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Segmental Fracture in Younger Children Managed by Submuscular Plating: A Case Report

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ABSTRACT

Introduction: Complex femur fractures in children are rare and occur due to high-energy trauma. Most of these fractures are managed surgically with the primary goal is the restoration of the anatomical alignment. In this report, we describe the management of complex femur fractures in pediatric patients.

Case Presentation: A 5-year-old boy who came to the emergency room at Andalas University Hospital with left thigh pain which occurred due to a high-energy traffic accident since 10 hours before admission. From primary survey, patient was in stable condition. From local examination there was discrepancy and angulation on the left thigh with local tenderness. Plain radiographic studies on the left femur showed a segmental diaphyseal fracture. Afterwards, patient underwent open reduction and internal fixation (ORIF) with submuscular plate fixation on the same day.

Result: After surgery, discrepancy was inapparent. On one month follow up, healing and rehabilitation was uneventful, with patient being active and no infection spotted. After three months of follow up, abundant callus formation was observed on the follow up x ray. Clinically, patient did not complain any pain, played actively, and range of motion almost returned to normal as shown by near-normal gait and ability to do various of movements.

Discussion: Although theoretically segmental fractures are best managed by Titanium Elastic Nailing System (TENS), multiple clinical setting and facilities considerations may sometimes varies the options available. Submuscular plate fixation is a good choice in settings where C-arm is unavailable and appropriate implants are scarce. This is beneficial in terms of attaining a good reduction and fixation especially for complex patterned fracture, although, one must point out the possible shortcomings such as more bleeding and much soft tissue stripping that may hinder healing process.

Conclusion: Complex femur fractures in children are uncommon and challenging to manage. Understanding principles of fracture fixation and choosing the best suitable implants for each case allows for excellent functional outcomes and early patients ambulation.

Keywords: comminuted, fracture, pediatric, plate fixation

INTRODUCTION

Complex femur fractures in children are rare and occur due to high-energy trauma such as road traffic accident or fall from height. Complex femur fractures are defined as combined fractures of shaft and proximal or distal femur.[1,2] Femur fractures are highly associated with high energy injuries, most commonly motor vehicle collisions. It

accounted for 18-40% of paediatric orthopaedic admissions in low and middle income countries.[3]

Orthopedic Trauma Association (OTA) considered complex femur fracture as type C fractures, which is multi-fragmentary fractures (oblique, spiral, or irregular) and segmental femur fractures. Meanwhile in children, complex femur fracture includes OTA 32-D4.2 and 5.2.[4]

Management of these fractures is very challenging. Most of these fractures are managed surgically as they are inherently unstable. The primary goal in the management of these fractures is the restoration of the anatomical alignment. In this report, we describe the management of complex femur fractures in pediatric patients.

CASE PRESENTASION

We presented a case of 5-year-old boy who came to the emergency room at Andalas University Hospital with left thigh pain as his chief complaints. The pain occurred due to a traffic accident since 10 hours before admission. The patient was in a car with his parents, when suddenly the vehicle had a collision with another car going in the opposite direction. The boy was sitting in the middle row with no seatbelt attached. The crash caused sudden high energy trauma with the patient leg in a bent position. Shortly after the incidence, the patient cried and there was no history of decreased consciousness after injury. From primary survey, patient was in stable condition. The patient has documented history of asthma and drug allergic reaction to ranitidine.

Figure 1. Clinical photo showing both legs.

Figure 2. Deformity in the left thigh caused by fracture.

Local examination was systematically performed on this patient. From inspection, there was deformity and shortening in the left thigh without any open wound. The palpation revealed crepitation and local pain, and the patient was not able to move his left leg because of the pain. There was no sign of neurovascular deficit from physical examination. Plain radiographic studies on the left femur showed a segmental diaphysis fracture.

Figure 3. Radiograph showing segmental diaphysis fracture.

Figure 4. Post-operative radiographic anteroposterior and lateral views showing fixation of left femur.

The patient was planned for open reduction and internal fixation (ORIF) on the same day. Laboratory test was done prior to surgery and showed no significant abnormal result so the patient was assessed with stable condition for surgery. Blood transfusion was also prepared for post-surgery as indicated.

The patient was taken to the operating room immediately. An incision was made posterolaterally, with the lateral vastus dissected carefully together with hemorrhage control. After exposing the, care was taken to not extensively disrupt the periosteum while reducing the fracture. as it was segmental, the distal and middle fragment was fixated first, followed by proximal fragment. after fixation was done, length of the was measured intraoperatively and was found satisfying. Closure was proceeded with layered fashion.

An attempt was made to reduce and stabilize femur position with plate installation. After the procedure, the patient underwent radiographic evaluation and then transferred to surgical ward for observation.

On the first day after surgery, the patient complained severe pain and have difficulty moving. Analgesics and antimicrobial agent were given for pain control and prevent infection. The patient also underwent blood transfusion for blood loss replacement. The patient was advised to do gradual passive mobilization. Third day post-surgery the patient was discharged from hospital and planned for outpatient control in orthopedic clinic for further evaluation.

One week after surgery, the patient came for check-up up with no pain complaints over the left thigh and no sign of infection. After one month, the wound was almost healed and the patient was able to move his left leg without difficulty. After three months follow up, the patient was able to do active mobilization and can return to do his normal daily activities. On the X-ray, adequate callus formation is observed. Clinically, the patient also demonstrates excellent mobility, good range of motion (ROM), equal leg length, and no apparent gait disturbances.

Figure 5. (A) Post-operative radiographic anteroposterior and lateral views one Month after surgery and (B) Three months after surgery.

Figure 6. Follow up after three months showing patient was able to do active mobilization

DISCUSSION

Complex fractures management offered major challenges, particularly in pediatric cases. The goal of surgical intervention is to restore the length, alignment, and rotation.[6] Juskovic et al classified complex femur fractures into three types. Type I defined as combined fractures of the shaft and proximal femur. Second type was defined as segmental femur fractures, and lastly, type III was described as combined fractures of the shaft and distal femur.[7] The *AO Pediatric Comprehensive Classification of Long-Bone Fractures* (AO-PCCF) classified pediatric femur fractures into four category. This case was categorized into the 32-D/5.2 which involved multi fragmentary oblique fractures with more than 30^{o} angulation.[6,7]

Closed segmental fractures are best managed by *Titanium Elastic Nailing System* (TENS), submuscular plating, or intramedullary locking nails depending on the age and patient weight.[8] TEN has its own advantages, including minimal surgical exposure, less intraoperative blood loss and low infection risk, but it is not suitable for comminuted fractures.[9] Despite providing relative stability and secondary bone healing, TEN has a high risk of femoral head avascular necrosis (AVN) occurrence in pediatric patients.[10]

Older and overweight or obese children could use some benefit from plate fixation. However, plating has drawbacks such as extensive soft tissue dissection, longer surgery time, more blood loss, and disruption of the periosteal blood supply,

which can increase delayed or non-union bone risks. On the other hand, submuscular plating acts as an internal 'external fixator' and considered as minimally invasive approach. This technique reduces fractures indirectly, causing minimal damage to the periosteal blood supply. Using longer plates with fewer screws provides maximum biomechanical stability by increasing the plate's working length.[8,9]

Submuscular plating is considered a better choice for length-unstable or comminuted fractures in children. It provides excellent stability and enables the management of proximal and distal fractures that are not suitable for nailing, but it increases the risk of leg-length discrepancy, deep infection, and refracture after plate removal. Also, it requires another extensive surgery to remove the plate.[6]

The management of complex femoral fractures in pediatric patients remains a topic of debate due to the variety of available treatment modalities. Treatment decisions should be guided by the best available evidence, with considerations such as the presence of open wounds and the patient's overall condition influencing the choice of intervention.[11,12] In this particular case, submuscular plate fixation was selected based on several factors. Primarily, the absence of a C-arm in our facility precluded the use of certain techniques, and TENS (*Titanium Elastic Nailing System*) was not readily available. For segmental fractures which requires strong and stable fixation, traditional plating, although not the most ideal option, proved to be a viable alternative that gives favorable outcomes. Long-term follow-up is crucial for pediatric patients, as these fractures are susceptible to delayed complications, and the growth of long bones ceases around the ages of 14–16 years in boys, necessitating monitoring for potential length discrepancies.[13]

CONCLUSION

Complex femur fractures in children are uncommon and challenging to manage. However, with thorough planning, understanding of fundamental principles of fracture fixation, and the use of most suitable implants for each case, excellent functional outcomes can be achieved including early patients' ambulation.

Declaration by Authors

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