley TJ., Dawson J, Davidson RS. *et al.,* 2004. Comparison of titanium elastic nails with traction and a spica cast to treat femoral fractures in children. *J Bone Joint Surg Am.,* 86:770-7

Gamal El-Adal, Mohamed F Mostafa, Mohamed A Khalil, Ahmed Enan. 2009. Titanium elastic nail fixation for femoral and tibial fractures. *Acta Orthop Belg.,* 75:512-20.

Goodwin RC., Gaynor T., Mahar A., Oka R., Lalonde FD. 2005. Intramedullary flexible nail fixation of unstable pediatric tibial diaphyseal fractures. *J Pediatr Orthop.,* 25(4):570–576.

Griffet J., Leroux J., Boudjouraf N., Abou-Daher A., El Hayek T. 2011. Elastic stable intramedullary nailing of tibial shaft fractures *J Child Orthop*. ug; 5(4): 297–304

Kubiak EN., Egol KA., Scher D., Wasserman B., Feldman D., Koval KJ. 2005. Operative treatment of tibial shaft fractures in children: are elastic stable intramedullary nails an improvement over external fixation? *J Bone Joint Surg Am.,* 87:1761–1768.

Lascombes P. 2009. Flexible intramedullary nailing in children: the Nancy University Manual. Heidelberg: Springer.

Ligier JN., Metaizeau JP., Prevot J., Lascombes P. 1985. Elastic stable intramedullary pinning of long bone fractures in children. Z Kinderchir. 40:209–212.

Mark G. Swindells, Rajan RA.2010. Elastic intramedullary nailing in unstable fractures of the paediatric tibial diaphysis: *J Child Orthop*. 4(1): 45–51.

Metaizeau J. Stable elastic intramedulary nailing of fractures of the femur in children. J Bone Joint Surg Br. 2004;86:954–957.

O'Brien T., Weisman DS., Ronchetti P., Piller CP., Maloney M. 2004. Flexible titanium elastic nailing for the treatment of the unstable pediatric tibial fracture. *J Pediatr Orthop*. 24(6):601–609.

Pradeep Choudhari, Sachin Chhabra, Vivek Kiyawat, 2014. Evaluation of Results of Titanium Elastic Nailing System in Paediatric Lower Extremity Fractures of Long Bones. *Journal of Evolution of Medical and Dental Sciences*. 3(72):15303-9.

Salem K., Lindemann I., Keppler P. 2006. Flexible intramedullary nailing in pediatric lower limb fractures. *J Pediatr Orthop*. 26(4):505–509.

Sankar WN., Jones KJ., David Horn B., Wells L. 2007. Titanium elastic nails for pediatric tibial shaft fractures. J Child Orthop. *J Child Orthop.,* Nov;1(5):281-6.

Shannak AO. 1988. Tibial fractures in children: follow-up study. *J Pediatr Orthop.,* 8:306–310.

Shital N Parikh, Viral VJain, Jaime Denning, Junichi Tamai, Charles T Mehlman, James J McCarthy et al. 2012. Complications of Elastic Stable Intramedullary Nailing in Pediatric Fracture Management. *J Bone Joint Surg Am.,* 94:e184(1-14).

Shrivastava AK., Mehlman CT., Wall EJ., Do TT. 2008. Elastic stable intramedullary nailing of tibial shaft fractures in children. *J. Pediatr Orthop.,* 28:152-8

Vallamshetla VRP., De Silva U., Bache CE., Gibbons PJ. 2006. Flexible intramedullary nails for unstable fractures of the tibia in children-An eight-year experience. *J Bone Joint Surg Br.,* 88B : 536-40

*******