https://doi.org/10.36570/jduhs.2022.2.1646

JDUHS

CASE REPORT

Endoscopic Physeal Bar Resection Combined with Guided Growth using Local Fat Graft Interposition and Post-Operative CT Assessment for the Treatment of Genu Valgus: a case report

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ABSTRACT

Distal femur physeal arrest due to physeal bar formation with progressive deformities is an unwanted complication following injury to the femur. Various techniques of physeal bar resection, either using open techniques or endoscopic methods, have been described in the available literature. The associated angular deformities could be addressed either with osteotomy in acute correction or gradual correction with an external fixator or guided growth principle. We would like to recommend the use of fat tissues from the surgical wound used for the guided growth and evaluation of the recurrence of the physeal bar via computed tomography in our case. To our knowledge there is no previous reports using similar approach. We shall share case of a severely comminuted distal femoral physeal injury Salter-Harris IV complicated with central physeal bar causing growth disturbance and angular knee deformity treated via endoscopic resection surgery and simultaneous 8-plate insertion for which has shown a good radiological and functional outcome.

Keywords: Endoscopic Physeal Bar Resection, Guided Growth, Genu Valgus, Distal Femoral Physeal Injury.

INTRODUCTION

Distal femur physis contributes the most to the linear growth of the entire lower limb. It is responsible for 70% of limb growth.[1] Physeal injury involving distal femoral physis is not common as it accounts for only 7% of the lower limb physeal fractures1. Although it is rare, injury to the distal femur physis is highly associated with complications including physeal bar formation, limb length discrepancy and angular deformity[1]. There are various surgical techniques described in the literature regarding physeal bar resection either peripheral or central physeal bar.[2]

CASE REPORT

A 4-year 5-month-old boy was involved in a road traffic accident. He sustained an open fracture distal third left femur (Gustilo Anderson IIIA) with extension to the distal femur growth plate (Figure 1A). Post-trauma 2 years, the femur fracture had united despite the massive bone loss. However, it was complicated by a physeal bar formation slightly to lateral aspect at distal femur growth plate and valgus deformity (lateral distal femoral angle of 58 degrees) with 3cm shortening (Figure 2A).

He underwent physeal bar resection via endoscopic technique and growth modulation for the angular deformity correction by using an 8-plate. The patient was put in a supine position. For the physeal bar resection, one portal was created at the medial and lateral side of the distal femur, respectively, as a viewing portal and working portal. The entry point for each portal was about 2.5cm proximal to the distal femur growth plate at the mid-sagittal plane (Figure 3A). A Kirschner wire (size 2.0mm) was inserted from both entry points until it reached the center of the physeal bar in both coronal and sagittal views under image intensifier guidance. Following the preliminary wires, a cannulated drill was used to create the tunnels until the appropriate size for the endoscope was created. After removing the preliminary wires, the sized 4.0mm endoscope was inserted through the tunnels. The physeal bar was identified as light-yellow bone tissues, whereas the normal physis was seen as white. Next, the physeal bar was removed using burr and curette until normal physis tissue was seen circumferentially (Figure 3B). After completing the bar

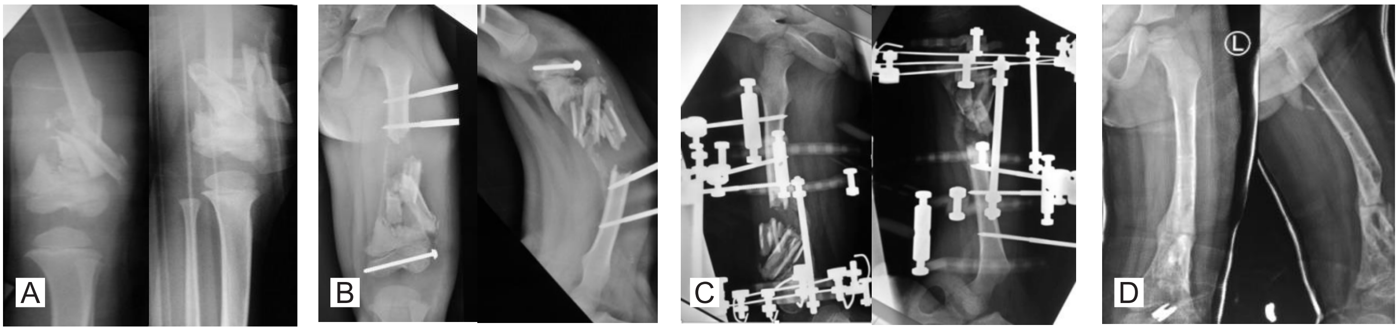

Figure 1: The serial radiographs of the left femur. (A) Radiograph of the left femur after the trauma showing severely comminuted fracture of the distal third with growth plate and intraarticular involvement. (B) Radiograph taken after the wound debridement and external fixation with intraarticular screw of the distal femur insertion. (C) Radiograph after Ilizarov external fixation performed approximately 3 months after the trauma (D) Radiograph done four months after the initial injury. Despite the severe bone loss noticed during the initial injury excellent bone remodelling led to fracture union. However, it was complicated by malalignment (valgus deformity) and shortening of the femur.

Figure 2: (A) The knee radiograph showed formation of physeal bar over the distal femur growth plate with valgus deformity of the distal femur. (B) CT scan was performed to confirm the location of the physeal bar at the distal femur growth plate. It showed the presence of the physeal bar measuring 13.22 mm x 14.30 mm x 12.87 mm that occupied 10% of the distal femur growth plate. The location was located slightly at the lateral aspect of the distal femur growth plate. (C) Long leg view radiograph and front view of the patient's bilateral lower limbs showed shortening of the femur associated with valgus knee deformity. The left distal femoral angle was 58 degrees. The left hemiplevis dropped to the left side to compensate for the shortening of the left femur of 3 cm.

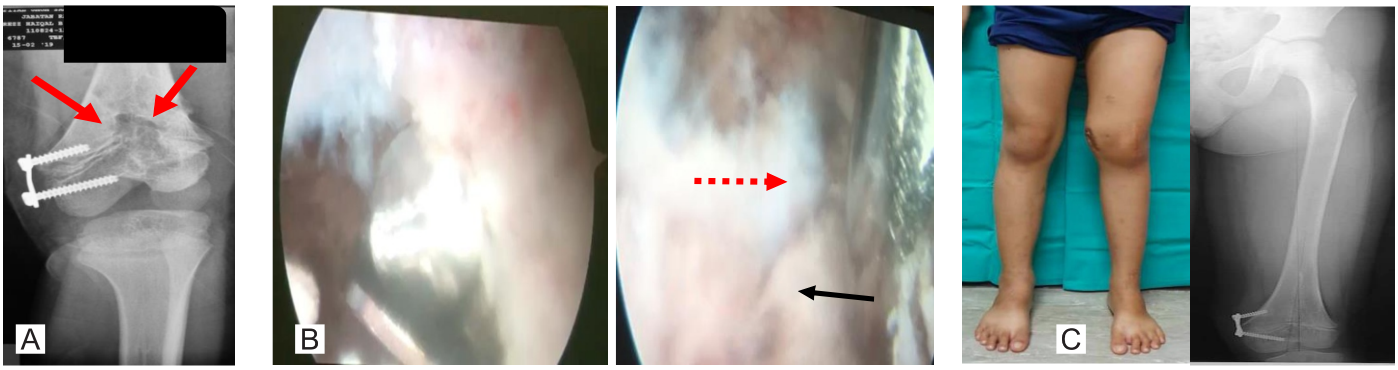

Figure 3: (A) Radiograph of the left knee after the endoscopic physeal bar excision and guided growth of the distal femur using plate. The red arrows showed the direction of the scope at the medial and lateral aspect of the femur for viewing and working portals. (B) Intraoperative images during the procedure. Curette and high speed were used to remove the physeal bar. Dotted red arrow indicates the normal look of the physis (white in color) and the black arrow showed the physeal bar (yellow in color). (C) The front view of the bilateral legs and anteroposterior radiograph of the left femur taken 2 years after the physeal bar excision and plating of the distal femur showed improvement of the valgus deformity and lateral distal femoral angle (78 degrees). However, there was presence of 2.5 cm shortening of the left femur.

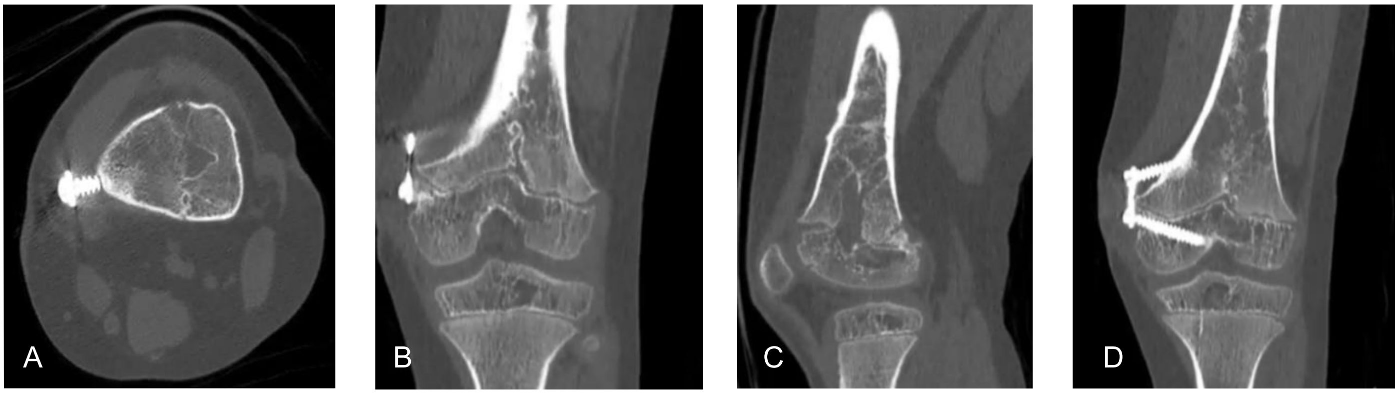

Figure 4: (A-C) Repeated CT scan of the left knee was performed 2 years after the bar physeal excision and 8-plate insertion. There was no reformation of the bar observed. However, the integrity of the fat graft used was not able to be seen from this study. (D) The 8-plate used for hemiepiphysiodesis still maintained at its original position, while the proximal screw might have slight backward migration.

resection, the empty space was irrigated with saline to remove the remaining floating bone bar debris. The defect was then filled up with subcutaneous fat tissues taken from the medial knee wound created for the 8-plate insertion. The endoscope confirmed the position of the fat tissues.

For the 8-plate insertion, a Kirschner wire (size 2.0mm) was used to locate the physis. The 8-plate was then glided on the wire via the center hole until it was placed on the periosteum. Two cannulated screws were inserted through the plate holes parallel to the growth plate.

Post-operatively, the patient was allowed to have passive knee motion and was allowed full weight-bearing after two weeks. 2 years after the surgery, there was a significant improvement of the knee angular deformity. The lateral distal femoral angle was corrected to 78 degrees from 58 degrees pre-operatively. The repeated CT scan after 2 years showed no evidence of physeal bar recurrence. (Figure 4). Finally, the 8-plate was removed two and a half years post insertion as the angular deformity had achieved correction.

DISCUSSION

Growth plate injury and premature arrest could happen following Salter-Harris fracture, infection, vascular insult, neoplasia or tumor-like conditions.[2,3] Among these pediatric fractures, about 15-30% of the cases are physeal-related injuries, of which 1-10% of them are complicated by physeal bar formation.[3,4] The physeal bar can cause premature physeal arrest, leading to limb length discrepancy if the bar is centrally located or angular deformity if the bar is at the periphery.[4]

A plain radiograph is always performed to preliminary assess the bar. CT scan can demonstrate the cross-sectional image of centrally located physeal bar. It also helps to determine the coronal and sagittal arrest lines and delineate the location of the healthy epiphyseal cartilage tissues surrounding the bar.[5] However, Sailhan et al. mentioned that a CT scan tends to overestimate the size of the bar by 50%. MRI is superior since it could help differentiate between the bar and normal cartilage tissue better than a CT scan, especially in smaller bones such as distal fibula and the fingers.[5]

The first published report on bar excision was in 1966, where a distal tibial growth arrest secondary to physeal bar formation was removed surgically.[6] The surgeon created a metaphyseal window to visualize and remove the bar and at the same time perform an acute deformity correction. For a centrally located bar, the technique described for a distal femur physeal bar case includes predrilled wedge metaphyseal fragment resection as a window for direct visualization of the bone bridge.[7] Using an image intensifier, the bar's location was identified, and a 4.5mm drill and high-speed burr were used to remove the bar.

There is limited evidence of endoscopic bar resection surgery combined with growth modulation for associated angular deformity for a centrally located bar. The open technique involves complete osteotomy that requires the additional implant to stabilize the osteotomy site, such as Kirshner's wires or plates.[8] Apart from that, the open technique also has the risk of causing injuries to the surrounding neurovascular structures, compartment syndrome, infection, delayed union and non-union.[2,8] Masquijo et al. shared five cases of distal femur central bar excision using the endoscopy technique combined with tension band plate hemiepiphysiodesis. In their case series, fat was taken from the gluteal cleft.[2]

In our case, we demonstrated the physeal bar image as well as normal physis from the endoscopic view, as shown in Figure 3. We used a piece of fat harvested from the subcutaneous layer of the medial knee wound created for the 8-plate insertion. It functioned well as an interposition spacer and contributed to the success of gradual correction of the genu valgus. Furthermore, post-operatively we did not use any immobilizer on the knee. We allowed passive knee motion with no weight-bearing for two weeks.

The interposition material is an important determining factor for the physal bridge reformation.). Various materials had been utilized, such as PMMA, fat tissues, bone wax, muscle and silicone. Studies showed that autogenous chondrocytes cultured in vitro and transplanted into the physis are the better option than fat tissues if the bar occupied more than two-third of the physis.[9] Fat tissues have the advantages of being autogenous, have the potential to grow in size with the patient and tend not to become necrotic.[9]

Epiphysiodesis is used to treat angular deformities and lower limb discrepancies between 2-5 cm with adequate remaining growth potential.[10] Growth modulation using a tension band plate is one of the available reversible techniques in young children. It is generally an easier technique with lesser morbidities due to smaller wound size and minimal soft tissue and bone manipulation.

In conclusion, endoscopic technique combined with 8-plate is a reliable approach. In addition, in contrast to other techniques, we utilized the fat tissue interposition placed after the procedure obtained from the knee wound (for 8-plate placement) that avoid additional wound creation. Smaller sized wounds and avoidance of osteotomy in our case lead to faster recovery, weight bearing, and rehabilitation. After 2 years, there was no recurrence of the physeal bar seen in our case, as demonstrated from the repeated CT scan. However, a serial CT scan may be needed to observe early recurrence.

PATIENT'S CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient's parent (father) has given his consent for his images and other clinical information to be reported in the journal. The patient and his parents understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

CONFLICT OF INTEREST: The authors declared no conflict of interest.

Received: May 10, 2022
Accepted: June 13, 2022

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