Reversible Physeal Arrest In An Adolescent Intraarticular Distal Femur Fracture With Unusual Configuration: A Case Report

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Abstract

Distal femur physeal fracture in adolescent age group are unpredictable in view of their prognosis and complications. We present a case of distal end femur fracture due to its unusual configuration and management in a 13 years male patient. This patient was treated by open reduction and internal fixation with distal femoral locking plate with screws spanning the physes. We also want to report this case as it showed features of impending physeal arrest which was reversible after removal of transphyseal screws which were promoting epiphysiodesis. End result was anatomical healing of fracture with no limb length discrepancy and deformity and fully preserved joint motion. This report shows that effective management of physeal injuries and timely intervention can lead to successful outcome even in a limited resource setup. However we should be prepared to anticipate and manage adverse outcome and complications while handling such injuries.

Keywords: Physeal, Distal femur, Fracture

Introduction

Distal femoral physeal fractures are uncommon injuries in children but are unique in view of higher rates of complications as compared to other physeal injuries [1]. Fractures of lower end femur in adolescent age group are difficult to treat and pose a challenge even to experienced orthopaedics surgeon. More so if such fracture present with intraarticular extension (Salter Harris type 3 and 4) situation becomes uncertain regarding plan of treatment and prognosis. In a meta-analysis 52% of such fractures resulted in growth disturbances [2]. The goal of treatment in such fractures is to provide a stable anatomical fixation, preservation of range of motion of joint, reduce chances of future secondary arthritis, preserve the biology and prevent iatrogenic insult to the already compromised physes. In an experimental animal study researchers found that destruction of 7% cross sectional area in distal femoral physes resulted in permanent shortening and growth disturbances in distal femur [3]. After reduction, fixation of fracture should be stable enough to allow early mobilization and prevent displacement as studies have shown that redisplaced fractures tend to have higher complication rates and poor prognosis and 43% of the reduced fractures displace in cast even after anatomical reduction [4].

We present an unusual case of distal end femur intercondylar fracture with metaphyseal extension in both columns in a 13 year old child. We treated this case with open reduction and fixation with distal femur locking plate with good results without any deformity and shortening at 1.5 years follow up. This fracture is interesting due to its unusual pattern which is difficult to classify and temporary physeal arrest seen which was reversible after removal of offending trans physeal screws.

Case report

A 13 years old male child presented to the emergency department at our hospital in Farrukhabad, a small town in India with history of road traffic accident being hit by a motorbike collision. Patient was unable to bear weight on his left lower limb and had swelling, tenderness and deformity in lower part of his left thigh. Clinical examination revealed stable vitals, no other associated injuries and no distal neurovascular deficit except some superficial abrasions. Limb was splinted and after stabilization of the patient radiographs were done which suggested intercondylar extension and proximal extension on both medial and lateral metaphyses (a Y shaped fracture). This resembled Salter Harris type 4 fracture but different as Salter Harris type 4 fracture involves Thurston Holland fragment on only one side of metaphyses and other condyle and metaphyses are in continuity (Fig. 1). CT scan of the fracture was not done due to unavailability of it in town. Based on the X rays Patient was planned for surgical stabilization and parents were explained regarding the prognosis and possible complications including physeal arrest, angular deformity and limb length discrepancy either due to injury or surgery itself. Parents gave the consent for surgery and we proceeded for open reduction and internal fixation with distal femur locking plate with screws spanning the physes. After removal of trans physeal screws the patient had no complications and achieved anatomical healing of fracture with no limb shortening and deformity in follow up at 6 months. The parents were satisfied with the outcome and the child was able to bear full weight on his left lower limb without pain and had full range of motion of knee joint. We believe that this report can be helpful for other orthopaedics surgeon to handle similar injuries and can see similar complications. This case also shows the importance of understanding the physeal development and their complications to handle such injuries effectively.
for surgery and patient was posted for surgery next day. Under spinal anesthesia part was cleaned painted and draped. Fracture was exposed through Schwash Buckler approach. On exposure fracture had intercondylar extension with small metaphyseal part which was sagittally split and it was not possible to give stable fixation without fixation in epiphyses so transphyseal fixation was planned without crossing pyseal plate with implants (Fig. 2). First articular reconstruction was done and two condylar pieces were held together by pointed reduction clamp in correct rotation and provisional fixation of the fracture was done with K-wires (Fig. 3). Than articular fixation was done with two screws. Next seven hole distal femur locking compression plate was applied and two distal screws through the plate were inserted in epiphyses and two screws through the plate into distal metaphyseal segment just short of physes (Fig. 4 and 5). Care was taken not to penetrate any implant in physes. Proximal fixation was done with 4 screws (Fig. 6). Knee range of motion exercises were started...
from second postoperative day and patient was mobilized with non weight bearing walking on crutches. Stitch removal was done on 14th postoperative day and patient was called up for monthly follow up and removal of distal screws through the plate 3 months post operation to allow growth but he presented at 4 months. At this time radiographs were done which suggested dense calcification near the physes and blurring of the physes indicative of physeal arrest (Fig. 8). However there was no coronal plane deformity and patient had full range of motion at the affected knee joint and could walk full weight bearing with normal gait. Parents were explained regarding possibility of physeal arrest and need for future reconstructive or lengthening procedures. As planned distal 2 screws through plate and one intercondylar screw were removed in the operation theatre and patient was advised to follow up every three months to look for any limb length discrepancy or deformity. At this time on clinical examination left limb showed 1 centimeter of true shortening and height of patient was recorded to be 4 feet and 11 inches. At each follow up visit limb length discrepancy begin to decrease and finally at 15 month postoperative both limb lengths became equal and patient developed increase in height to 5 feet and four inches. Radiographs at 15 months were surprising as the physes which was previously blurred was now clearly visible and had considerable growth as could be seen by the migration of 4 mm screw which was previously below and proximal to the plate had clearly migrated distal to the plate and there was no evidence of any physeal abnormality or deformity (Fig. 9,11). Implants removal were done at sixteen months post initial surgery. Patient was asymptomatic at final follow up and had full range of motion without any deformity at affected knee joint (Fig. 10).

Discussion
Physeal injuries in pediatric age group are difficult to treat and more difficult is to predict there outcome. The fastest growing physes in human body is femoral physes. It grows approximately 1 cm per year and is responsible for 40% of growth of lower extremity [5,6]. In growing children distal femoral physes is weak biomechanically thus making it vulnerable to injury and due to its undulating shape, fracture lines may cross multiple zones of physes leading to high chances of physeal bar formation and permanent physeal arrest [7]. In adolescent age group near maturity, potential for remodeling is minimal and chances of deformity are high. Various treatment methods have been cited in literature regarding management of distal femoral physeal fractures including closed reduction and cast, closed or open reduction and fixation with k wires, screws and plates but none has been free of complication. In an experimental study on white rabbits Makela EA et al recommended, fixation of distal femoral physeal fractures by biodegradable self-reinforced polyglycolic acid pins resulted in adequate strength and minimal chances of growth disturbances [8]. During early childhood ligaments of the knee are stronger than the physes so these injuries cause disruption of the growth plate and follow the usual Salter Harris classification pattern [9]. But during adolescence physeal strength increases and fracture pattern may be a mix of distal femoral peri-articular fracture pattern in adults and physeal fracture in children as in this case. The main challenge of fixation of such injuries is to provide strong, anatomical and stable fixation to
allow early range of motion while allowing for future growth and prevention of deformity.

Stress across the joint in juxta articular fractures in adolescent are high almost as in adults however open physes has some growth remaining and cannot be neglected in such age groups. A balance has to be made between strong, stable fixation and prevention of physeal disturbances as continued micro motion at fracture site in case of unstable fixation may promote physeal arrest [10]. In distal femur epiphyseal injuries malunion is a concern and appropriate reduction and rigid internal fixation is done to avoid this complication. Next concern is permanent, complete or partial physeal arrest which may cause limb length discrepancy or angular deformity depending on location and extent of physeal arrest. Such complication can be dealt later by femoral lengthening, physeal bar resection, guided growth, corrective angular osteotomies or contralateral femoral epiphysiodesis or shortening, once the fracture has healed anatomically [11].

Usually the lower end femur fractures in adolescent age group are supracondylar type without intra articular extension but fracture pattern in our case was like Y type fracture where metaphyses was also splitted in sagittal plane (Fig. 7) so fixation in metaphyses alone could not be relied upon to be stable. In this case metaphyseal fragment was small and splitted and adequate purchase could not be obtained in metaphyseal segment, so it was planned to provide transphyseal fixation. Strong fixation to allow early range of motion exercises was aimed and prevention of growth arrest was planned by the removal of screws through the plate at three months but since patient presented at 4 months, radiographs at that time showed physeal arrest as screw in the epiphyses could not allow for growth and promoted epiphysiodesis which was temporary and led to shortening of 1 centimeter. One intercondylar screw could not be removed as it was buried under the plate and we thought it would not hinder growth as it was not through the plate. Immediately after removing the screws epiphysiodesis effect of the plate was neutralized and physeal was stimulated to regrow again. Coverage of the limb length discrepancy took 14 months (18 months post operation) with biology at its best as could be seen by the migration of the epiphyseal screw and the fracture healed with normal limb alignment and no limb length discrepancy.

**Conclusion**

To conclude intra-articular distal femur fractures in adolescent age groups should be handled with meticulous care. Whenever possible transphyseal fixation should be avoided, however not at the cost of stability. Goal of treatment in such injuries should be restoration of normal limb alignment and fracture reduction and fixation in a near-anatomic position, without risking further damage to the growing physis. However even with recent advances in understanding of such fractures it is very difficult to predict the outcome of such injuries and treatment of such injuries should be individualized based on patient’s age, fracture configuration and surgeon’s competency. Though a single case is not sufficient to provide good quality evidence but this unusual fracture pattern and reversible arrest of the physes are worth reporting and this case will certainly add to the deficient literature regarding such injuries in future.

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Conflict of Interest: Nil
Source of Support: None

How to Cite this Article