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A SIMULTANEOUS ARTHROSCOPIC PULL-OUT SUTURE FIXATION FOR ACL AVULSION WITH DIRECT REPAIR OF PATELLA TENDON AVULSION USING ANCHOR SUTURE IN AN 11-YEARS OLD GIRL – A CASE REPORT

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ABSTRACT

Tibial tuberosity avulsion and tibial spine fractures are rare injuries, though they occur more commonly in children and adolescents due to incomplete ossification of the tibial tuberosity and tibial spine, which renders these structures weaker than the attached ligaments and musculature. However, to our knowledge, no case of combined tibial tuberosity avulsion and tibial spine fracture has been reported in the literature, presenting unique diagnostic and surgical challenges. This case report details the presentation, diagnosis, and surgical management of an 11-year-old girl who sustained this unprecedented dual injury following a motor vehicle accident. The surgical approach included the Krackow suture technique of patella tendon with a knotless anchor for tibial tuberosity fixation and an arthroscopic suture pull-out technique with cortical button fixation for the anterior cruciate ligament (ACL) tibial spine fracture. This case underscores the importance of early diagnosis and a tailored surgical approach to ensure optimal outcome.

1.0 INTRODUCTION

Paediatric knee trauma represents a unique intersection of skeletal immaturity and biomechanical vulnerability, where the physeal cartilage's relative weakness compared to ligaments and tendons predisposes adolescents to avulsion fractures [1]. Tibial tuberosity and tibial spine fractures exemplify this phenomenon, each with distinct mechanisms and clinical implications. Tibial tuberosity fractures, often occurring during explosive quadriceps contractions in sports like basketball or sprinting, typically affect males aged 12–15 nearing skeletal maturity, with an incidence of less than 1 % of paediatric fractures [2]. Conversely, tibial spine fractures avulsions of the ACL insertion are more common in children aged 8–14, accounting for 2–5 % of paediatric knee injuries [3].

The pathophysiology of these fractures' hinges on the asynchronous closure of proximal tibial ossification centres. The tibial tuberosity's secondary ossification centre, the last to fuse, becomes a critical failure point during adolescence [4]. Where else, for the partially ossified tibial spine, it succumbs to rotational forces that would typically injure the ACL in adults [5]. Although both fractures are well-documented individually, their coexistence has never been reported, likely due to differing injury mechanisms tibial tuberosity fractures arise from extensor mechanism overload, whereas tibial spine fractures result from ACL tensile forces [6]. This anatomic and mechanistic dichotomy underscores the unprecedented nature of combined injuries, which may complicate diagnosis, compromise knee stability, and demand innovative surgical strategies.

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Diagnostic challenges abound, as overlapping clinical features hemarthrosis, extensor lag, and restricted motion mask the true injury pattern. Plain radiographs often suffice for isolated fractures, but combined injuries necessitate advanced imaging. CT scans delineate bony displacement, while MRI evaluates concomitant soft tissue damage, such as meniscal entrapment or ligament injury [6].

Surgical management emphasizes anatomic reduction and physeal-sparing strategies: tibial tuberosity fractures are stabilized using suture anchors to preserve growth potential, while tibial spine fractures increasingly employ arthroscopic pull-through sutures, minimizing hardware-related risks such as implant irritation or physeal disruption [7-8]. This report presents the first documented case of concurrent tibial tuberosity avulsion and tibial spine fracture in an 11-year-old girl following a motor vehicle accident. By addressing this novel injury pattern, we aim to refine diagnostic workflows, advocate for tailored surgical interventions, and highlight the importance of vigilance in paediatric trauma.

2.0 CASE PRESENTATION

An 11-year-old girl presented to the emergency department with complaints of left knee pain and swelling following a motor vehicle accident. She skidded from her motorbike and fell onto her left side with her left knee in a flexed position. At the time of the accident, her speed was approximately 60 km/h. post-trauma, she was alert and conscious; however, she was unable to bear weight and demonstrated a limited range of motion in the affected knee. She was subsequently transported to Hospital Angkatan Tentera Tuanku Mizan by a passerby. Upon arrival at the emergency department, a thorough clinical examination was performed. An abrasion wound was noted on the anterior aspect of her left knee, along with significant swelling and tenderness. Examination of the other systems was unremarkable.

2.1 Diagnostic Workup

From the radiographs, Anteroposterior and lateral knee plain radiographs revealed tibial tuberosity avulsion fracture, tibial spine fracture, and Segond fracture. On the other hand, the computed tomography (CT) scan performed for detailed fracture evaluation, confirming displacement of the tibial tuberosity and tibial spine fragments.

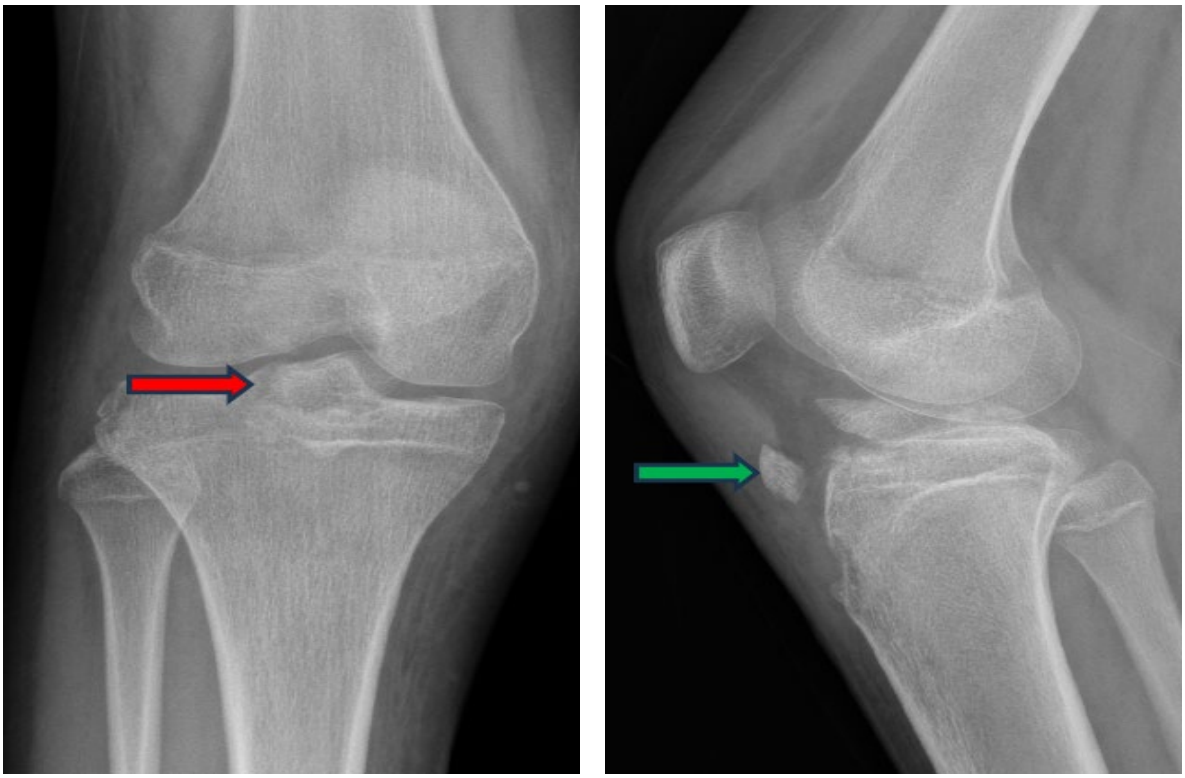

Figure 1. Plain radiographs of the right knee (green arrow), a comminuted tibial spine fracture (red arrow)

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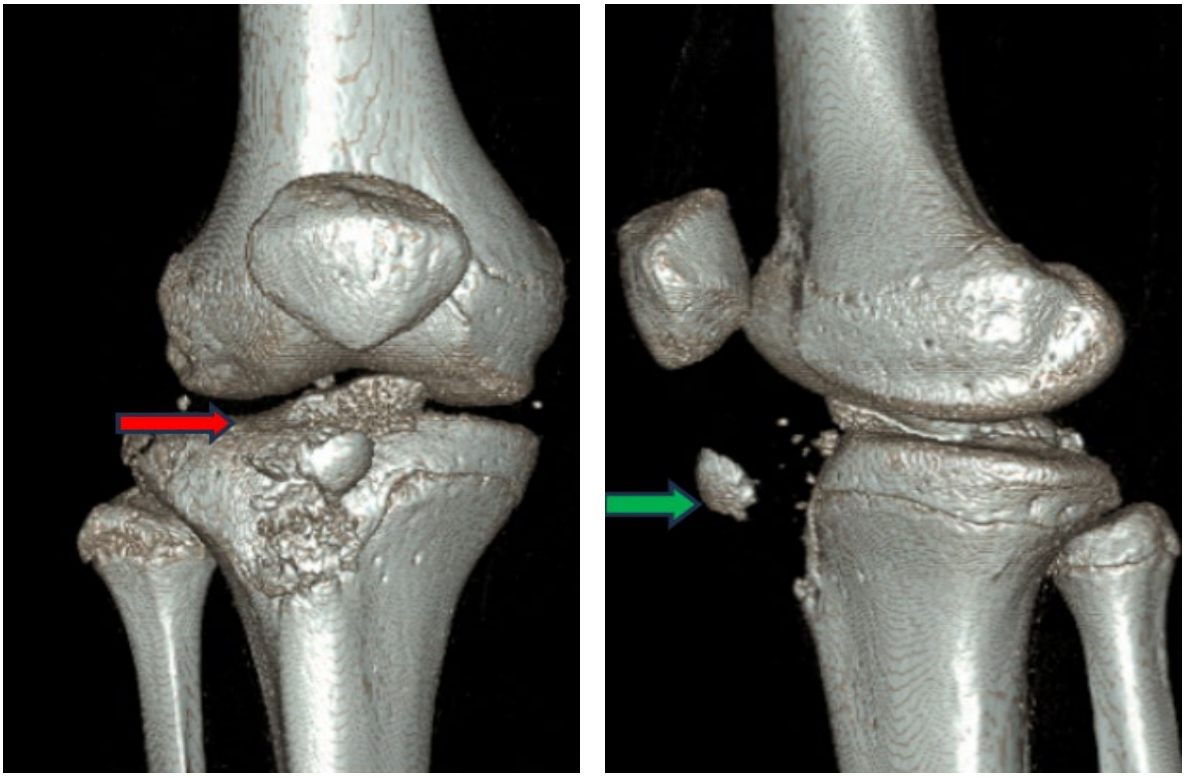

Figure 2. CT 3-D Reconstruction showed tibial tuberosity avulsion fracture (green arrow), comminuted tibial spine fracture (red arrow) and Segond fracture

Figure 1 shows the plain radiographs of the right knee revealed a tibial tuberosity avulsion fracture (green arrow), while a comminuted tibial spine fracture (red arrow), and a Segond fracture, indicating patellar tendon avulsion and ACL avulsion. Figure 2 shows CT 3-D reconstruction showed tibial tuberosity avulsion fracture (green arrow) and comminuted tibial spine fracture (red arrow) and Segond fracture. Those figures confirming our diagnosis and for pre-operative assessment.

3.0 SURGICAL APPROACH

Given the severity and displacement of the fractures, surgical intervention was warranted.

3.1 Tibial Tuberosity Avulsion Fixation

A midline anterior incision was made then the avulsed tibial tuberosity fragment was identified and reduced. The Krackow suture technique was used to reinforce the patellar tendon attachment [9]. Then, a knotless suture anchor (Poplook 4.5mm ConMed) was used to secure the avulsion fragment back to the tibial tuberosity, ensuring anatomical reduction and stable fixation.

3.2 ACL Tibial Spine Fracture Fixation

A diagnostic arthroscopy was performed to assess fracture displacement, ACL attachment and to check for additional knee joint injuries. The tibial spine fragment was reduced using an arthroscopic probe and a pull-out suture technique was employed using high strength fibretape sutures, which were tied over the anterior tibia using a cortical button (infinity tibial button ConMed) to provide stable fixation, like ACL reconstruction techniques [10]. Figure. 3 show the arthroscopy view ACL tibial arthroscope jig used to mark the tibial tunnel for drilling and to secure the tibial spine avulsion back to its anatomical footprint. In Figure 4, Fibretape suture was chosen and passed through the ACL using suture passing device (Autopass ConMed) and later was retrieved at end of tibial tunnel.

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Figure 3. Arthroscopy view ACL tibial arthroscope jig used to mark the tibial tunnel for drill

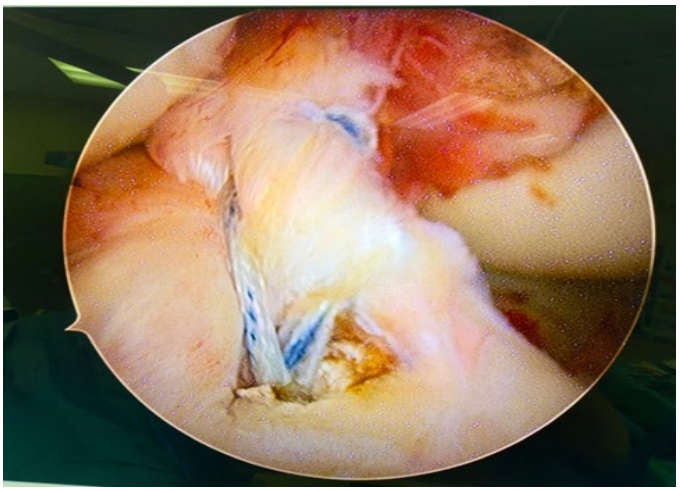

Figure 4. Arthroscopy view: Fibretape suture passed through the ACL

Figure 5. the tibial tuberosity (green arrow) was completely avulsed from its bony origin, and a cortical button was used to secure the ACL avulsion (orange arrow). Figure 6, a Krackow suture technique (blue arrow) was applied to reinforce the patellar tendon, while a knotless suture was utilized to reduce and fix the tibial tuberosity to its bony origin.

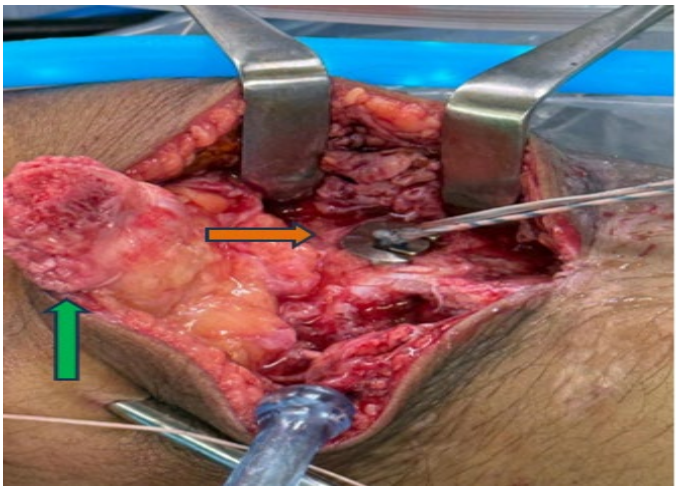

Figure 5. The tibial tuberosity (green arrow) was completely avulsed from its bony origin

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Figure 6. A Krackow suture technique (blue arrow) was applied to reinforce the patellar tendon

4.0 POSTOPERATIVE MANAGEMENT

The knee was immobilized in a hinged knee brace, allowing 20 degrees of flexion for four weeks. The patient was non-weight-bearing and mobilized using crutches and the wound healed well, with no complications. After completing four weeks, the knee brace was removed, and full range of motion was permitted as tolerated. The patient also began partial weight-bearing ambulation. During this period, the rehabilitation program focused on quadriceps strengthening and improving range of motion. The patient needs to reduced range of motion at 4 weeks post-operation detected and the frequency of physiotherapy sessions increased from every two weeks to weekly. Then, full weight-bearing was allowed at two months post-operation and the patient was able to return to her pre-injury level of function at six months post-operation.

5.0 DISCUSSION

5.1 Diagnostic Dilemma

The diagnosis of a combined tibial tuberosity avulsion and tibial spine fracture is challenging due to overlapping clinical presentations and inconclusive findings on plain radiographs. Both fractures can present with knee pain, swelling, hemarthrosis, and an inability to bear weight, making differentiation difficult during the initial examination. Both fractures are commonly identified on plain radiographs; however, subtle displacements or associated injuries may be overlooked. MRI is recommended to assess concomitant soft tissue injuries, including meniscal entrapment, ACL integrity, and capsular damage. CT scans offer superior visualization of bony displacement and are valuable for preoperative planning [11]. In this case, the CT scan was crucial in confirming the extent of both fractures and in guiding the surgical strategy.

5.2 Surgical Techniques

The management of tibial spine fractures continues to evolve, with arthroscopic-assisted fixation emerging as the preferred approach. Suture fixation techniques, such as pull-through sutures combined with cortical button fixation, have demonstrated the ability to provide stable fixation while facilitating early mobilization [12]. For tibial tuberosity avulsion fractures, several fixation methods are available, including screws, tension band wiring, and suture anchors. The Krackow technique, utilizing a knotless anchor, provides secure fixation while reducing the risk of hardware-related complications. In our case, a combination of these techniques achieved optimal stability and supported the initiation of an early rehabilitation protocol.

5.3 Rehabilitation Considerations

Postoperative rehabilitation is crucial in optimizing outcomes. Early mobilization reduces stiffness and promotes quadriceps function. Partial weight-bearing is typically recommended for 4-6 weeks, with a gradual increase in activity [13]. Delayed weight-bearing or inadequate rehabilitation can lead to muscle atrophy, decreased range of motion, and prolonged recovery. In our patient, we observed a reduced range

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of motion at 4 weeks post-operation. As a proactive measure, we increased the frequency of physiotherapy sessions from every two weeks to weekly. Fortunately, the patient demonstrated favourable clinical progress, achieving a gradual return to function within six months.

6.0 CONCLUSION

This case report highlights the successful management of a rare paediatric knee injury involving tibial tuberosity avulsion and tibial spine fracture. Surgical fixation using the Krakow technique with a knotless anchor alongside pull-through suture fixation with a cortical button, provided stable fixation and resulted in favourable clinical outcomes. Early diagnosis, meticulous surgical intervention, and structured rehabilitation program are crucial for preventing complications such as non-union, growth disturbances, and knee instability.

7.0 CONFLICT OF INTEREST

The authors declare no conflict of interest.

8.0 AUTHORS CONTRIBUTION

Ab Halim, M. A. H. (Conceptualisation; Methodology; Formal analysis; Data curation; Formal analysis; Investigation; Visualisation; Writing - original draft; Writing - review & editing)
Mahidon, R. (Conceptualisation; Methodology; Validation; Formal analysis; Data curation; Formal analysis; Investigation; Writing - original draft; Supervision)
Abdul Rahiman Ghani, M. A. (Software; Writing - review & editing)
Aziz, M. A. (Project administration; Supervision)

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