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Minimally Invasive Management of Pediatric Distal Tibial Fracture: A Case-Based Perspective on Clinical Decision-Making and Patient Care

الإدارة محدودة التدخل لكسر الجزء البعيد من عظم الظنبوب لدى الأطفال: منظور قائم على دراسة حالة حول اتخاذ القرار السريري ورعاية المريض

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Abstract:

Pediatric fractures require careful clinical decision-making that considers the patient's age, fracture characteristics, treatment approach, and subsequent recovery. This case-based study presents the clinical management and follow-up of a 13-year-old boy with a displaced oblique right distal tibial Salter-Harris type IV fracture. The fracture was diagnosed using plain radiographs and computed tomography (CT). The patient underwent closed reduction and fixation using a conventional anti-gliding plate and screws through a minimally invasive plate osteosynthesis (MIPO) technique. Clinical follow-up was conducted for 16 weeks, and the final radiographic assessment demonstrated fracture healing. At the end of the follow-up period, the patient was able to achieve full weight-bearing without complications.

The case highlights the importance of appropriate clinical decision-making and careful follow-up in the management of pediatric fractures. It also demonstrates the practical application of a minimally invasive treatment approach using conventional plate and screw fixation while maintaining satisfactory clinical and radiological outcomes. From a patient-care perspective, the case illustrates the role of an appropriate treatment strategy, continuous clinical monitoring, and follow-up in supporting recovery among pediatric and adolescent patients with distal tibial fractures.

Keywords: Pediatric patient care; clinical decision-making; distal tibia; Salter-Harris type IV fracture; minimally invasive treatment; minimally invasive plate osteosynthesis; MIPO; clinical follow-up.

المخلص:

تتطلب كسور الأطفال اتخاذ قرارات سريرية دقيقة تراعي عمر المريض، وخصائص الكسر، ونهج العلاج، ومسار التعافي اللاحق. تقدم هذه الدراسة القائمة على الحالة وصفاً للإدارة السريرية والمتابعة لطفل يبلغ من العمر 13 عامًا، يعاني من كسر مائل ومُزاح في الجزء البعيد من عظم الظنوب الأيمن من نوع سالتز-هاريس الرابع. تم تشخيص الكسر باستخدام الصور الشعاعية العادية والتصوير المقطعي المحوسب (CT). خضع المريض لرد مغلق للكسر وتثبيتته باستخدام صفيحة تقليدية مانعة للانزلاق وبراغ، من خلال تقنية التثبيت بالصفيحة عبر التدخل الجراحي المحدود (MIPO). تمت المتابعة السريرية لمدة 16 أسبوعًا، وأظهر التقييم الشعاعي النهائي التئام الكسر. وفي نهاية فترة المتابعة، تمكن المريض من الوصول إلى التحميل الكامل للوزن دون حدوث أي مضاعفات.

تسلط الحالة الضوء على أهمية اتخاذ القرار السريري المناسب والمتابعة الدقيقة في إدارة كسور الأطفال. كما توضح التطبيق العملي لنهج علاجي محدود التدخل باستخدام التثبيت التقليدي بالصفيحة والبراغي، مع تحقيق نتائج سريرية وشعاعية مرضية. ومن منظور رعاية المريض، توضح الحالة دور الاستراتيجية العلاجية المناسبة، والمراقبة السريرية المستمرة، والمتابعة في دعم التعافي لدى الأطفال والمراهقين المصابين بكسور الجزء البعيد من عظم الظنوب.

الكلمات المفتاحية : رعاية الأطفال المرضى؛ اتخاذ القرار السريري؛ الظنوب البعيد؛ كسر سالتز-هاريس من النوع الرابع؛ العلاج محدود التدخل؛ التثبيت بالصفيحة عبر التدخل الجراحي المحدود؛ MIPO ؛ المتابعة السريرية.

Introduction

Pediatric orthopedic injuries represent an important area of healthcare practice because the management of fractures in children and adolescents requires consideration of age, skeletal maturity, fracture pattern, and the potential impact of treatment on subsequent growth and function. In this context, appropriate clinical decision-making and individualized patient care are essential for achieving satisfactory outcomes and reducing the risk of complications.

Triplane fractures represent an uncommon and complex injury pattern involving the distal tibia in the pediatric population, typically occurring between 12 and 17 years of age. They account for approximately 6% of ankle injuries in this age group [1, 2]. These fractures extend through three anatomical planes of the distal tibia: coronally through the metaphysis, sagittally through the epiphysis, and axially through the physis. This pattern corresponds to a Salter-Harris type IV fracture and reflects the progressive closure of the distal tibial physis. Physeal closure generally begins centrally and medially, often referred to as Kump's bump, and subsequently progresses laterally toward the posterior and anterolateral aspects of the tibia [19, 20].

The management of distal tibial fractures in adolescents requires accurate assessment and an appropriate treatment strategy because injury to the epiphysis during this developmental stage may produce specific fracture patterns related to changes in biomechanics. Achieving an appropriate reduction is particularly important in intra-articular fractures because residual displacement or malalignment may affect subsequent joint function and increase the risk of early degenerative changes.

From a patient-care perspective, the selection of a treatment technique should take into account not only the anatomical characteristics of the fracture but also the patient's age, recovery requirements, potential complications, and the need for appropriate postoperative monitoring. Minimally invasive plate osteosynthesis (MIPO) represents an approach that can be used for fracture fixation while limiting the extent of surgical exposure. When combined with appropriate reduction, fixation, and clinical follow-up, this technique may provide satisfactory fracture healing in selected pediatric and adolescent patients.

Case History

A 13 years old overweight boy not known to have any chronic illness sustained twisting injury to right ankle joint during walking in the beach in unsteady floor 3 months ago and brought by her father to emergency department complaining of right ankle pain , swelling and difficulty in walking on arrival he was looks well in pain , vital signs were normal On local examination right ankle looks swollen , deformed , tender , their painful limited range of motion , he unable to bear weight on right lower limb , distal pulses and nerves were intact , no signs of compartment and right knee & hip were normal .Patient received analgesia realignment done for right ankle pulses and nerves rechecked after that which were intact then plan x ray and Ct scan done for right ankle and foot which showed displaced salter harris type 4 distal tibia physeal fracture or triplane fracture (figures from 1,2,3,4,5)

Figure number 1 preoperative anteroposterior view ankle x ray



Figure number 2 preoperative Lateral view ankle x ray



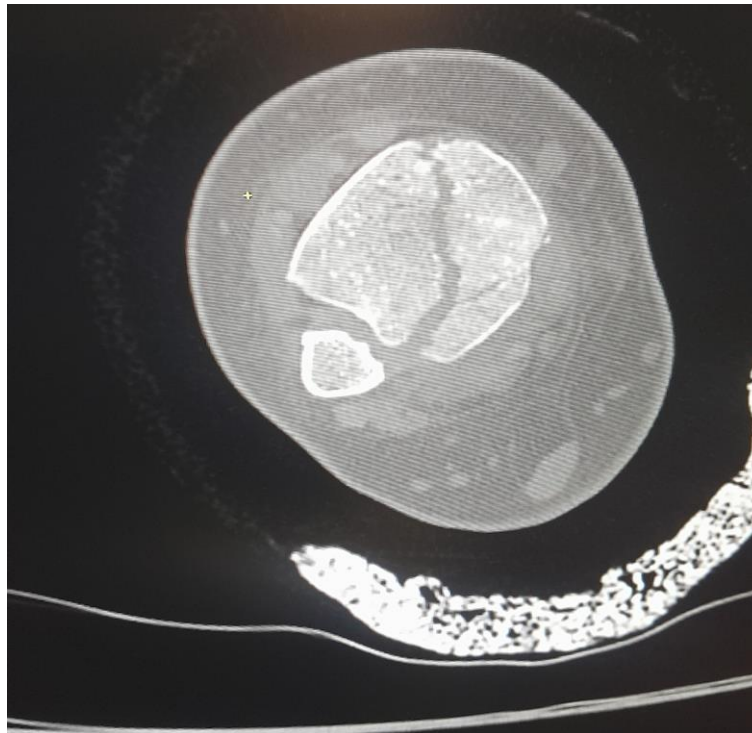
Figure number 3 preoperative CT scan ankle coronal view



Figure number 4 preoperative CT scan ankle sagittal view



Figure number 5 preoperative CT scan ankle axial view



Also in emergency room back slap below knee applied to the patient and then admitted in surgical ward for analgesia, elevation of right ankle in pillow and for preoperative assessment by anaesthetist also for surgery preparation. After 3 days back slap removed reassessment done which revealed subsidence of swelling and no signs of compartment then patient booked for operative intervention, patient taken to operating room after 4 days.

On operation room, patient given regional lock by anaesthetist around the right knee for block of tibial, peroneal and femoral nerves then patient positioned in supine position, C arm image intensifier used for closed reduction of distal tibial salter harris type 4 physeal fracture then check done by C arm which showed accurate anatomical reduction with congruency of ankle joint then fixation done by temporary k wires then size 36mm x 4mm partial threaded canulated screw inserted above and parallel to physis to hold the fracture because fracture is long oblique and extended to physis, metaphysis and epiphysis also check x ray done by C arm and showed anatomic well reduced fracture (figure number 7), then we used minimally invasive plate osteosynthesis MIPO techniques. we make 3 small skin incision first one about 1 cm distal to fracture side and second and third ones about 0.5 cm, (figure number 6) then we slide 6 holes convention small fragment plate subcutaneously to buttress the fracture also as antegliding plate to prevent shearing forces, then we fixed plate by 3 partially threaded canulated screws size 34mm, 32mm & 30mm then check x ray taken post operatively which showed anatomically reduced fracture with good fixation, (figure number 8, 9) irrigation done and small incisions sutured by prolon 3/0 and below knee back slap applied

Patient discharged home after 3 days instruction given to both patient and family to be non weight bearing on right lower limb for 6 weeks physiotherapy done for him for teaching for walking with walker frame, also he given follow up in orthopedic clinic. On clinic followed for 12 weeks, back slap removed after 6 weeks and serial x ray done for him every 2 weeks after 4 weeks (figure 10, 11) and

last x ray done after 8 weeks (figure number 12 ,13) which showed healed fracture and now patient doing fine has full range of motion of right ankle and foot also he walking normally without any limitation or limping and small wounds were healed nicely with very tiny scares

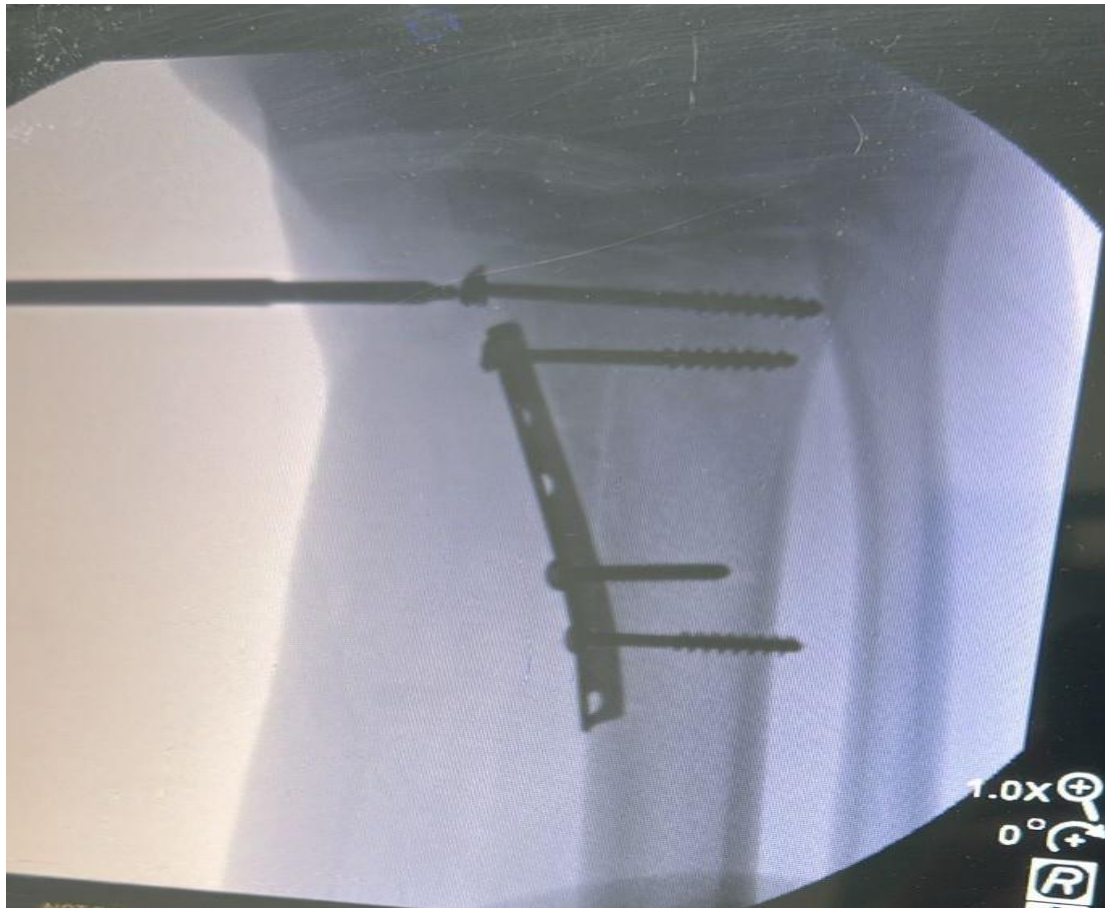
Figure number 6 right leg and ankle intraoperative picture showed three small surgical incisions



Figures number 7 intraoperative anteroposterior C arm anteroposterior view ankle image



Figuer number 8 intraoperative C arm anteroposterior view ankle image



Figures number 9 immediate postoperative anteroposterior view ankle x ray



Figures number 10 immediate postoperative mortise view ankle x ray



Figures number 11 immediate postoperative lateral view ankle x ray



Figure number 12 postoperative follow up x ray anteroposterior view x ray after 4 weeks



Figure number 13 postoperative follow up x ray lateral view x ray after 4 weeks



Figure number 14 postoperative follow up x ray anteroposterior view x ray after 8 weeks

Without back slap

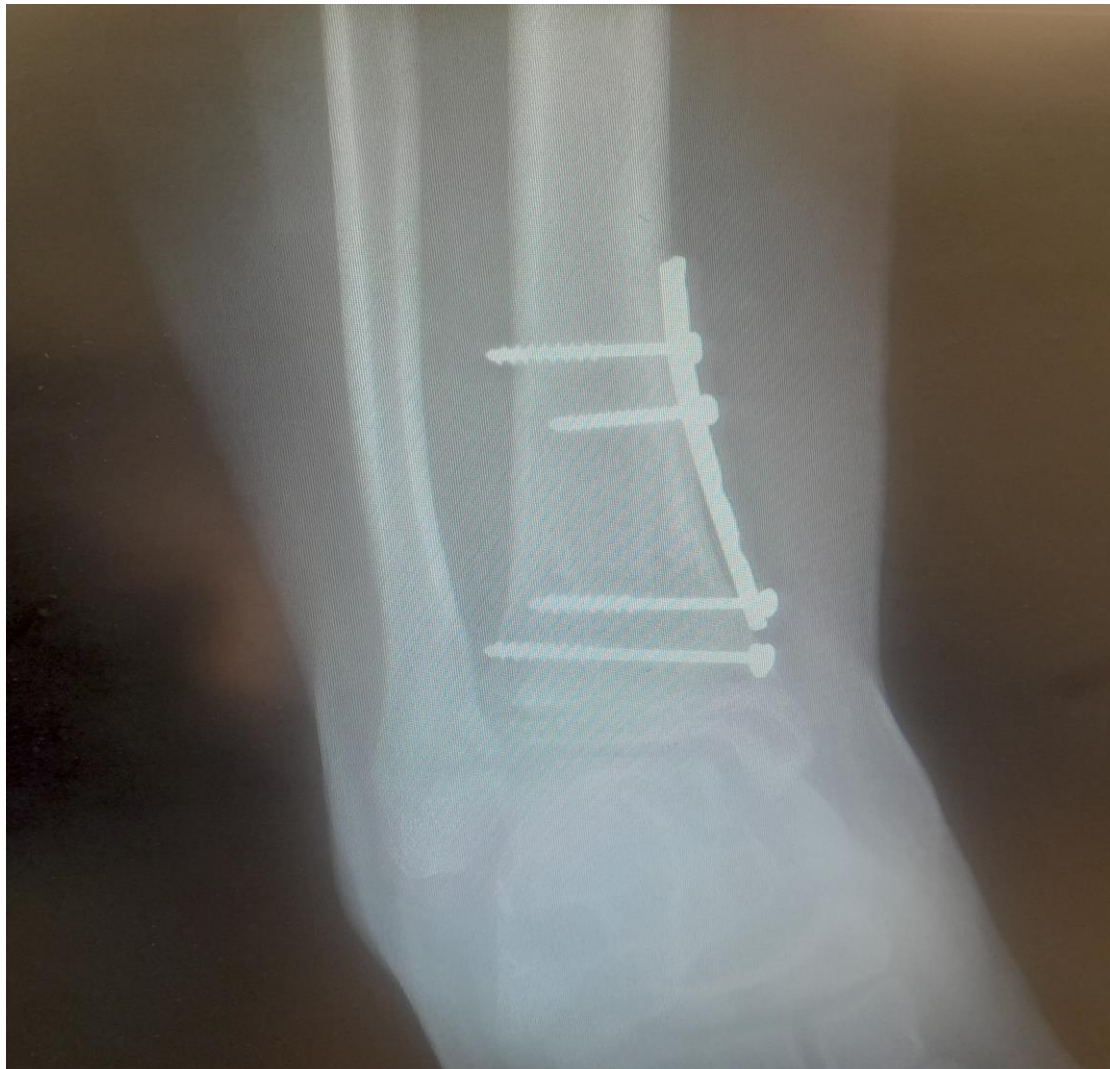


Figure number 15 postoperative follow up x ray lateral view x ray after 4 weeks without back slap



Discussion

Early [fracture](#) surgery often involved anatomic reduction with fixation of all fracture fragments, but with a cost of extensive exposure and soft tissue compromise; thus, a more “biologically friendly” surgery that guaranteed preservation of osseous and soft tissue vascularity was warranted. [\[3\]](#)

Since its conception in 1989, MIPO has received widespread acceptance and interest in this procedure has led to studies in over forty countries with most of the publications originating from Asia, Europe and North America. [\[4\]](#)

The use of MIPO (Minimally Invasive Plate Osteosynthesis) in pediatric ankle fractures—particularly distal tibia and pilon fractures—focuses on preserving the bone's biological environment and vascularity. By using smaller incisions and sliding the plate through a submuscular tunnel, surgeons minimize soft tissue damage and support rapid, robust healing.

Minimally invasive plate osteosynthesis (MIPO) was developed over the past 20 years as an alternative to ORIF for the management of distal [tibial](#) fractures. MIPO techniques aim to minimize soft tissue dissection, preserve the [fracture's](#) blood supply by utilizing smaller incisions, percutaneous insertion of the fixation plate. This method facilitates fracture healing via keeping the biological environment around the fracture site, reducing the [risk of infection and soft tissue complications](#), promoting quicker recovery and better functional [outcomes](#) [\[5-1\]](#)

Allowing relative stability thus permitting limited controlled motion at the fracture site with secondary [bone healing](#) and callus formation. [\[5-2\]](#)

The evidence suggests that MIPO is associated with several advantages over ORIF.

Patients treated with MIPO generally experienced shorter operative times, reduced blood loss, and shorter hospital stays. [\[6-10\]](#) .

These benefits can be attributed to the less invasive nature of the technique, which minimizes soft tissue disruption and blood vessel damage around the fracture site.

Additionally, the risk of postoperative infection, a significant concern with ORIF due to larger surgical exposures, appears to be lower in patients treated with MIPO.

This could lead to a reduction in the overall complication rate, potentially translating into better long-term outcomes for patients. [\[11,15-16\]](#).

Healing times and the rate of fracture union are critical factors in evaluating the effectiveness of any fracture treatment method.

The literature indicates that the time to fracture union in patients treated with MIPO is comparable to those treated with ORIF, with some studies suggesting a slight advantage for MIPO. [\[12\]](#) .

This finding is particularly relevant, as earlier weight-bearing and return to daily activities are crucial for patient recovery and satisfaction. Furthermore, the functional outcomes and restoration of the limb's anatomical alignment, as measured by standard scoring systems, were generally favorable for MIPO. Patients often reported satisfactory levels of pain management, mobility, and return to preinjury activity levels. [\[13,14,17\]](#) , despite these advantages, the application of MIPO is not without challenges, technical considerations, including the need for specialized training and familiarity with fluoroscopic guidance, are essential for the successful application of MIPO. [\[17\]](#)

Moreover, the technique may not be suitable for all types of distal tibial fractures, particularly those with significant comminution or where precise anatomical reduction is difficult to achieve without direct visualization

4.CONCLUSION:

Distal tibial physeal fractures are one of the most common childhood fractures and can lead to severe complications.

The mid- and long-term outcomes of surgical treatment of distal tibial physeal fractures are favorable, the method of reduction (open or closed), the choice of implant (K-wire or cannulated screw), and the location of the fracture (intra-articular or extra-articular) do not affect outcomes or complications in patients with these injuries. The crucial factor in the treatment of distal tibial physeal fractures is achieving anatomical reduction. havati kart study etal [4]

Minimally invasive plate osteosynthesis (MIPO) is a satisfactory and appealing alternative surgical option for a wide variety of [fractures](#), with more studies needed to establish its widespread clinical utility.

The accumulated evidence supports the use of MIPO as an effective and safe alternative to traditional ORIF for the treatment of distal tibial fractures. It offers several clinical advantages, including reduced operative trauma, lower infection rates, and comparable, if not superior, healing times and functional outcomes. However, the selection of the most appropriate treatment method should be tailored to the individual patient, considering the specific characteristics of the fracture, the patient's overall health status, and the surgeon's expertise.

Further research, particularly randomized controlled trials with long-term follow-up, is needed to solidify these findings and explore the potential of MIPO in the broader context of lower limb fracture management. Manesh Chacko Philip¹ , Girish Kumar K² [18]

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