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Iatrogenic physeal plate injuries and its sequelae.

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Introduction

Epiphyseal plate constitutes longitudinal growth of the bone. Four layers of physis include resting zone, proliferating zone, hypertrophic zone and zone of provisional calcification (1). Injury to the epiphysis is any form, whether traumatic, iatrogenic, metabolic or infective may lead to long-term sequelae of growth arrest or angular deformity (2). These injuries results in two ways, either destruction of the cartilage and development of the bony bridge between the epiphysis and metaphysis – physeal bar formation or the ischemic necrosis of the growth plate resting and proliferating zones (3).It was found by the study done on animal model by Hajdu et al.(3) the amount of permanent damage to the physeal plate is more when the implant(screw or K wire) passes from epiphysis towards metaphysis. In comparison the damage is in the form of temporary arrest if the implant passed from metaphysis towards the epiphysis.

Traumatic physeal injuries are relatively more common constituting 18% to 33 % of all the fractures in pediatric age group. The incidence of growth arrest varies depending on physeal location, type of injury, and treatment received. The outcome of premature growth arrest is depends on skeletal age, location and extent of the physeal bar. If the physeal bar is central physeal it results in cessation of longitudinal growth, and subsequently a limb length discrepancy (LLD). And if the physeal bar is peripheral and partial, it may result in both limb length discrepancy as well as angular deformity (4).

There are two things to be considered while operating over the deformity following physeal bar secondary to the physeal plate injury. This includes the resection of the physeal bar and the osteotomy to correct existing deformity (5).

The indication of bar excision includes (6):

- Bars size of 25 – 40 % surface area.

- More than two years of remaining bone growth (calculated by left wrist X ray)
- If infection, minimum of one year of infection free period.

The indications of corrective osteotomy vary from author to author and range from the deformity more than 10 degrees to deformity more than 30 degrees (6). The bar excision is difficult with high chances of failure if the area is 50% or more. In such cases epiphysiodesis is the treatment and later on limb lengthening as per requirement can be done (7).

The growth contributed by distal femur is about 70% of whole femur and 40% of overall limb growth and the proximal tibia contribute 55% of whole tibial length and 25 % of lower limb growth (8). The fractures around this segment of the lower limb tend to remodel much and the physeal injuries around this area will affect the growth maximum. Considering this fact any type of implant, crossing physeal plate of distal femur and proximal tibia has to be avoided (9).

Described are the two cases of iatrogenic proximal tibial physeal injuries resulted after lack of respecting the biology of growth and anatomy of physeal plate. To the best of our knowledge, there is no such case described in literature where the physeal plate damaged due to lack of surgeon's knowledge.

Case descriptions

Case 1(Fig 1) is the 5 years old female child presented with deformity of the left leg, noticed since past 1 year and progressing as time passes. History revealed that patient had trauma to the leg while playing and she was operated in home town after that. The implant was removed after 3 months of primary surgery. The Scar revealed a surgical procedure done over the lateral aspect of proximal tibia. The x rays evaluation showed displaced fracture of proximal tibial metaphysis which was operated by open reduction and fixed with the plate. The proximal screws (2 in number) were passed from metaphysis to the epiphysis through the plate. The implant was removed and there was physeal bar noticed along the lateral aspect of the proximal tibia.

This resulted in valgus deformity at the knee. X – ray and Ct scan revealed bony bar measuring around 25 percent of surface area with the angular deformity of about 25 degrees. The bar resection, single stage corrective osteotomy and medial proximal Steven's 8 plate application done. The patient was kept under strict follow up to look for any recurrence of physeal bar.

Case 2 (fig 2) is the 4 years old female child with right leg deformity noticed since 7 to 8 months. History revealed that there was cleft palate defect for which the bone was grafted from the proximal tibia to fill cleft palate defect. This surgery was done by a plastic surgeon in patient's home town. The grafted site was medial aspect of proximal tibia and the damage to it created a bony bar along the medial aspect. This resulted in partial growth arrest and varus deformity of proximal tibia.

The area of physeal bar was around 15 percent and located superficially with 10 degrees of angular deformity. The mapping of bar done, using x ray and CT scan. Patient was operated, the physeal bar excision with cement spacer done along with corrective osteotomy. Patient was followed till osteotomy healed and plan for strict observation periodically till skeletal maturity.

Discussion

The traumatic injury to the physeal plate has been described in literature, it was found more commonly in femur than tibia due to ligamentous attachments (10).This may result in complete arrest causing LLD or partial arrest creating angular deformity.

Davis et al. (2016) has discussed regarding the iatrogenic injuries involving the proximal tibial while ACL reconstruction and placement of the tibial tunnel. They recommended the epiphyseal tunnel to avoid possible physeal plate injury (11).

Shaw N. et.al.(2018) has discussed regarding the various current therapeutic techniques following growth arrest. If involved physis is 30 percent or less than it bony bar resection, and filling the gap with an inter positional material such as fat, muscle, or silicone rubber to prevent reformation of bony tissue and allow the uninjured physeal cartilage to restore normal growth (12).

Monsel et.al (2011) described regarding the indication of the corrective osteotomy and the need of epiphysiodesis of remaining healthy physis. If pronounced angular limb deformities of more than 30 degrees following bony bar formation exist, corrective osteotomy of the affected limb may be performed to improve limb length and joint biomechanics (13). The same thing was done in case one where the physeal bar was relatively larger in size with the deformity was about 25 degrees. Considering the high risk of recurrence of bar the normal half of the physeal plate was temporarily blocked by application of Steven's 8 plates.

There are many studies regarding the physeal plate damage following cross physeal pinning in human and animal models. Dahl et.al(2014) and others has described regarding the development of physeal bar in the transphyseal pins passed along distal femur and the distal radius (14,15).This are dependent on the K wire (threaded or non threaded), the size and abliquity of wire. The location whether central or peripheral has no much importance in development of bar.

There was no description in literature where the described amount of iatrogenic physeal damage has happened. This case reports seems to be first of its type.

Conclusion

The physeal injuries following trauma are common, but the iatrogenic injuries arises after over enthusiastic surgical interventions for the pediatric fractures.

It needs to be kept in mind while dealing with pediatric injuries that the amount of deformity is far acceptable and reversible in conservative management when compare to that arises following the physeal damage due to surgical intervention.

The budding surgeons, should be taught regarding the satisfactory result following the conservative management, importance of respecting epiphyseal plate and avoid offering unnecessary and avoidable sufferings to the pediatric patients.

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Legends Figures

Fig 1: Case 1: Physeal bar following fracture fixation

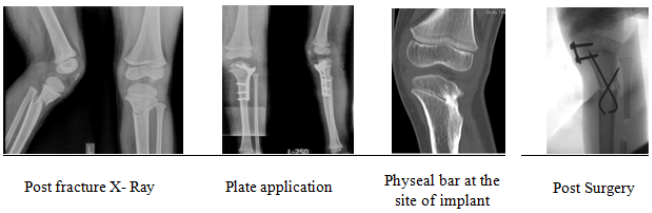

Fig 2: Case 2: Physeal bar follwing collection of graft from tibia.