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Proximal Hamstring Avulsion through Growth Plate: Case Report of an Innovative Solution with Early Return to Sports

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ABSTRACT

Introduction: Proximal hamstring avulsion injuries significantly impact young athletes, particularly when involving growth plates. This case report and literature review aim to provide a comprehensive analysis of proximal hamstring avulsion through the growth plate, focusing on an innovative surgical solution designed to ensure early return to sports.

Case Presentation: A 13-year-old male soccer player presented with acute posterior thigh pain following a match. Initial conservative management failed to relieve symptoms. Radiographic imaging and MRI confirmed a proximal hamstring avulsion through the growth plate. The innovative surgical intervention involved reattachment using two 2.5 mm triple-loaded soft anchors to avoid growth plate interference and potential future reinterventions. Postoperative rehabilitation included phased exercises starting with painfree mobility and progressing to strength training and sport-specific drills, leading to a full recovery within six months.

Discussion: Surgical indications for hamstring avulsion include significant displacement of the avulsed fragment (>1-2 cm), conservative treatment failure, severe functional loss, and high-demand athletes requiring robust repair. Early MRI diagnosis, tailored surgical techniques avoiding growth plate disruption, and structured rehabilitation programs focusing on muscle balance and flexibility are crucial. Literature underscores the importance of early surgical intervention, as population-based studies show tailored rehabilitation reduces recurrence and improves functional outcomes.

Conclusion: Proximal hamstring avulsion injuries in young athletes require meticulous diagnosis and treatment. The innovative use of soft anchors facilitates proper healing and early return to sports, highlighting the necessity for precise surgical techniques and comprehensive rehabilitation protocols. This integrated approach ensures optimal recovery, minimizes re-injury risks, and facilitates a safe return to high-level athletic activities.

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Abbreviations

MRI: Magnetic Resonance Image

Introduction

Hamstring avulsion injuries, though relatively uncommon, are a significant concern for young athletes due to their impact on mobility and athletic performance. The hamstring muscle group, consisting of the biceps femoris, semitendinosus, and semimembranosus, is essential for knee flexion and hip extension. These muscles originate from the ischial tuberosity and insert along the tibia and fibula, making them susceptible to high strain during dynamic activities. While hamstring injuries are notable in adult athletes, their occurrence is even less frequent in adolescents due to their distinct anatomical and functional characteristics [1]. Several factors contribute to the risk of hamstring injuries, including anatomical variations, previous injuries, and the bi-articular nature of these muscles, which increases their mechanical demands [2,3]. Hamstring avulsion can occur during vigorous eccentric contractions, such as high-speed running or sudden directional changes [1]. Functional imbalances, suboptimal flexibility, and inadequate warm-up routines further elevate the risk [4,5]. In young athletes, the injury often results from the relative weakness at the growth plates during rapid growth periods [6,7]. The incidence of hamstring injuries in adults is about 12–16% annually in professional soccer players. In contrast, acute avulsion fractures of the pelvis in young athletes range from 9% to 35%, depending on the sport. Studies highlight that the prevalence of these injuries varies significantly between adults and youth,

emphasizing the need for tailored prevention and rehabilitation programs [5-10]. Treatment options for hamstring avulsion injuries vary based on the severity and specifics of the injury; conservative management includes rest, physical therapy, and gradual return to activity, while surgical intervention may be indicated in cases with significant displacement or failure of conservative treatment [10]. Indications for surgical treatment of hamstring avulsion lesions include significant displacement of the avulsed fragment by more than 1-2 centimeters, failure of conservative treatment to alleviate symptoms or promote healing within 6-8 weeks, acute severe avulsions resulting in substantial loss of function or significant pain, high-demand athletes requiring reliable and robust repair, and associated musculoskeletal injuries necessitating comprehensive intervention [9-11].

This case report and literature review aim to provide an in-depth analysis of Proximal Hamstring Avulsion Through Growth Plate in young athletes and it introduces an innovative surgical technique designed to avoid reinterventions with an early return to sports.

Case Presentation

A 13-year-old male amateur soccer player presented with acute posterior thigh pain after kicking a ball during a match. Initially evaluated at another hospital, he was advised to rest and follow up with physiotherapy. One week later, he visited our clinic, reporting pain in the posterior region of the right thigh, noticeable swelling, and a deficit in active knee flexion strength (M3/M5), but no signs of sciatic nerve neurapraxia. Radiographic imaging and MRI confirmed a diagnosis of Proximal Hamstring Avulsion Through Growth Plate. (Figures 1 and 2) Preoperative X-ray image reveals osseous avulsion of the ischial tuberosity, showcasing a distinct bone fragment displaced from its original position, indicative of an acute hamstring injury. (Figure 1)

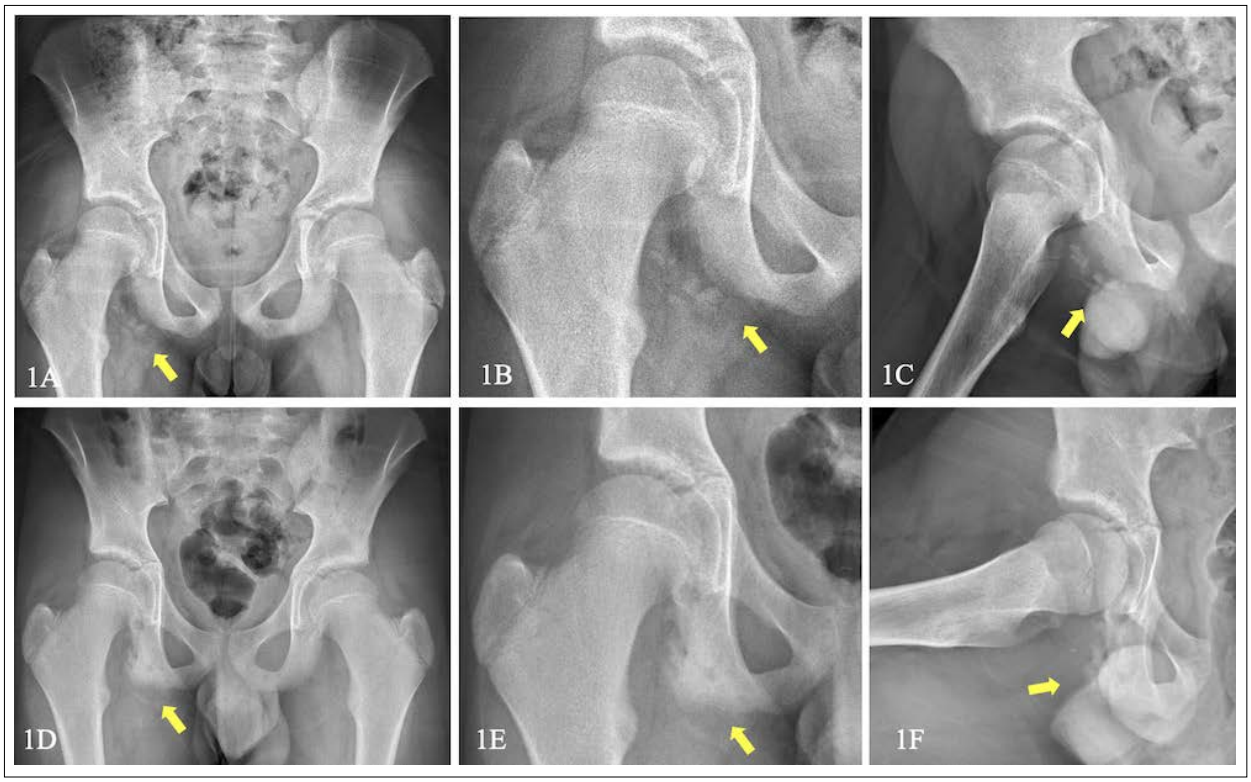

Figure 1: A) Preoperative X-ray reveals osseous avulsion of the ischial tuberosity (yellow arrow). B) A closer view emphasizes injury details. C) Axial view shows similar characteristics. D) AP X-ray at 7 months post-surgery demonstrates successful healing with normal alignment (yellow arrow). E) Closer AP view highlights callous formation. F) Axial view shows comparable features.

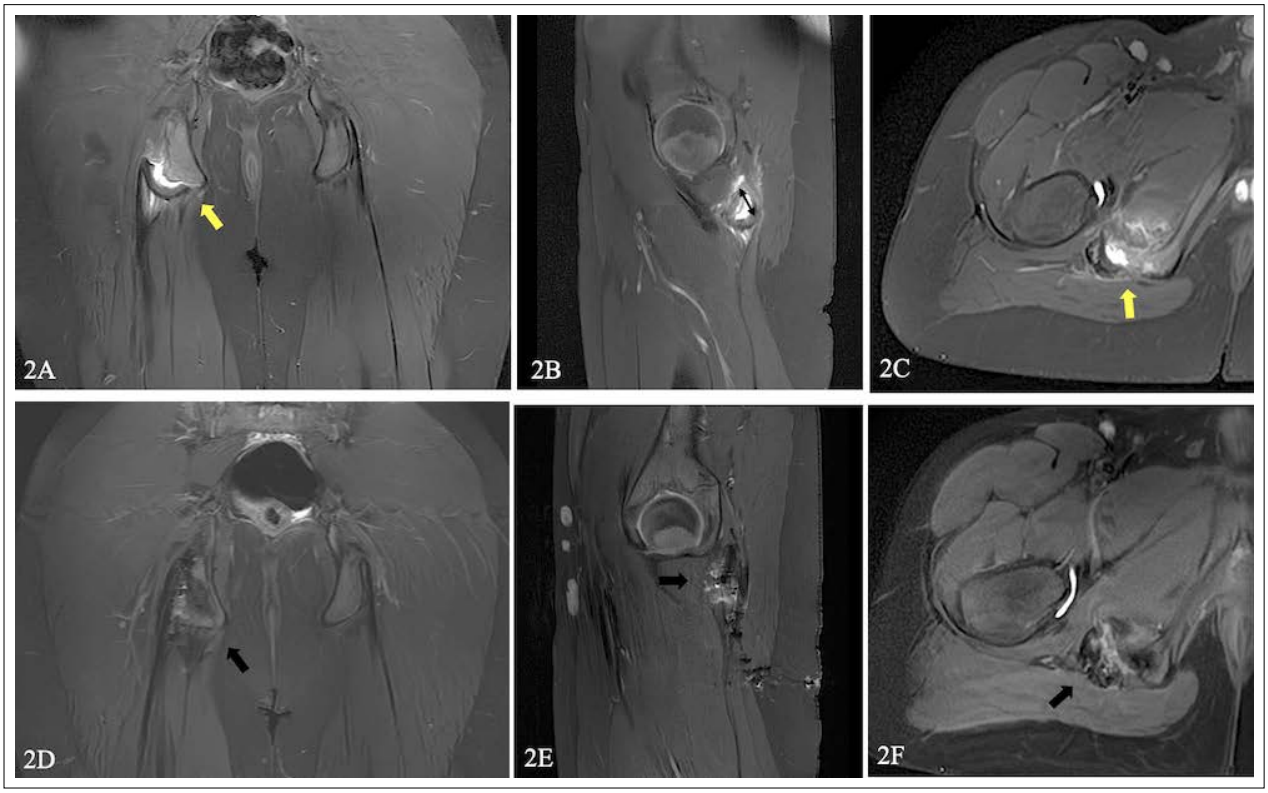

Figure 2: A) Preoperative coronal T2-weighted MRI shows edema in the right ischium, indicating hamstring avulsion at the secondary physis (yellow arrow).B) Sagittal MRI reveals 13mm separation (black double arrow). C) Axial MRI confirms the avulsion, with new bone formation. D-F) 7-months postoperative MRIs demonstrate successful reinsertion and no complications (black arrow).

Surgical Technique

The patient underwent anatomical reconstruction using a transverse subgluteal approach, positioned prone. Dissection and neurolysis of the sciatic nerve adhering to the bone fragment were performed. Due to the avulsion through the growth plate, the use of cannulated screws was avoided, as they could interfere with growth and may fail owing to the small size of the bone fragment. Additionally, their use might necessitate future removal surgery. Instead, an innovative technique similar to that employed for myotendinous injuries in adults was utilized, wherein the fragment was reattached to its original position using two 2.5 mm triple-loaded soft anchors (Versaloop™ Anchor System, DePuy Synthes) under fluoroscopic guidance. The first anchor facilitated accurate fragment reduction by securing it with a Krackow stitch reinforcement, while the second anchor was used to reposition the bone fragment in the ischium by passing the sutures through the tendon rather than the growth plate (Figure 3). Proper reduction placement was confirmed, the surgical site was closed, and an articulated splint with a 30º knee extension lock was applied.

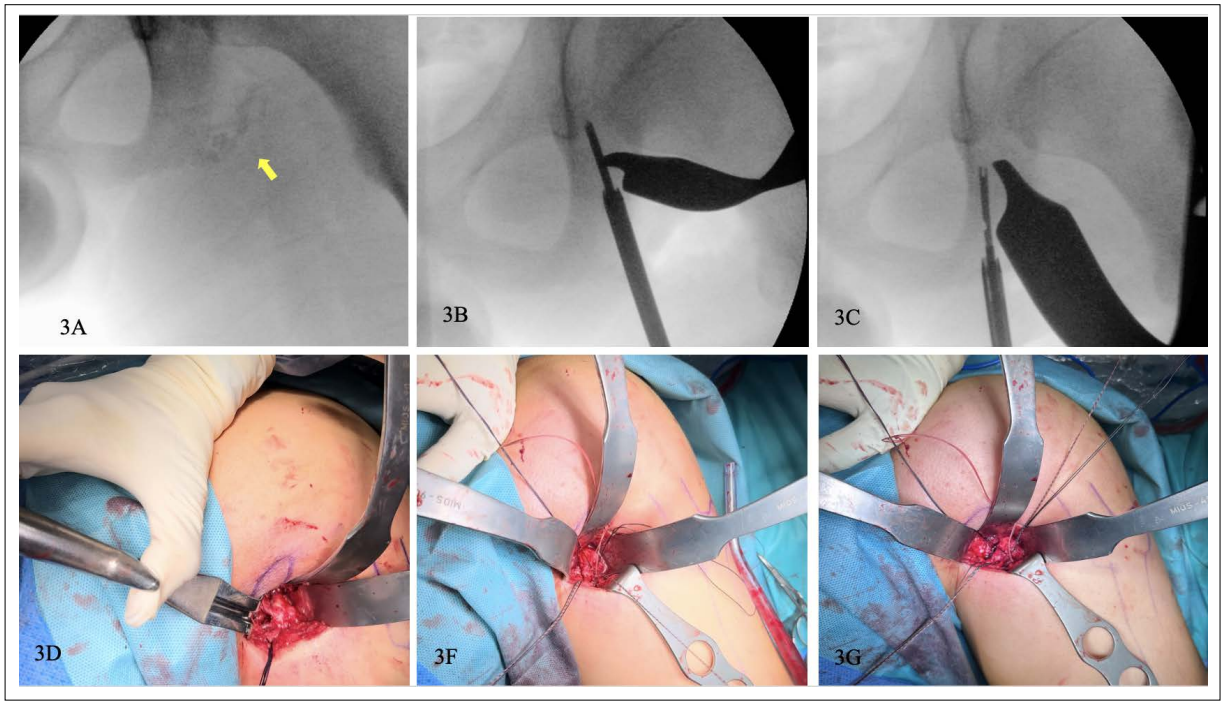

Figure 3: Intraoperative fluoroscopic images show the placement of two Versaloop 2.5mm anchors with triple sutures for hamstring reinsertion. A) An avulsed bone fragment is visible. B-C) Images depict preparation and placement of anchors. D-F) Repair images illustrate suture use to approximate and anatomically reposition the hamstrings.

Rehabilitation Protocol

The rehabilitation protocol started with pain-free active mobility exercises at two weeks and partial weight-bearing (without orthosis) using two crutches at three weeks. During this period, low-load isometric hamstring exercises were implemented. Between the fourth and eighth weeks, closed-chain strengthening exercises were introduced. From the ninth to the sixteenth week, running technique exercises were initiated to prepare the hamstrings for increased speed and acceleration demands. Controlled eccentric exercises, such as the "Nordic Hamstring," single-leg deadlift, and hip extension pulley, along with machine work, weights, and low-intensity plyometrics, were also introduced. From the seventeenth week onward, a progressive return to playing soccer began with specific and personalized drills that increased in speed and load.

Return to Sports and Clinical Outcomes

At three months postoperatively, the patient started a graded return to sports, beginning with running, followed by directional changes, and then integrating ball-handling maneuvers. By six months postoperative, the patient had completely recovered knee range of motion and hamstring muscle strength. Radiographic imaging and MRI confirmed satisfactory progression (Figure 1 and 2). The patient's recovery was monitored at three and six months post-injury using the Perth Hamstring Assessment Tool and the Lysholm-Tegner scale, initially assessed preoperatively. Scores on these assessments increased from 8 to 62, 95, and from 70 to 83, 100, respectively. At six months, maximum knee flexion strength was evaluated, revealing a 10.36% deficit compared to the contralateral limb, measured with dynamometer (ActivForce2™, Activbody) (Figure 4).

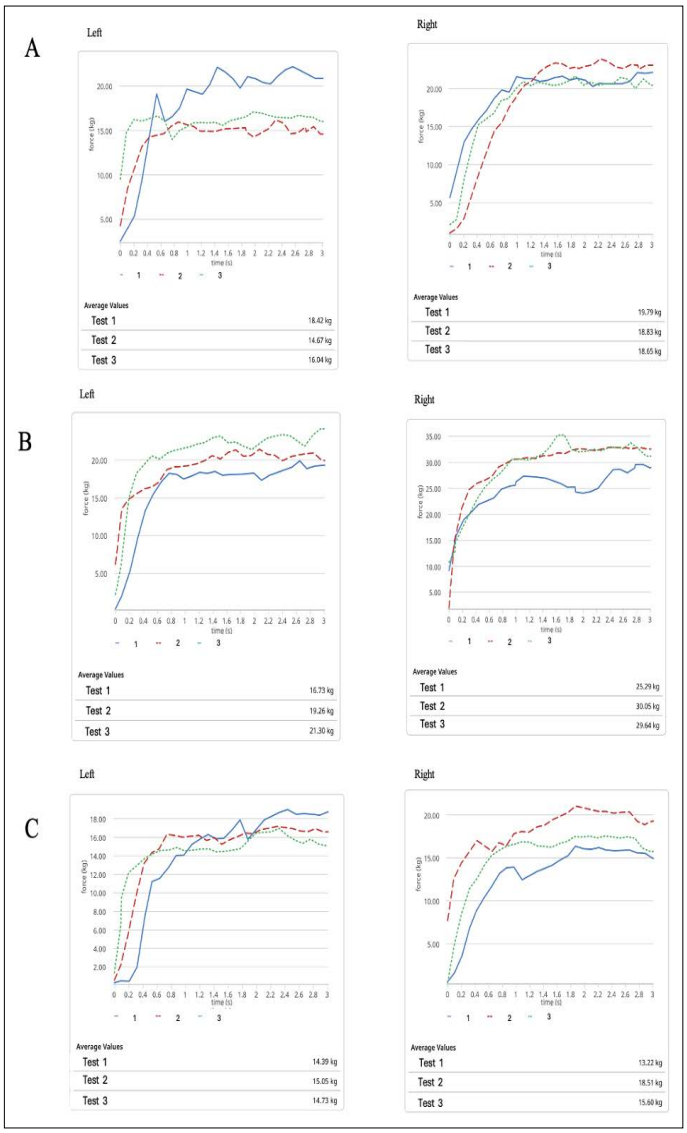

Figure 4: Muscle strength testing results by limb (left and right) using a dynamometer (ActivForce2™ by Activbody) at 7 months postoperatively. A) Hip abduction shows a 7.51% deficit in the left limb. B) Knee extension reveals a 37.56% deficit. C) Knee flexion shows a 10.36% deficit in the left limb.

Discussion

This study highlights that proximal hamstring avulsion through growth plate injuries in young athletes necessitate a thorough and methodical approach to diagnosis, treatment, and rehabilitation.

Pathology and Early Diagnosis

Hamstring avulsion injuries in young athletes present a complex clinical challenge requiring early diagnosis and definitive treatment to ensure optimal recovery and return to sport. Delays in diagnosis and treatment can prolong recovery, increase re-injury risk, and potentially lead to chronic conditions [12]. MRI is considered the gold standard for diagnosing soft tissue injuries and avulsions due to its ability to clearly delineate the extent of muscle, tendon, and bone involvement [13]. Population-based studies underscore the importance of imaging for accurate diagnosis and treatment planning [14, 15].

Surgical Intervention and Rehabilitation

The dichotomy between conservative and surgical management should be based on individualized assessment considering the athlete's level of activity, injury severity, and personal goals [16]. The literature suggests a favourable outcome with surgical reattachment in active young athletes, providing stability and facilitating a quicker return to high-function activities [9, 10].

Surgical reattachment with soft anchors aims to restore the anatomical structure, avoid iatrogenic damage to the growth plate and recover the functional integrity of the hamstrings, crucial for high-level athletic performance. In this case, the use of soft anchors provided the necessary fixation and stability for effective healing avoiding reintervention. Precise surgical techniques are essential to ensure proper reattachment and avoid complications like sciatic nerve entrapment or non-union [1,9].

Tailored Rehabilitation Programs

A well-defined, progressive rehabilitation protocol is indispensable for complete recovery post-surgery. Initial phases focus on pain management and gradual mobilization, advancing to strength training and functional exercises tailored to the sport's demands [17]. Controlled eccentric exercises, proven to enhance muscle-tendon strength and resilience, are crucial in this process [18, 19]. Structured rehabilitation protocols minimize re-injury risk and ensure a safe return to activity [14, 20].

Population-based studies consistently show that tailored rehabilitation programs reduce recurrence risk and improve functional outcomes in athletes [21]. Specific rehabilitation regimens lower recurrence rates of hamstring injuries in professional soccer players [15]. Addressing intrinsic factors such as muscle imbalances and flexibility deficits is critical in rehabilitation programs [2, 20].

Preventive Strategies

Preventive strategies, including tailored strengthening and flexibility exercises, are crucial to reduce the incidence of hamstring avulsion injuries [22]. Educational programs targeting coaches and athletes about appropriate warm-up practices and gradual training load increments can mitigate injury risks [23, 24]. Future research should focus on refining surgical techniques, optimizing rehabilitation protocols, and investigating the long-term outcomes of both surgical and conservative treatments to formulate comprehensive management guidelines [25-28].

Conclusion

Proximal hamstring avulsion through growth plate injuries in young athletes require careful diagnosis and treatment. The innovative surgical technique introduced in this study using soft anchors aims to minimize reinterventions and support an early return to sports. Effective early intervention, combined with tailored rehabilitation and monitoring, promotes optimal recovery and reduces re-injury risk, facilitating a safe return to athletic activities.

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