MANAGEMENT OF RECENT LOWER TIBIAL EPIPHYSEAL INJURY IN PEDIATRIC BY PERCUTANEOUS PINNING

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ABSTRACT

Objectives: The aim of the work is evaluation of the clinical and radiological outcome of lower tibial epiphyseal injury managed by percutaneous pinning.

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 thesis 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. After management, whether by open or closed reduction any intra_articular residual displacement had unsatisfactory results.

Conclusion: 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.

Key words: Percutaneous, Tibial, Antero posterior, Extra cellular matrix, Kirschner wire, Salter-Harris type I,II,III,IV,V

I. 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,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%) (1,2,3).

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. This 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) was performed. A long-leg, non–weight-bearing cast was applied for 4 weeks postoperatively and was changed into a short-leg, weight-bearing cast for 2 weeks. If the K-wire was used for internal fixation, it was removed 6 weeks postoperatively. If a screw was used for fixation, it was 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, \(8 \text{ males (60\% and 4 patients were females 40\%)}\) ages \(8 - 16\) years old and the mean age 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 (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.

Types of physeal injuries according to Salter-Harris classification; Salter-Harris type II was the most common type.

**Inclusion criteria were:** Patient below skeletal maturity and Recent physeal fractures; Salter-Harris Type I, Salter-Harris Type II, Salter-Harris Type III, Salter-Harris Type IV. **Exclude criteria were:** Patients after skeletal maturity. Pathological fractures. neurovascular injuries. Pre-existing tibial shaft deformities.

Approval taking Institutional Review Board (IRB) approval and also informed written consent was taken from patients and/or their caregivers. This Work was performed according to the code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

### II. METHODS

**Methods of examination:**

All patients were subjected to thorough clinical and radiological examination. The study is prospective.

**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.
2. Radiological evaluation.

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.

   1. 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

   Ankle deformity; by determining the mechanical axis of the tibia and that line which represents the transverse axis of the ankle

   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 for malleolar screws not removed yet.

III. METHOD OF ASSESSMENT OF THE RESULTS:

Functional and clinical assessment.

The results was been assessed according to the method proposed by Olerud-Molander which is a functional ankle score. This assessment will include 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)) 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 Social Science (SPSS 25) for windows (SPSS Inc., Chicago, IL, USA). Data was presented and suitable analysis was done depending upon the type of data obtained for each parameter.

IV. 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 thesis 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 was improved with physiotherapy.

Chronic pain was detected in 3 cases Table 7.

Angular deformity secondary to premature closure of the epiphyseal growth plate and is 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 at 75%. There was with significant relation with the type according to Salter-Harris classification Table 6.

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Excellent</th>
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<th>Fair</th>
<th>Poor</th>
<th>Total</th>
</tr>
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<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
<tr>
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<td></td>
</tr>
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<td>10</td>
<td>2</td>
<td>100%</td>
<td></td>
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</tr>
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<td>15</td>
<td>7</td>
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<td>1</td>
<td>11.12%</td>
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</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td>1</td>
<td>100%</td>
<td></td>
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<tr>
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<td>2</td>
<td>16.66%</td>
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Table 1 : Relation between age group and results.
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<th>Fair Number</th>
<th>Poor Number</th>
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<td>1</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Opened</td>
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<td>50%</td>
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<td>2</td>
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<tr>
<td>Total</td>
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<td>2</td>
<td>16.66%</td>
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<td>12</td>
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<table>
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<th>S-H type</th>
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<th>Good Number</th>
<th>Fair Number</th>
<th>Poor Number</th>
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<td>-</td>
<td>-</td>
<td>2</td>
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<tr>
<td>Type II</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>7</td>
</tr>
<tr>
<td>Type III</td>
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<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Type IV</td>
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<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
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<td>2</td>
<td>16.66%</td>
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<td>12</td>
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<table>
<thead>
<tr>
<th>Type of implant</th>
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<th>Good Number</th>
<th>Fair Number</th>
<th>Poor Number</th>
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<td>-</td>
<td>-</td>
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<td>Kw</td>
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<td>Total</td>
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<th>Fair Number</th>
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<td>12.5%</td>
<td>-</td>
<td>8</td>
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<tr>
<td>1mm</td>
<td>4</td>
<td>1</td>
<td>33.3%</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>2mm</td>
<td>4</td>
<td>-</td>
<td>25%</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
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<td>2</td>
<td>16.66%</td>
<td>1</td>
<td>12</td>
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<table>
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<th>Limitation&gt;10 degrees</th>
<th>Total</th>
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<td>1</td>
<td>2</td>
</tr>
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<td>Type II</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Type III</td>
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<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Type IV</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
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<td>3</td>
<td>12</td>
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</table>

<table>
<thead>
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<th>S-H type</th>
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<th>Chronic pain</th>
<th>Total</th>
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<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Type II</td>
<td>5</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Type III</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Type IV</td>
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</tr>
<tr>
<td>Total</td>
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<td>12</td>
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</table>
Distal tibial physeal fractures account for 11% of all physeal injuries. 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.

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 cases (8.33%) and poor results in 0 case.

In Salter RB, Harris WR study (14) it was stated that the treatment should be done within a matter of hours of the accident. Other authors (15) 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 PG study (11) their results were distinguished into 3 groups, low risk group which include 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 2mm, 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 PG study (14) obtained satisfactory results when residual displacement was 2mm.

Siffert (12) study obtained unsatisfactory results even if the displacement was 1 mm. The last finding had been proved in this study.

Paul et al. (13) 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 et al (18) 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 (14) recommended open reduction and internal fixation in intra-articular epiphyseal fractures used a smooth pins of small diameter as stated by Salter. (38) other authors, published a research work of 20 cases with open reduction and internal fixation with smooth pins with net results of 95% good results and only 5% bad results which was due to the development of bony ridge. In this research work, 2 cases were managed by open reduction and internal fixation; 2 cases were irreducible Salter-Harris type II.

Backs (15) 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 (16) recommend follow-up of at least 6 months after trauma. Other authors (19,18) 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 its need more time.

3 cases in this thesis 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 a 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.

In this work, angular deformity and Leg length discrepancy can’t be assessed because of the short period of follow up.

VI. 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.

REFERENCES