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Percutaneous Pinning for Recent Lower Tibial Epiphyseal Injury in Pediatric

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ABSTRACT

Background: Physeal fractures of long bones are common injuries treated by orthopedists. Distal tibial physeal fractures account for 11% of all physeal injuries. **Objectives:** The aim of the work is evaluation of the clinical and radiological outcome of lower tibial epiphyseal injury managed by percutaneous pinning.

Patients and Methods: This was a prospective randomized study carried out on 12 cases with distal tibial epiphyseal injuries admitted to Zagazig University with follow up period up to six months. The youngest patient was 8 years old, while the oldest was 16 years old, with an average of 12 years; the high incidence was in the age group 10-15 years.

Results: Overall results obtained from 12 cases were satisfactory in 11 cases (91.66%) and unsatisfactory in 1 cases (8.37%). More satisfactory results in this work were in the age group 10-15 years. However, age did not affect the results significantly. Cases with closed injury showed more satisfactory results (100%) than those with open injury, the difference was statistically highly significant. All cases in this study were presented within the first 48 hours from onset of trauma. 8 cases were immobilized for 8 weeks and 4 cases for 6 weeks. The difference was statistically insignificant. 2 cases were managed by open reduction and internal fixation and the difference was statistically insignificant.

Conclusion: The percutaneous pinning for lower tibial epiphyseal injury showed good reduction of fracture, satisfactory functional outcome and less complications. The technique provided speed recovery, secure fixation and avoiding prolonged cast immobilization and conservative treatment.

Keywords: Anteroposterior, Extracellular matrix, Kirschner wire, Percutaneous, Salter-Harris type I, II, III, IV, V, Tibial.

INTRODUCTION

Physeal fractures of long bones are common injuries treated by orthopedists. Distal radius fracture are the most common long bone physeal fractures closely followed by distal tibial physeal fractures[1]. These injuries account for 11% of all physeal injuries and carry a significant risk of growth disturbances such as premature physeal closure, angular deformity and leg length discrepancy. The incidence of premature physeal closure has been reported to be between 2-5 %. The mechanism of injury was categorized according to the Lauge-Hansen classification and Diaz and Tachdjian classification of ankle fractures. The most common mechanism of injury was supination-external rotation (66%), followed by pronation-abduction (30%), pronation-external rotation (3%) and axial crush (1%)[1-3]. The Salter-Harris classification system is simple and reproducible, and it remains the most widely used system for children's ankle fractures[2].

The physical exam of the injured ankle should include a thorough visual inspection and palpation around the entire ankle. Identifying lacerations, blisters or evidence of an open wound is paramount and may alter the treatment plan. Vascular exam should include palpation of the dorsalis pedis, anterior and posterior tibial arteries. If excessive swelling impedes palpation of the pulses, Doppler exam of the arteries should be performed, combined with careful sensory and motor exam of the nerves of the foot (superficial and deep peroneal, tibial and sural). Compartment syndrome of the leg or foot, although uncommon, can be associated with physeal fractures of the distal tibia and fibula[4].

The decision to treat pediatric ankle fractures is based on the fracture type, amount of displacement and the ability to restore and maintain the alignment of the physis and the congruity of the ankle joint. If a satisfactory closed reduction can be achieved and maintained internal fixation is unnecessary. However if closed reduction is unsuccessful, open reduction with skeletal fixation is warranted. If the fracture displacement was still more than 2 mm after reduction, open reduction and internal fixation (ORIF) is performed. A long-leg, non–weight-bearing cast is applied for 4 weeks postoperatively and is changed into a short-leg, weight-bearing cast for 2 weeks. If the K-wire (KW) is used for internal fixation, it is removed 6 weeks postoperatively. If a screw is used for fixation, it is removed 2 to 6 months postoperatively[5,6].

This study aimed to evaluation of the clinical and radiological outcome of lower tibial epiphyseal injury managed by percutaneous pinning.

PATIENTS AND METHODS

This was a prospective randomized study carried out on 12 cases with distal tibial epiphyseal injuries, (8 males 60% and 4 patients were females 40%) aged (8 - 16) years old and the mean age was 12 years, the high incidence was in the age group 10-15 years. Car accident was the commonest cause of injury; it was encountered in 58.33% of cases. The right side was affected in 8 cases

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(66.66%), and the left side in 4 cases (33.34%). The cases were presented with pain, swelling, inability to bear weight and limitation of ankle movements. The initial treatment was done within the first 24 hours after trauma in most of the cases. 2 cases (16.66%) were presented with open injuries and 10 cases (83.34%) were presented with closed injuries. Salter-Harris type II was the most common type.

Inclusion criteria: Patient below skeletal maturity and recent physeal fractures; Salter-Harris Types I, II, III, and IV.

Exclude criteria: Patients after skeletal maturity. Pathological fractures. Neurovascular injuries. Pre-existing tibial shaft deformities.

Ethical considerations:

An approval of the study was obtained from Zagazig University academic and ethical committee. Every patient signed an informed written consent for acceptance of the operation. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Methods of examination:

All patients were subjected to thorough clinical and radiological examination.

A) History and clinical data:

The patient history was carefully studied as regards the symptoms and history of trauma, its mechanism and time lag between trauma and start of initial treatment.

B) Examination:

1. Clinical examination:

- Primary survey according to Advanced Trauma Life support (ATLS) protocol.
- Inspection of skin condition and any swelling or deformity.
- Palpation for tenderness and crepitus.
- Examination of the neurovascular status (dorsalis pedis, posterior and anterior tibial arteries, common peroneal and tibial nerves) to exclude any vascular injuries, neurological injuries or compartmental syndrome.
- Examination of other regions that were subjected to trauma and detection of any associated injuries.

Clinical assessment at the end of follow-up: **To detect**

- Limping.
- Leg length discrepancy.

2. Radiological evaluation:

1. Anteroposterior, lateral and mortise views of the affected leg with visualization of the ankle and knee joints were taken to assess the following:
    - The type of the fracture according to the Salter-Harris classification.
    - Initial displacement.
    - Associated injuries.
2. Radiographic views were taken for other skeletal injuries if suspected.

At end of follow-up to detect: Deformity of the ankle.

- Other items.

Leg length discrepancy; could be detected by long leg standing x-ray from pelvis to heel [7].

Ankle deformity; by determining the mechanical axis of the tibia and that line which represents the transverse axis of the ankle [8, 9].

Weight bearing: Most of the cases started weight bearing after pain relief, which varied much among peoples, though they were instructed not to bear weight all over the period of immobilization.

Methods of treatment: Conservative or operative

Conservative treatment: If displacement was less than 2 mm and it was not applied in this study.

Surgical treatment:

It was applied for 12 cases; 3 cases of them (25%) were of Salter and Harris type III and IV who showed displacement more than 2 mm after trial of closed reduction, the remaining 9 cases (75%) were of irreducible type I and II. The implants used were: KW in 10 cases (83.33%) and KW with malleolar screw in 2 cases (16.67%). 10 cases (83.33%) were treated by closed reduction and percutaneous pinning using K-wire. 2 cases (16.67%) were treated by open reduction and internal fixation by K-wire and screw.

Period of immobilization after internal fixation; 4 cases (33.33%) were immobilized for 6 weeks and 8 cases (66.67%) for 8 weeks.

Removal of implant: Implants were removed in all cases with KW with shortest period of 6 weeks and longest period was 8 weeks, with an average of 7 weeks. But malleolar screws were not removed till the end of the follow up period.

Method of assessment of the results:

Functional and clinical assessment:

The results were assessed according to the method proposed by Olerud-Molander, which is a functional ankle score. This assessment included functional clinical data. Excellent and good scores are considered satisfactory results while fair and poor scores are considered unsatisfactory results.

Radiological assessment:

Exact X-rays are important (Anteroposterior, lateral, anteroposterior with 15° inside rotation (mortise)) and they were used to exclude malunion, articular step off, osteoarthritis and deformity.

Statistical analysis

The collected data was revised, coded, tabulated and introduced to a PC using Statistical Package for the Social Science (SPSS 25) for windows (SPSS Inc., Chicago, IL, USA). Data were presented as frequency and percentage.

RESULT

Overall results obtained from 12 cases were satisfactory in 11 cases (91.66%), (excellent in 9 cases and good in 2 cases), and unsatisfactory in 1 cases (8.37%), (fair in 1 cases and poor in 0 case). More satisfactory results in this work were in the age group 10-15 years. However age did not affect the results significantly (Table 1). Cases with closed injury showed more satisfactory results (100%) than those with open injury, the difference was statistically highly significant (Table 2).

All cases in this study were presented within the first 48 hours from onset of trauma. 8 cases were immobilized for 8 weeks. And 4 cases for 6 weeks. The difference was statistically insignificant. 2 cases were managed by open reduction and internal fixation by screw and K-wire. 9 cases were managed by closed reduction and fixation by K-wires. The difference was statistically insignificant (Table 4). After management, whether by open or closed reduction any intra-articular residual displacement had unsatisfactory results (Table 5). Salter-Harris type I, II have good prognosis and type III, IV have a bad prognosis. The type of injury had affected the results significantly (Table 3).

Most of the cases started weight bearing after pain relief, and this was subjected to wide personal variation in pain tolerability.

Pin tract infection was detected in only 2 cases. We just removed K-wires (Table 5).

Pin migration was detected in one case. Patient was admitted to hospital. K-wires was removed under c-arm in operation room (Table 3).

Stiffness was detected in 2 cases. Patients were improved with physiotherapy.

Chronic pain was detected in 3 cases (Table 7).

Angular deformity secondary to premature closure of the epiphyseal growth plate was difficult to be assessed due to short period of follow up.

Gross limitation of movement above 10 degrees was found in 3 cases (25%) while less or no affection in 75%. There was significant relation with the type according to Salter-Harris classification (Table 6).

Table (1): Relation between age group and results

Age Group	Excellent		Good		Fair		Poor		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
0-5	-	-	-	-	-	-	-	-	-	-
-10	2	100%	-	-	-	-	-	-	2	16.66
-15	7	77.77%	1	11.12%	1	11.11%	-	-	9	75
-17	-	-	1	100%	-	-	-		1	8.34
Total	9	75%	2	16.66%	1	8.33%	-	-	12	100

Table (2): Relation between type of injury (open, closed) and end results

Type of injury	Excellent		Good		fair		Poor		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Closed	9	90%	1	10%	-	-	-	-	10	83.34%
Opened	-	-	1	50%	1	50%	-	-	2	16..66%
Total	9	75%	2	16.66%	1	8.33%	-	-	12	100%

Table (3): Relation between types according to Salter-Harris (S-H) classification and end results

S-H type	Excellent		Good		Fair		Poor		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
Type I	1	50%	1	50%	-	-	-	-	2	16.66%
Type II	5	71.42%	1	14.29%	1	14.29%	-	-	7	58.33%
Type III	2	100%	-	-	-	-	-	-	2	16.66%
Type IV	1	100%	-	-	-	-	-	-	1	8.34%
Total	9	75%	2	16.66%	1	8.34%	-	-	12	100%

Table (4): Relation between types of implants and end results

Type of implant	Excellent		Good		Fair		poor		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
KW and Malleolar screw	2	100%	-	-	-	-	-	-	2	16.66%
Kw	7	70%	2	20%	1	10%	-	-	10	83.34%
Total	9	75%	2	16.66%	1	8.34%	-	-	12	100

Table (5): Relation between residual displacement in intra-articular injuries and end results

Residual displacement	excellent		Good		Fair		Poor		Total	
	Number	%	Number	%	Number	%	Number	%	Number	%
No displacement	7	87.5%	1	12.5%	-	-	-	-	8	66.66%
1 mm	2	66.66%	1	33,34%	-	-	-	-	3	25%
2 mm	-	-	-	-	1	100%	-	-	1	8.34%
Total	9	75%	2	16.66%	1	8.33%	-	-	12	100

Table (6): Relation between Salter-Harris (S-H) classification and limitation of ankle movement

S-H type	No limitation or <10 deg.		Limitation>10 degrees		Total	
	NO	%	NO	%	NO	%
Type I	1	50%	1	50%	2	16,66
Type II	5	71,42%	2	28.58%	7	58,33
Type III	2	100%	-	-	2	16.66
Type IV	1	100%	-	-	1	8.33
Total	9	75%	3	25%	12	100

Table (7): Relation between chronic pain and Salter-Harris (S-H) type

S-H type	No pain		Chronic pain		Total	
	NO	%	NO	%	NO	%
Type I	1	50%	1	50%	2	16.66%
Type II	5	71.42%	2	28.57%	7	58.33%
Type III	2	100%	-	-	2	16.66%
Type IV	1	100%	-	-	1	8.33%
Total	9	75%	3	25%	12	100%

DISCUSSION

Distal tibial physeal fractures are treated either conservatively, or operatively with K-wire and screws. The percutaneous pinning for lower tibial epiphyseal injury showed good reduction of fracture, provide speed recovery, secure fixation and avoiding prolonged cast immobilization [(6)].

This study included 12 cases with traumatic injuries of the distal tibial epiphysis: 8 males and 4 females. The youngest was 8 years old and the oldest was 16 years old.10 patients (83.3%) had closed fractures and 2 patients (16.7%) open fractures.

According to Olerud-Molander, which is a functional ankle score, excellent results were encountered in 9 cases (75%), good results in 2 cases (16.66%), fair results in 1 case (8.33%) and poor results in 0 case.

In **Salter and Harris** [(10)] study it was stated that the treatment should be done within a matter of hours of the accident. **Rockwood *et al.*** [(11)] stated that it is wiser to accept an imperfect reduction than to risk the danger of open reduction or forceful manipulation except in intra-articular types (type III, type IV) where delayed reduction although non desirable is preferable than leaving the intra-articular fragment displaced. In this work initial treatment was done in the majority of cases (75%) during the first 24 hours, and only 3 cases (25%) were treated in the 2nd 24 hours after trauma. However, the effect of time lag was insignificant in this study.

In **Spiegel *et al.*** [(12)] study their results were distinguished into 3 groups, low risk group which included Salter-Harris type I, minimally displaced type II and IV up to 2 mm displacement, high risk group included type III and IV with displacement above 2 mm, juvenile tillaux, triplane fractures, and unpredicted risk group which included Salter-Harris type II tibial fractures. Other authors [(18)] found good prognosis in Salter-Harris type I, II and type III. Type IV carries a bad prognosis unless the epiphyseal plate is completely realigned, and type V had the worst prognosis. The results in this work coincided with the pre-mentioned items.

Controversy exists about the prognosis of intra-articular types (III, IV), although some reports such as in **Spiegel *et al.*** [(12)] study obtained satisfactory results when residual displacement was 2 mm. **Siffert** [(13)] study obtained unsatisfactory results even if the displacement was 1 mm. The last finding had been proved in this study.

Paul *et al.*[(14)] stated that cases with Salter-Harris type I injuries can be immobilized in a short leg cast immobilization for 3-4 weeks with full weight bearing all over immobilization period. Cases with Salter-Harris type II, need long leg cast immobilization for 4-6 weeks with weight bearing in the latter half of immobilization period. Type III and IV, need long leg cast immobilization with the knee flexed for 4-6 weeks. **Salter and Harris**[10] stated that epiphyseal injuries do unite in about half the time required for union of fracture through the metaphysis of the same bone at the same age group. In this work, immobilization period was 6-8 weeks, and this coincided with other reports.

Kling *et al.* [15] recommended open reduction and internal fixation in intra-articular epiphyseal fractures used a smooth pins of small diameter. In this research work, 2 cases were managed by open reduction and internal fixation; 2 cases were irreducible Salter-Harris type II. **Backx *et al.*** [16] found that open injuries had less satisfactory results and this coincided with the end results of this work, where open injuries had 8.33% satisfactory results.

Roger [17] recommend follow-up of at least 6 months after trauma. Another author[18] stated that 12 months must lapse before valuable assessment of the results. In this study, follow up period was six months, so early complications were detected as; chronic pain, limitation of ankle movement and limping. But late complications as; limb length discrepancy and angular deformity of the ankle were difficult to be detected; as it needs more time.

3 cases in this study ended by limitation of movements more than 10 degrees, and were considered as unsatisfactory results. This was explained by that limitation of movements below 10 degrees were not noticed by the patient and did not affect their activities. 2 cases of them was associated with open injury with subsequent ugly scar formation, with its subsequent limitation of movements and 1 case due neglecting the role of physical medicine in an 8 weeks casted patient.

Limping was recorded in 3 cases. Chronic pain was detected in 3 cases. It was explained by loss of smooth joint surface and development of osteoarthritis, leg length discrepancy with unequal distribution of body weight.

CONCLUSION

The study only concentrated on the operative parameters clinical and radiological outcomes, and complications. The percutaneous pinning for lower tibial epiphyseal injury showed good reduction of fracture, satisfactory functional outcome and less complications. The technique provide speed recovery, secure fixation and avoiding prolonged cast immobilization and conservative treatment.

Open injuries are less favorable than closed injuries regardless of its types. Reduction should be a traumatic and anatomic especially in intra-articular fractures. Age, sex, side affected and period of follow up had no statistical significant effect on the prognosis. The percutaneous pinning showed excellent and good results in more than 91% in this study.

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REFERENCES

1. **Michael T, Tracey P, Jeff P (2006):** Salter Harris I, II, fractures of the distal tibia: Does mechanism of injury related to premature physeal closure?. J Pediatr Orthop., 26: 322-328.
2. **Waleed A, Manaf H, Abdulaziz F (2018):** Open versus closed treatment of distal tibia physeal fractures: a systematic review and meta-analysis. Eur J Orthop Surg Traumatol., 28:503–509.
3. **Pomeranz C, Bartolotta R (2020):** Pediatric ankle injuries: utilizing the dias-tachdjian classification. Skeletal Radiol., 49: 521-530.
4. **David A, Scott J (2012):** Physeal fractures of the distal tibia and fibula (Salter-Harris Type I, II, III, and IV fractures) J Pediatr Orthop., 32: 62–68.
5. **Haoqi C, Zhigang W, Haiqing C (2015):** Surgical Indications for distal tibial epiphyseal fractures in children. Orthopedics, 38(3): 189-195.
6. **Ethan W, David D, James H (2012):** Current concepts review ankle fractures in children. J Bone Joint Surg Am., 94:1234-44.
7. **Harris E (1981):** Epiphyseal plate injuries in pediatric ankle traumatology. J Foot Surgery, 20: 145-147.
8. **Michael C, Richard C, Mooney J *et al.* (2005):** Transepiphyseal screw fixation of the distal tibial. Pediatr Orthop., 25: 635-640.
9. **Dias L, Tachdjian M (1978):** Physeal injuries of the ankle in children: classification. Clin Orthop Relat., 136: 230-233.
10. **Salter R, Harris W (1963):** Injuries involving the epiphyseal plate. J Bone Joint Surg [Am], 277:7-71.
11. **Rockwood C, Wilkins K, king R (1987):** Fractures in children. JB Lippincott Company. Philadelphia. Fractures of the distal tibial and fibular epiphysis, Pp. 1014-42.
12. **Spiegel P, Cooperman D, Loras G (1978):** Epiphyseal fractures of distal ends of the tibia and fibula. A retrospective study of 237 cases in children. J Bone Joint Surg (Am), 60: 1046-50.
13. **Siffert R (1956):** The effect of staples and longitudinal wires on epiphyseal growth: An experimental study. J Bone joint Surg (Am), 38:1077-88.
14. **Paul G, Yablen I, Segal D *et al.* (1981):** Epiphyseal growth plate injuries in ankle injuries. Churchill Livingstone. Newyork, Gelenberg, London and Melbourne, Pp. 131-59.
15. **Kling T, Bright R, Hensinger R (1984):** Distal tibial physeal fractures in children that may require open reduction. J Bone Surg (Am), 66: 647-57.
16. **Backx F, Erick W, Kemper A *et al.* (1989):** Sports injuries in school aged children-An epidemiological study. Am J Sports Med., 17: 234-40.
17. **Roger L (1970):** The radiology of epiphyseal injuries. Radial, 96-2:289-99.
18. **Shapira F, Holtnop M, Glincher M (1977):** Organization and cellular biology of the perichondrial ossification groove of Ranvier. G Bone Goint Surg (Am), 59: 703-23.