

Original Article

PEDIATRIC FRACTURE NECK FEMUR FIXATION BY PLATE AND SCREWS

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**Abstract**

**Background:** Fracture neck femur Although rarely seen, there is a considerable risk of complications such as avascular necrosis (AVN) of the femoral head and neck, coxa vara, non-union, delayed union, premature physeal arrest and infection in pediatric neck femur fractures. The most common and serious complication of pediatric neck femur fractures is known to be AVN, which can lead to a further degenerative joint disease. It has been stated that several factors may contribute to the development of complications and affect the outcome. The incidence of femoral neck fractures in children is between 0.3 and 0.5% of all childhood fractures per year. The incidence is maximum at the ages of 11 and 12 years, with a male preponderance ranging from 1.3 to 1.7:1. In contrast to the osteoporotic proximal femur fractures in the elderly, the majority of cases in children occur due to high-energy trauma such as road traffic accidents and falls from heights. **Objective:** This study's objective is to improve outcome of pediatric fracture neck femur fractures using plate and screws. **Patients and Methods:** A prospective study was conducted on eight children who underwent plate and screws fixation of neck femur fractures, at orthopedic and traumatology department of Sohag university hospital. They were treated between April 2023 till October 2023 and follow-up for 6 months. **Results:** According to the Ratliff assessment criteria, 75% of the patients were good (6 patients), 12.5% of the patients were fair (1 patient) and 12.5% of the patients were poor (1 patient). **Conclusion:** Plate and screws technique in fixation of pediatric fracture neck femur isn't recommended due to high rate of complications and poor outcomes.

**Keywords:** Fracture fixation, Plate, Screws, Neck femur.

**1. Introduction**

Fracture neck femur Although rarely seen, there is a considerable risk of complications such as avascular necrosis (AVN) of the femoral head and neck, coxa vara, non-union, delayed union, premature physeal arrest and infection in pediatric neck femur fractures. The most common and serious complication of pediatric neck femur fractures is known to be AVN, which can lead to further degenerative joint disease. It has been stated that several factors may contribute to the development of complications and affect the outcome [1,2]. We initially hypothesized that there should be

some factors determining the clinical and radiographic outcomes in pediatric femur neck fractures. Closed reduction and percutaneous pinning can be carried out. In certain situations, in very young infants and toddlers under the age of 2, closed reduction and fixation with smooth 1.8 or 2-mm K wires may be carried out and cannulated screw fixation using 4-4.5 mm cannulated screws in older children. This should be carried out without any delay since this potentially can reduce the incidence of AVN [3]. Pediatric neck femur fractures can be fixed by plates. The

standard dynamic hip screw constructs which are sized for children, adolescents, and adults can be used. There are also newer generation locking plates which allow locking screws to be placed into the femoral neck. These come in sizes of small (3.5 mm) or large (5 mm) with varying degrees of screw plate angle. Minimally invasive surgery has a place in undisplaced fractures, and cannulated screws can be inserted directly on guide wires to achieve firm and compressive fixation of the fragments. In a recent study of 58 children with displaced femoral neck fractures, open reduction with internal fixation was compared with closed reduction and internal fixation and the results of open reduction were superior with a lower incidence of AVN and better outcomes than the closed reduction internal fixation group [4]. The aim of this retrospective study is to evaluate the clinical and radiological outcomes of fixation of the pediatric patients with fracture neck femur by plating with small T plate and partially cancellous screws.

## **2. Patients and Methods**

eight children who underwent plate and screws fixation of neck femur fractures, at orthopedic and traumatology department of Sohag university hospital. They were treated between April 2023 till October 2024 and follow-up for 6 months in this prospective study. An approval of the study was obtained from Ethical Committee at our institute. Inclusion criteria were children less than 16 years having fracture neck femur after complete clinical and radiographic data and exclusion criteria were polytraumatized patients with other associated fractures, patients more than 16 years, patients with preexisting deformity, patients with open fractures and patients with chronic diseases as renal, hepatic or cardiac patients.

### **2.1. Preoperative assessment**

The initial evaluation of patients will include history, clinical examination, and radiographic evaluation, Full preoperative neurological and vascular assessment, Routine laboratory investigation, under spinal or general anesthesia patient in supine position,

lateral approach of the femur will be done, Open reduction of the neck femur and fixation is done by small T plate, cannulated screws and cortical screws.

## **2.2. Surgical technique**

### **2.2.1. Anaesthesia and positioning**

Under general or spinal anaesthesia, Prophylactic antibiotic was administered. the patient was positioned supine on a radiolucent surgical table. An image intensifier was utilized during the procedure.

### **2.2.2. Procedure**

A 10-centimeter longitudinal incision is made at the top lateral side of the thigh, just below the greater trochanter, cutting the vastus lateralis muscle, the iliotibial band, the skin, and the subcutaneous fat. With the assistance of the C arm, the soft tissues are retracted, exposing the base of the greater trochanter and the surrounding portion of the femoral shaft then a guiding pin is drilled into the femoral neck, reaching just distal to the femoral head's epiphysis, from a location approximately 1.5 below the bony ridge at the distal border of the greater trochanter, the source of the vastus lateralis muscle. Half way between the anterior and posterior cortices of the femoral shaft is where the guide pin enters the lateral femoral cortex. Holding the drill at about a 5-degree angle with the femoral shaft, the pin is entered. Next, the guide pin's location inside the femoral head and neck is examined in both the lateral and anteroposterior planes on the x-ray screen although center location in the posterior and/or inferior directions is acceptable, the optimum position is the center of the neck and head. It is OK for the guide pin's angle to vary slightly from the neck as long as the pin's point is positioned in the middle of the femur head. Pins are inserted via proximal holes, and the plate is attached to the lateral surface of the femoral shaft. The screw lengths are then measured, and the positions are verified on the X-ray screen in both the anteroposterior and lateral planes, after the plate and guide pin location inside the femoral head and neck have been examined and approved. After that, the wound is closed in layers.

### 2.3. Postoperative management

Intravenous antibiotics were given for 3 days post-operative, Postoperative radiographs were obtained to check the reduction and adequacy of the fixation and Analgesics were given until complete resolution of pain.

### 2.4. Follow up

For a year, the patients got clinical and radiological examinations every three months. The patients were evaluated for motion, activity, pain, and roentgenographic findings at the conclusion of the follow-up period according to Ratliff criteria: \*) **Pain:** A patient responds well when there is no pain or when it is tolerable, but not well when it is incapacitating. \*) **Movement:** When the patient's range of motion is fully restored or only has terminal restrictions, their results are good; when more than 50% of the range is preserved, their results are fair; and when less than 50% of the range is preserved, their results are poor. \*) **Activity:** When the patient resumes regular activity or just avoids games, he has a good or fair mark; when activity is restricted, he receives a low grade. \*) **Radiographic results:** When there is no femoral neck deformity or minor avascular necrosis, the patient is evaluated excellent on the x-ray; when there is significant avascular necrosis, deg-enerative arthritis, or arthrodesis, the patient is classified poor. Complete obliteration of the fracture line with bone trabeculae crossing over was a criteria for union. In cases when the neck shaft angle is less than 130, the deformity is also recorded. When there is femoral head sclerosis and expansion of the joint space, and few months later, fragmentation occurs, it is classified as avascular necrosis.

## 3. Results

In evaluating the results, we assessed pain, activity, motion and radiographic findings. The results at the end of the follow up period are shown in tab., (1-5). The results obtained in 8 patients were:

Table (1) The total results

Score	Number	Percent
Poor	1	12.5
Fair	1	25.0
Good	6	75.0
<b>Total</b>	<b>8</b>	<b>100.0</b>

Table (2) Effect of preoperative delay

	Good		Fair		Poor		Total	
	No	%	No	%	No	%	No	%
Time lag before operation								
Eithin 24 hours	6	75	0	0	0	0	6	75
From 1-3 days	0	0	1	12.5	0	0	1	12.5
More than 3 days	0	0	0	0	1	12.5	1	12.5
<b>Total</b>	<b>6</b>	<b>75</b>	<b>1</b>	<b>12.5</b>	<b>1</b>	<b>12.5</b>	<b>8</b>	<b>100</b>

Table (3) Effect of fracture type

Fracture type	Good		Fair		Poor		Total	
	No	%	No	%	No	%	No	%
Type I	0	0	0	0	0	0	---	0
Type II	3	37.5	0	0	1	12.5	4	50
Type III	2	25	1	12.5	0	0	3	37.5
Type IV	1	12.5	0	0	0	0	1	12.5
<b>Total</b>	<b>6</b>	<b>75</b>	<b>1</b>	<b>12.5</b>	<b>1</b>	<b>12.5</b>	<b>8</b>	<b>100</b>

Table (4) Effect of type of trauma

Type of trauma	Good		Fair		Poor		Total	
	No	%	No	%	No	%	No	%
Falling from height	4	50	0	0	1	12.5	5	62.5
Traffic accident	2	25	1	12.5	0	0	3	37.5
<b>Total</b>	<b>6</b>	<b>75</b>	<b>1</b>	<b>12.5</b>	<b>1</b>	<b>12.5</b>	<b>8</b>	<b>100</b>

## 4. Complications

### 4.1. Avascular necrosis

In two cases (25%), ischemic necrosis of the femoral head occurred. The displacement of the fracture and the interruption of the blood supply at the moment of the fracture are associated with avascular necrosis. This case was graded poor.

### 4.2. Coxa vara

In two cases (25%), there was a diminution of the femur's neck-shaft angle, resulting in a limp and shortening of the leg. One patient was clinically evaluated fair, whereas the other patient had a 2 cm shortening of the afflicted limb combined with avascular necrosis.

### 4.3. Non-union

In our study, there were no cases of non-union.

### 4.4. Backing-out of the screws:

Six cases (75%) in our series experienced this problem. Four of them had a good prognosis (50%) one fair (12.5%), and one poor (12.5%).

### 4.5. Shortening

In a single case (12.5%), the injured limb was two centimeters shorter than the uninjured limb. There was also avascular necrosis in this case.

Table (5) Complication

	WB	union	AVN	Back out	Coxa vara	Shortening
1	1 month	1 month	-----	3 months	-----	-----
2	2 months	2 months	3 months	1 month	3 months	6 months
3	1 month	1 month	-----	-----	-----	-----
4	1 month	1 month	-----	3 months	-----	-----
5	2 months	2 month	3 months	1 month	3 months	6 months
6	1 month	1 month	-----	-----	-----	-----
7	1 month	1 month	-----	3 months	-----	-----
8	1 month	1 month	-----	3 months	-----	-----

## 5. Illustrative Cases

### 5.1. Case 1

A 10 years female patient presented after falling from height with displaced type II right side fracture neck femur fixed by 3 cancellous screws 4.5 mm and small T plate. The patient was followed up for 9 months and the fracture was without complications and with full range of motion. The case was graded good. (A) preoperative x-ray. (B) postoperative x-ray. (C) 3 months follow up. (D) 6 months follow up.



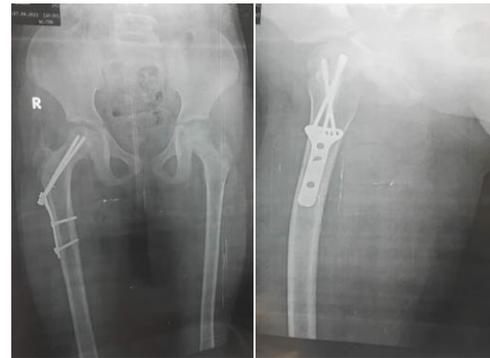
(A)



(B)



(C)



(D)

### 5.2. Case (2)

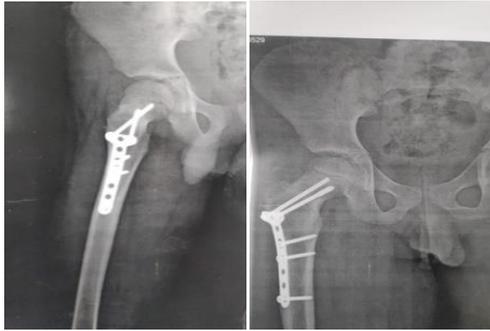
A 13 years male patient presented after falling from height with displaced type II right side fracture neck femur fixed by 2 cancellous screws 4.5 mm and small T plate. The patient was followed up for 9 months and the fracture was without complications and with full range of motion. The case was graded good. (A) preoperative x-ray. (B) postoperative x-ray. (C) 3 months follow up. (D) 6 months follow up.



(A)



(B)



(C)



(D)



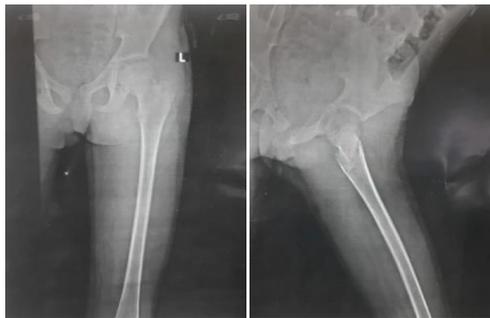
(C)



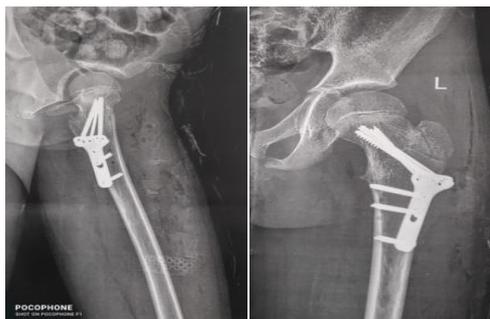
(D)

### 5.3. Case (3)

A 6 years female patient presented after falling from height with displaced type IV left side fracture neck femur fixed by 3 cancellous screws 4.5 mm and small T plate. The patient was followed up for 9 months and the fracture was without complications and with full range of motion. (A) preoperative x-ray. (B) postoperative x-ray. (C) 3 months follow up. (D) 6 months follow up.



(A)



(B)

### 6. Discussion

One of the more challenging issues in orthopaedic surgery is treating femoral neck fractures in children. There's still debate regarding the best way to accurately reduce these kinds of fractures. Fracture neck femur Although rarely seen, there is a considerable risk of complications such as avascular necrosis (AVN) of the femoral head and neck, coxa vara, non-union, delayed union, premature physal arrest and infection in pediatric neck femur fractures. The most common and serious complication of pediatric neck femur fractures is known to be AVN, which can lead to a further degenerative joint disease. It has been stated that several factors may contribute to the development of complications and affect the outcome. This was a prospective study conducted on 8 cases of children with fracture neck femur who treated with small T plate and cannulated screws in traumatology & orthopedic department Sohag University from April 2023 to October 2023. The aim of this study was to evaluate the clinical outcome of fracture neck femur in children treated with small T plate and Regarding pain score at the end of the

follow up period, it was poor in 12.5% of cases, fair in 12.5% of cases and good in 75% of cases. The youngest patient in this series was 4 years old and the oldest 13 years old with an average of 9 years. The right side was fractured in 4 cases (50%), while the left was fractured in 4 cases (50%). cannulated screws. In a study by Pavone et al., (2019) From May 2008 to November 2013, the Orthopedic and Traumatologic Department of the Univ. of Catania treated 8 pediatric patients with femoral neck fractures [5]; 6 (75%) of the patients were male, and 2 (25%) were female. Of the 8 patients, 5 (62.5%) had fractures in the right hip, and 3 (37.5%) had fractures on the left side. The average age of the patients at the time of trauma was  $9.2 \pm 3.3$  years (range 5.1-15). All of the patients suffered from high-energy trauma: 4 (50%) were involved in a traffic accident (car or pedestrian), 2 (25%) fell off a bike, and 2 (25%) fell from a height. Based on the classification proposed by Delbet, 3 (37.5%) of the fractures were type I, 2 (25%) were type II, 2 (25%) were type III, and only 1 (12.5%) was type IV. Ischemic necrosis of the femoral head was seen in two cases (25%). Avascular necrosis is linked to the fracture's displacement and the blood supply being cut off at the site of the fracture. This case received a low grade. Two cases (25%) had a reduction in the neck-shaft angle of the femur, which caused the limb to shorten. One patient had a clinical evaluation of fair, while the other had avascular necrosis and a 2 cm shortening of the affected limb. In 1 case (12.5%) of this work, there was premature physal closure; the patient suffered avascular necrosis and was clinically graded poor. Six cases (75%) in our series had Backing-out of screws. One fair (12.5%), one bad (12.5%), and four good (50%) prognoses were given. Only one (12.5%) of the cases had the wounded limb being two cm shorter than the uninjured limb. In this instance, there was also avascular necrosis. We did not find any case of superficial wound infection in our study.

And a child suffering from avascular necrosis was the only case with a dismal prognosis. Six (75%) of the children in research by Pavone, et al. [5] had a favorable outcome. In accordance with Ratliff's criteria, six (75%) of the treated children had good hip outcomes, comprising one type I fracture from Delbet, two type II, two type III, and one type IV fracture. These patients did not report any pain, movement limitations, or restrictions on their ability to engage in educational activities. The neck-shaft angle and anatomical configuration were both normal on radiograms. Because of the femoral head's development of avascular necrosis, 2 (25%) of the cases had fair outcomes. In the first instance, an MRI that was requested 14 months after surgery helped to diagnose a six-year-old kid Osteonecrosis was classified as type II by Ratliff because the disease process appears to only impact specific regions of the epiphysis. In the second instance, a 15-year-old kid with a type I fracture reported severe limitations in his functional activities along with sporadic discomfort and a minor reduction in range of motion. When the femoral head was examined 16 months following therapy, radiographs and an MRI revealed type II avascular necrosis with segmental involvement of the epiphysis. There were no other issues mentioned. The majority of research on pediatric femur neck fractures found that Delbet type II fractures were the most common, followed by type III (which together account for 65–85% of pediatric femur neck fracture occurrences) and type IV (12%). Type II fractures are the most common in our study (37.5%), yet they are exceedingly uncommon in the literature [6,7]. We think that the reduction of a femoral neck fracture should ideally be carried out within six hours after the injury, in spite of the lack of helpful data in the literature [8]. Because of the early restoration of blood supply, early reduction might decrease the possibility of osteonecrosis to the proximal femur; nevertheless, a number of authors [9,10] speculate that vascular damage occurs at the time of the injury. Children with type II and III

fractures [11] who received open reduction and internal fixation (ORIF) experienced less complications than those who underwent closed reduction and internal fixation (CRIF), according to certain research [7,9]. It's probable that in pediatric femur neck situations, orthopedic surgeons rarely use ORIF in order to prevent upsetting the vascular supply, which could raise the danger of avascular necrosis. Recent research, however, indicates that individuals receiving ORIF had a lower incidence of avascular necrosis. The capsulotomy-induced release of intracapsular pressure could be one explanation [12]. Furthermore, rather of running along the capsule, the lateral epiphyseal arteries primarily follow the femoral neck. Because the vessels that run through the neck are not in danger as a result of the anterior capsulotomy performed for ORIF, the surgeon can obtain a high-quality reduction, which lowers the risk of problems like non-union and coxa vara. It is also evident that ORIF does not result in a higher incidence of avascular necrosis, and that the primary factors influencing the long-term risk of avascular necrosis are the initial trauma and the disruption of head vascularity [10,13]. It is still unknown how important it is to decompress the joint as soon as possible using a capsulotomy or aspiration. In their study population, Ng and Cole [14] did not find any significant differences. However, in a statistical analysis involving patients from other published case series, they discovered a tendency toward a decreased rate of avascular femoral head necrosis following early joint evacuation. We think that the child's soft tissues' increased flexibility should shield against an unnecessary rise in intracapsular pressure, which is thought to be the cause of the increased risk of osteonecrosis. Conservative treatment was not an option for any of the patients. There has been a high chance of reduction failure when hip spica cast treatment is administered without surgical intervention [15,16]. This is to be expected as there is little resistance to the traction of the pelvi-femoral muscles in the cranial direction

and the inherent instability of these fractures, which cannot be prevented with a cast. The child's age, size, and skeletal development, as well as the preferences of the operating surgeon, all influence the choice of implants. According to Canale et al. [17], there is evidence that using fewer pins appears to lower the likelihood of complications because this arrangement prevents the femoral neck's diameter from fully filling, which could damage the femoral head's vascular structure. However, there is no proof that the prevalence of postoperative problems such coxa vara or avascular femoral head necrosis is influenced by a particular implant type. The significance of the postoperative regimen is rarely mentioned in studies. Although there is insufficient evidence to support the impact of early or late weight bearing, using an additional hip spica cast may help [16]. For this kind of damage, the literature reports varying prognoses depending on the study. Leung and Lam pointed out that it can be challenging to derive trustworthy conclusions from the outcomes of various treatment procedures since clinical and radiological outcomes can change dramatically in a few of years [18]. The most frequent consequence that follows a hip fracture in youngsters is avascular necrosis. Age, the type of fracture, the degree of initial dislocation, and the amount of time before surgery are some of the factors that affect the risk of avascular necrosis [19,20]. The degree of vascular injury acquired at the time of trauma is the most crucial component [21]. The greatest indicators of osteonecrosis are fracture type and age at the time of injury, according to a meta-analysis of 360 pediatric hip fractures [22]. They demonstrated that compared to type IV fractures, osteonecrosis occurred in type I, II, and III fractures 15, 6, and 4 times more frequently. Moreover, with every year of age increase, the frequency of osteonecrosis in older children increased by 1.14 times. This happens because the femoral head cannot be revascularized in

these patients. In addition, type I, II, and III fractures happen more frequently in them than in younger children because of their attitude. The prognosis appears to be greatly impacted by the amount of time that passes between the damage and therapy. In patients treated with a delay of at least 24 hours, Bombaci et al. [23], reported a 54.6% rate of avascular necrosis, which is marginally higher than the rates of 47% from Davison and Weinstein [24], 42% from Ratliff [25], and 43% from Canale and Bourland [26]. Our study also included non-union, coxa vara, early physis closure, and post-operative infections as problems. One-third of treated patients may experience coxa vara [6]. It arises from a loss of reduction in displaced fractures treated with or without fixation, or from increasing deformity of undisplaced fractures [15]. The greatest defense against this complication is to maintain an anatomical reduction with a stable fixation [27]. According to reports, 6% to 62% of instances result in premature closure of the physis, which is caused by a direct trauma to the physis or a blood supply injury. Just 13%, or around 3 mm of growth per year, of the thigh's growth is attributed to the proximal femoral physis. Therefore, only very young children may experience a considerable (>2 cm) limb length difference as a result of a complete physeal closure [28]. The incidence of non-union in pediatric femoral neck fractures is 7-10 %, which is significantly lower than in adult cases. It could have to do with how hard it is to keep the fractures stable while receiving treatment. Oblique patterns, type II and III fractures, insufficient or unsuccessful fixation, and infections are predisposing factors. [29]. Post-operative infections are an uncommon consequence following either closed or open surgery, occurring in less than 1% of patients [30]. Results may be enhanced by rigorous wound debridement, intravenous antibiotic therapy, and early infection detection. Whenever feasible, fixation must be kept in place until the fracture union. Osteo-

myelitis and deep wound infections can have negative effects even with proper treatment.

## 7. Conclusion

*As compared to displaced fractures, non-displaced fractures have a far lower incidence of complications. Plate and screws technique in fixation of pediatric fracture neck femur isn't recommended because it has no advantage in promoting union or weight bearing and due to poor outcomes and high rate of complications as regard avascular necrosis, coxa vara, shortening and backing out of screws.*

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