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## LONG TERM FUNCTIONAL OUTCOME OF FEMORAL DIAPHYSEAL FRACTURES TREATED WITH DYNAMIC COMPRESSION PLATE AND TITANIUM ELASTIC NAILING

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### ABSTRACT

**Background:** There are a wide variety of non surgical treatment and surgical options available such as spica casting, traction followed by casting, plate fixation and flexible intramedullary nails for femur diaphyseal fractures in children. There is no clear consensus as to the ideal treatment.

**Methods:** We report our experience with a prospective comparative study involving 120 cases of femoral diaphyseal fractures treated with DCP and TENS with follow up of over a period of three years. Outcome was assessed with criteria of Flynn *et al*<sup>1</sup>. At the end of second and third year Harris hip score<sup>2</sup> was applied to assess the functional outcome.

**Results:** Out of the hundred and twenty cases 96 had middle / 3<sup>rd</sup> fractures. Mean age was 10.85± 2.26 years. Time taken for toe touch walking and union time for Group-I (DCP) and Group-II (TENS) were 7.85±2.23 & 17.90±5.09 weeks and 3.97±1.68 & 13.00±1.37 weeks respectively. Nine cases in Group-I and 6 cases in Group-II had limb length discrepancy and there were 6 cases with coronal plane angulation in Group-II. Functional outcome was better in Group-II at the end of one year. But the functional outcome at the end of second and third year of both the groups was similar.

**Conclusion:** Even though long term functional outcome of both procedures are similar, TENS has several statistically significant advantages over DCP in relation to patient morbidity. Hence a better choice of implant for pediatric femoral diaphyseal fractures.

**Keywords:** Femur; Dynamic compression plating (DCP); Titanium elastic nailing (TENS).

### INTRODUCTION

Femoral shaft fracture is an incapacitating pediatric injury<sup>3</sup>. There are a wide variety of non surgical treatment and surgical options available such as spica casting, traction followed by casting, plate fixation and flexible intramedullary nails with no clear consensus as to the preferred treatment<sup>4</sup>. Internal fixation of paediatric shaft femur fracture by elastically stable intramedullary nail (ESIN) is gradually replacing conservative treatment<sup>5</sup>. The material properties of titanium confer advantages for an implant used to stabilize pediatric femur fractures<sup>6</sup>. Although good results have been reported with elastic

intramedullary nails, plate fixation continues to be a viable alternative in surgical treatment of femoral shaft fractures<sup>7</sup>. It is also considered that, compression plate fixation is a safe and effective treatment in children with both isolated femoral shaft fracture and those associated multiple injuries<sup>8</sup>.

The aim of this study was to identify the implant of choice for femoral diaphyseal fractures in paediatric age group with regard to immediate and long term functional outcomes.

## MATERIAL AND METHODS

The ethical clearance for the study was obtained from the Institutional Ethical Committee of our hospital on 21-07-2008 and Informed consent was taken from each of the parents/guardians of the patients in their own vernacular language.

We conducted a prospective comparative study. Patients who presented to the out-patient department and casualty of the hospital with femoral diaphyseal fractures during August 2008 to August 2010 were considered for the study and each case was followed up for a period of three years from the date of enrollment. Closed femur diaphyseal fractures in the age group of 6-14 years were included in the study. Children aged < 6 years and > 14 years, children with open fractures and in whom metaphyseal extension was present were excluded from the study.

**DCP Procedure:** Lateral approach for femur was used in all patients. After achieving the temporary anatomical stable reduction with k-wires, it was fixed with Dynamic Compression Plate.

**TENS Procedure:** Nail diameter was determined by using the formula, Nail Diameter=Diameter of the medullary cavity at its narrowest part/2 - 0.5<sup>9</sup>. The nails were prebent to three times the diameter of the narrowest part of the medullary cavity to generate optimal resistance to malaligning forces<sup>10</sup>. The insertion points on femur were marked 2 to 3 cms proximal to the distal epiphyseal plate, determined under image intensifier. Nails of predetermined diameter were prebent and inserted to the medullary cavity with the help of a nail inserter.

Postoperatively 2 days of intravenous third generation cephalosporin was given. Isometric quadriceps strengthening exercise, hip and knee joint mobilization exercises were advised on first post operative day. Toe touch walking was delayed till the appearance of callus radiologically. All the patients had regular follow ups at an

interval of 4 weeks till six months and then, they were followed up once in every three months for one year and once in six months for next two years. There were no drop outs.

The TENS outcome score suggested by Flynn *et.al*<sup>1</sup> was applied to all the cases in the study after fracture union, irrespective of the mode of treatment. The outcome was graded as Excellent / Satisfactory / Poor. Then Harris hip score<sup>2</sup> was applied the end of second and third year of follow up.

## RESULTS

Femur shaft fractures were found to have high incidence in the age group of 12-14 years with Mean  $\pm$  SD 10.85 $\pm$ 2.26. Out of the 120 cases there were 93 (77.5%) males and 27 (22.5%) females. The most common mode of injury in our study was road traffic accident (RTA).

In the study 96 cases (80%) had femur shaft fracture in the middle 3<sup>rd</sup>. There were 54 cases (45%), 51 cases (42.5%) and 15 cases (12.5%) of transverse, oblique and spiral fractures respectively.

The time taken for the completion of procedure in group I was 95.60 $\pm$ 8.47 minutes and in group II was 93. $\pm$ 9.04 minutes with a p value of 0.496. The amount of blood loss in group I was 96.5 $\pm$  13.02 ml and in group II was 36.75 $\pm$  8.77ml with a p value of <0.001. Three case (5%) in group I was immobilized with hip spica. Twelve (20%) cases in group II were immobilized with hip spica.

Group I had a mean hospital stay of 15.30  $\pm$  6.14 days, mean duration for toe touch walking was (started after the appearance of callus radiologically) 7.85  $\pm$  2.23 weeks and mean duration of union was 17.90  $\pm$  5.09 weeks. In group II mean hospital stay was 11.80  $\pm$  5.87 days, mean duration for toe touch walking was 3.97  $\pm$  1.68 weeks and the mean duration of union was 13.00 $\pm$ 1.37 weeks.

**Table 1 Comparison of outcome variables between two groups**

Outcome	DCP (n=60)	TENS (n=60)	Total (n=120)	P value
Mean Hospital stay in days	15.30±6.14	11.80±5.17	13.55±5.87	0.059+
Ambulation-toe touch walking( weeks)	7.85±2.23	3.97±1.68	5.91±2.77	<0.001**
Callus(weeks)	12.00±2.75	5.45±1.28	8.73±3.94	<0.001**
Union(weeks)	17.90±5.09	13.00±1.37	15.45±4.44	<0.001**

Limb length inequality was found in 9 cases (15%) and 6 cases (10%) in group I and group II respectively at the end of first year. In all these cases it was <2cms. At the end of third year only 2 cases of group I had limb length inequality in the form of lengthening. Malalignment was not observed in group I and was noted in 6 cases (10%) of group II. In group II malalignment was in coronal plane and was < 5° in all the cases. At the end of three years none of the cases had malalignment in any plane. There were 12(20%) cases with complications in group I, of which 9 cases had superficial infection and 3 cases had implant failure. Nine cases (15%) developed complications in group II 6 in the form of entry point bursitis and 3 cases had superficial infection.

Functional outcome was assessed with Flynn's TENS outcome score<sup>2</sup>, applied to both the groups at the end of first year of follow up. Functional outcome at the end of first year-Group I had poor result in 3 cases (5%), satisfactory in 15 cases (25%) and excellent in 42 cases (70%). In group II satisfactory results was observed in 12 cases (20%) and excellent results in 48 cases (80%). Harris hip score at the end of second year of follow up had 6 cases (10%) in group I and 4 cases (6.6%) in group II with good functional outcome rest had excellent outcome. At the end of third year all cases in each group showed excellent outcome according to Harris hip score<sup>2</sup>.

**Table 2 Comparison of complications between two procedures**

Complications	DCP (n=60)	TENS (n=60)	Total (n=120)
Nil	48(80.0%)	51(85.0%)	99(82.5%)
Yes	12(20.0%)	9(15.0%)	21(17.5%)
• Entry point bursae	0	6(10.0%)	6(5.0%)
• Superficial infection	9(15.0%)	3(5.0%)	12(10.0%)
• Implant failure+Knee stiffness	3(5.0%)	0	3(2.5%)
Inference	Complication are more in statistically similar in two groups with P=0.677		



“Entry point infection” “Entry point bursa” “Implant failure with DCP”

## DISCUSSION

As surgeons consider different methods to treat pediatric femur fractures and mobilize the injured child, the ideal mode of treatment remains controversial<sup>11</sup>.

Titanium elastic nails are popular for the management of length-stable diaphyseal femoral fractures in school-age children. Recently, sub muscular plating has been found to be a successful alternative option for management of length-unstable femoral fractures in school-age children<sup>11</sup>.

In the present study the average time taken for union in patients treated with DCP (Group-I) was  $17.90 \pm 5.09$  weeks and that in patients treated with TENS (Group-II) was  $13.00 \pm 1.37$  weeks which was statistically significant. In Group-I the union time is slightly higher when compared to reported results<sup>8,13, 14, 15</sup> and in Group-II it is comparable to reported time for union<sup>6, 1, 16, 17</sup>. In our study we advised the patients, pain tolerated toe touch weight bearing with assistive devices as soon as the callus was visible radiologically. Group-I patients started toe touch walking at around  $7.85 \pm 2.23$  weeks where as Group-II patients started toe touch walking early at  $3.97 \pm 1.68$  weeks which is statistically significant with p value  $< 0.001$ . The results are similar to Fyodorov I et al<sup>13</sup> (6 weeks) and Agus H<sup>14</sup> (8.5 weeks) in those treated with DCP for femur shaft fractures. And

the study involving TENS as treatment modality reports of about 4 weeks (Flynn JM et al<sup>1</sup>).

Three cases in group I (5%) were immobilized with hip spica. Twelve cases in group II (20%) were immobilized with hip spica. We found that incidence of hip spica was higher in Group-II (TENS) but was not statistically significant. Eren OT et al<sup>1</sup> reported about 25% incidence of immobilization in patients treated with DCP and Flynn JM et al<sup>1</sup> reported around 29.3% incidence of immobilization in femur shaft fractures treated with TENS, similarly Moroz LA et al<sup>18</sup> report it to be around 22.2%. As the decision to immobilize was based on fracture anatomy, the strength of the fixation and confidence of the operating surgeon on the fixation, it is difficult to draw a statistically valid conclusion.

In our study, after the procedure, except the patients who were immobilized the rest were advised to move the hip and the knee while lying on the bed from the second day. None of the patients moved their limbs on second post operative day in Group- I where as in Group-II 16(80%) patients started hip and knee mobilization from second day onwards, which was statistically significant with p value  $< 0.001$ . The presence of the large surgical wound and the associated pain in patients treated with DCP may have caused the delay in mobilization. Carey TP et al<sup>16</sup> report an average time for mobilization of 5.5 days with TENS, similarly Flynn JM et al<sup>1</sup>

report it as 9 days. Timothy W et al<sup>19</sup> report average time for mobilization as six weeks in patients treated with DCP.

Our study noted a mean duration of hospital stay in Group-I to be 15.30±6.14 days and in Group-II to be 11.80±5.17, which was not statistically significant. Many reports suggest decreased hospital stay in patients treated with TENS<sup>6, 9, 17</sup> compared to those treated with DCP, but this could not be observed in our study, probably because the time of discharge was seldom decided by the surgeon. It was more commonly influenced by the financial constrains of the patient.

In our study we noted the limb length inequality was around 15 % (9) in Group-I and around 10% (6) in Group-II but the distribution was statistically similar in both the groups and it was in all cases <2cms. There is wide range of limb length inequality reported in other studies. Timothy W et al<sup>19</sup> reports 4.3% where as Eren OT et al<sup>14</sup> report around 54% in femur shaft fractures treated with DCP. In patients treated with TENS, reports by Ligier JN et al<sup>9</sup>, Saikia KC et al<sup>16</sup> and Roop Singh et al<sup>6</sup> have recorded 12%, 13.6% and 8.5% respectively. Malalignment (angulation or rotation) was not found in Group-I and was 10 % (6) in Group-II (varus angulation only, no rotation), which was statistically similar in both the groups, none of the cases showed >5<sup>0</sup> of malalignment. Carey TP et al<sup>16</sup>, Ligier JN et al<sup>9</sup>, Saikia KC et al<sup>17</sup> and Roop Singh et al<sup>6</sup> report 8%, 11%, 9.09% and 8.57% incidence of malalignment in cases treated with TENS respectively.

In our study 12 cases out of 60 in group I developed complications in the form superficial infection in 9 and implant failure in 3 cases. The cases which developed superficial infection resolved with regular dressings and extended oral antibiotics. The patients (3) who had implant failure were dealt individually. Group-II had 9 cases with minor complications. Six cases (10%) had burse at the site of entry point in distal femur and 3 (5%) case developed superficial infection. Superficial infection was resolved with regular

dressings and extended oral antibiotics, which could have been avoided by leaving shorter length of nail outside femur and proper trimming of the nail ends.

Functional outcome was assessed in both Group-I and Group-II by applying the TENS outcome scoring<sup>1</sup> system at the end of one year. Group I had poor result in 3 cases (5%), satisfactory in 15 cases (25%) and excellent in 42 cases (70%). In group II satisfactory results was observed in 12 cases (20%) and excellent results in 48 cases (80%). Harris hip score at the end of second year of follow up had 6 cases (10%) in group I and 4 cases (6.6%) in group II with good functional outcome rest had excellent outcome. At the end of third year all cases in each group showed excellent outcome according to Harris hip score<sup>2</sup>.

## CONCLUSION

In TENS blood loss is minimal, minimally invasive, has got good early union rate. Implant failure rate is less and easy to remove. Only disadvantage is radiation and some cases required short term immobilization. Even though functional outcome at the end of one year and three years are statistically similar, TENS has a number of statistically significant advantages over DCP in terms patient morbidity. Hence TENS is the implant of choice at present for femoral diaphyseal fractures in children aged 6-14 years.

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