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MANAGEMENT OF DIAPHYSEAL FRACTURES WITH TITANIUM ELASTIC NAILING A PROSPECTIVE STUDY

Orthopaedics

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ABSTRACT

Diaphyseal fractures can be treated in many ways where plating , nailing, external fixation and casting all have their indications and limitations. We have studied the use of Titanium Elastic Nailing used in humeral, femoral and tibial shaft fractures in paediatric and adult groups. Studying the average blood loss, complain of pain, encountered irritation at nail insertion site, fewer scars, easy implant removal, shorter bed stay, angulation, average union time and stability with already establish modalities we found that TENS is an attractive alternative. The elasticity and 6point fixation advantage over enders nails enable it to preserve the length and shape of the bone. This method is therefore well tolerated by doctors and patients.

KEYWORDS

Minimally invasive, titanium elastic nail, diaphyseal fracture, TENS, intramedullary fixation, damage control orthopaedics

INTRODUCTION

Diaphyseal fractures of long bones are common major causes of morbidity and mortality in patients. It can be life threatening due to hypovolemic shock, fat embolism and acute respiratory distress syndrome. Disability usually result due to fracture shortening, mal alignment or prolonged immobilization of extremity. Its treatment has undergone modification in recent time due to scientific advances in metallurgy and computerisation.

Methods of diaphyseal fracture treatment include

A . Conservative Methods:

1. Closed Reduction and cast immobilization, Skeletal Traction, Cast bracing

B. Operative Methods:

External Fixation , Internal Fixation –

i) Intramedullary nail - e.g. K- Nailing
a.) Open Technique
b.) Closed Technique

ii) Interlocking Intramedullary nail –

iii) Plate fixation.

Intramedullary devices have been used for many years to stabilize diaphyseal fractures in different age group Interlocking nail has broadened the indications for its use to include high energy fractures with communition, segmental, oblique and spiral segments and patients with multiple Injuries but its role is limited in case of patients critical situation (e.g. poly trauma needing *damage control surgery*, head injury, patient in ICU, paediatric age, associated with vascular and soft tissue injury)[1]. To overcome this, Ender's nailing can be performed in selected fractures. *Stainless steel rods have greater strength, therefore not dependent for opposing bent technique, whereas elastic nature of Titanium rods allow axial deviation with return to normal alignment.* The beneficial principle is now being utilized in managing diaphyseal femoral shaft fractures, tibia & humerus in adolescent, adult & geriatric age group. TENs are titanium nails having elastic property which takes up contour of medullary cavity but at the same time provides sufficient stability and strength at fracture sites[2]. Stainless steel Nails are stronger than Titanium nails in counteracting the bending stress, but it does not have the needed elasticity to achieve *a 6-point contact* and adapt itself to curved medullary contour of diaphysis of long bone. Titanium Elastic Nail has a shape like " Hockey stick" at end, because of its shape, it provides smooth insertion and greater stability. It facilitates bio-mechanics due to its elasticity, hence the outcome of this technique is better. Besides this, the nails protruding outside from the bone facilitates removal[3].

In this study have tried to assess the superiority of TENS for various diaphyseal fractures.

MATERIALS AND METHODS

This was a Randomised prospective study conducted in Dep't of Orthopaedics, in a tertiary hospital conducted over a period of 30 months in Central India.

Inclusion criteria: All closed and open (Gr I) long bone fractures (diaphyseal) e.g. femur, tibia, humerus were included in this study.

Exclusion criteria: Gr II & Gr III, Compound fractures and fractures of fore arm and small bones of hands and feet were excluded from this study. Fractures close to the joint (3") were also excluded. Total study group had 78 patients of all age groups with femoral, tibial and humeral fractures

Criteria for results:

The overall outcome was determined as excellent, good, fair or Poor on following criteria:-

1. Range of motion of neighbouring joint :

- Full and Free…….....**Excellent (4**
- < 15 degree of loss of full flexion/ Extension…….....**Good (3)**
- 30-40 degree of loss of flexion/extension …….....**Fair (2)**
- Restricted …… **Poor (1)**

2. Power of Major muscle group :

- Normal muscle power ……..**Excellent (4)**
- Movement against the resistance ……**Good (3)**
- Movement against the gravity …… **Fair (2)**
- Movement when gravity eliminated ……**Poor (1)**

3. Pain :

- No Pain ……**Excellent (4)**
- Slight Pain in activity …… **Good (3)**
- Slight Pain in rest ……**Fair (2)**
- Variable …… ..**Poor(1)**

4. Radialological assessment:

Residual Angulations (in degrees)

		Excellent(4)	Good (3)	Fair (2)	Poor(1)
Humerus	Saggital plane	< 10	10 -20	20 – 30	> 30
	Coronal plane	< 10	10 – 15	15 –20	> 20
Femur	Saggital plane	<10	10 - 15	15 – 20	> 20
	Coronal plane	< 5	5 – 10	10 - 15	>15
Tibia	Saggital plane	< 4	4 – 8	8 – 10	>10
	Coronal plane	< 5	5 – 10	10 – 15	> 15

MANAGEMENT PROTOCOL

Appropriate traction applied analgesic and other symptomatic treatment started and all relevant tests done after stabilizing a patient in emergency dept. anaesthetic check up requested. Surgery with TENS done and movements started 24 hours later. Patient discharged from hospital with advice to attend physiotherapy clinic for gait training and muscle strengthening exercises. Patients were called after 6 weeks, 3 months, 6 months and 12 months for functional and radiological

assessment. Appropriate statistical tests were applied on observations e.g. student t-test, Chi-square test, Fischer exact test and Pearson correlation.

RESULTS

96 patients were taken for study out of which 18 patients were lost during the follow up, so the observation were done on 78 patients with a one year follow-up. Pre operatively there were no associated nerve palsies. 48 fractures were fixed within five days of injury, 18 were fixed at ten days and 12 fractures were fixed at three weeks. There were 50 male and 28 females.

Age distribution

Age	No of pt.
0-15	28
16-30	12
31-45	4
46-60	10
> 60	24

Mode of injury

RTA	38
fall at home	22
Industrial accident	18

46 - dominant extremity, 32 in non dominant extremity. 59 (76%) patients achieved full and free range of motion , 12 (15%) patients achieved <15 degree of loss of full Extension /Flexion and 7 (9%) had 30-40 degree of loss of Extension/ Flexion and no patients had grossly restricted range of motion.

Power of major muscle group

Normal muscle power	57 (73%)
Movement against the resistance	11(14%)
Movement against the gravity	10(13%)
Movement when gravity eliminated	0

Functional outcome

Excellent	57(73%)
Good	15 (19%)
Fair	6 (8%)
Poor	0

Site

40 patients (51%) had humeral fractures, 24 patients (30%) had femoral fractures and 14 patients (18%) had tibial shaft fractures in our series.

DISCUSSION

.A minimal invasive procedure with minimal blood loss can be an answer to meet special situations like head injury, Damage control orthopaedics, debilitated patients,etc. TENS which involve a small less than 1 cm incision can be considered as a welcome approach , which satisfies both the patient and doctors[4] .In various conditions children with diaphyseal fractures cannot be treated by prolong traction or POP cast immobilization .The need of the day for the adolescents and children should be to stabilize such fractures with minimal invasive procedure and restore early mobility.

The Titanium elastic nails quicken the stabilization and at the same time it encourages early mobility. Considering its elastic property such immobilization allows some amount of movements at the fracture site which encourages good amount of callus formation.

Though the recommended method of treatment of diaphyseal fractures in adult and middle age group is interlocking IM nailing needing sophisticated instrumentations Besides the ante-grade nailing fracture shaft of femur has an inherent problem of avascular necrosis, of the femoral head as it involves extensive reaming. The retrograde nail in femur involves opening of the knee joint. The results of humeral shaft fractures of intra-medullary nail are inferior to plate fixation The tibial locking nail has definitely a superior acceptability than the TENs because the tibial nails encourages early mobility whereas, fractures treated with TENs an additional cast support in the initial period followed by an AFO is required .

In patients with polytrauma, head injury, and with multi-system disorders, there is an inherent hesitation on the parts of surgeons as well as the anesthetist to take up such cases. TENs provide an easier solution as the femoral and tibial fractures can be stabilized with elastic nails under an epidural and caudal anesthesia. Humeral fractures can be stabilized retrogradely with a brachial block.

Some of the fixation of femoral shaft fractures in such patients with MODs was carried out in CCU setup with image intensifier. The primary objective of stabilizing such fracture was to provide good nursing care. Though there was no death related to the operative procedure either in CCU and ICU setup. Average blood loss for femoral shaft fracture fixation was 90ml, tibial shaft was about 60ml and humeral shaft 50ml.

Post operative pain at fracture site is primarily because of the deforming forces acting at the fracture site as TENs with its elastic property is meant not to provide a rigid fixation. For this splintage was given for few days. In any comminuted or segmental fracture, complain of pain was more noticeable. This might be primarily because of instability at the fracture site. We agree that the 3rd segment can be stabilized with circlage wiring which might provide a greater stability. On the other hand t it takes away the very philosophy of treating diaphyseal fracture with minimal invasive and minimal blood loss as it involves opening of the fracture site .We used circlage wiring in only in one patient.

We encountered irritation at nail insertion site in 24 (30%) cases and erosion of soft tissue at insertion point in 3 cases. There was definite association between prominence of nail and skin irritation, but erosion was more noticed in thin and fragile individuals. TENs provide 6 point contact in the inner cortex of diaphysis and it does not allow much of rotational stress acting at the fracture site. It should not be compared with the rigid inter locking nail.

The primary objective of TENs to offer an internal splintage rather than rigid fixation . It is superior to skeletal traction and cast immobilization, because it does not allow a loss of reduction and alignment. It is desirable in children and in adults with special needs to be treated with TENs rather than rigid fixation with interlocking nail, as it involves minimum blood loss, minimal incision and fewer scars, besides implant removal can be a short procedure. The rigid IM nail may injure the blood supply to the femoral head when the IM nail introduced through the pyriformis fossa .The rigid IM nailing requires reaming, hence there is every possibility of AVN and growth disturbances.

TEN is associated with much shorter bed stay and hospital stay in paediatric shaft femur fracture. This has a significant potential of social, psychological and economic benefit. R.F. Hall & A.M. Pankovich (1987) reported 8 cases of post-operative nail back out & 2 cases of post operative radial nerve palsy while treating humeral shaft fractures with Ender's nail[8]. We have encounter only 1 case of post op radial nerve palsy in humeral shaft fractures, which could be attributed to neuropraxia related to intra operative manipulation and traction. The above mention patients had a good recovery within 6 weeks. There were 2 cases of nail back out, out of which one in tibia and the other in humerus. This was seen only in adult age group with osteoporosed bones, which didn't have enough bone stock to offer stable anchoring, but both the fractures healed subsequently. A 6.5 degree of angulation was noticed in humerus in coronal plane and about 10 degree of angulation seen in femur. The femoral angulatory deformity more noticed in heavier children, where as the humeral angulation was noticeable in younger adults with good muscle stock. The angulatory deformity was equally noticeable in comminuted long bone fractures.

The acceptable amount of angulatory deformity is controversial, according to S. Terry Canale *a*ngulation of more than 15 degree in coronal plane and more than 20 degree in saggital plane unacceptable, but he feels that the acceptability depends upon the age of the individuals and he suggests that 45 degree of angulation in saggital plane is acceptable in children[5]. But we feel that such angulation is not acceptable to the X-ray conscious clientele of our hospital.

According to Chapman's Text Book of Orthopaedics[6], in patients of low to moderate functional demands anterior angulation up to 20 degree and 10- 30 degree of varus angulation is acceptable in humeral shaft fractures. Hooper G J, Keddell R G and Penny I D (1991) treated closed or grade I open tibial shaft fractures by closed IM nailing with 10 degree of angulation and concluded that IM nailing is better

treatment[7]. We had almost identical results with TENs, while treating tibial shaft fractures with angulation of 7 degree .we had an average of 8 degree of angulation in femoral shaft fractures and 6.5 degree in humeral shaft fractures. The angulation in femoral and tibial shaft fractures in heavier individuals who started early weight bearing, where as humeral angulation was noticed in unstable and comminuted fractures .but this was avoided by using a little thicker size nail.

The average union time in femoral shaft fractures was 16 weeks in the paediatric age group. In tibial shaft fracture the average union time was 26 weeks, whereas the humeral shaft fractures it was 15 weeks. Z. Zehtab ,Keivan Ahadi and Sadat (2004)[10] while treating tibial shaft fractures with Ender's nail had an average of 32 weeks as healing. Restricted shoulder movement was reported by R F Hall & Pankowitch[8] while treating humeral shaft fractures (We didn't have any single case of restricted shoulder movement while treating humeral shaft fractures. While treating tibial shaft fractures there was no stiffness noticed in knee or in ankle .But in femoral shaft fractures, we noticed restriction of last 15-20 degree of flexion and 10 degree of extension in our initial 2 cases, as our over protective and conservative mind set prevented such patients to start early knee and hip mobilization.

Mataizeu (1993 in France) & Heinrich et al (2000) in their series recommended TENs only for treating femoral shaft fractures in children[9]. We realized the basic principle behind managing diaphyseal femoral fractures with elastic nails. We utilized that fundamental principle in treating diaphyseal fractures of tibia as well as humerus of different age group. Our primary objective while treating diaphyseal fractures in adult patient was to reduce post operative pain , encourage bony healing ,and provide some amount of stability and helped in nursing care . The elastic nail is not designed to provide rigid fixation, hence they are not strong enough to counteract muscle spasm post operatively. But we have realized that TENs provide a unique solution to diaphyseal fractures with patients of special needs. This technique is very refined and cosmetically acceptable to the patients and his family members. Besides in bed ridden patient the method is uniformly acceptable to the nursing care providers in CCU and ICU.

SUMMARY AND CONCLUSION

In this study on 78 patients collected data were analysed and summarized as:-

- Functional results were excellent & complications were minor when treated with Titanium Elastic Nails.
- TENs obviate the need for prolonged bed rest.
- It cut shorts the hospital stay.
- It can quicken stabilization while allowing enough of movements at fracture site to generate excellent callus.
- TENs are easy to use implants.
- Post operative complications are minimal.
- Method of treatment is well tolerated by patients and care providers.
- The implantation technique and after care are refined.

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