

Comparison of Complications of Stable and Unstable Paediatric Shaft of Femur Fractures Treated With Titanium

Elastic Nails: A prospective study (50 Cases)

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Abstract

Introduction: Fracture shaft of femur is amongst one of the commonest major diaphyseal injuries in school going children presenting to us at emergency department. Over the past two decades the advantages of fracture fixation and early mobilization has been increasingly recognized. Thus there is increasing trend towards internal fixation of the pediatric femoral fractures. Mataizeau & his team from France developed and revolutionized the technique of flexible stable intramedullary pinning (FSIP) using titanium pins which is now popularly known as TENS has become the choice of operative management for pediatric femoral shaft fractures.

Aims: The purpose of this study was to analyze complications seen in children with femur fractures stabilized with titanium elastic nails, comparing their use in stable and unstable fracture patterns.

Methods: A prospective review was performed on 50 consecutive children with femur fractures treated with titanium elastic nails. Patients with comminuted or long

oblique fractures were classified as having “length-unstable” fractures.

Results: In our present study there total 33(66%) complications. Out of total 33 complications which 22 (66.66%) were minor complications and 11(33.33%) were major complications. We observed that there were total 9 patients with minor complications and 5 patients with major complications in out of total 27 patients of stable group. There were total 13 patients with minor complications and 6 patients with major complications in out of total 23 patients of unstable group.

Conclusions: The demonstrated safety of TENS for treatment of length unstable femur fractures—without increased rates of malunion, nonunion, and leg discrepancy—makes TENS an appealing choice for the operative fixation of pediatric femoral shaft fractures regardless of fracture pattern.

Keywords: Pediatric femur fractures, TENS

Introduction

Fracture shaft of femur is amongst one of the commonest major diaphyseal injuries in school going children

presenting to emergency department. Diaphyseal femur fractures account for 1.4% -1.7% of all pediatric fractures.^(1,2) Peak incidence occur at 2 & 17 years of age in a bimodal distribution and boys have a 2.6 times greater incidence than girls (Michael et al 2004).⁽³⁾ .The most of incidents in infants involve falls and child abuse. Motor vehicle collisions are main cause of severe injury in teenagers.

Length unstable fractures have been defined as spiral/long oblique or comminuted, with a fracture line length \geq twice the diameter of the femoral shaft at the level of the fracture.

Fractures of femoral shaft in children have been conservative treated by immobilization in a hip spica cast, Pavlik harness either immediately or after a period of traction.^(4,5,6) Conservative management necessitates a long stay in hospital for traction, subsequent immobilization in an uncomfortable cast. Even conservative management can lead to compartment syndrome, psychological harm, limb discrepancy, angle deviation .^(7,8,9)

The ideal device to treat paediatric femoral shaft fractures would be a simple, load sharing internal splint allowing mobilization and maintenance of alignment for a few weeks until bridging callus forms .The device would also allow rapid healing and ability to remodel without risking the physes or blood supply to the femoral head. Flexible nailing meets the requirements of this ideal device (Flynn et al 2001).⁽¹⁰⁾

Mataizeau& his team from France developed and revolutionized the technique of flexible stable intramedullary pinning (FSIP) using titanium pins which is now popularly known as TENS has become the choice of operative management for pediatric femoral shaft fractures.

Usual complications following TENS are Pain at the site of nail insertion, Inflammatory reaction/bursitis at the entry site, Superficial or deep infection, Knee swelling (synovitis due to nails), Knee stiffness, Leg length discrepancy, Delayed union, Non union, Breakage of nail.^(11,12,13)

Methods

This comparative prospective study was carried out in Dept. of Orthopaedics, S.P. Medical College and P.B.M Hospital, Bikaner. Total 50 patients were included as per predefined inclusion and exclusion criteria. Patients were divided into two groups.

Group 1: - Unstable fractures (spiral, comminuted, or long oblique fractures)

Group 2: -Stable - (transverse and short oblique)

Inclusion Criteria

1. Children between 5-15 years of age
2. Diaphyseal fracture
3. All closed fracture
4. Gustillo Anderson type 1 and 2 fractures

Exclusion Criteria

1. Patients <5 or >15 years of age
2. Metaphyseal fractures
3. Gustillo Anderson type 3 fractures
4. Parents not giving consent for surgery

All the patients with the diagnosis of the shaft femur fracture were assessed clinically after the admission. Primary survey and Initial resuscitation was done in all cases as per latest ATLS guidelines. Radiological examination was done. According to type of fracture group were decided (STABLE,UNSTABLE) biochemical and pathological investigations were done in all the cases. Close observation of all hemodynamic parameters were done. Considering clinical evaluation, radiological evaluation and laboratory results collectively patient were

subjected to either non-operative or operative management according to guidelines.

Operative technique

Two nails were used, one from medial and one from lateral side. Nail diameter measured 40% of the narrowest Isthmus diameter of diaphysis. Both nails were of equal diameter.

Determination of nail length

Length will be measured by placing the nail on draped thigh. The lateral nail should extend from 0.3 cm proximal to distal femoral physis to 1cm. distal to greater trochanteric physis and medial nail should extent from the distal femoral physis to 2cm distal to capital femoral physis.

Nail diameter

Width of the canal was measured at the narrowest point of the diaphysis in both AP and lateral view. Nail diameter measured 40% of the narrowest diameter (Flynn et al). Nails were prepared by bending them at 45 degree° about 2 cm from proximal end to facilitate its entry into the medullary canal and will also bent into an even curve over their entire length. The apex of the bend lie at the fracture site and the depth of curvature would be about three times the diameter of the femoral canal. Medial nail should rest 2 cm. distal to capital femoral physis. Distally nails were cut so that 2 cm. of the nail remain outside the cortex.

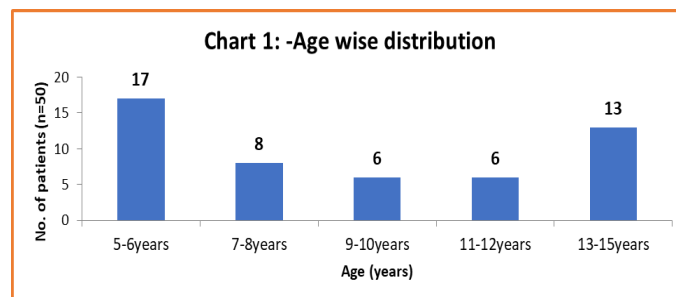
Post Operative Protocol

1. Static quadriceps exercise was started after 24 hours of operation.
2. Gentle knee bending exercise was started on 1st or 2nd postoperative day.
3. Timing of weight bearing was individualized depending on comminution, stability of reduction and rigidity of fixation.
4. Patients who needed unplanned surgery prior to fracture healing categorized as having a “major

complication.” Patients who did not need surgery to address their complication were categorized as having a minor complication.

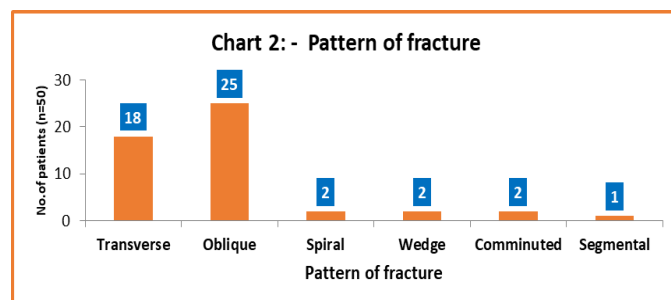
Results

Mean age in our present study (n=50) was 9.27±3.62 years. Maximum patients were from 5-6 years of age group followed by 13-15 years age group. (Chart 1)

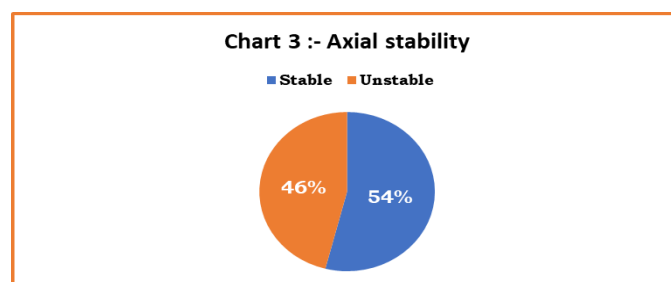


Male to female ratio in our study was 3.54:1 there were 39(78%) males and 11(22%) female n our study.

RTA was most common mode of injury 35 out of total 50 patients (70%) The most common pattern of fracture was oblique (50%) followed by transverse pattern (36%) (Chart 2)



In our present study (n=50) there were total 27 cases (54%) of stable and 23 cases (46%) of unstable pediatric shaft femur fracture. (Chart 3).



There were total 44 close (88%) and 6 open (12%) type of fracture in our present study (n=50).

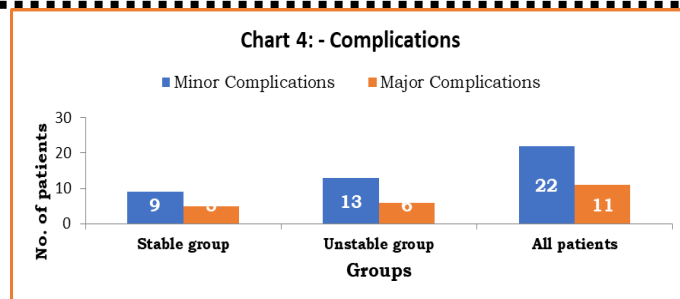
Out of total 50 cases, 40 patients (80%) underwent close reduction and 10 patients 20(%) underwent open reduction in our present study (n=50). Statistically there was no significant difference in the incidence of open reduction between patients. (p=0.279)(x²=1.17)

We found that most patients from both groups had union of fracture between 8-10 weeks. Average time of union was 9.85weeks (unstable=10weeks, stable= 9.69weeks). Statistically there was no significant difference in union time between stable and unstable group. (P=0.719)(x²=1.35) (Table 1)

Table 1: -Distribution of patients according to Union time (weeks)

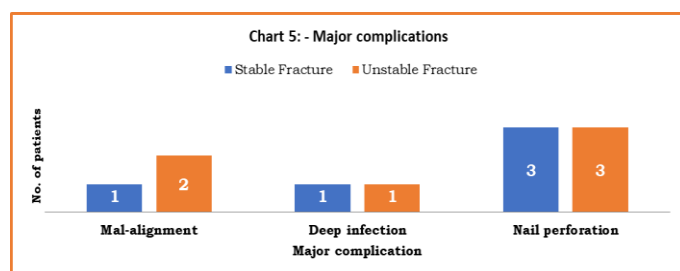
| Sn | Union Time | Stable (n=27) | Unstable (n=23) | Total (n=50) | Percentage (%) | p-value |
|-------|-------------|---------------|-----------------|--------------|----------------|---------|
| 1 | 8-10 weeks | 19 | 13 | 32 | 64% | 0.719 |
| 2 | 10-12 weeks | 5 | 5 | 10 | 20% | |
| 3. | >12 weeks | 2 | 3 | 5 | 10% | |
| 4. | Not united | 1 | 2 | 3 | 6% | |
| Total | | 27 | 23 | 50 | 100% | |

In our present study there total 33(66%) complications. Out of total 33 complications which 22 (66.66%) were minor complications and 11(33.33%) were major complications. (Chart 4)



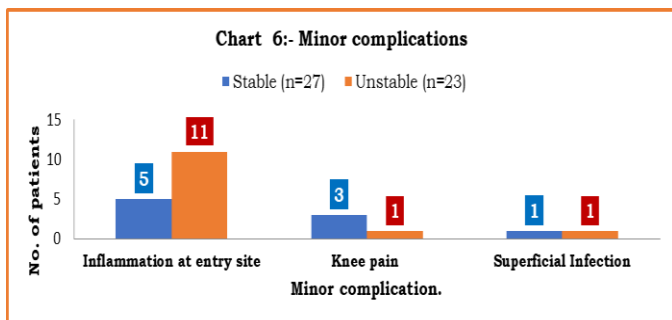
We observed that there were total 9 patients with minor complications and 5 patients with major complications in out of total 27 patients of stable group. There were total 13 patients with minor complications and 6 patients with major complications in out of total 23 patients of unstable group.

We observed that out of 5(18.51%) total patients with major complications in stable group (n=27), 1(3.70%) patient had mal-alignment, 1(3.70%) patient had deep infection and 3(11.10%) patients had nail perforation. Out of 6 (26.08%) total patients with major complications in stable group (n=23), 2(8.69%) patients had mal-alignment, 1(4.34%) patient had deep infection and 3(13.04%) patients had nail perforation. Statistically here was no significant difference in major complications between stable and unstable group. (P=0.855)(x²=0.244) (Chart 5)

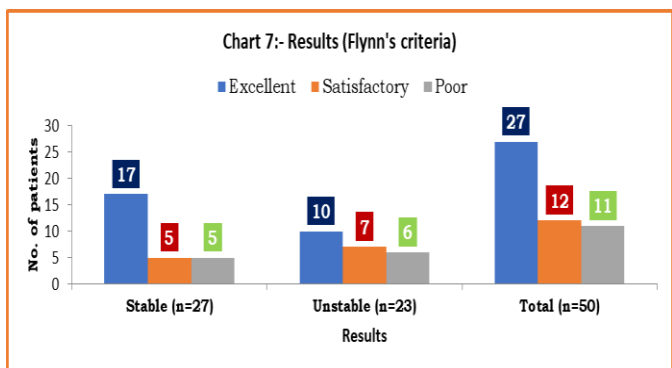


We observed that out of 9(33.33%) total patients with minor complications in stable group (n=27), 5(18.51%) patient had inflammation at entry site, 3(11.10%) patient had knee pain and 1(3.70%) patients had superficial infection. Out of 13 (56.52%) total patients with minor complications in unstable group (n=23), 11(47.82%) patients had inflammation at entry site, 1(4.34%) patient

had knee pain and 1(4.34%) patients had superficial infection. Statistically here was no significant difference in minor between stable and unstable group. (P=0.251)($\chi^2=1.32$) (Chart 6)

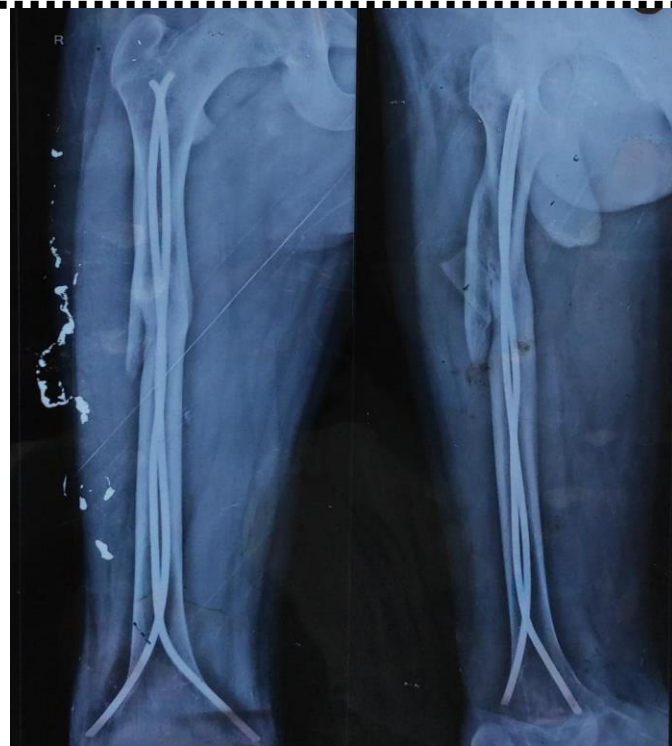


We observed that out of total 27 stable group patients 16 (59.2%) patients had excellent results, 6(22.2%) had satisfactory results and 5(18.51%) had poor results according to Flynn’s criteria. Out of total 23unstable group patients 10(39.13%) patients had excellent results, 7(34.74%) had satisfactory results and 6(26.08%) had poor results according to Flynn’s criteria. Statistically there was no significant difference in result between stable and unstable group.(P=0.362)($\chi^2=2.03$) (Chart 7)



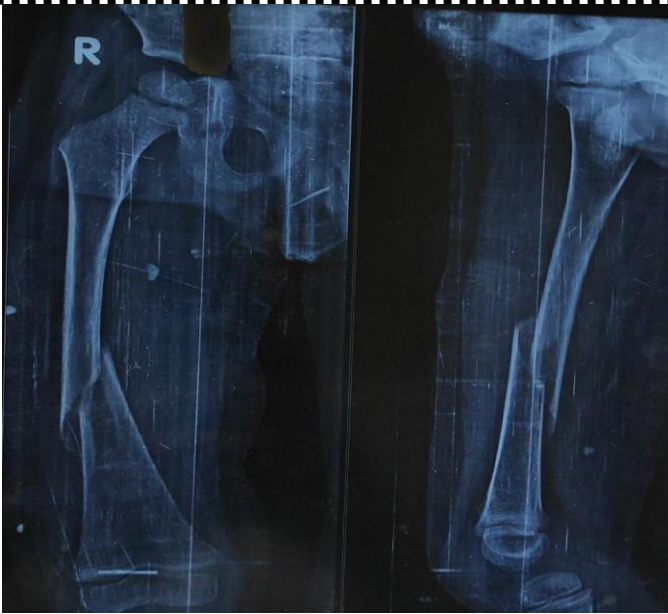
Clinical photograph 1

Excellent outcome in unstable fracture



Clinical photograph 2

Poor outcome 2a pre-operative shaft femur fracture



2b Re-fracture due to malunion



2c Wedge osteotomy and TENS Inserted



Discussion

We compared complications of stable and unstable femur fracture treated with tens nails. It was found that most of complications are due to improper technique, inadequate

size of nails, bending of nails at entry site. Due to significant change in management, complications decreased and now even in unstable femur fracture tens nails is a good implant.

There is learning curve for surgeons in change in complications gradually will decrease with time. Factors described to decrease complications when using elastic nails are: using the largest nail diameter possible, use the same diameter nails, and leave the nail ends short, do not bend nails at entry point, immediate knee bending after dressing, avoid cork screw phenomena and concavo convex loop should be at fracture site for good reduction. Knowledge of these technical “tips” and greater experience with the elastic nail technique certainly played a role in the change in complications.

Minor complications

Knee pain is one of the most common complication of tens in femur fracture. Most common cause of knee pain is soft tissue irritation due to nail at entry. As in flexion of knee nails become more prominent and try to perforate skin. When nails are cut away from entry site repeated soft tissue trauma due to knee movement can lead to higher chances of infection and restriction of knee movement due to pain.

Complications of cutting and bending tens distal from entry can be disasters in study 2 patients got deep infection one of them was lucky union already occurred and tens removed. After few days’ infection resolved, and patient is now healthy with full range of motion at knee joint without any deformity.

Another patient with deep infection presented with thigh swelling, nail perforation with stiff knee. Whole thigh was full of frank pus incision and drainage, tens nails were removed and irrigation and drainage system was also applied.(Clinical Photograph 3)



Clinical photograph 3- Nail perforation

In study it was found that these complications are rare in patents in which TENS nails were cut just distal to entry point without banding nail. After surgery, knee bending in OT table lead to tens nails ends go beneath soft tissue .In study it was found that cutting nails proximally without bending makes implant removal much more difficult .

Limb length discrepancy and malalignment

In study it was found that LLD and malalignment is more common in unstable femur fracture then in stable femur fracture but most of them were having satisfactory outcome(malalignment<10 and LLD <2 cm)

2 patients were presented with malalignment>10 one of them was treated with submuscular plate and another was treated with wedge osteotomy and antegrade TENS. In both of these patient size of nails were smaller than required(nail size <80% of medullary cavity size).

Table 2: Comparison of complication with other studies

| Sn | Studies | Minor Complications | Major complications |
|----|---|---------------------|---------------------|
| | Present study (n=50) | 22 | 11 |
| | Ali A. Siddiqui et al 2021 (n=57) ⁽¹²⁾ | 26 | 3 |
| | Sink EL et al 2018 (n=39) ⁽¹⁴⁾ | 16 | 8 |

Conclusions

Results of our study indicate that skeletally immature children with length unstable femoral shaft fractures can be successfully treated with TENS. TENS yield low rates of both complications and re- vision surgeries, and produce equivalent time to union in both length stable

and length unstable fracture patterns. The demonstrated safety of TENS for treatment of length unstable femur fractures—without increased rates of malunion, nonunion, and leg discrepancy—makes TENS an appealing choice for the operative fixation of pediatric femoral shaft fractures regardless of fracture pattern.

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