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Original Research Article

A prospective study of 15 patients with Kaplan's like variant of distal femoral epiphysiolysis

Sarabjeet Kohli[1], Nilesh Vishwakarma[2], Kuldip Salgotra[3], Siddhant Jain[4]
[1]Associate Professor, [2]Assistant Professor, [3]Medical superintendent and director, [4]Senior Resident, Dept of Orthopaedics, MGM university of Health Sciences, Navi Mumbai, Maharashtra, India

***Corresponding author**
Dr. Nilesh Vishwakarma
Email: nsv1978@gmail.com

Abstract: Epiphysiolysis is an uncommon injury which is fraught with complications. Completely separated physical 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 epiphysiolysis. Clinically puckered sign indicates irreducibility in distal femur epiphysiolysis. The long term complications are mainly limited to angular deformity and shortening of the limb.
Keywords: Distal femoral epiphysiolysis.

INTRODUCTION

Distal femur is unique as the longitudinal growth contribution provided is 70% of segmental and 40% of total limb [1, 2, 3, 4, 9]. Ollier was the first to mention epiphyseal injuries in literature in 1867 [15]. Salter-Harris classification has been the most commonly used classification. Salter-Harris type 2 is the most encountered form [2, 3, 15].

Epiphysiolysis is a fracture dislocation of the physis involving complete separation of epiphysis from the metaphysis. It tends to occur through the hypertrophic zone of the physis or can involve multiple zones [9].

The literature search suggests that distal femur physeal injuries from 30% of peadiatric fractures [1, 2, 4, 5]. 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 upto 4% around the peadiatric knee [3].

Mechanical studies have proven that the protective periosteum guards the physis and secondarily bony injuries are more common than ligamentous injuries [9].

Most of the epiphysiolysis is caused by indirect trauma by angular deforming forces [3, 4, 5]. Abduction, adduction, hyper flexion and hyperextension are known mechanisms of distal femoral physeal fractures[1]. Hutchinson *et al* in 1894 reported that rotation or traction injury also forms the patho- mechanism of the femoral epiphysiolysis [1, 15].

A high energy trauma is needed to produce physeal injuries [3, 5]. 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 [3, 5]. Horse riding forms one of the predominant mechanisms in sports group in western subcontinents [3]. The amount of displacement as per Arkader *et al.;* [2] 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

AIM:

1. To identify irreducible distal femoral physeal fracture dislocations requiring open reduction and fixation for osteosynthesis.
2. To study the complications of osteosynthesis in distal femoral epiphysiolysis.

MATERIALS AND METHODS:

Type of study:

Prospective: The enrollment 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 distal femoral physeal fracture dislocations presenting at our casualty/ institute. Completely displaced fractures were enrolled in the study.
2. Peadiatrics 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 physeal fractures treated conservatively.
3. Patients lost to follow up.

Sample size: 15 patients.

METHODS:

All the peadiatric cases presenting to the casualty with distal femur physeal dislocations 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 stabilization of the general condition. Temporary stabilization 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 [2, 3, 15]. The fractures were classified as per displacement according to Arkader *et al.;* [2]. The patients were immediately taken to the operation theatre after adequate pre-anaesthetic evaluation on emergency basis due to physeal 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 mobilization after 3 weeks.
- Non-weight bearing, crutch walking was initiated on postoperative day 4,
- K-wires were removed after 6 weeks,
- Partial weight bearing-2 month,
- Full weight bearing-3 month.

Follow was done at following intervals

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

We chose the endpoint of follow up until full maturity to assess the long term complications of such an injury pattern.

Radiological examination in two orthogonal planes done at-

- Immediate post op
- 3 weeks
- 6weeks before k wire removal
- 3 months
- 1year
- 3 years

Complications [9] evaluated were grouped under

Short term: cast disease, neurovascular compromise, re-subluxation or re-dislocation, stiffness in neighboring 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. 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.

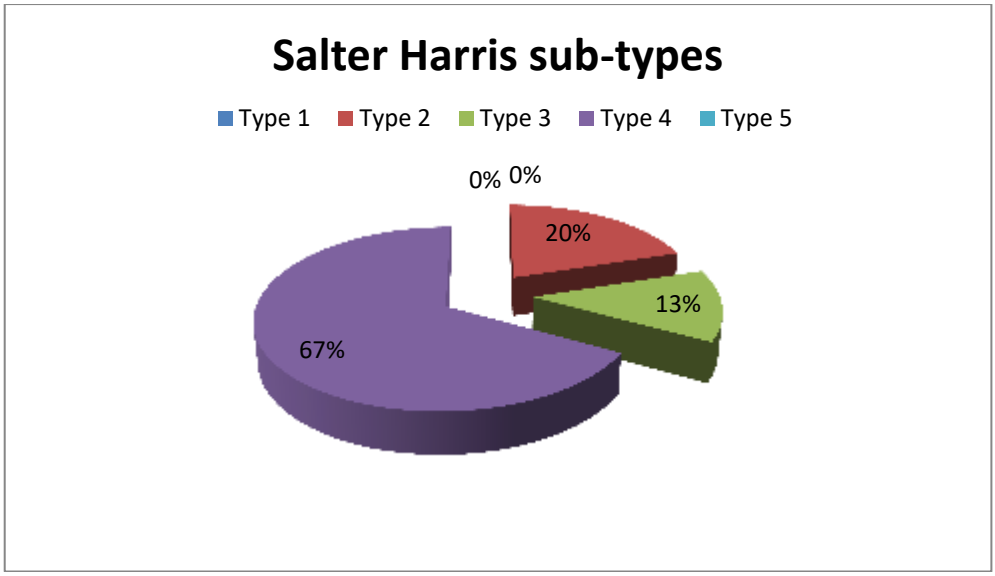


Fig 1: Salter Harris subtypes

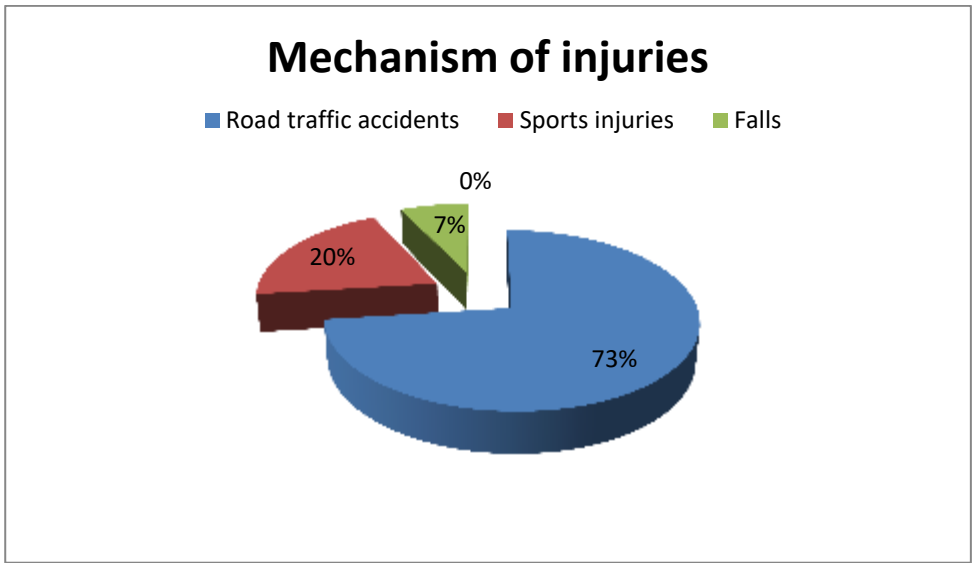


Fig 2: Mechanism of injuries of distal physeal fractures.

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.

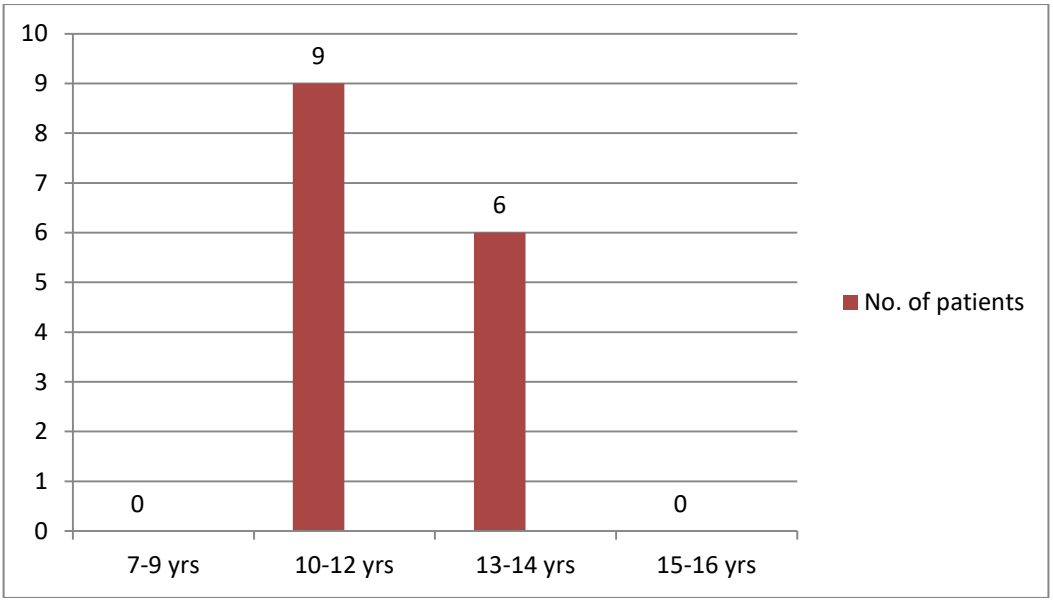
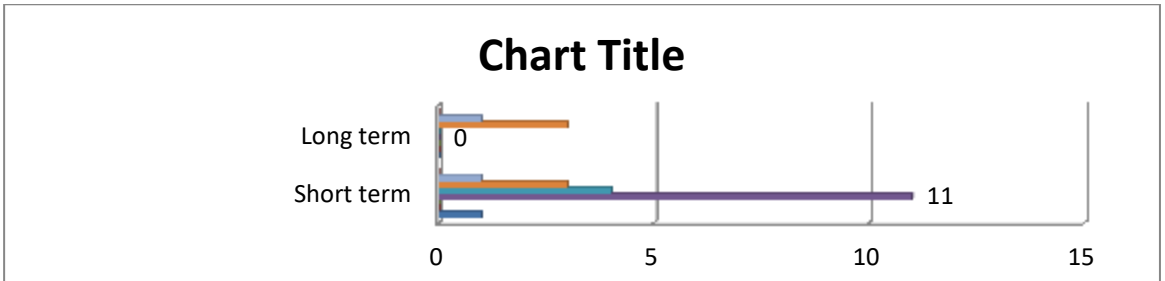


Fig 3: Bar diagram with age distribution



	Short term	Long term
Physeal bar	0	0
Deformity	1	1
Physeal porosis	3	3
Pin tract infection	4	0
Adjacent Joints stiffess	11	0
Re-subluxation / Re-dislocation	0	0
eurovascular complications	0	0
Cast disease	1	0

Fig 4: Complications grouped under short term and long term

Complications [9] evaluated were grouped under-

Short term: cast disease, neurovascular compromise, resubluxation or redislocation, stiffness in neighboring 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.

Intra-operative findings:

All knees were was 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 Medial is 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 medial is 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.

(a) (b)

(c)

Fig 5 : Roentgenogram (a) , clinical appearance (b) and intraoperative pathoanatomy (c) . The clinical appearance of the puckered anteromedial skin is highly suggestive of irreducible dislocation which will invariably need open reduction.

Fig 6: The intraoperative c-arm picture depicting the reduction of the physeal separation fixed with smooth k wires.

Fig 7: 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.

(a) (b) (c)

(d) (e).

Fig 8: Clinical follow up demonstrating range of motion (a), (b), (c) and X-rays at skeletal maturity (d), (e).

DISCUSSION:

Our all 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.

We have referred the patho-anatomy of this particular epiphysiolysis as Kaplan's lesions of knee as the patho-anatomy is same in both i.e. herniation of bony fragment through the capsule leading to irreducibility.

Ogden [9] has summarized 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.
- Long term complications include osteomyelitis and osteoarthritis.

The amount of displacement was given by Arkader et al 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 [2]. Growth disturbance in the extremely displaced and nondisplaced fractures was reported at 65% and 31%, respectively [2]. Significant impact of the amount of displacement on the development of complications has been demonstrated statistically 1, 2].

Table 1: shows the different long term studies with their respective percentages with respect to the growth disturbances / limb length discrepancy objectively

Study	Growth disturbance	
	Less than 1.5 cm	More than 1.5 cm
Baesner *et al.;*[1]	52 %	22%
Arkader *et al.;*[2]	40%	0 %
Present study	6.7%	0%

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 ≥1.5cm and varus, valgus or flexion deformity of ≥10° [1, 6]. Growth arrest is frequently seen; especially in SH type 4 fractures [13, 14].

The follow up 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 [5] leading to widened metaphysis with absence of lateral notch with growth.

As per Garett *et al.;* [5] 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 physeal injury depends on the age of injury too [1, 6, 8]. 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 [6, 8]. The reason being as the less number of years are available for deformity post treatment at higher age of presentation [13, 14]. All studies have recommended follow up until skeletal maturity [14]. 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 physeal fractures are more common in younger patients [1, 6, 8].

Studies have shown that MRI forms the best method to detect any bony bridge formation [7, 9]. 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 physeal cartilage is able to grow in between to separate them [10, 11]. Management decisions regarding these injuries are generally constructed around the degree of displacement and SH grading [3, 12, 15].

Various studies [3, 12] have accepted criteria's 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 long term complications are mainly limited to angular deformity and shortening of the limb.

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