ORIGINAL RESEARCH PAPER

Orthopaedics

EVALUATION OF CLINICAL AND FUNCTIONAL OUTCOME OF TITANIUM ELASTIC NAIL SYSTEM (TENS) VERSUS MINIMALLY INVASIVE PLATE OSTEOSYNTHESIS (MIPO) IN CLOSED PAEDIATRICSHAFT FEMUR FRACTURE

KEY WORDS: Shaft femur fractures, Minimally Invasive Plate Osteosynthesis (MIPO), Titanium Elastic Nail System (TENS)

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ABSTRACT

Objective: To evaluate the clinical and functional outcome of closed paediatric shaft femur fractures treated by titanium elastic nail and treated by minimally invasive plate osteosynthesis in patients admitted in the Orthopaedics Department of Medical College, Kolkata over a period of 24 months from August 2022 to July 2024.This is a prospective study, which will provide data and the possible variations in the clinical and functional outcome between titanium elastic nail versus minimally invasive plate osteosynthesis in closed paediatric shaft femur fractures, complications and benefits of both procedures. **Methods:** It is an Institution based prospective comparative study. Study will be conducted for 24 months. In the first 8 months, there will be patient recruitment. Patients would be followed up for 12 months. The patients recruited in August 2022 will be followed up till February 2024.Next two months would be for statistical analysis and another of two months for thesis writing and submission. **Results:** In our series 37 cases of shaft femur fractures were assessed .All patients were followed until fracture union occurred. Fall from height is the most common cause, male preponderance & right side is more common than left. **Conclusions:** Minimally Invasive Plate Osteosynthesis (MIPO) is slightly better than Titanium Elastic Nail System (TENS) so far as radiation exposure time, limb immobilization time, knee stiffness & limb length discrepancy are concerned.

INTRODUCTION:

Paediatric shaft femur fracture represents 1.6% of all fractures in paediatric population. Paediatric shaft femur fracture affects more in male than female at a ratio of 2.6:1 with a bimodal distribution of the incidence of fractures(first peak2-4years age & second peak at mid-adolescence) with a higher incidence during summer months.[1]The closed reamed interlocking IM nail is the gold standard for shaft femur fractures in adult, whereas children 6years & below can be managed by traction and spica cast .Controversy among the modalities of treatment of shaft of femur fractures in school going children makes difficult to choose the best one. There has been dramatic & sustained trend towards the operative stabilization of shaft femur fractures in school-going children using flexible intra-medullary nails, sub-muscular plate, external fixation & locked intra-medullary nails over last 20 years.[2]These advanced modalities of treatment have reduced the sustantial early disability for the children & decrease the family's burden of care during recovery phase. Hippocrates (460 BC-370 BC) advised the principles of traction & counter traction.[3]Limb immobilization as a method of the treatment of fracture used by Ancient Egyptians, based on archaeological discoveries of wooden sticks surrounding a preserved mummy with a femur fracture.[4]The Plaster impregnated fabric strips development that allowed the modern techniques of splinting & casting has attributed to Mathijsen in 1851.[5]Thomas splint developed in 1865 for applying and maintaining controlled traction specifically to femur fractures & popularized during World War I.[6]Moore & Shafer mentioned hip spica casting for paediatric femur fractures.[7]German orthopaedist Gerhard Kuntscher (1900-1972) invented metallic intramedullary nail for fixation of femoral fractures in the 1930s &also performed subtrochanteric fracture nailing in November 1939.[8]The idea of using relatively low diameter intramedullary nails has been used by Rush & Enders to stabilize long bone fractures particularly shaft of femur & subtrochanteric fractures showing efficacy in children not in adult.[9] Introduction of flexible nails by the Nancy group, the treatment of shaft femur fractures in children has completely changed during last 30years.[10]Lane & Lambote applied plates merely to fix two bone fragments in an approximate alignment in early twentieth century. Danis reported the use of inter fragmentary compression by applying plates under tension along the longitudinal axis of the bone in 1949 & this concept was enriched by Muller and AO group.[11]The concept of without touching the fracture site, when applying a plate as an extramedullary splint, was introduced by Mast et al in thelate1980s.Kretteketal described the attempts at percutaneoussubmuscular fixation with the introduction of a plate through a small incision.[12]In 1990 Perren introduced LC-DCP, the gold standard for plate fixation.[13]In 1999, the LCP(locking compression plate) was developed.[14] The introduction of new adaptations to plate technology with locking head screws has facilitated the surgical technique & the world wide spread of the minimally invasive plate osteosynthesis (MIPO) technique since last two decades.[15]Sela et al. Found that the TEN approach was superior to spica casting for children who had reached an average age of 4 years.[16]Gwyn et al. Showed that 4 mm titanium rods impart satisfactory torsional stability regardless of fracture pattern. Frick et al. found that there to be greater stiffness & resistance to torsional deformation when retrograde nails are contoured into double C pattern than antegrade C and S pattern. Bourdelat compared retrograde & antegrade flexible intramedullary rodding in 73 femoral fractures. Carey & Galpin recommended an antegrade transtrochanteric approach and they found excellent results in 25 patients without growth arrest of the upper femur or osteonecrosis. Herscovici et al. Recommended 3.5mm Ender nail in 6 to 10 years & 4mm in more than 10 years children. Ligier et al. used retrograde nailing by using 3 to 4 mm titanium nails. Heinrich et al. Recommended flexible intmedullary nails for fixing diaphyseal femoral fractures in children with multiple system injury, head injury. Flynn et al. published titanium elastic nailing in North America. Narayanan et al. Looked at one center's learning curve with

titanium elastic nails. A retrospective study was performed by Morshed et al. Showed that 25 percent children had their nails removed for persistent pain.[17] Mazdaet al. described technique related complications like long rods, painful bursae & limited knee flexion in 10 out of 34 patients. Flynn et al. Compared traction and spica cast with titanium elastic nails & found the complication rate was 34 percent in traction group & 21 percent in elastic nail group. An international multicenter study & Ho et al. found that complications of flexible nailing are higher in older & heavier children.[18] Elastic intramedullary nails has its own set of problems like nail irritation, refracture, superficial & deep infection and in addition some investigators have suggested limited success in older & heavier children.[19] Kanlicetal. reported a series of 51 patients using submuscular bridge plating upto 10 year follow up with 50%had unstable fracture pattern & they found an excellent functional outcome with 8% significant leg length discrepancy & two significant complications: one plate breakage, one fracture after plate removal. Hedequist et al.reported on 32 patient saged 6 to 15 years & most of the fractures were comminuted, pathologic, osteopenic or in difficult location. Moderntechnique of plate fixation was described by Rozbruch et al.[20] Pateetal. Observed that the incision & surgical dissection was more extensive in the plate removal than in the initial incision in 7out of 22 cases of plate removal after submuscular plating in shaft femur fractures.[21]

Patients & Methods:

This prospective study has been conducted in Medical College, Kolkata on 37 patients including 18 patients treated with TENS and 19 patients treated with MIPO, fulfilling the study criteria with closed fracture shaft of femur, after taking clearance from the Institutional Ethics committee and informed consent from the patients and has been analysed using standard statistical software. We recruited the patients 7-14 years of age with closed fractures of shaft of femur attending Medical College, Kolkata, Orthopaedics OPD for 8 months & these patients are followed up for 12 months. We evaluated the clinical outcome like surgical wound healing, range of movements at knee joint, deformity at fracture site, limb length discrepancy, time of union, time of implant removal after surgery &radiological outcome like union, non-union, mal-union, implant failure or breakage.

RESULT:

In our series 37cases of shaft femur fractures were assessed. All patients were followed until fracture union occurred.

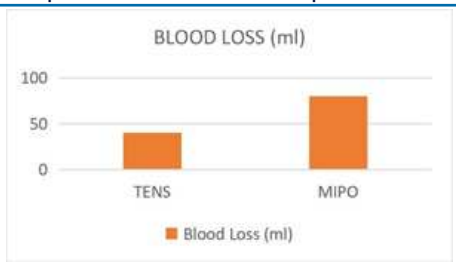
Operationtime

Operative Procedure	Operation Time (Mean)
TENS	60 min
MIPO	50 min

Comment- Operative time is more in TENS than MIPO

Bloodloss

Operative Procedure	Blood Loss (Mean)
TENS	40 ml
MIPO	80 ml



Comment- Blood loss is slightly more in MIPO than TENS

Time Of Union

Operative Procedure	Time of Union
TENS	9 weeks
MIPO	8.2 weeks

Comment- The bony unio noccurs early in MIPO than TENS

Weightbearing

Operative Procedure	Time(Mean)
TENS	10 weeks
MIPO	9 weeks

Comment- Weight bearing is slightly earlier in MIPO than TENS.

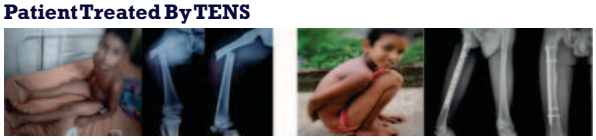
Limblengthdiscrepency

Operative Procedure	Limb length discrepancy (shortening)
TENS	2
MIPO	0

Followup Period

Months	No. Of Case	Mean
15	03	12.25 months
14	10	
12	15	
8	09	

Patient Treated By TENS



Patient Treated By MIPO

DISCUSSION:

There are many effective treatment modalities make the treatment of paediatric shaft femur fracture controversial. Over past few years, for the treatment of paediatric lower limb

fractures various methods have been tried to reduce prolong immobilization & complications. Each method has its own complications : pica cast immobilization alone or following traction had resulted in limb length discrepancy, angulations, rotational deformity, psychologic and economic complications.[22,23]External fixation had resulted in pin-tract infection, loss of knee range of motion and refracture after fixator removal.[24,25]Classic antegrade intramedullary nailing from piriform fossa in growing child can cause avascular necrosis of the femoral head.[26]Open plating allows anatomical reduction however higher incidence of complications like excessive bleeding, ugly scar, infection and non-unionmakes this method less popular.[27]The ideal device to treat paediatric femoral and/or tibial fractures should be a simple, load sharing internal splint, allowing early mobilization while maintaining length and alignment for several weeks until bridging callus forms, without endangering the blood supply to the epiphysis.[28,29] Titanium Elastic Nail System (TENS) & Minimally Invasive Plate Osteosynthesis (MIPO) both are excellent methods of paediatric shaft femur fracture treatment. Among the surgical treatment Titanium Elastic Nail (TEN) showed to be safe & useful in the management of isolated femoral fracture in pediatric population older than six years and under 45 kg of weight.[30,31] Submuscular bridge plating is increasingly being used for paediatric femoral fractures with advantages of preserving fracture biology, less blood loss, smaller scar and lesser chances of infection compared to open $_{\text{plating.}}$32,33,34

CONCLUSION:

In this study, we have evaluated 37patients (18 patients treated with TENS & 19 patients treated with MIPO). We found that patients treated with titanium elastic nail have minimum blood loss during operation, less scar, less operative time, early return to activities, early healing without infection or any major morbidity. But radiation exposure , post operative limb immobilization, knee stiffness & limb length discrepency are the major disadvantage. In this study we also observed that patients treated with minimally invasive plate osteosynthesis have less operative time, early healing, early return to activities, minimum blood loss (slightly more thanTENS) during operation without infection or any major morbidity. But relatively large scar is the major disadvantage.

In our study we found that paediatric shaft femur fractures treated by both methods have satisfactory outcome, but the Minimally Invasive Plate Osteosynthesis (MIPO) is slightly better than Titanium Elastic Nail System (TENS) so far as radiation exposure time, limb immobilization time, knee stiffness & limb length discrepency are concerned.

Ethical & Human Considerations

All the patients gave written informed consent to be included in this study. The study was authorized by ethical committee.

Conflicts Of Interests

The authors declare that they have no conflict of interests regarding the publication of this paper & no financial support was taken from any organization.

Authors' Contributions

All the authors contributed equally & each should be considered as first author.

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