

Original Research Article

Comparative Study of Paediatric Femur Shaft Fracture Treated With TENS and DCP

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Abstract: Introduction: Paediatric femoral shaft fractures are common injuries in the age group treated by an orthopaedic surgeon. These fractures typically occur either in the early childhood when weak woven bone is changing to the stronger lamellar bone or at adolescence when children are subject to high energy trauma from motor vehicle accidents or from sports [1]. Femoral shaft fractures represent around 2.2% of all bony injuries in children. There are varieties of approaches to treat femoral fractures in the field of medical science. The aim of this study is to compare the outcomes between TENS and DCP approach for paediatric femur shaft fracture. **Methodology:** This was a prospective comparative study conducted at the department of Orthopaedics Surgery in Dhaka Orthopaedics Hospital, Dhaka, Bangladesh during December, 2017 to November, 2019. The ethical clearance of this study was obtained from the ethics committee of the hospital and a total of 23 children were enrolled in this study. The children were divided into two groups, TENS group (n=14), DCP group (n=9). The collected data were analyzed using Statistical Package for Social Sciences (SPSS), software, version-23.0. **Results:** A total of 23 children aged 6-18 were enrolled in this study. Among the children 78 % were male and 22% were female. The mean age of the children was 10.7 years. In TENS group 9(63%) children fall from height and followed by 4(28%) got road traffic accident, and 1(7%) blunt trauma whereas in DCP group, 6(66%) fall from height and followed by 2(22%) got road traffic accident, and 1(11%) blunt trauma. In TENS group, 2(14%) children had radiologically comminuted fracture and followed by 3(21%) oblique, 9(63%) transverse whereas, in DCP group, 1(11%) children had comminuted radiological fracture and followed by 2(22%) oblique and 6(66%) transverse. In TENS group, the mean duration of surgery was 53.00 ± 9.20 minutes while the mean duration of surgery in DCP group was 60.00 ± 16.52 minutes, which was not statistically significant (P= 0.204). The mean duration of hospital stay of the children of TENS group was 6.10 ± 1.20 days while the DCP group was 7.64 ± 1.3 days which was statistically significant (p=0.005). According to Flynn criteria, in TENS group, excellent performed 13(93%) and followed by Satisfactory (17%) and there was no poor performance observed while in DCP group, Excellent performed 5(55%) and followed by Satisfactory (33%) and 1(11%) poor, which was statistically significant (p=0.035). In TENS group, the mean time of complete radiographic union was 3.99 months whereas in DCP, the mean time of complete radiographic union was 3.66 months which was statistically significant (p=0.016). The mean time for weight bearing was the same as the mean time of complete radiographic union in both TENS and DCP groups. Among the children in TENS group, 4(28%) had Knee stiffness and followed by superficial Infection (1(7%) Non Union (0%), acceptable Mal Union 1(7%) while in DCP group, 1(11%) children had Knee stiffness and followed by 3(33%) superficial infection, (0 %) Non Union and 1(11%) acceptable Mal union which was statistically significant (p=0.050). **Conclusion:** This

Comparative study suggests that TENS is more adaptable and can achieve biological fixation, with minimal complications compared to DCP. Therefore, this study concluded that TENS is better procedure for fracture shaft femur in children than DCP.

Keywords: Comparison, Outcome, Between, TENS, DCP, Paediatric Femur, Shaft Fracture.

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INTRODUCTION

Paediatric femoral shaft fractures are common injuries in the pediatric age group treated by an orthopaedic surgeon. These fractures typically occur either in the early childhood when weak woven bone is changing to the stronger lamellar bone or at adolescence when children are subject to high energy trauma from motor vehicle accidents or from sports [1]. Femoral shaft fractures represent around 2.2% (approximately) of all bony injuries in children [2, 3] In the last twenty years, there was an increased interest in the operative treatment of pediatric fractures, although debate persisted over its indications [4]. Historical treatment is with plaster of paris cast [5].

There is little disagreement concerning the treatment of long bone fractures in children less than 5 years (plaster of paris cast) and adolescents older than 16 years (locked intramedullary nailing). But regarding the optimal treatment between age 5 to 16 years controversy persists, with several available alternatives: traction followed by hip spica and intramedullary nailing, external fixation, flexible stable intramedullary nails and plate fixation [6]. Whatever the method of treatment, the goals should be to stabilize the fracture, to maintain length and alignment, to promote bone healing, and to minimize the morbidity and complications for the child and his/her family. Treatment of pediatric fractures dramatically changed in 1982, when Metaizeau and the team from Nancy, France, developed the technique of elastic stable intramedullary nailing (ESIN) using titanium nails [7].

The flexibility of the titanium elastic nails (TENS) allows it to be inserted at a point which avoids disruption of the growth plate [8]. The aim of this biological, minimally invasive fracture treatment is to achieve a level of reduction and stabilization that is appropriate to the age of the child. The biomechanical principle of the titanium elastic nail (TEN) is based on "3 point principle" (the symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which bears against the inner bone at three points) [8, 9].

The ESIN has the benefits of early immediate stability to the involved bone segment, which permits early mobilization and return to the normal activities of the patients, respect for the physes, minimal scarring with very low complication rate [10]. Added to this,

repeated micromotion at fracture site enables early union whereas, usually, fixation is achieved by a dynamic compression plate (DCP), and it is generally accepted that this gives satisfactory results [11- 13] Use of this plate, however, requires extensive dissection and is complicated by the proximity of neuro-vascular structures and the risk of mechanical failure in osteopenic bone. But, there are very few studies and limited data on comparing the efficacy of TENS and DCP in the treatment of femur shaft fractures in Bangladesh. Therefore, the researcher has designed this study to justify the exact efficacy of TENS and DCP approach in the treatment of femur shaft fractures in children in Bangladesh.

OBJECTIVES

General objective: To Compare the outcomes between TENS and DCP approach for paediatric femur shaft fracture:

Specific Objectives:

- To find out the Demographic characteristics of the study patients.
- To know the gender distribution of the study patients.
- To identify the types of injury observed among the study patients.
- To calculate the duration of surgery and hospital stay of the study patients
- To compare the outcomes of the children operated for femur fractures TENS VS DCP groups
- To observe the complications among the children operated for femur fractures TENS VS DCP groups.

METHODOLOGY

This was a prospective comparative study conducted at the Department of Orthopaedic Surgery in Dhaka Orthopaedics Hospital, Dhaka, Bangladesh during December, 2018 to November, 2019. The ethical clearance of this study was obtained from the ethics committee of the hospital. A written consent was obtained by the guardian/ care givers of the children and a total of 23 children aged (6-18) years with various types of Femur Shaft Fracture were enrolled in this study and divided into two groups, TENS(n=14) and DCP(n=9). Children in the TENS group were treated with Titanium Elastic Nailing System (TENS) and the children in the DCP group were treated with Dynamic

Compression Plating (DCP). The patients having multiple fractures, open fractures, pathological fractures and unwilling to give consent were excluded from this study. All the cases were operated within 24 hours of their admission in the hospital. Routine pre anesthetic work up was performed for all patients. Preoperative planning was done as per standard guidelines for both the treatment procedures. The TENS group included classification of fracture according to Winquist classification and measuring the diameter of the medullary canal at the isthmus in order to calculate probable diameter of the elastic nail. This was obtained using the formula (diameter in mm x 0.4) i.e 40% of canal diameter. Standard aseptic precautions were followed in the operation theater. Surgeries were performed on traction table and fluoroscopy used to guide fracture reduction and implant placement. Two titanium elastic nails were used for each fracture. The nails were pre-bent before insertion. Insertion was done in retrograde direction. Closed stable reduction of the fracture was attempted prior to incision. Skin incision of about 2 cm size was given over medial and lateral aspect of lower thigh at the level of the upper pole of patella. Using a 4.5 mm bone awl or Steinman pin entry was made about 2–3 cm proximal to the physis at an angle directed into the canal. Titanium elastic nails of appropriate size was inserted and gently hammered across the fracture site and rotated appropriately to

engage in the proximal femoral metaphyses in a divergent fashion. Approximately 2–3 cm of nail was left outside the entry site and cut to allow for extraction. End of the nail were not bent and allowed to lie flush with the bone to prevent skin irritation. Patients were discharged from hospital on 3rd to 5th postoperative day, stitches were cut on 10th to 14th postoperative day, called for first follow up at 3rd week for radiological evaluation and knee bending status, and allowed partial weight bearing on 4 to 6 weeks if the X- ray showed bridging callus formation in both AP and Lateral views. Subsequent follow up was done at 3rd month, 6th month and 12th month (1 year) postoperatively. In follow up visits patients were evaluated for functional outcome by Flynn’s criteria and were looked in for complications like malunion, delayed union, knee stiffness, pain at entry site and evidence of infection. The observed data were collected and preserved in a pre-structured Case Record Form (CRF). The collected and preserved data were analyzed using Statistical Package for Social Sciences (SPSS), software, version-23.0. The results were compare between the groups by Chi-square test and Unpaired t test with 95% CI, where $p < 0.05$ considered as the level of significance.

RESULTS

Table 1: Demographic characteristics of the study patients (n=23).

Age group (in years)	TENS (n=14)	Percentage	DCP (n=9)	Percentage (%)
6-12	5	36	3	33
13-18	8	50	6	66
Gender				
Male	12	86	6	66
Female	3	21	3	22
Mean Age (years)	10.70			

Table 1 shows the demographic characteristics of the study patients. According to the demographic characteristics distribution, in TENS group, 2914%) children belong to the age group of <6 years and followed by 5936%) children age group of (6-12), 7(50%) children age group of (13-18) while in the DCP group, 1(11%) children belong to the age group of <6

years and followed by 3(33%) children (6-12) years and 6(66%) children (13-18) years. Among the study children, 18(78%) were male and 5(22%) were female. Of them, 12(86%) were male in TENS group and 6(66%) in DCP group while 3(21%) were female children in TENS group and 2(22%) in DCP group.

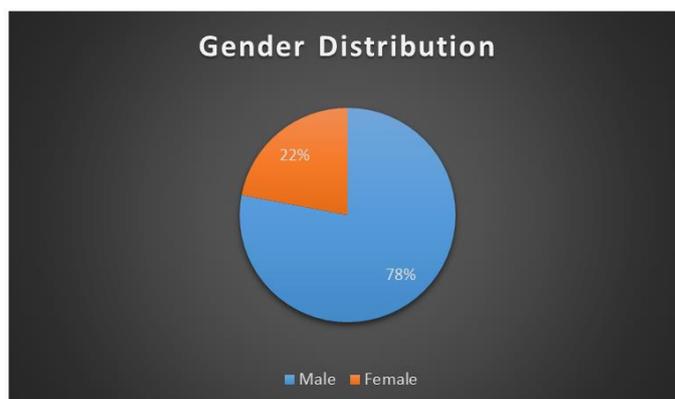


Fig 1 shows the gender distribution of the study patients.

Table 2: Mechanism of injury observed among the study patients (n=23).

Mechanism of Injury	TENS (n=14)	%	DCP (n=9)	%
Fall from height	9	63	6	66
Road traffic Accident	4	28	2	22
Blunt trauma	1	7	1	11

Table-2 shows the mechanism of injury observed among the study patients. In TENS group 9(63%) fall from height and followed by 4(28%) got

road traffic accident, 1(7%) blunt trauma whereas in DCP group, 6(66%) fall from height and followed by 2(22%) got road traffic accident, 1(11%) blunt trauma.

Table 3: Radiological fracture observed among the study patients (n=23).

Radiological Fracture	TENS (n=14)	%	DCP (n=9)	%
Comminuted	2	14	1	11
Oblique	3	21	2	22
Transverse	9	63	6	66

Table-3: shows the types of injury among the study patients. In TENS group, 2(14%) children had comminuted radiological fracture and followed by 3(21%) oblique, 9(63%) transverse whereas, in DCP

group, 1(11%) children had comminuted radiological fracture and followed by 2(22%) oblique and 6(66%) transverse.

Table 4: Duration of surgery and hospital stay operated for femur fractures TENS VS DCP (n=23).

Mode of Surgery	Duration of surgery (in minutes) Mean± SD	Duration of hospital stay (in days) Mean± SD
TENS	53.00 ±9.20	6.10 ± 1.20
DCP	60.00±16.52	7.64 ± 1.3
P-Value	0.204 ^{NS}	0.008 ^S

Table-4 shows the duration of surgery and hospital stay of the operated children for femur fractures TENS VS DCP group. In TENS group, the mean duration of surgery was 53.00 ±9.20 minutes while the mean duration of surgery in DCP group was 60.00±16.52 minutes, which was not statistically

significant (P= 0.204). The mean duration of hospital stay of the children of TENS group was 6.10 ± 1.20 days while the DCP group was 7.64 ± 1.3 days which was statistically significant (p=0.005).

Table 5: Outcomes in children operated for femur fractures TENS VS DCP (n=23).

Outcomes	TENS(n=14)	%	DCP(n=9)	%	P-value
Flynn Criteria					
Excellent	13	93	5	55	0.035 ^S
Satisfactory	1	7	3	33	0.114
Poor	0	0	1	11	0.214
Mean time of complete radiographic union (in months)	3.99		3.66		0.016
Mean time for full weight bearing (in months)	3.99		3.66		0.016

Table 5 shows the outcomes in children operated for femur fractures TENS VS DCP (1 year follow up). According to Flynn criteria, in TENS group, excellent performed 13(93%) and follower by Satisfactory (17%) and there was no poor performance observed while in DCP group, Excellent performed 5(55%) and followed by Satisfactory 3(33%) and 1(11%) poor, which was statistically significant

(p=0.035).In TENS group, the mean time of complete radiographic union was 3.99 months whereas in DCP, the mean time of complete radiographic union was 3.66 months which was statistically significant(p=0.016). The mean time for weight bearing was the same as the mean time of complete radiographic union in both TENS group and DCP group.

Table 6: Complications seen among children operated for femur fractures TENS VS DCP (n=23).

Complications	TENS(n=14)	%	DCP(n=9)	%	P-value
Knee Stiffness	4	28	1	11	0.050
Infection	1	7	3	33	
Non Union	0	0	0	0	

Mal Union	1	7	1	11	
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Table-6 shows the complications observed among the children operated for femur fractures TENS VS DCP. Among the children in TENS group, 4(28%) had Knee stiffness and followed by superficial Infection (1(7%) Non-Union (0%), acceptable Mal Union 1(7%) while in DCP group, 1(11%) children had Knee stiffness and followed by 3(33%) superficial infection, 0(0%) Non Union and 1(11%) acceptable Mal union which was statistically significant ($p=0.050$).

DISCUSSION

Fracture shaft of femur is common pediatric orthopedic injuries in day to day practice. The femoral shaft fractures are treated by surgical methods among the adults; however, conservative treatment is mainly adopted among the children, mainly due to the better acceptance by the parents and children. However, it has a disadvantage of longer period of union, mal union and prolonged immobilization due to casting. For the treatment of lower extremity long bone fractures in this pediatric age group an ideal implant should be load sharing, and should allow early mobilization, should allow early complete healing assessed radiologically by bridging callus. Recently, after the introduction of flexible intra medullary nailing, the management of pediatric femoral shaft fractures, the procedure had gained popularity both in terms of acceptance and reduction in the loss of school days. Hence, it became imperative to determine the functional and radiological outcomes of fracture shaft of femur treated with TENS Verses DCP along with the complications among the children aged 6–18 years in a tertiary care hospital. Our study showed that the majority (78%) of the children with fracture shaft of femur were males and the mean age of the children was 10.7 years. A study by Sandhu *et al.*, [14] had shown that males were 60.33% which is also comparable to Heybeli *et al.*, [15]. Where the males were 57.14% and 72.7%, respectively. This could be explained by the fact that the boys tend to involve in outdoor activities when compared to girls and more chance of road traffic accidents. These results are supported by various other studies conducted elsewhere [16, 17] with regard to age, literatures have shown that the fracture has a bimodal distribution with the peak at age of 2 and at 17 years, which might be due to various factors. Various other studies have shown similar results [18]. In this current study it was observed, the majority of mechanism of injury in both TENS and DCP were fall from height 56% and 55% respectively. These results are consistent with another study conducted by Heybeli *et al.*, [19]. Our study also reported that the majority types of femur shaft fractures were Transverse in both the TENS and DCP group (63%)(66%) respectively. Transverse fracture was the common pattern of fracture [20, 21]. This present study reported that in TENS group, the mean duration of

surgery was 53.00 ± 9.20 minutes while the mean duration of surgery in DCP group was 60.00 ± 16.52 minutes, which was not statistically significant ($P=0.204$) and the mean duration of hospital stay of the children of TENS group was 6.10 ± 1.20 days while the DCP group was 7.64 ± 1.3 days which was statistically significant ($p=0.005$). These results of our study prevailed, TENS approach is better and cost effective than that of DCP. Agarwal *et al.*, [22] Similarly, the mean duration of hospital stay was 6.5 days. According to Flynn criteria, our study observed in 1 year follow up, in TENS group, excellent performed 13(93%) and follower by Satisfactory 1(7%) and there was no poor performance observed while in DCP group, Excellent performed 5(55%) and followed by Satisfactory 3 (33%) and 1(11%) poor, which was statistically significant ($p=0.035$). In TENS group, the mean time of complete radiographic union was 3.99 months whereas in DCP, the mean time of complete radiographic union was 3.66 months which was statistically significant ($p=0.016$). The mean time for complete weight bearing was the same as the mean time of complete radiographic union in both the TENS group and DCP group. These results claimed that finally the functional outcome of TENS approach is better than DCP for the treatment of femur shaft fractures in children. Similar finding of functional outcomes were observed in some comparative other studies [23, 24]. This current study claimed, among the children in TENS group, 4(7%) had Knee stiffness and superficial Infection 1(7%), Non-Union (0%), acceptable Mal Union 1(7%). In DCP group, 1(11%) children had Knee stiffness, superficial infection 3(33%), Non Union (0%) and acceptable Mal union 1(11%) which was statistically significant ($p=0.050$). These results represent the TENS Approach had comparatively less complications than the DCP approach in the treatment of femur shaft fractures in children [25].

CONCLUSION

This Comparative study suggests that TENS is more adaptable and can achieve biological fixation, with minimal complications compared to DCP. Therefore, this study concluded that TENS is better procedure for fracture shaft femur in children than DCP.

Limitations of the Study

This study was conducted with a purposive sample size and limited data within a short study period. Therefore, the findings of this study may not represent for a specific calculated large sample size and long study period.

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Conflict Of Interest: None declared

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