

A PROSPECTIVE STUDY OF 15 PATIENTS WITH KAPLAN'S LIKE VARIANT OF DISTAL FEMORAL EPIPHYSIOLYSIS

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ABSTRACT

INTRODUCTION

Epiphysiolsis is an uncommon injury which is fraught with complications. Completely separated physal fractures of distal femur invariably need osteosynthesis with open reduction and fixation to prevent redisplacement. We evaluated 15 patients prospectively until their skeletal maturity to assess the complications in distal femur epiphysiolsis. Clinically puckered sign indicates irreducibility in distal femur epiphysiolsis. The longterm complications are mainly limited to angular deformity and shortening of the limb.

KEYWORDS

Distal Femoral Epiphysiolsis.

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INTRODUCTION: Kaplan's lesion of the metacarpal is well known entity for its irreducibility. We describe a similar lesion involving the fracture dislocation of distal femoral epiphysis which is irreducible by closed means. Such epiphysiolsis invariably need open reduction and fixation to maintain the position. The longterm complications are high in complete epiphysiolsis and the following study was initiated to document the results in Indian scenario.

AIM: To identify irreducible distal femoral physal fracture dislocations requiring open reduction and fixation for osteosynthesis.

To study the complications of osteosynthesis in distal femoral epiphysiolsis.

MATERIALS AND METHODS:

Type of Study: Prospective: The enrolment was done with prior intimation of the patient and their relatives. Ethical Committee approval was sought as per prospective study protocol.

Inclusion Criteria:

1. All the patients having completely displaced distal femoral physal fracture dislocations presenting at our Casualty/Institute were enrolled in the study.
2. Paediatrics age group patients were included presenting between the year 2009 to 2014.

Exclusion Criteria:

1. Patients with compound fractures needing external fixation and reconstructive procedures including flaps or skin grafting.
2. Patients with undisplaced or partially displaced distal femoral physal fractures treated conservatively.
3. Patients lost to followup.

Sample Size: 15 patients.

METHODS: All the paediatric cases presenting to the casualty with distal femur physal dislocation injuries were enrolled in the study from 2009-2014. Each patient having a specific mechanism of trauma was noted and emergency measures carried out on the principles of life saving over limb saving and stabilisation of the general condition. Temporary stabilisation of the limb with a long knee brace was given immediately. Emergency arterial Doppler was carried out in each patient to confirm the vascularity of the limb followed by radiographic evaluation of the distal femur with the knee joint in two orthogonal views.

Clinical evaluation preceded the radiographic evaluation in detail. All the fractures were classified as per standard Salter-Harris classification system.^{1,2,3} The fractures were classified as per displacement according to Arkader et al.¹

The patients were immediately taken to the operation theatre after adequate pre-anaesthetic evaluation on emergency basis due to physal injuries. The patients enrolled in the study were intimated after the completion of radiological evaluation to avoid unnecessary conversation priorly, which might have caused delay in treatment.

Post-Operative Protocol Was as Follows:

- Long knee brace-3 weeks.
- Knee mobilisation after 3 weeks.

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- Non-weight bearing, crutch walking was initiated on postoperative day 4.
- K-wires were removed after 6 weeks.
- Partial weightbearing-2 month.
- Full weightbearing-3 month.

Followup Was Done at Following Intervals:

- 2 weeks for suture removal.
- 3 weeks for start of range of motion.
- 6 weeks for k wire removal.
- 3 months, 1 year and 4 years.

We chose the endpoint of followup until full maturity to assess the longterm complications of such an injury pattern.

Radiological examination in two orthogonal planes done at.

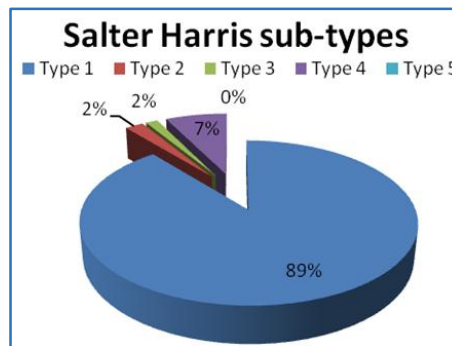
- Immediate postop.
- 3 weeks.
- 6 weeks before k wire removal.
- 3 months.
- 1 year.
- 3 years.

Complications⁴ Evaluated Were Grouped Under:

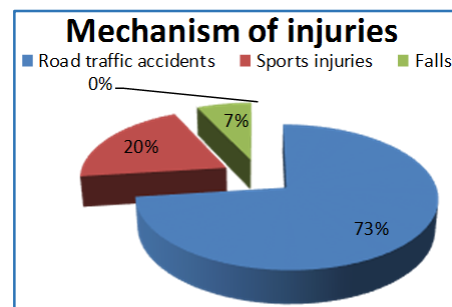
Short Term: Cast disease, neurovascular compromise, re-subluxation or re-dislocation, stiffness in neighbouring joints, pin tract infection, septic arthritis.

Long Term: Physeal porosis, deformity angulation or shortening, physeal bar formation on x-ray and CT scan, osteomyelitis, degenerative arthritis.

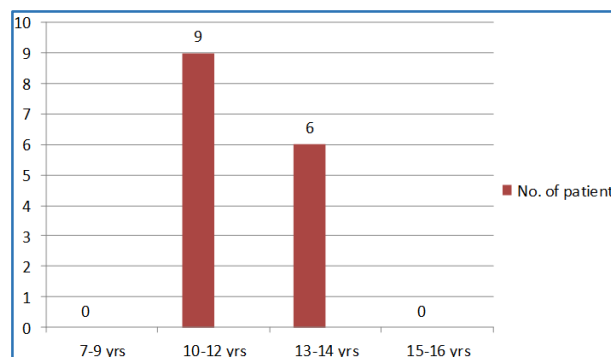
Results of the Study: The patients were prospectively followed up to 16 years of age which was the endpoint for a particular patient and the results were tabulated as depicted in the following graphs.



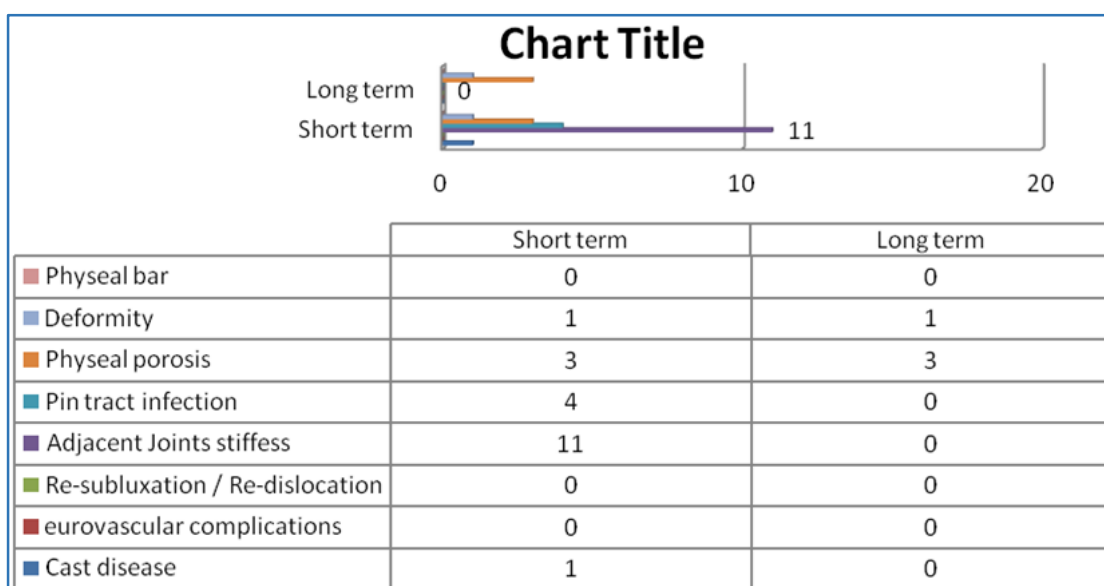
Salter Harris subtypes



Mechanism of injuries of distal physeal fractures



Bar diagram with age distribution



Complications grouped under short term and long term

All the patients enrolled in the study were males depicting a major role of outdoor activities predominance in the male subgroup. There were 11 right-sided and 4 left-sided injuries. The side of injury has skewed towards right knee as the most of the road traffic accidents involved the patient being sorted on a bike with direct hit on the knee. None involved any indirect impact or transmitted injuries. All the cycle injuries were due to fall.

OBSERVATIONS: All 15 distal femur cases had a puckered appearance of the skin over the anteromedial aspect of knee giving the appearance similar to medial femoral condylar being driven out of the medial capsule as in adult knee dislocation. The gentle initial reduction was attempted in all cases with failure in each. None of the cases could be managed with closed reduction and all 15 cases with puckering of skin needed open reduction.

Intra-Operative Findings: All knees were approached through a 5 cm long longitudinal incision at the level of the distal femoral physis, skin, subcutaneous tissue were dissected. Disrupted proximal fragment of the fracture was noted popping out between vastus medialis oblique muscle and the septum. There was a split in the epiphyseal fragments in few cases which after flexion of the knee was reduced with help of blunt periosteal elevator. All these fractures were unstable, and were fixed with cross k-wire under guidance of image intensifier. Vastus medialis was repaired with Vicryl No. 1.

The rupture was restricted to VMO and capsule in all the cases. Because of the interposition of the soft tissue, closed reduction was not possible in any of the cases presenting with a typical puckered Kaplan like capsule rupture similar to that in irreducible metacarpophalangeal joint dislocation or like a knee fracture dislocation with medial femoral condylar buttoning through the medial capsule.



Fig. 1b: Intraoperative Pathoanatomy



Fig. 2



Fig. 3



Fig. 1a: Clinical Appearance

The clinical appearance of the puckered anteromedial skin is highly suggestive of irreducible dislocation which will invariably need open reduction.

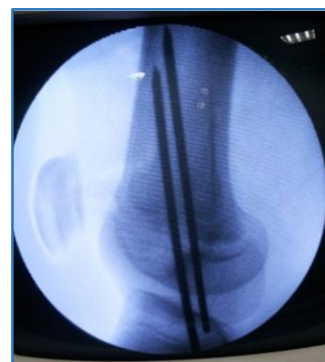


Fig. 4: The intraoperative C-arm picture depicting the reduction of the physeal separation fixed with smooth k wires

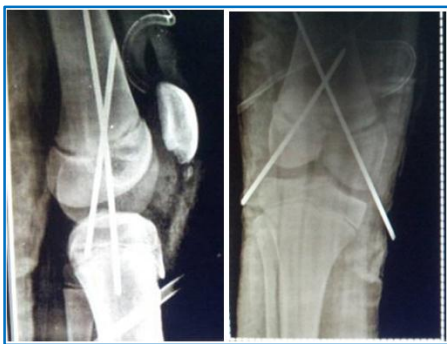


Fig. 5: The post-operative x-rays with acceptable reduction. The k wires were kept outside the skin to be pulled out in the old during follow-up at 6 weeks

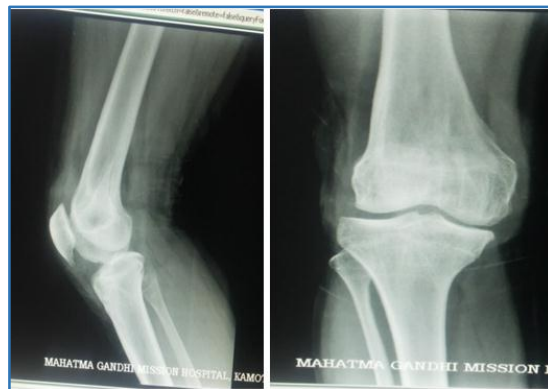


Fig. 6d & e

Figure 6: Clinical follow-up demonstrating range of motion (a), (b), (c) and x-rays at skeletal maturity (d), (e).



Fig. 6a

DISCUSSION: Kaplan’s lesion is a rare dorsal dislocation of metacarpophalangeal joint commonly occurring in index finger.⁵ There is metacarpal head dislocation, which gets button-holed within the various anatomical soft tissue structures and prevents reduction. The chief obstacle is the volar plate which tends to dislocate dorsally & gets caught between the metacarpal head and phalanx thereby preventing the reduction.^{5,6}

We have referred the pathoanatomy of this particular epiphysiolysis as a Kaplan’s lesions of knee as the pathoanatomy is same in both i.e. herniation of proximal bony metaphyseal fragment through the vastus medialis and capsule leading to irreducibility.



Fig. 6b

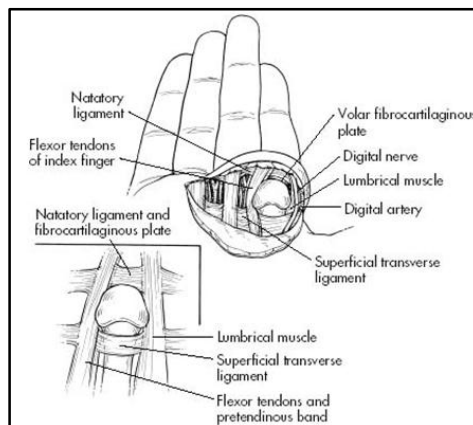


Fig. 7a



Fig. 6c



Fig. 7b

Figure 7: The comparison of two lesions. (a) shows typical pathoanatomy of Kaplan's lesion of metacarpal dislocations which necessitates open reduction. (b) The herniation of proximal fragment through the muscle capsule preventing reduction by closed means in complete epiphysiolysis.

Distal femur is unique as the longitudinal growth contribution provided is 70% of segmental and 40% of total limb.^{1,2,4,7,8} Ollier was the first to mention epiphyseal injuries in literature in 1867.³ Salter-Harris classification has been the most commonly used classification. Salter-Harris type 2 is the most encountered form.^{1,2,3}

Epiphysiolysis is a fracture dislocation of the physes involving complete separation of epiphysis from the metaphysis. It tends to occur through the hypertrophic zone of the physis or can involve multiple zones.⁴

The literature search suggests that distal femur physal injuries form 30% of paediatric fractures.^{1,7,8,9} During the prepubertal and pubertal phase, anatomically the lateral notch deepens and the central ridges for distal femur decreases in height thereby predisposing it to injuries which incidence wise is up to 4% around the paediatric knee.²

Mechanical studies have proven that the protective periosteum guards the physis and secondarily bony injuries are more common than ligamentous injuries.⁴

Most of the epiphysiolysis is caused by indirect trauma by angular deforming forces.^{2,8,9} Abduction, adduction, hyperflexion and hyperextension are known mechanisms of distal femoral physal fractures.⁷ Hutchinson et al in 1894 reported that rotation or traction injury also forms the pathomechanism of the femoral epiphysiolysis.^{7,3}

A high energy trauma is needed to produce physal injuries.^{2,9} Motorbike and recreational cycle injuries are the commonest mode followed by pedestrians. Sports injuries especially including competitive cycling and high impact football and racquet sports. Domestic falls form the least group among mechanisms.^{2,9} Horse riding forms one of the predominant mechanism in sports group in Western subcontinents.²

The amount of displacement as per Arkader et al¹ is as follows:

- Grade 1, <1/3 of the bone diameter.
- Grade 2, 1/3 to 2/3 of the bone diameter.
- Grade 3, >2/3 of the bone diameter.
- Grade 4, comminuted fractures.

All our cases were total loss of contact between metaphysis and epiphysis. Thus, our cases were grade 3 befitted in the above classification system as dislocation would be beyond grade 3 as per this classification.

Ogden⁴ has summarised complications as:

- Post-injury angulation, shortening of femur.
- Development of porosis in distal femur.
- Limitation of knee and hip movement.
- Re-dislocation.
- Re-surgery.
- Damage to neural vascular plexus.

Longterm complications include osteomyelitis and osteoarthritis.

The amount of displacement given by Arkader et al is as follows: Grade 1, <1/3 of the bone diameter; grade 2, 1/3 to 2/3 of the bone diameter; grade 3, >2/3 of the bone diameter; grade 4, comminuted fractures.¹ Growth disturbance in the extremely displaced and nondisplaced fractures was reported at 65% and 31%, respectively.¹ Significant impact of the amount of displacement on the development of complications has been demonstrated statistically.^{1,7}

The limitations of the present study was the fewer cases enrolled in the study. Clinically, poor outcomes were cases which would have a limb length discrepancy of ≥ 1.5 cm and varus, valgus or flexion deformity of $\geq 10^\circ$.^{7,10} Growth arrest is frequently seen, especially in SH type 4 fractures.^{11,12}

The followup x-rays suggests a deformed femur distally with wide metaphysis as compared to the normal femur. The possible explanation is disruption of the zone of Ranvier leading to widened metaphysis with absence of lateral notch with growth.

As per Garrett et al⁹ all the following factors have a prognostic impact.

- Type of Salter-Harris fracture.
- Fracture mechanism including direction and degree of displacement.
- Treatment adopted.

Apart from the above factors the clinical outcome of a distal femoral physal injury depends on the age of injury too.^{10,13,14} Younger the child, more is the deformity and growth disturbance and thus the complication rate decreases at the higher age at the time of injury.^{10,14} The reason being as the less number of years are available for deformity post treatment at higher age of presentation.^{11,12} All studies have recommended followup until skeletal maturity.¹² Thus, the endpoint of the present study was at the age of 16 years. There is a correlation between poor outcomes and age, in that undesirable outcomes after distal femoral physal fractures are more common in younger patients.^{7,10,14}

Studies have shown that MRI forms the best method to detect any bony bridge formation.^{4,13} Conventional x-ray forms the cost effective way to follow up such patients and advanced investigations should be needed only when the suspicion of growth disturbance is obvious.⁹ The Salter-Harris classification has been used extensively and correlates well with the prognosis as well.

For growth plate fractures, the aim of management is to keep the metaphysis, epiphysis and physis separate so that the physal cartilage is able to grow in between to separate them.^{15,16} Management decisions regarding these injuries are generally constructed around the degree of displacement and SH grading.^{2,17}

Various studies^{2,17} have accepted criteria for acceptable reduction.

- Posterior angulation up to 20 deg. will remodel in child <10 yrs. old.
- Adolescent, however, will not remodel and will not tolerate this degree of angulation.
- No >5 deg. of varus-valgus angulation is acceptable.

CONCLUSION: Distal femoral growth plate injuries are uncommon fractures and their management is fraught with complications. Clinically puckered sign indicates irreducibility in distal femur epiphysiolysis. The longterm complications are mainly limited to angular deformity and shortening of the limb.

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