Original Article

Outcome of Submuscular Dynamic Compression Plates in Pediatric Subtrochanteric Fracture in a Tertiary Hospital

Taufiq Morshed[1], M Asraf ul Matin[2], M Shafiul Umam[3], M Mizanur Rahman Bhuiyan[4], Liton Kumar Roy[5], M Shahed Anwar Bhuya[6], M Monjur ul Alam[7], M Moniruzzaman[8]

Abstract:

Background: Femur subtrochanteric fractures are not common in paediatric patients. Several therapeutic approaches have been used with adults and children. The submuscular technique using Dynamic Compression Plates (DCP) is a minimally invasive approach that aims to provide stable fixation while minimizing soft tissue disruption. **Methods:** This is a retrospective study at the Orthopaedic Department at Comilla Medical College Hospital. All the pediatric subtrochanteric fracture patients operated with submuscular DCP at the Orthopaedic Department at Comilla Medical College Hospital between January 2022 to December 2023. **Results:** We had operated a total of 22 pediatric subtrochanteric fracture with submuscular small DCP. Flynn score was improved significantly after 12 months where 17 children were excellent category and 4 were satisfactory. Only one child had poor functional outcome. All the children were poor according to Beaty score. After 1-year, overall criteria were excellent in 18 cases. Rest 4 children were in satisfactory category. Conclusion: Submuscular DCP emerges as a reliable option, particularly in cases where conservative management or other surgical approaches may be less feasible.

Key words: Subtrochanteric fracture, Dynamic Compression Plate, Limb Length Discrepancy

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1. Dr Taufiq Morshed
   Assistant Professor , Sports Medicine and Arthroscopy
   Comilla Medical College, Cumilla
2. Dr Md. Asraf ul Matin
   Assistant Professor, Spine, Trauma and Orthopaedic Surgery, Comilla Medical College, Cumilla
3. Dr Md. Shafiul Umam
   Junior Consultant, Department of Orthopaedics
   Comilla Medical College Hospital, Cumilla
4. Dr Md. Mizanur Rahman Bhuiyan
   Medical Officer, Department of Orthopaedics
   Comilla Medical College Hospital, Cumilla
5. Dr Liton Kumar Roy
   Associate Professor and Head
   Department of Orthopaedics
   Comilla Medical College, Cumilla
6. Dr Muhammed Shahed Anwar Bhuya
   Assistant Professor, Department of Orthopaedics
   Comilla Medical College Hospital, Cumilla
7. Dr Muhammad Monjur-ul-Alam
   Assistant Professor, Department of Orthopaedics
   Comilla Medical College Hospital, Cumilla
8. Dr Mohammad Moniruzzaman
   Registrar, Department of Orthopaedics
   Comilla Medical College Hospital, Cumilla

Address of Correspondence
Dr Taufiq Morshed
Assistant Professor, Sports Medicine and Arthroscopy
Comilla Medical College, Cumilla
Mobile: 01911 020858
Email: taufiqmorshed@gmail.com

Introduction:

Due to their high energy levels and high level of activity, children are more vulnerable to injuries, including fractures[1]. A femur fracture is one of the many injuries that can occur to children. Falls are the primary cause of these injuries, particularly in younger children or toddlers. Adolescent femur fractures are primarily caused by recreational and competitive sports activities, while they can occur in people of any age due to auto accidents[2]. A subtrochanteric fracture was characterized as one that occurred within 10 percent of the femur's entire height distal to the lesser trochanter[3]. Among the femur fracture subtrochanteric fractures are not common in paediatric patients[4]. Blount et al.[2] discovered that these fractures made up 17% of all femoral fractures[5], contrary to Johnston's finding that they made up 4% of all femoral fractures[6]. Subtrochanteric femoral fractures in teenagers with underdeveloped skeletons have not been extensively studied in the literature due to their rarity[4]. These fractures typically occur in younger children, are linked to a strong male preponderance, and are most frequently caused by high-energy trauma.[7,8,9]

The higher frequency of comminution, shortening, and coronal plane angulation sets subtrochanteric fractures apart from other paediatric femoral fractures[6,7,10].

Furthermore, because of their considerably higher union rate, less complex fracture pattern, and less comminution, these fractures in children and skeletally immature adolescents differ from those in adults[11].

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The proximal fragment's displacement, soft tissue condition, presence of compressive medial and tensile lateral surface have all been implicated in management difficulties[7,12,13,14]. Several therapeutic approaches have been used with adults and children[4]. These consist of external fixation, stiff and flexible intramedullary rods, internal fixation with plates, traction in 90 degrees of hip and knee flexion with delayed hip spica immobilization1[5,7,8,9,16,11]. High refracture rate, pin tract issues, and ugly scars hinder external fixation[17]. Up to 10% of nonunions occur in traditional compression plating, along with hardware problems[18,19]. It is challenging to apply elastic intramedullary nailing for fractures involving metaphyseal extensions, and it does not stop shortening or malrotation[20,21,22,23]. Interlocked intramedullary nailing may result in osteonecrosis of the femoral head and disruptions in the growth of the proximal femur, and it is not capable of fixing the majority of proximal and distal femur fractures[24,25]. No compelling remedy for these circumstances is offered by the literature[26].

Long bone fractures treated with traditional plating offer good stability, length, and alignment preservation, but at the expense of more soft tissue damage at the fracture site. This is improved by using a less invasive submuscular technique to place the plate [27]. For youngsters under the age of eleven, the Titanium Elastic Nailing System (TENS) is the recommended course of treatment[28]. For stable midshaft fractures, TENs are appropriate. Proximal and distal fractures, spiral and comminuted fractures, as well as fractures in children weighing 40–45 kg, may not respond well to TENS treatment and may have more problems[21,20,22]. Because the length of nail-bone contact is short in proximal and distal fractures, intramedullary nails may not provide enough support[29,30,31,32,21,20,33,34,35]. The submuscular technique using Dynamic Compression Plates (DCP) is a minimally invasive approach that aims to provide stable fixation while minimizing soft tissue disruption. This technique involves the placement of the plate beneath the muscles, preserving the periosteal blood supply and reducing surgical trauma.

This study aims to assess the efficacy of nonlocking plate submuscular plating for subtrochanteric femur fracture in children.

Methods:

This was a retrospective study on patients operated with submuscular DCP in pediatric subtrochanteric fracture at the Orthopaedic Department at Comilla Medical College Hospital. This study was conducted at the Orthopaedic Department at Comilla Medical College Hospital. All the pediatric subtrochanteric fracture patients were operated with submuscular DCP at the Orthopaedic Department at Comilla Medical College Hospital between January 2022 to December 2023. Seinsheimer's fracture categorization was used in this series[36]. Failure of union to form within three months of injury was referred to as delayed union[4]. This study included patients diagnosed with a subtrochanteric femoral fracture, provided they did not have any associated injuries in the ipsilateral lower extremity. Additionally, only those who had undergone a follow-up period exceeding 12 months were considered eligible. The age range for inclusion was strictly between 6 and 14 years. Patients were excluded if they were older than 14 years or if their fractures were highly comminuted. Cases involving neurovascular injuries, pathological fractures, or open fractures were not included in the study. Furthermore, patients undergoing double Elastic Stable Intramedullary Nailing (ESIN) treatment, as well as those with a body weight exceeding 50 kg, were excluded from the selection process.

The primary outcomes were measured by pain, postoperative immobilization, duration of radiological union and normal weight bearing, interval between radiographic union and advancement to full weightbearing, and follow-up period were among the information gathered. Bridging callus across at least three of the four cortices seen on lateral and anteroposterior x-ray was considered radiographic union[33,34]. The secondary outcomes were measured by VAS for pain, Beaty score[37] for radiologic union and Flynn criteria[20] for outcomes.

Data analysis:

All consecutive cases were checked for eligibility criteria (inclusion & exclusion criteria). A structured questionnaire was used for collecting the information. All the data was processed with Microsoft Excel and SPSS 26. Continuous data was described in the form of mean ± SD and categorical data as percentages (proportions).

Surgical technique with follow-up

The patient was laid out on a regular, flat radiolucent table in the supine position. Leg length, alignment, and rotation might be more easily estimated by comparison in patients with complicated fractures if both lower extremities were prepared and draped. To align the new fracture, the patient was thoroughly sedated and subjected to modest manual traction and rotation. To assist in determining reduction, the image intensifier was employed. A tiny incision at the fracture site allowed a finger or other device to assist in reduction due to the considerable displacement and muscle tissue that was in the way. After that, the plate was shaped as needed to accommodate the metaphyseal flares by laying along the bone's lateral surface. One could insert plates from a proximal or distal position. Usually no more than 2.5 cm in length, the incision for plate insertion started at the plate's suggested end point and went towards the end of the bone. The second incision, which measured no more than 2.5 cm, was created at the other end of the plate and extended towards the centre of the bone. The plate was moved to the other end of the femur after being placed above the periosteum. Working through the two end incisions allows you to manipulate the plate; if needed, a percutaneous K wire can help. A second wire or screw was inserted into the other end. More screws were inserted once reduction and plate position have been assessed.

After surgery, patients were kept not bearing for six weeks before being able to bear some weight38. There was no need for casting or bracing. The clinic planned follow-up appointments at two-week, six-week, three-month, and eight to twelve-month intervals.

Results:

In our retrospective study from January 2022 to December 2023, we had operated a total of 22 pediatric subtrochanteric fracture with submuscular small DCP. The mean age of the patient was 9.23±2.39 years (range 6-14 years). Most of the children were male (68%). Only 32% children were female. The right femur was involved in 59% (12) of children and left side in 41% (10) of children. The mechanism of injury was road traffic accident in 50% cases, fall in 36% cases and other in 3 cases. There were associated injuries in 9 (41%) children.

According to the Seinsheimer classification, there were 6 (27%) cases of type IIIB fractures, 10 (45%) cases of type IIB fractures and 6 (27%) patients of type IIA fractures. Average hospital stay was 3.59±0.73 days ranging from 2-5 days. We advised patients to move their joints when pain permitted with few exceptions. So, the mean postoperative immobilization was 0.23±1.07 days (range 0-5 days).

To find out the radiological union, we had done X-rays routinely. The average duration of radiological union was 13±4.82 weeks ranging from 8-32 weeks where one femur took 32 weeks to unite. We permitted normal weight bearing after 6.45±1.01 weeks (range 6-10 weeks). The interval between radiographic union and full weight bearing was 6.55±4.13 weeks (range 2-22 weeks).

Pain was measured using visual analogue scale (VAS) which was 6.41±1.50 preoperatively. There was significant decrease in VAS after 12 months of operation to 0.41±1.01. Before operation almost all (91%) the patients had more than 2 cm limb length discrepancy (LLD). Only 2 (9%) patients had LLD between 1-2 cm. Nineteen (86%) children had more than 10-degree angular deformity, Rest (14%) of the children had angular deformity within 5-10 degree. All the 22 patients had persistent pain and major limitations of functions before operation.

Preoperative radiograph showed more than 10-degree of varus or valgus deformity and more than 10-degree of procurvatum or recurvatum deformity in 17 (77%) children. Rest 5 patients had coronal and sagittal plane malalignment within 5-10 degree. Most (17) of the patients had rotational deformity. Only 5 children had no rotational deformity. Radiographs showed equal number of limb length discrepancy (LLD) same as clinical examination.

After 12 months of follow-up, there were no limb length discrepancy (LLD) in 18 patients. Only four patients had 1-2 cm limb length discrepancy (LLD). Angular deformity of 5-10 degree persisted in one children. All other children improved completely in perspective of angular deformity. At the 12 months of operation 2 patients felt occasional pain and 1 patient had persistent pain. All of the children had full range of motion without any limitation except two who had minor limitation of movement.

There were 5-10 degree of malalignment both in coronal and sagittal plane in only one child with subtrochanteric fracture after 1 year of operation. In rest 95% patients had no such malalignment. There was no rotational malalignment after 1 year. Most (18) of the patients had no limb length discrepancy at the end of 1 year postoperatively.

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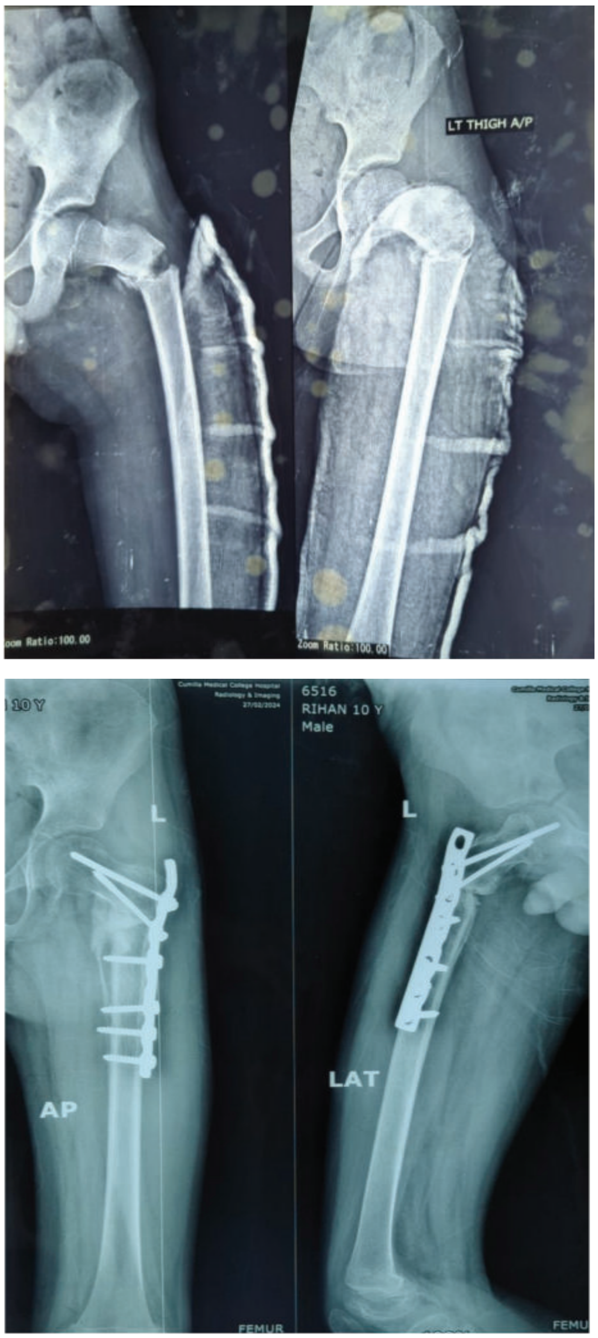
To see the functional outcome, Flyn criteria was used which was poor in all the 22 patients. But it was improved significantly after 12 months where 17 children were excellent category and 4 were satisfactory. Only one child had poor functional outcome according to the Flyn criteria. Beaty radiological outcome score was used to find out the radiographic outcome. All the children were poor according to Beaty score. After 1-year, overall criteria were excellent in 18 cases. Rest 4 children were in satisfactory category.

There was postoperative infection in 3 cases which were cured after proper antibiotics.



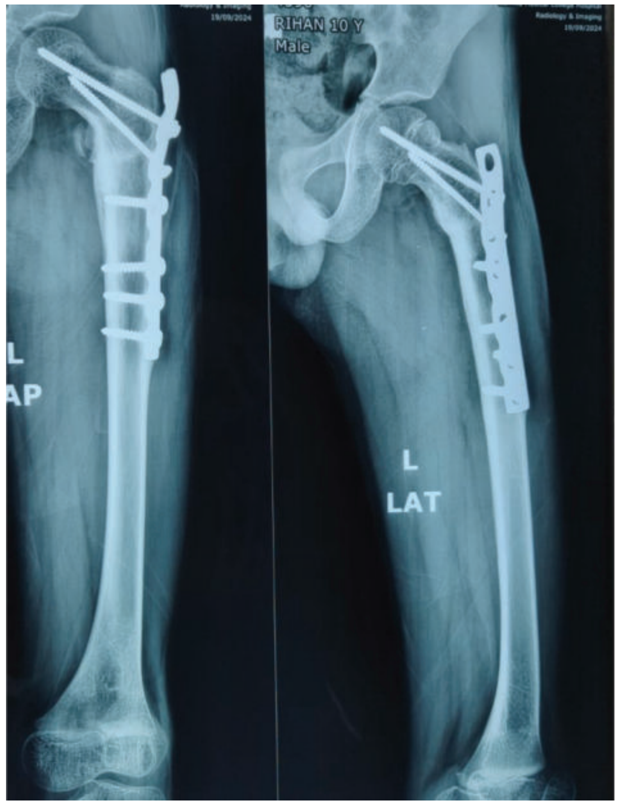


Figure 1 : Preoperative, Immediate postoperative, 12 months follow-up

Discussion:

While the submuscular DCP technique has shown promise in adults, there is limited literature on its application and outcomes in pediatric populations. The unique aspects of pediatric bone healing, growth potential, and the challenges associated with maintaining fixation stability in the presence of active growth plates necessitate a focused study in this demographic. The results of this study could significantly influence clinical practice by providing evidence-based guidelines for the treatment of pediatric subtrochanteric fractures. Demonstrating the efficacy and safety of the submuscular DCP technique could lead to its widespread adoption, improving patient outcomes and reducing the burden of these challenging fractures on healthcare systems. This study aims to fill a critical gap in pediatric orthopedic trauma management by providing robust data on the submuscular DCP technique. The findings will have the potential to optimize treatment protocols, enhance patient recovery, and ensure better long-term outcomes for pediatric patients with subtrochanteric fractures.

Li et. al. allowed full weight bearing after 9.9 weeks after operation with plate in pediatric subtrochanteric

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patients. In our study we permitted normal weight bearing after 6.45±1.01 weeks. Li e. al. found average radiographic union after 11.4 weeks. Hong et. al found that average union time of pediatric subtrochanteric fracture operated with locking plate was 13.2±1.7 weeks. Jarvis et. al. and Al-Ashhab et. al. also showed radiographic union time 10 weeks and 6-10 weeks respectively. Our finding was also similar to above study which was 13±4.82 weeks. In perspective of overall outcome Li et. al. showed excellent result in 87% cases, satisfactory in 10% and poor outcome 3% cases of pediatric subtrochanteric fracture treated with platting. Xu et. al. found that 68% patients of subtrochanteric fracture operated with open platting had excellent outcome. He showed that outcome of 32% patients was satisfactory with no poor outcome. Waghala et. al. described submuscular non-locking plate was an effective option for pediatric subtrochanteric fracture as he found excellent outcome in 87% cases according to Flynn criteria. There was 13% satisfactory outcome with no poor outcome.

In our setting, according to Flyn functional outcome score 77% children had excellent outcome. There were 18% satisfactory outcome and 4% poor outcome. According Beaty radiological outcome, 82% patients had excellent result and 18% had satisfactory outcome with no poor radiographic outcome. In this study there was limited sample size. The use of submuscular DCP requires a high level of surgical skill and experience. In a resource-limited tertiary hospital setting, variability in surgeon expertise may impact the consistency of outcomes. The need for secondary surgery for plate removal is a significant drawback, as hardware irritation or discomfort can necessitate an additional procedure, adding to the overall treatment burden.

Conclusion:

The use of submuscular dynamic compression plating (DCP) for pediatric subtrochanteric fractures in a tertiary hospital setting has demonstrated favorable outcomes. This technique provides stable fixation, facilitates early mobilization, and minimizes soft tissue disruption, promoting faster recovery. The study highlights excellent union rates, low complication rates, and the restoration of functional outcomes, emphasizing its efficacy and safety in managing these complex fractures. Submuscular DCP emerges as a reliable option, particularly in cases where conservative management or other surgical approaches may be less feasible. Further studies with larger sample sizes and long-term follow-up are recommended to validate these findings.

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