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Outcome of paediatric dynamic hip screw fixation for the treatment of proximal femoral fracture in the age group of 6-16 years

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ABSTRACT

Background: Pediatric proximal femoral fractures continue to be a topic of great interest because of their rarity, related complications and morbidity, and variation in treatment methods. Recently, paediatric Dynamic Hip Screw (DHS) has got popularity by the orthopaedic surgeon which is biomechanically more stable construct with fewer complication rates.
Methods: A prospective observational study was conducted at NITOR from January 2020 to December 2021. Paediatric patients in above age group with Delbet type III, IV and subtrochanteric fractures meeting the selection criteria were study population. Total 36 patients were included in the study. Cases were evaluated by clinical findings, imaging by X-ray and HHS. Twenty-four weeks follow up was done with clinical, functional and radiological assessment.
Results: In this study, the mean age was 10.1±3 years with a male predominance (72.2%). In 28 cases of Delbet type III and IV fracture closed reduction could be done but in 8 cases of subtrochanteric fracture open reduction was needed. The mean HHS was 89.9±12.1 at last follow up. Finally, out of 36 cases, 20 (55.56%) were excellent, 10 (27.8%) were good, 4 (11.1%) were fair and the rest 2 (5.6%) was poor.
Conclusion: Delbet type III and IV fracture and subtrochanteric fracture can be effectively treated with paediatric DHS in paediatric age group with a good safety profile.

Keywords: Proximal femoral fracture, Dynamic hip screw, Delbet classification

INTRODUCTION

Proximal femoral fractures in the paediatric patient are rare, accounting for less than one percent of all paediatric fractures.[1] These fractures are associated with various complications like coxa vara, delayed union, nonunion, avascular necrosis of femoral head, premature physeal closure and limb length discrepancy etc.[2] This fact was best summarized by Canale stating that "hip fractures in children are of interest because of the frequency of complications rather than the frequency of fractures".[2] Proximal femoral fractures pose a great challenge to the orthopaedic surgeons due to variation in osseous & vascular anatomy in different age group as well as distinct biomechanics in the neck, trochanter and subtrochanteric region. Regarding biomechanics of proximal femur, AO considered that torsional and shear forces at the fracture site are the main stress factors that impair the healing of fractures, while axial compressive stress is beneficial.[3] The ideal fixation device must stand to weight bearing loads

and provide stability across the fracture site to reduce complication rates during healing process. In addition to this, most devastating complication like AVN should be kept in mind before choosing an implant. These fractures can be managed by hip spica, cannulated screw, DHS, proximal femur anatomical plate or angled blade plate, intramedullary nails. While hip spica cast is appropriate in younger children, angled blade plate lacks compression effects and cannulated screws lack buttressing effect, more emphasis has been implicated on paediatric DHS due to its biomechanical superiority. It can resist bending and shearing forces and can maintain neck shaft angle and provides better rotational stability at the fracture site.

Now-a-days, it is widely performed technique because of its better outcome in relation to available implants in our country. The objective of this study was to evaluate the clinical, functional, and radiological outcomes of paediatric DHS fixation for the treatment of proximal femoral fractures, including Delbet type III, type IV, and subtrochanteric fractures, in children aged 6–16 years. The study also aimed to assess fracture union, functional recovery using the Harris Hip Score, and postoperative complications following DHS fixation.

METHODS

This prospective observational study was conducted from January 2020 to December 2021 at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh, to evaluate the outcome of DHS fixation for proximal femoral fractures in children. A total of 36 consecutive paediatric patients with Delbet type III, type IV, and subtrochanteric fractures were included.

All patients underwent clinical assessment and conventional anteroposterior and lateral radiographic evaluation of the affected hip, and fractures were classified according to the Delbet classification. Closed reduction under fluoroscopic guidance was initially attempted, while open reduction was performed when satisfactory alignment could not be achieved.

Paediatric DHS was subsequently used for fracture fixation, followed by routine postoperative rehabilitation. Clinical, functional, and radiological assessments were performed at 6, 12, and 24 weeks. Functional outcome was assessed using the HHS, and radiological union was determined by the presence of bridging callus formation.

Data were analyzed using SPSS. Continuous variables were expressed as mean±standard deviation, while categorical variables were presented as frequency and percentage. Comparisons were performed using the unpaired t-test, with $p<0.05$ considered statistically significant.

Ethical approval was obtained from the institutional review committee, and informed consent was obtained from the guardians of all participants.

Inclusion criteria

Children aged 6–16 years with proximal femoral fractures classified as Delbet type III, Delbet type IV, or subtrochanteric fractures who were treated with paediatric DHS fixation were included in the study.

Exclusion criteria

Patients outside the 6–16-year age range, those with proximal femoral fracture patterns other than Delbet type III, type IV, or subtrochanteric fractures, and those who did not undergo paediatric DHS fixation were excluded from the study.

RESULTS

In this study, the highest number of patients 16 (44.4 %) were 6-to-9-year age group followed by 10 (27.8%) cases in 10-to-12-year age group and in 13-to-16-year age group each. The mean age was 10.1±3 years with range from 6 to 16 years. Among the 36 cases, 16 (44.4%) had a Delbet type III fracture, 12 (33.3%) had Delbet type IV fracture and the remaining 8 (22.2%) had subtrochanteric fracture. The mean radiological union time was 12.8±2.7 weeks, ranging from 8 weeks to 18 weeks. Mean radiological union time in Delbet type III and IV was 13.9±1.8 weeks while in subtrochanteric fracture, it was significantly shorter to 9±1.2 weeks (p value <0.05).

The functional ability of the cases was measured according to Harris hip score (Harris, 1969). Regarding limping, 20 (55.6%) cases did not limp, 14 (38.9%) cases slightly limped and 2 (5.6%) case limped moderately. 20 (55.6%) cases walked without support, 10 (27.8%) case needed cane for long walk and 6 (16.7%) needed cane most of the time. 20 (55.6%) patients could walk unlimited distance and 16 (44.4%) patients could walk six blocks.

32 (88.9%) patients could comfortably sit on ordinary chair for at least 1 hour but 4 (11.1%) patients could sit in high chair for 30 minutes. 22 (61.1%) could use public transport. No help was needed to climb stairs in 18 (50%) patients, aid of railing was needed for 18 (50%) cases. 26 (72.2%) patients could put on socks/ shoes easily whereas 10 (27.8%) patients could do it with difficulties.

The mean HHS showed progressive improvement during follow-up. The mean HHS increased from 44.7±11.9 at 6 weeks to 76.1±12.2 at 12 weeks and further to 89.9±12.1 at the last follow-up, with statistically significant improvement over time ($p<0.05$). At the final assessment, 20 (55.6%) patients had an excellent outcome, 10 (27.8%) had a good outcome, 4 (11.1%) had a fair outcome, and 2 (5.6%) had a poor outcome.

Overall, 83.3% of patients achieved an excellent or good functional outcome following paediatric DHS fixation. Anteroposterior and lateral radiographic views of the hip joint demonstrating a displaced fracture of the femoral

neck. The images show cortical discontinuity at the intracapsular region with varus angulation and loss of normal femoral head–neck alignment. A radiographic scale marker (50 mm) is visible for reference.

Table 1: Distribution of cases according to age (n=36).

Age (in years)	Frequency	%
6-9	16	44.40
10-12	10	27.80
13-16	10	27.80
Total	36	100.00
Mean±SD		10.1±3

Table 2: Duration of radiological union in weeks (n=36).

Type of fracture	Mean±SD	P value
Delbet III or IV	13.9±1.8	
Subtrochanteric	9.0±1.2	<0.001
Total	12.8±2.7	

Table 3: Distribution of cases by to functional ability at last follow up (n=36).

Function	Category	Frequency	%
Limp	None	20	55.60
	Slight	14	38.90
	Moderate	2	5.60
Support	None	20	55.60
	Cane for long walks	10	27.80
	Cane for most of time	6	16.70
Distance walked	Unlimited	20	55.60
	Six blocks	16	44.40
Sitting	Comfortable in ordinary chair for 1 hour	32	88.90
	Comfortable on a high chair for 30 minutes	4	1.10
Use of public transport	Yes	22	61.10
	No	14	38.90
Stairs	Normal	18	50.00
	Use railing	18	50.00
Put on shoes or socks	Easily	26	72.20
	With difficult	10	27.80

Table 4: Functional outcome according to Harris Hip Score at different follow-up periods and final assessment (n=36).

Harris hip score/final outcome	Mean±SD/Frequency	%	P value
HHS at 6 weeks	44.7±11.9	—	—
HHS at 12 weeks	76.1±12.2	—	<0.001
HHS at last follow-up	89.9±12.1	—	0.0014
Final outcome			
Excellent	20	55.56	—
Good	10	27.78	—
Fair	4	11.11	—
Poor	2	5.56	—
Total	36	100.00	—

Intraoperative clinical photograph showing the patient positioned on the operating table with the affected lower limb prepared and draped under aseptic conditions. The surgical site over the hip and proximal thigh has been disinfected with antiseptic solution prior to operative intervention, while fluoroscopic imaging monitors are

visible in the background for intraoperative guidance. Anteroposterior radiographs of the pelvis with both hip joints are shown. The images are labeled "R" and "L" to indicate the right and left sides. A fracture involving the proximal femur (intertrochanteric region) is evident. Postoperative fixation has been performed using a DHS with a side plate and multiple cortical screws on the affected side. The implant is appropriately positioned along the lateral aspect of the proximal femur with the lag screw traversing the femoral neck into the head. The contralateral hip joint appears intact without evidence of fracture or implant.

Anteroposterior and lateral radiographs of the left hip joint are shown. The images demonstrate a proximal femoral fracture involving the intertrochanteric region. Postoperative fixation has been performed using a DHS with a side plate and multiple cortical screws. The lag screw is seen extending through the femoral neck into the femoral head, and the side plate is positioned along the lateral cortex of the femoral shaft. The implant alignment appears satisfactory, with maintained reduction of the fracture fragments and no obvious signs of implant loosening or displacement.

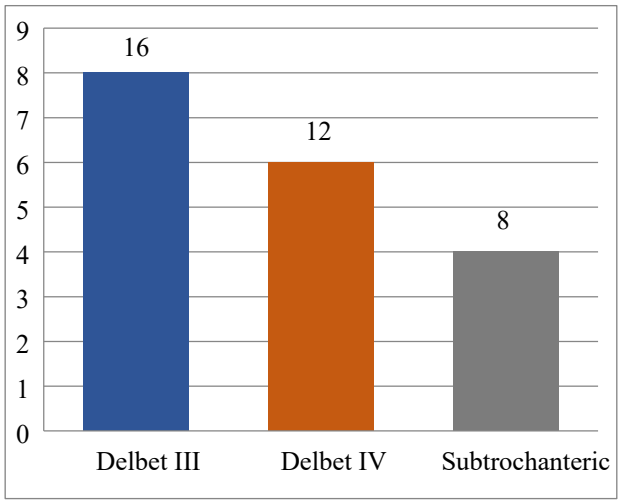


Figure 1: Distribution of cases according to type of fracture (n=36).

DISCUSSION

Paediatric proximal femoral fracture is a rarity. During the span of the study, 36 cases were included with mean age of 10.1±3 years ranging from 6 to 16 years. There were 26 (72.2%) male and 10 (27.8%) female with a male-female ratio of 2.6:1. In 66.7% (n=24) cases, fractures were due to motor vehicle accident while in the remaining 33.3% (n=12) cases it was due to fall from height. Among the 36 cases, 16 (44.4%) had a Delbet type III fracture, 12 (33.3%) had Delbet type IV fracture and the remaining 8 (22.2%) had subtrochanteric fracture. In a previous study, the incidence of Delbet type III fracture was the highest among these three types of fracture which is 35%.[4] Out of 36 cases, in 20 (55.6%) cases, duration of injury to surgery was between 6 to 9 days and in 16 (44.4%) cases, duration was 10 to 13 days.



Figure 2 (A, B): Preoperative X-ray.



Figure 3: Fluroscopic image of closed reduction with positioning of patient.

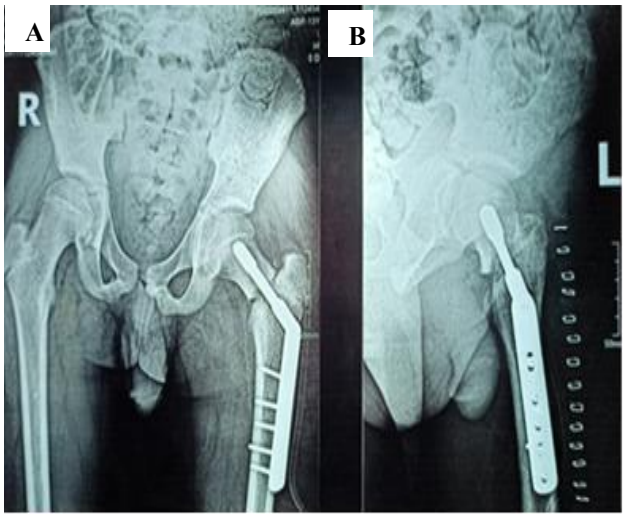


Figure 4 (A, B): Immediate postoperative X-ray.



Figure 5 (A, B): X-ray at 24 weeks.



Figure 6 (A, B): Functional status at last follows up showing flexion of hip and knee and full weight bearing status.

The mean duration of injury to surgery was 9.2±1.9 days, ranging from 6 days to 13 days. In three cases, presentation was late, may be due to poor referral system, dependency on traditional bone setter, transport difficulties due to COVID-19 pandemic etc. Theoretically, early reduction reduces ischemic time and decreases the risk of necrosis.[5] However, several authors did not demonstrate a difference between early and delayed reduction and they relied on the theory that the initial injury determines the development of AVN irrespective of how the injury is managed.[6]

In 28 cases of Delbet type III and IV fracture, authors performed closed reduction whereas we performed open reduction in rest 8 cases of subtrochanteric fracture. It is assumed that orthopaedic surgeons avoid open reduction of paediatric neck fracture due to fear of disrupting the blood supply which may increase the risk of AVN.[7] Debate still exists between open or closed method; however, achieving an anatomic reduction is priority whether it is performed open or closed.[8,9] The mean radiological union time was 12.8±2.7 weeks, ranging from 8 weeks to 18 weeks. Out of 36 cases, 1 patient developed superficial and infection which was managed by regular dressing and antibiotic according to culture and sensitivity, 1 patient developed lag screw cutout which was managed by non-weight bearing for 18 weeks. Despite these, there was no instance of nonunion, malunion or coxa vera deformity.

AVN of femoral head is the most common complication of proximal femoral fracture.[10] In Delbet type III and type IV fractures, risk of AVN is 20% and 5% respectively and in subtrochanteric fracture, it is not described.[4] AVN becomes visible in X-ray within 1 year after injury.[11] But, none of the patient during the follow up period has showed any sign of AVN either clinically or radiologically within follow up period.

Occurrence of AVN could not be evaluated in the present study. The functional ability of the cases was measured according to HHS.[12] At last follow up, only in 3 (16.7%) cases, at least one out of four deformities, defined by Harris (1969), was present.12 The mean flexion of hip at last follow up was 119.17°±10.47°. Again, the mean abduction and adduction were 31.11°±4.04° and 31.67°±3.83° respectively. Internal rotation and external rotation at last follow up was 30°±4.2° and 29.17°±3.54° respectively. The mean HHS at 6 weeks was 44.7±11.9. At 12 weeks, it has increased significantly to 76.1±12.2 (p value <0.05). Again, at last follow up, the mean has increased significantly to 89.9±12.1 (p value <.05). After last follow up, out of 36 cases, 20 (55.56%) were excellent, 10 (27.8%) were good, 4 (11.1%) were fair and the rest 2 (5.6%) was poor. In a previous series, the mean HHS was 94.16 (range 11 to 100).[13] This mean is slightly higher than the present study because of their longer follow up (50 months).

Limitations

This study was conducted at a single center with a small sample size, limiting the generalizability of the findings. The absence of a comparison group and relatively short follow-up period restricted the assessment of long-term complications and comparison with other fixation methods. Additionally, potential selection and observer bias could not be completely excluded.

CONCLUSION

On the basis of results in the present study, it can be concluded that treatment of Delbet type III and IV fracture and subtrochanteric fracture can be effectively treated with paediatric DHS in paediatric age group with a good safety profile. Authors have found satisfactory outcome of paediatric DHS fixation in subtrochenteric fracture management, though literature recommendation in this regard is very much scanty.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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