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COMPARATIVE STUDY BETWEEN USE OF STAINLESS STEEL ENDERS NAILS AND TITANIUM ELASTIC NAILS FOR TREATMENT OF FRACTURES OF SHAFT FEMUR IN CHILDREN

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ABSTRACT

Objectives: To compare results of Enders and titanium elastic intramedullary nailing for treatment of fractures of shaft femur in children between 5-15 years.

Method: Twenty patients between age group of 5-15 years were treated with stainless steel Enders nailing and twenty patients of same age group were treated with titanium elastic nailing. Results were compared using Flynn etal 2001 criteria.

Results: Average operative time was 36.2 minutes for Enders and 34.6minutes for titanium nailing. Average hospital stay was 6.21 days for Enders and 7.4 days titanium nailing. Average union time was 9.44 weeks in Enders and 9.52 weeks in titanium group. Average full weight bearing was achieved after 10.28 weeks in Enders and after 10.21 weeks in titanium group. Average full range of motion was achieved after 9.97weeks in Enders and after 9.50weeks in titanium group. Nail exterioration, nail irritation, superficial infection and asymptomatic lengthening were complications. Sixteen patients of Enders and fifteen of titanium group had excellent result as per Flynn etal2001 criteria. Rest had satisfactory results. There were no poor results. It indicated similar results in both groups.

Conclusion: We found no statistically significant difference in outcomes of fractures treated with either method in clinical setting. Both methods have their own advantages and disadvantages.

Keywords: Enders nails, Titanium elastic nails, fractures of shaft femur in children

INTRODUCTION

Shaft or diaphyseal fractures of the femur are uncommon but significant injuries in children. They constitute less than 2% of all skeletal injuries in children. The commonest causes of femoral shaft fractures are falls and road traffic accidents. For children under walking age, abuse needs to be considered.[1] For generations traction and casting were standard treatment for all femoral shaft fractures in children and femoral fractures ranked high in duration of hospitalization for single diagnosis. Advantages of spica cast include low cost, excellent safety profile and very high rate of good results with acceptable leg length equality, healing time and motion.[2]

Operative management is becoming a preferred option because of fact that there is decrease in incidence of malunion, shorter hospital stay, lesser surgical cost, better nursing care and early ambulation.[3] There has been growing trend to widen the indications for surgical treatment as attention has been focused on the difficulty of caring for children in body cast for 2-3 months.[4] The methods included external fixation, compression plating and intramedullary nailing with either rigid or flexible nails.[5]

Intramedullary nail fixation has advantages as it is a percutaneous technique which does not damage growth cartilage. It keeps intact the fracture hematoma, maintains stability in three planes and provides opportunity to an early weight bearing giving an early rehabilitation at low cost with a minimal rate of complications.[6] It allows early weight bearing and walking.It aims to develop early bridging callus which contributes to rapid restoration of bone continuity.[7] In addition it requires much less operative time and fluoroscopy time.[8]

MATERIAL AND METHODS

This prospective study is an institutional based comparative study conducted at Indira Gandhi Government Medical College, Nagpur. All surgeries were performed by same surgical team.All patients between 5-15 years age group with closed or uncontaminated grade I compound fracture were included in study.Thorough history taking and clinical examination was done at first visit and patients were admitted after radiological investigations were done.

Patients were divided in two groups, one group to be treated with stainless steel Enders nailingand other with titanium elastic nailing. All patients were operated in supine position.After proper preparation medial and lateral incisions were taken. Using awl, 2-2.5 centimeters proximal to physis, entry point was made. Nails were chosen so that each nail should fill at least 40% of canal by thickness. Nail lengths were predetermined on C-arm for Enders nailing. Two nails of similar thickness were bent approximately 25° at 1.5 centimeters from blunt ends. Both nails were passed up to fracture site. Closed reduction was done and whenever required open reduction was done and either of nail was passed in proximal fragment followed by second nail. Nails hammered to their final position. Thorough wound wash was given. Wounds closed in layers. Sterile dressing applied.Sutures were removed on outpatient basis between 10-14th day.

Patients were allowed partial weight bearing to full weight bearing at first follow up between 4-8 weeks as per pain tolerance of patients.X-rays were taken at every follow up.Clinically wound related complications and limb length discrepancy was monitored.

Results were classified as per criteria described by Flynn et al 2001[11] as depicted in table no 1. Children exceeding the criteria in any category were assigned the worse results.[11]All cases were at least followed for minimum duration of six months.Cases were further followed till the nail removal was done at varying periods.

STATISTICAL METHODS

The descriptive statistics for demographic variables like age, sex were obtained according to two nail types used in the surgery. The mean and standard deviations of diameters were obtained for the two nail types. The significance of difference in the mean nail diameter in both groups was evaluated using *t*-test for independent samples. Mean duration of surgery of two groups was evaluated for significance of difference using *t*-test for independent samples. Also, the difference between the mean stay at hospital for two groups of surgeries was determined using t-test for independent samples. The mean time for union, full weight bearing and full range motion between two surgery types was assessed for statistical significance using the above test.

RESULTS

In our study we derived the following results :-

Minimum age in our series for Enders nailing group was six years, and for titanium elastic nailing group was also six years. And maximum age for Enders nailing group was thirteen years and for titanium elastic nailing group was fifteen years. An average mean age for Enders nailing group was 9.95years and for titanium elastic nailing group was 9.81years. Average age of male patient for Enders nailing was 10.6 years and for titanium elastic nailing was 9.5 years. Average age

of female patients for Enders nailing was 8.3 years and 10.5 years was for titanium elastic nailing. The difference between the mean ages of patients was found statistically insignificant ($p > 0.05$) between two selected groups of Enders and titanium elastic nailing. It indicates that there was no age bias while selecting patients for treatment as regards to age.

In our study overall there was a male preponderance. In our series there were 70% males in Enders nailing group and in titanium elastic nailing group 75% were males and rest were the females. The proportion of males and females selected for the two types of surgeries was statistically insignificant with $p > 0.05$. This indicated randomization as regards the gender distribution in two surgeries.

In our series right side was involved in 42.5 % of patients and in 57.5% of patients left side was involved. In our study side distribution was almost similar in both surgical groups. This indicated randomization as regards the side distribution in two surgeries.

In our study low energy injuries which includes fall were more common cause of fracture femur in children than high energy injuries including road traffic accidents. Distribution of mode of trauma was almost similar in two surgical groups indicating randomization regarding distribution of patients considering the mode of trauma. We had one grade I compound fracture which was treated with Enders nailing and rest were closed ones.

We had two patients with associated injuries. Both hadipsilateral tibia fracture. One patient was treated with Enders nailing for femur and closed reduction and cast for tibia. Other patient was treated with titanium elastic nailing for fractures of femur as well as tibia.

In our series transverse fractures were commonest overall. Oblique fractures were commoner than spiral fractures and comminuted fractures were least common. In our series middle third level fractures were commoner than upper third followed by lower thirdlevel fractures.

In our series total operative time required was average 36.2 minutes for Enders nailing and for titanium elastic nailing it was 34.6 minutes. Maximum time required was 42 minutes and minimum was 30 minutes for Enders nail. For titanium elastic nailing maximum time required was 40 minutes and minimum time required was 30 minutes. There was no statistical significant difference in mean duration of surgery between two surgical groups indicating similar results.

We had to open the fracture for getting reduction in four cases of Enders nailing and two cases of titanium elastic nailing. In most of the situation open reduction was required due to soft tissue interposition.

Average stay at hospital was 6.21 days for patients treated with Enders nailing and 7.4 days for patients treated with titanium elastic nailing. The difference was found to be statistically insignificant with $p > 0.05$ using t-test for independent samples.

On an average union was achieved in 9.44 weeks in Enders nailing group and in 9.52 weeks in titanium elastic nailing group.

Union time was similar in both types of treatments. The difference was statistically insignificant ($p > 0.05$) for 'Union time'.

Our patients were able to bear full weight on an average after 10.28 weeks in Enders nailing group and after 10.21 weeks in titanium elastic nailing group. Out come in terms of time for full weight bearing was similar in both types of treatment. The difference was statistically insignificant ($p > 0.05$) for time for full weight bearing.

Full range of motion was achieved in on an average after 9.97weeks in Enders nailing group and after 9.50weeks in titanium elastic nailing group. Outcome in terms of time for full range of motion was similar in both types of treatments. The difference was statistically insignificant ($p > 0.05$) for full range of motion.

In our series there were no major complications. There was a single case of superficial infection in both groups which resolved with course of

antibiotics for few days. There was one case of nail exterioration in titanium elastic nailing group which was asymptomatic and was found incidentally when a patient was called for implant removal. There were three patients in titanium elastic nailing group and two in Enders nailing group who suffered irritation at entry site of nail. All were resolved with course of few days of analgesics. There were four cases of lengthening in Enders nailing group and five cases of lengthening in titanium elastic nailing group. Lengthening was less than one centimeter in all cases and was clinically asymptomatic.

In our series in Enders nailing group sixteen patients had excellent results and four patients had satisfactory results. There were no poor results. In titanium elastic nailing group fifteen patients had excellent results and five patients had satisfactory results. There were no poor results.

Flynn et al 2001 scoring was almost similar in both surgical groups indicating similar results in both groups. The results of our study are also depicted in the X- ray photographs provided.

DISCUSSION

Goals of treatment of femoral shaft fractures in children and adolescent are achieving bone union with length, alignment and limb's functional restoration, without losing movements of adjacent joints.[12]

Enders and titanium elastic nails are the two types of flexible intramedullary nails used over the years; and both of them are consistently producing good results. [13]Small incision is required for these procedures. They usually require less time and minimal blood loss occur without damaging epiphyseal area. [14] Retrograde fixation is preferred. It has demonstrated significantly less axial range of motion and greater torsional stiffness than antegrade fixation in transverse as well as communited fracture patterns.[15]Normally recommendation for distal third femur fractures is antegrade nail insertion. But study done by Mehlman et al in synthetic models demonstrated that given satisfactory cortical starting points in the distal fragment, retrograde insertion provides greater stability.[16] Even about rotational stability, the study done by Gwyn et al has proved that this method of fixation provides a consistent mean of rotational stability for variety of fracture pattern in a synthetic model.[17]Most of the complications are caused by use of too thin nails, asymmetry of the frame, and malorientation of the implants.[18]

Many studies have proven efficacy of both methods in treatment of femoral shaft fractures but very few have discussed about comparison of both methods of fixation. According to Wall EJ et al 2008 the in vitro mechanical studies comparing the two types of nails have demonstrated superior or equal stability in association with the use of titanium nails as compared with stainless steel nail. Biomechanical properties of titanium are often considered to be better than those of stainless steel with regard to biocompatibility, modulus of elasticity, osseointegration, corrosion resistance, and magnetic resonance imaging compatibility.But in clinical setting he has found superior results with use Enders nails as compared with titanium elastic nails in terms of rate of malunion. He hypothesized that the increased flexibility of titanium as compared with stainless steel nails may be responsible for the outcome. He stated that stainless steel nails are stiffer than titanium nails, which may be beneficial for preventing angular malunions following pediatric femoral fractures. [19] But there are some recent studies which have found no difference between clinical outcomes of both procedures.

According to study performed by Lohiya et al 2011, there was no difference in results with type of nail used in his series ($p = 0.12$). Furthermore, he concluded that stainless steel nails produce results similar to titanium nails at considerably lesser price. [20]

In another study performed by Kumar et al 2011 in sixty two fractures treated with flexible intramedullary nailing, he did not find any mismatch in the results of fractures stabilized with

titanium elastic nails or with that of Enders nails.[21]

CONCLUSION

We found that flexible intramedullary nailing is effective method of treatment for fractures of shaft of femur in pediatric age group between five to fifteen years with good outcomes and reasonably less complications. Enders nailing and titanium elastic nailing both are effective in treatment of femoral shaft fractures in children. We found no statistically significant difference in outcomes of fractures treated with either method in clinical setting. Both methods have their own advantages. Using titanium elastic nail the insertion of nail and negotiation of fracture was much easier as compared with Enders Nails. But implant removal was difficult compared to Enders nail. On the other hand Enders nail are much cheaper as compared to titanium elastic nail which is important aspect in Indian scenario.

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Criteria described by Flynn *et al* for evaluation of final outcome in fixation of fracture shaft femur (2001)

Parameters	Excellent	Satisfactory	Poor
Limb length inequality	Less than 1 centimeter	Less than 2 centimeters	More than 2 centimeters
Malalignment	Up to 5^0	$5\text{-}10^0$	More than 10^0
Pain	None	None	Present
Other complications	None	Minor	Major complication and/or lasting morbidity

Photographs of X rays

Titanium Elastic Nailing Group X-Rays

1) Case – 1

a) Pre-operative X ray

b) Immediate post operative X ray

c) Union seen on X ray at 9 weeks

Enders Nailing Group X-Rays

Case no. 1 :-a) Preoperative X ray

b) Immediate post operative X ray

c) Union seen on X ray at 9 weeks