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# OUTCOME OF SUBMUSCULAR PLATING IN PEDIATRIC LENGTH UNSTABLE FEMORAL SHAFT FRACTURES

**Orthopaedics**

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## ABSTRACT

**Background:** Femoral shaft fracture is the most common orthopaedic injury among the paediatric age group requiring hospital admissions. The management for the age group of 6-12 years of age is still remains controversial. Literature states that the submuscular plating has a favourable outcome and can be considered as the best alternative in treating unstable variety of femoral fractures. **Aim:** The aim of the study is to assess the outcome of submuscular bridge plating in length unstable paediatric femoral shaft fractures. **Methodology:** This is a prospective study conducted in the Department of Orthopaedics in the Assam Medical College, Dibrugarh for the period of 2 years from February 2021 to January 2023. The total sample size was 25. Demographic details, fractures characteristics, both intraoperative and postoperative findings, radiological outcomes and complications were noted. The statistical analysis was done with MS excel and SPSS 16 and the P value was found to be <0.05 which is considered as significant. **Results:** The mean age of the cases was 8.60±1.5 years and majority were males 20(80%) and most common mode of injury was due to motor car accident. Majority of the study participants have comminuted fracture 10 (40%) involving Proximal one third. All fractures were united with excellent clinical results without any major complications. **Conclusion:** Thus, the submuscular plating is considered as an effective method for the length unstable femoral shaft fractures among the paediatric age group and having minimal complication compared to other surgical methods.

## KEYWORDS

Femur, Fractures, Submuscular plating, Comminuted, length unstable.

## INTRODUCTION:

Among the paediatric fractures, femur fractures accounts for 1.4%-1.6%. It is commonly seen in the preschool children and adolescents. Fractures are more in boys than girls(1)(2) and is also the most common fracture demanding hospitalization. Children can sustain femoral fractures varying from trivial trauma, recreational or competitive sports, fall from height to road traffic accidents. Low energy trauma fractures occurs in younger children, toddlers whereas, high energy trauma occurs in the adolescents(3).Non accidental trauma occurs in children of age less than 18 months.

For children <5 years of age, the fractures can be managed conservatively through traction and applying spica cast. However, in case of older children (> 6 years) several factors come into play while deciding the treatment plan, including the age and weight of the patient, fracture pattern, associated injuries, and surgeon preference. Non-operative treatment is also planned in case of simple fractures. However, in light of increased risk of malalignment, increased cost due to hospitalization and prolonged immobilization which occurs in the conservative method, nowadays, the treatment modality has shifted to operative intervention, mostly in older children.

Operative modalities include antegrade trochanteric rigid nailing, Titanium elastic nailing (TENS), conventional open reduction and plate fixation and submuscular bridge plating. The ultimate aim of any operative procedures is to achieve adequate fracture stability by means of preserving the femoral blood supply and preventing the physeal damage (4)(5)(6).

The entry point of the medullary nail of rigid type can lead to damage in the femoral head vascular supply. Even by using the greater trochanteric entry points does not address problem completely. TENS although most commonly preferred treatment cannot address some types of femoral fractures. Adequate stability will not be obtained in fractures at proximal one-third and distal-one third with the intramedullary nails(7)(8)(9). The reason behind this is due to smaller length of the nail bone contact. It is also not preferrable in length unstable fractures like spiral and oblique fractures.

Long incisions and more soft tissue dissections were required for the traditional open reduction and applying compression plate, thus, a higher risk for infection and a delayed healing. 10% of reoperation was also reported in some studies(10).

Submuscular plating method is considered as an alternative method for the intramedullary nailing in the children for an unstable fracture of femur. This method gives a fracture stability without disrupting the fracture biology.

The aim of our study is to assess the outcomes and complications among the paediatric patients who have been treated with the submuscular bridge plating.

## METHODOLOGY:

### Study Setting:

Hospital based prospective study was conducted in the Department of Orthopaedics, Assam Medical College, Dibrugarh which is a tertiary care centre.

### Sample Size:

Between February 2021 to January 2023, 25 patients with closed femoral fractures were operated on at Department of Orthopaedics, using sub muscular plating technique.

**Inclusion Criteria:**
Candidates for this study were children over the age 5 years (6 to 12 years). Submuscular plating was selected over TENS because the fracture types were of length unstable, segmental, comminuted, long oblique and spiral variety, hence, unsuitable for TENS. Even Gustilo-Anderson open type 1 fractures were included. In addition, informed consent was obtained for print and electronic publications.

**Exclusion Criteria:**
Patients with open type II and III fractures and also those associated neurovascular injuries, pathological fractures and patients with less than 6 years and above 12 years were excluded.

**Statistical Analysis:**
After collecting the data, it was entered in MS excel Windows10.Statistical analysis was done in SPSS 23. Continuous data were expressed in terms of Mean ±Standard deviation and Categorical variable were expressed in terms of numbers(percentages). P value of <0.05 was considered as significant.

**Surgical Technique:**
A preoperative intravenous antibiotic was given before surgery. The patient was positioned supine on a fracture table under the effect of general anaesthesia. Skin preparation done with povidone iodine followed by proper draping of the limb to be operated. Provisional reduction was achieved by gentle manual traction or boot traction. For all patients a long (8-14 hole) locking compression plate (LCP) was used. The length of the plate for each case was determined by placing the plate over the anterior thigh and confirmed by fluoroscope. The plate length should, in general, allow for the purchase of six cortices proximally and six cortices distally from the fracture. Using a table plate bender, the plate was contoured, typically resulting in a slight bend to accommodate the proximal femur and a larger bend for the distal metaphysis. Just above the distal lateral femoral physis, a 3-4 cm long incision was made and soft tissue dissection done to expose the distal fibres of the vastus lateralis muscle. Tunnelling was done between vastus lateralis and periosteum using a periosteal elevator. After which the plate was advanced proximally which itself gets lodged in the sub-vastus plane. It was then adequately positioned and provisionally fixed to the femur using a Kirschner wire in the most proximal and distal screw holes after confirming the reduction under the guidance of C-arm using both AP and lateral views. Another incision was made proximally (just below the greater trochanter) to allow placement of three cortical 4.5-mm screws. The distal three screws were placed through the distal primary incision under direct vision. (Figure 1.1)(11)(12)(13).

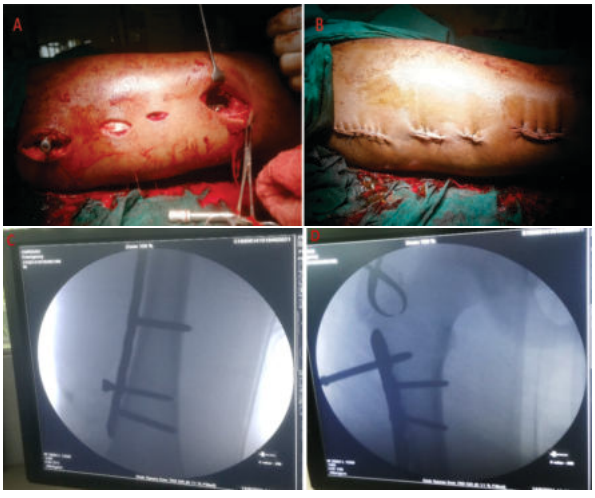

**Fig 1.1:** Intra Operative Images A), B) skin incision; C), D) fluoroscopic images

**Postoperative Care** Following surgery, patients were advised physiotherapy including active knee bending, both static and dynamic quadriceps from post op day 2 onwards, as per pain tolerance. Strict non-weight bearing was advised for first 6 weeks. Toe touch weight bearing was allowed after 6 weeks and full weight bearing allowed after radiological union (8-12 weeks)(14). They were followed at 2 weeks, 6weeks and 12 weeks, 6months and 12 months. (figure 1.3). Implant removal done on patients request from 7 months to 2 years.

**Fig 1.2:** Post operative range of movements at 3 months follow-up in a 11 year old boy

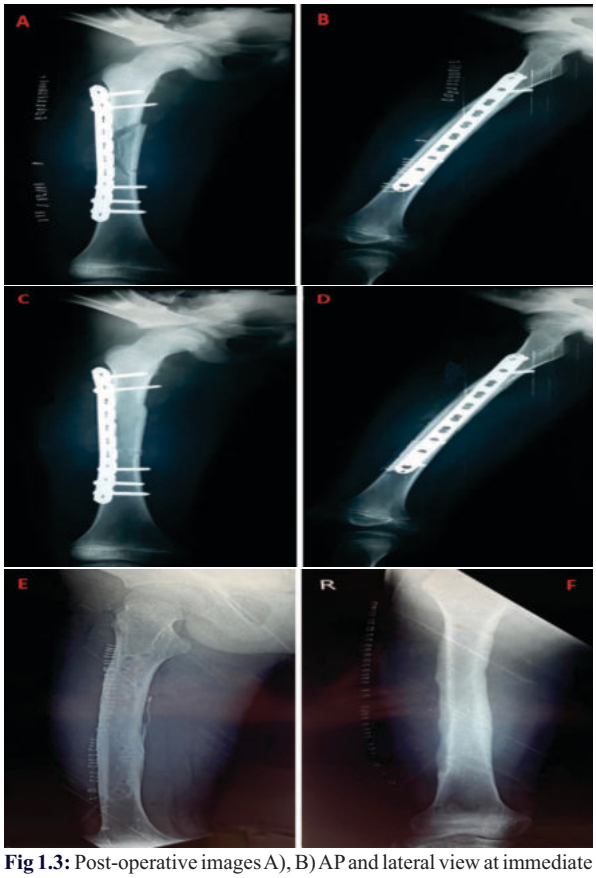

**Fig 1.3:** Post-operative images A), B) AP and lateral view at immediate post-op; C), D) AP and Lateral radiographs at union (3 months); E), F) After implant removal in a 11 year old boy

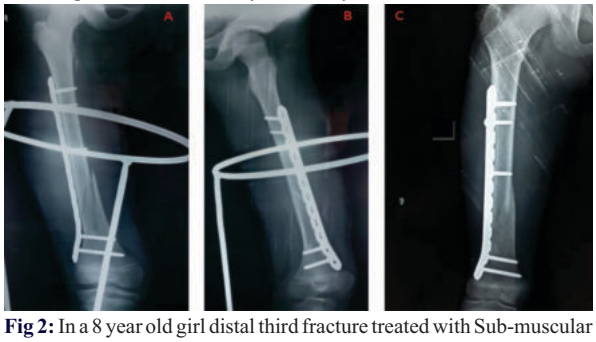

**Fig 2:** In a 8 year old girl distal third fracture treated with Sub-muscular plating A) AP views immediately post surgery; B), C) AP and Lateral radiograph at 3 months follow-up.

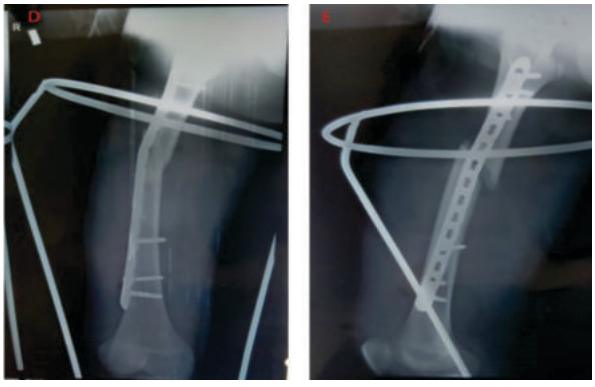

**Fig 3:** Complications: in a 12 years old male, A), B) Anteroposterior and lateral radiograph made immediately following the surgery, showing a broken plate. The patient undergone implant removal and open reduction and plating with an acceptable alignment.

## RESULTS:

**Table 1: Baseline characteristics of the study participants:**

| Variables | (M±SD /N) |
|---|---|
| Mean Age | 8.60±1.5 |
| Sex | |
| Male | 20(80%) |
| Female | 5(20%) |
| Laterality | |
| Right Side | 13(52%) |
| Left Side | 12(48%) |
| Mode Of The Fracture | |
| Motor Car Accident | 15(60%) |
| Fall From Height | 10(40%) |
| Fracture Type | |
| Proximal Third | 11(45%) |
| Middle Third | 8(32%) |
| Distal Third | 6(24%) |
| Fracture Pattern | |
| Transverse | 5(20%) |
| Oblique | 3(12%) |
| Spiral | 7(28%) |
| Comminuted | 10(40%) |
| Follow Up | |
| Complete 12 Months Follow Up | 19(76%) |
| <12 Months Follow Up | 6(24%) |

**Table 2: Perioperative parameters, follow up and outcome measures:**

| Variables | (M±SD /N) |
|---|---|
| Duration of the Surgery (min) | 96.8±12.5 |
| Average duration of hospital stay (days) | 11.60±1 |
| Average time for callous formation (weeks) | 4.1±2.7 |
| Union time (weeks) | 12.3 ± 3.4 |
| Complications | |
| Superficial infections | 1 |
| Deep infections | 0 |
| Insignificant Limb length discrepancy | 1 |
| Significant Limb length discrepancy | 0 |
| Non union | 0 |
| Refracture | 0 |
| Implant failure | 1 |

In our study among the 25 study participants majority were male 20(80%). The mean age of the study participants was found to be 8.60±1.5 years with the minimum age as 6 years old and the maximum age being 12 years old.

13(52%) of our study participants have right side fracture whereas 12(48%) of the study participants have left side fracture.15(60%) fractures were as a result of motor car accident whereas, 10(40%) fractures resulted due to fall from the height. The most common type of fracture observed Comminuted fracture 10(40%) followed by the Spiral fracture 7(28%) which mostly involved the proximal third (45%) of femur. All fractures united without any obvious deformity limb length discrepancy. Range of motion during follow-up was not affected in any patient. Union was achieved by 12 weeks. There was a case of implant breakage treated with implant removal and open reduction and plating in the same sitting. Moreover, one (4%) superficial infection was noted which was managed accordingly by oral antibiotics after culture sensitivity but no deep infections were reported. We didn't observe any physeal arrest after surgery among our study participants.

## DISCUSSION:

The treatment modalities for femoral shaft fractures has been shifting among the paediatric age group from conservative methods like hip spica and Pavlik harness for children below 6 years to operative methods mostly for adolescent age group. Advocates of surgical intervention cites early recovery and mobility, shorter hospital stay, quicker return to school and social settings. But controversies still exist in literature regarding the best method in the paediatric age group. Many surgical methods were used in the femoral fractures among the paediatric group. They are the open plating or submuscular plating, elastic nailing (retrograde) and rigid nailing (antegrade) or the external fixation.

Rigid nailing (antegrade) was considered to cause complications like avascular necrosis and damage to the trochanteric physis as it passes through the trochanteric tip. It is also not suitable for fractures involving femur's distal and proximal end. This method mainly suits the late adolescent age group(15).

For patients less than 45 Kg of weight and with stable mid shaft femoral fractures the most suitable method for fixation is retrograde elastic nailing. However, fractures that are length unstable, comminuted or that are near proximal or distal epiphyses have been observed to have more complications.(13) Obese patients and for unstable femoral fractures this method produces complications like implant irritation and malunion thus, limiting its use(16).

For open fractures and the patients with multiple trauma external fixation is the feasible method. Many studies states that pin site infection, formation of the scar and high chance for refractures make it less acceptable method(5)(16)(17).

Excessive bleeding, non-union, infection and ugly scar formation in case of open plate osteosynthesis makes it a less popular method, although it provides an anatomical reduction of the fracture.(18)

Preserving the fracture biology, small scar with less blood loss and less chance of infection makes the submuscular plating a preferred method over open plating among the paediatric femoral fracture. Advantages of using this method is that, it can be used for both stable and unstable fractures, proximal and distal femur fractures, pathological fractures and in patients with narrow medullary canal and in patients with deformed femur when intramedullary nailing is not an option(4).

Many studies projected the good results among the paediatric patients who has submuscular plating with no or minimal complications.

Mathew et al in his study compared the submuscular plating and open method and he stated that more complications like implant breakage and the revision surgeries were observed among the patients who underwent open method compared to the submuscular plating method(19). Similarly, Sutphen et al also did a comparative study in which he compared different methods like retrograde elastic nailing, rigid antegrade nailing and the submuscular bridge plating. His results showed that early mobility and early callus formation and less implant related complications were seen in the submuscular plating method compared to the other methods(20). The patients in our study also have similar results, all fractures united and have not shown any major complications.

In our study, a male preponderance is observed 20(80%) which is similar to a study done in Bihar by Kushagra et al(16) and by Valenza et al(17). Right side fractures were more common in our study and Road traffic accident is the most common reasons for fractures. All these results were similar to the study done in Bihar and in Brazil. Similar findings were also found in a study done in the Egypt by Elsayed et al(18).

In our study, the average time for callous formation 4.1 weeks and radiological fracture union at 12 weeks. 6 (24%) patients were followed up for <12 months. The most common complication found in

our study was the superficial infection. Refracture and non-union was not observed in any of the cases. Limb discrepancy observed in our submuscular plating similar to Kushagra et al study(21). May et al also found 1% of his case having limb discrepancy which is of more than 3 cm subsequently treated by epiphysiodesis (18). No such clinically significant limb length discrepancy (LLD >2cm) was found in our study. We observed implant breakage in 1 patient where an improperly sized implant was used, done in the beginning of the study but later on no complications were noted with better understanding of the principles of the technique. This was similar to the report by Kanlic et al, where they reported 4% rate of 'significant' complications including one hardware failure and one case of refracture after plate removal(24). However, minor complications (not requiring re-operation) occurred in 4 % of patients and included one superficial infection.

We insisted the patients to remove the plate from 7 months to 24 months. Plates staying for longer duration shows a) stress shielding effect thereby, increasing the risk of fracture; b) bone growth over plate warranting a large incision during implant removal. Studies done by Kelly et al(25) had stated that retention of plates among his three patients who lost to follow up in due course and later on the plates were removed.

**Limitations:**

It is a cross sectional study without a long term follow up so we cannot find the long term effect of the treatment in the children and the sample size is also relatively small. We didn't compare any other surgical method with the submuscular plating.

## CONCLUSION:

Submuscular plating is the most effective method with good results as it has its own advantages like early mobilisation and less hospitalisation time with minimal complications. It is safe for the distal and proximal femoral fractures in children. Regardless of patient's age, weight, fracture location and mechanism of injury submuscular plating is a good alternative for the length unstable femoral fractures.

**Recommendation:**

We believe that submuscular plating techniques should be a part of the armamentarium of orthopaedic surgeons managing trauma in unstable variety of paediatric femur fracture as well as the emerging literature elaborating several limitations of other treatment approaches. To better illustrate how specialised fracture treatment may be tailored for the various age groups of paediatric patients, prospective research is required in the future. A longer duration of follow up will help us in finding out the complications like non-union, implant related complications and the limb lengthening.

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