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Anterior Tibialis Muscle Herniation in a Pediatric Patient

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Abstract

Muscle herniations of the anterior compartment of the lower extremity occur when increasing compartmental pressure forms a fascial defect. This leads to severe pain in the region, preventing those affected from performing activities of daily living. Weak fascia can be congenital, or tears can come from direct trauma. Both can lead to muscle herniation. Anterior tibialis herniations are uncommon, and there is not much present in the literature documenting treatment for pediatric patients. Traditionally, young adult male athletes are most likely to develop this problem due to constitutional weakness of the fascia associated with overuse of the muscle, and penetrating or blunt trauma. [1] [2] The affected region can become painful with physical activity when the muscle herniates. If conservative treatments such as rest, physical therapy, compression (i.e. wearing compression socks) are not successful, patients are directed to surgical treatment. Three options of surgical treatment exist in the literature: fasciotomy, direct repair, or repair with synthetic grafts/mesh. The authors of this paper recommend performing a fasciotomy because this technique prevents the patient from suffering persistent compartment syndrome and negates the possibility of re-herniation. This case study discusses an 18-year-old female who experienced a muscle herniation in the anterior compartment of the right lower right extremity for which she underwent fasciotomy, and then had the same problem on the contralateral side also requiring surgical intervention. This case presentation adds to the literature as there is no visual surgical technique available for pediatric patients undergoing surgical treatment for muscle herniation. The patient is 18 years old, which is within the category considered pediatric by the American Academy of pediatrics and pain started at 16 years of age [3]. Additionally, the bilateral nature of the lower extremity muscle herniations makes this an especially unusual case.

Keywords

Exertional Compartment Syndrome, Fascial Defect, Muscle Herniation,

Fasciotomy

1. Introduction

Myofascial defects leading to muscle herniations are uncommon in females 18 years old and younger. This reduced frequency suggests that muscle herniations in this population are a result of congenital fascial weakness. [1] The deep fascia (**Figure 1**) separates the leg into four separate compartments: anterior, lateral, superficial posterior, and deep posterior (**Figure 2**).

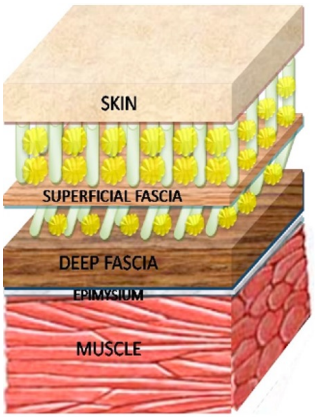

Figure 1. Layers of tissue from deep fascia to skin. [4]

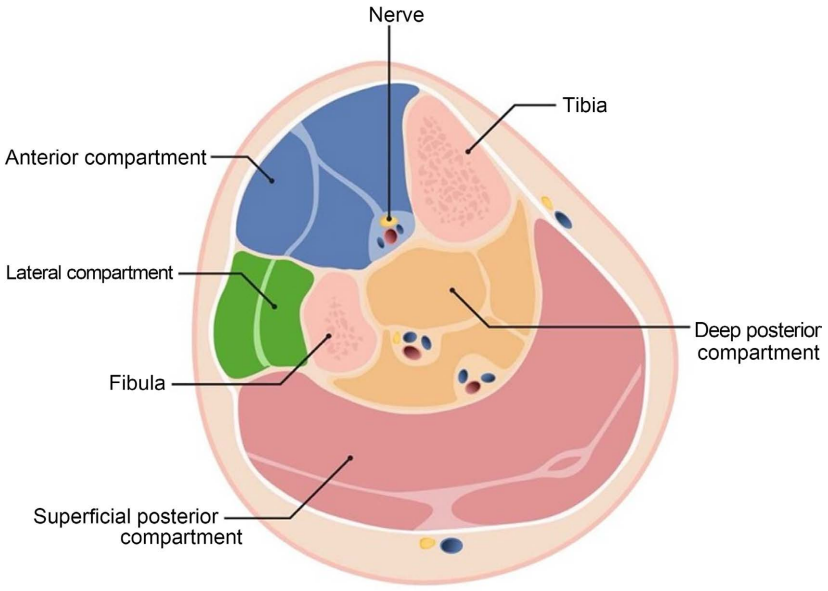

Figure 2. 4 compartments of lower extremity. [5]

People can be born with a weak fascia explaining incidental muscle herniation, or a fascial tear can come from direct trauma. This is often the case for athletes who encounter this problem. [1] Those born with weak fascia and herniation may

feel pain during physical activity, due to the muscle and fat protruding against the fascia. The pain stems from herniation of the fat and muscle or due to growing pressure within the affected compartment. A soft tissue mass may intermittently be present when there is increased pressure during physical activity. [1] Elevated compartmental pressures can lead to exertional compartment syndrome, associated with pain. Diagnosis of exertional compartment syndrome is typically made using criteria available for acute compartment syndrome seen with trauma. Absolute compartment pressure values are elevated to 30 - 45 mm Hg. [6] Previous studies have shown that the average compartment pressure for children ranges from 13.3 mm Hg to 16.6 mm Hg. [7] When pain develops with herniation of muscle seen as a mass located on the extremity, treatment should be explored. Conservative treatment should be employed first, which includes rest, stretching, physical therapy, and wearing compression socks. [2] [8] When conservative treatment fails for patients with moderate to severe symptoms, they should pursue a surgical treatment option. [9] For diagnosis, MRI is often unable to identify muscle herniations because it is a static exam compared with ultrasound, which is dynamic, making it a more reliable method for diagnosis. [1] Muscle herniating through the fascial defect is generally visible with dorsiflexion of the lower extremity, so it is important to use dynamic imaging when looking for muscle herniations and can be missed with static imaging.

In past cases reported in the literature, a fascial defect has been treated with fasciotomy, direct repair, or insertion of a synthetic graft. The fasciotomy is the gold standard for today's treatment of muscle herniations in the lower extremity. [10] Direct repair does not release the compartmental pressure, and the patient may experience compartment syndrome post-operatively, requiring fasciotomy later to release the compartmental pressure. [1] Compartment syndrome is characterized as pain with stretching, paleness, paresthesia, lack of pulse, and sometimes paralysis in the affected compartment of the lower extremity. [4] Repair with a synthetic graft has the potential for infection due to the introduction of a foreign substance in the body. [11] Performing a fasciotomy to completely release the compartment negates the possible complication of recurrent compartment syndrome and has a lower risk of infection because no foreign material is involved. However, there are still risks associated with fasciotomy, with the most common being adhesion and damage to the superficial peroneal nerve (**Figure 3**).

Since this condition is rare among pediatric patients, literature on preferred treatment options is lacking. Prior literature outlines a case study in support of fasciotomies. [10] Support for treatment by both repair and release of the fascia is present in adult literature. The purpose of this manuscript is to review the existing literature regarding pediatric patients and expand on the current literature by adding a video of surgical treatment of fasciotomy for muscle herniation in the anterior compartment of the lower right extremity in an 18-year-old female with bilateral lower extremity herniations and reviewing her complicated clinical course.

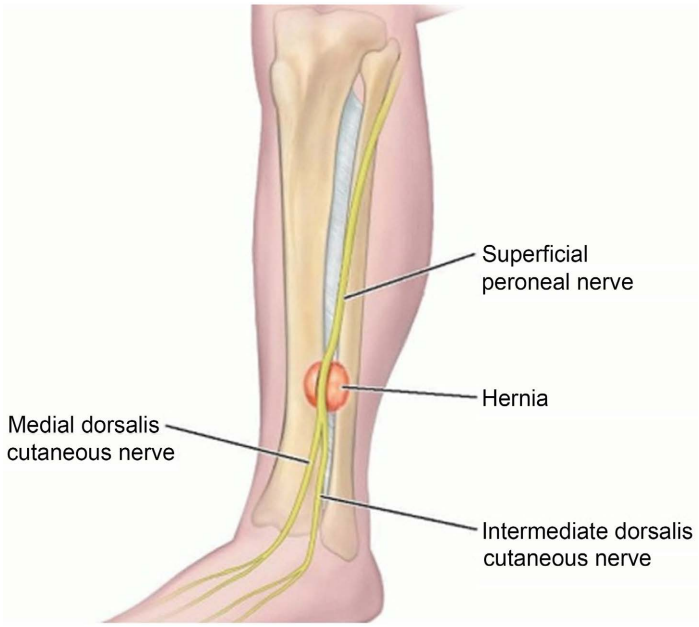

Figure 3. Hernia in anterior compartment of lower extremity compressing the superficial peroneal nerve. [12]

2. Case Presentation

The patient presented as an 18-year-old with a soft tissue mass on the lower right extremity. The mass was just under 1cm in diameter and palpable in the distal third of the anterolateral compartment of the right lower extremity. It had been present for a few years, unchanged in size, and two years prior, pain developed with walking and other physical activity. The pain was severe with any walking, was relieved by rest, and had become progressively worse over time. Although the patient had not tried physical therapy, surgical treatment was recommended because severe pain was present with any physical activity, preventing her from even walking for short periods of time without pain. X-ray obtained at the initial visit was normal. MRI without contrast was performed and did not identify the mass in the affected area. An addendum to the MRI after an ultrasound clearly revealed muscle herniation was later addended to weakly point out the fascial defect (**Figure 4**).

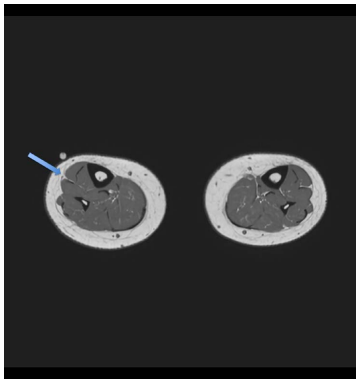

Figure 4. MRI image showing "fascial defect"—Axial T1 FSE image (arrow).

Diagnosis was made with ultrasound (Figure 5), which was able to clearly identify the anterior tibialis muscle protruding through a fascial defect with dorsiflexion. Compartment pressures were not checked due to confirmation of the defect with ultrasound and no complaint of pain in any other compartments of the leg. The procedure chosen for treatment was a fasciotomy.

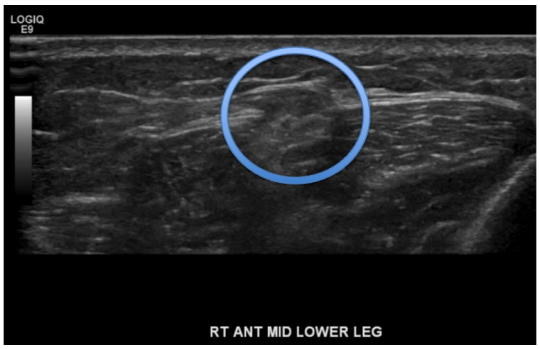

Figure 5. Ultrasound image of right lower extremity showing fascial hernia defect (circled).

Pre-operatively, the leg was marked while the patient was awake, and the mass was circled (Figure 6). After the patient was brought to the OR and put under general anesthesia, the right leg was prepped and draped, and an appropriate time out was performed. The leg was esmarched and a tourniquet was inflated at the thigh. The leg was marked along the tibia tuberosity, tibia spine, and tip of the distal fibula (Figure 6).

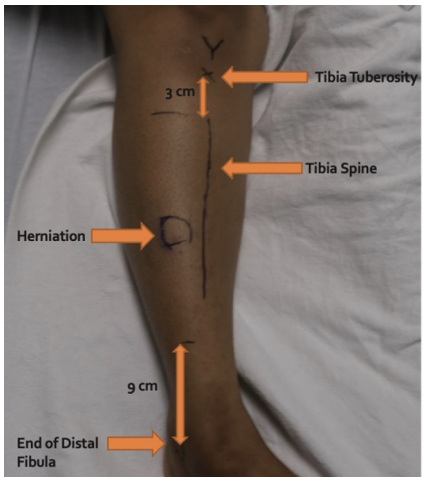

Figure 6. Pre- and intra-operative marking on leg (tibia tuberosity, tibia spine, mass, & tip of distal fibula).

A 4 cm incision was made longitudinally over the mass through the skin. The incision was made as small as possible because the location of the defect was known. Dissection continued down to the fascia. A circular 1 cm defect in the fascia was visible with the anterior tibialis muscle and fat protruding through the fascial defect (Figure 7).

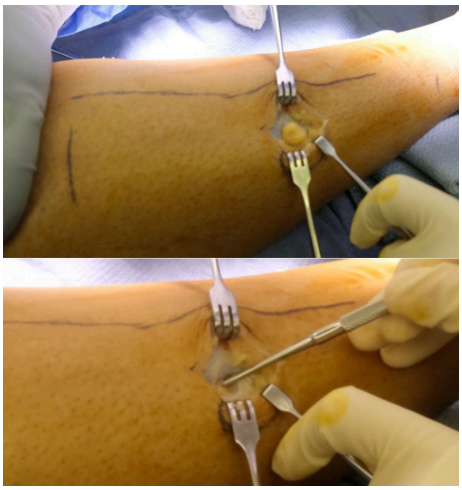

Figure 7. Anterior tibialis muscle protruding through fascial defect in anterior compartment of lower right extremity & Hernia reduced with freer.

Care was taken to look for any neurovascular structures, notably the superficial peroneal nerve (see Figure 3 for anatomical location of superficial peroneal nerve). No neurovascular structures were encountered at any time during the procedure. The area above and below the fascia at the fascial defect was opened with a scissor proximally and released to within 3 cm of the tibia tuberosity (Figure 8, Figure 9. The tissue was loosened and released starting from the herniation distally and ending 9 cm proximal to the distal fibula (Figure 10, Figure 11), completely releasing the anterior compartment.

Figure 8. Fascia is loosened from subcutaneous muscle and fat.

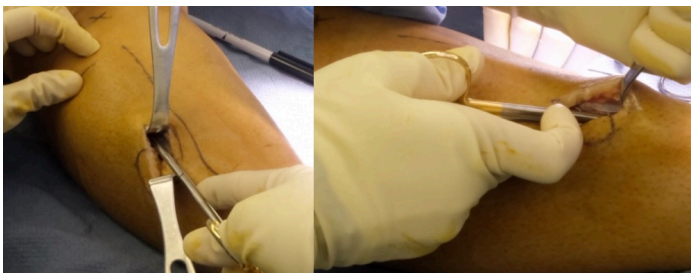

Figure 9. Fascia is released with Metzenbaum scissors anteriorly and distally.

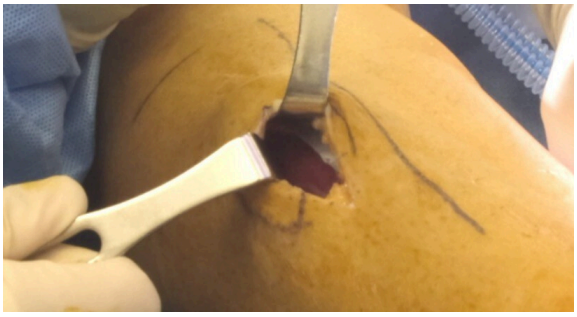

Figure 10. Anterior Tibialis muscle is visible after fascial release.

Figure 11. Anterior Tibialis Muscle formed in circular shape due to herniation through fascial defect.

The skin was closed with subcuticular sutures and then steri-strips were applied followed by the tegaderm dressing. Webril and ace wrap was placed above the knee to the ankle to provide support over the entire area of the fascia release.

3. Discussion

In prior cases of muscle herniations (**Table 1**), there have consistently been three methods of surgical treatment: fasciotomy, direct repair of the fascial defect, and repair of the fascial defect using a synthetic graft/mesh. Directly repairing the fascia exposes the patient to a high chance of muscle re-herniation. [13] With direct repair, the compartmental pressure has not been released and closing the defect can cause the pressure within the compartment to build up again requiring subsequent fasciotomy. Repair of fascia with decreased volume in the compartment can cause chronic compartment syndrome and persistent pain leading to edema and hematoma development, further increasing compartmental pressure. [1] In a severe scenario, necrosis of the anterior tibialis muscle developed in one patient which required an emergency fasciotomy. [8] Complications when using synthetic graft or mesh can involve the introduction of foreign material into the body, which puts the patient at greater risk for developing an infection or rejecting the material. [11] With fasciotomy there is a risk of damage to the superficial peroneal nerve which is in the general vicinity of herniations that develop in the anterior compartment of the lower extremity, which will cause sensory loss in the distal

third of the lower extremity in the anterolateral distribution. In addition, there are potential complications from adhesion between scar and muscle post-operatively. [14] Potential drawbacks of a fasciotomy are an incomplete release resulting in persistent muscle herniation, and an increase in incision size and dissection. [15] Even with these complications in mind, fasciotomy is considered to be the safest surgical option; dissection allows for higher likelihood of identification and protection of the superficial peroneal nerve and fasciotomy treats the herniation by enlarging the defect and therefore decreasing the risk recurrent compartment syndrome or muscle strangulation/ischemia, all of which can result in recurrent or chronic pain. [2]

Table 1. Literature review of prior cases (ages 25 and younger) (years old = yo).

Literature	Age	Symptoms/Diagnosis	Treatment	Results
1) Ultrasound-Guided Fasciotomy for Anterior Chronic Exertional Compartment Syndrome of the Leg [13] 2016	N = 7 18 - 34 yo Mean age: 25.7 yo	Chronic exertional compartment syndrome	Fasciotomy	Median time return to sports was 35 days No reported symptoms related to superficial peroneal nerve damage
2) US diagnosis of pediatric muscle hernias of the lower extremities [1] 2013	N = 16 11 females 5 males 3 - 18 yo Mean age: 13.8 yo	11 patients with anterior tibialis muscle pain 7 patients diagnosed with fascial defect before imaging US diagnosed muscle herniations in 9 Patients	4 - fasciotomy 12 - conservative treatment	Not reported – focus of paper was diagnosis
3. The treatment of muscle hernias by fascial splitting [15] 1976	20 yo male 20 yo female	Failed prior fascial repair Trauma to leg causing tear over anterior tibialis muscle	Fasciotomy Fasciotomy	Complications from scar and muscle adhesion
4) Primary repair of symptomatic lower leg Fascial Defect [10] 2022	14 yo male	Fascial defect of anterior tibialis with muscle herniation Paresthesia and numbness	Direct repair	Pain and tingling resolved post-op week 6 Returned to sports post-op week 10
5) Compartment Syndrome Following Directly Repair of Hernia of Anterior Tibialis [4] 2015	20 yo male	Painful mass MRI confirmed diagnosis of anterior tibialis muscle herniation	Direct repair	Intense pain and weakness in wound 24 hours after surgery 48 hours after surgery wound was reopened and had fasciotomy Necrosis of the anterior tibialis muscle was noted

Continued

6) Double layer repair of tibialis anterior muscle hernia in a soccer player: A case report and review of the literature [5] 2015	17 yo male	Direct trauma playing soccer US confirmed anterior tibialis muscle herniation	Primary repair reinforced by double-layer mesh graft	Pain significantly reduced post-op week 12 and returned to physical activity
7) Painful bilateral herniation of the anterior tibial muscle: A case report [2] 2006	23 yo male	Pain developed bilateral separate masses from anterior tibialis herniation when running Right proximal and distal defect Left defect	Direct repair and mesh right defects and mesh only left side	Returned to ADLs 12 months after procedure
8) Repair of tibialis anterior muscle herniation using periosteum [8] 2006	20 yo female	US imaging identified anterior tibialis muscle herniation	Repair with periosteum graft	Full weight bearing post-op week 4 No pain and complete return to activities 12 months after procedure

4. Conclusions

The patient healed uneventfully after fasciotomy for right muscle herniation in the anterior compartment of the lower extremity without complication (**Figure 12**). Pain disappeared after 6 weeks. At this same post-operative appointment, she complained about similar pain in the left leg, that had been ongoing for 4 weeks now that she was more active. Dynamic ultrasound of left lower extremity was normal. Compartment pressures were tested. Compartment pressures need three pressure measurements and must meet 1 of the following requirements to be diagnosed with compartment syndrome: Resting pre-exercise ≥15 mm Hg, 1 min post-exercise ≥30 mm Hg, or 5 min post-exercise ≥20 mm Hg. High compartment pressures were found in anterior and anterolateral compartments (**Table 2**) confirming the diagnosis of compartment syndrome in the left lower extremity.

Figure 12. Patient wound post-op week 2.

Table 2. Patient's intracompartmental pressures of left lower extremity 2 months after right sided procedure. Anterior and lateral compartment pressures meet criteria for diagnosis of compartment syndrome (bolded).

Compartment	Pressure (mm Hg) Pre-exercise	Pressure (mm Hg) 1 min post-exercise	Pressure (mm Hg) 5 min post-exercise
Anterior	23	30	11
Lateral	25	35	33
Superficial Posterior	9	20	14

Patient had surgical release of both anterior and lateral compartments for these complaints 3 months after the surgery on the right side. During surgery, a 5 mm defect in the fascia with anterior tibialis muscle/fat herniation was discovered in the anterior compartment (**Figure 13**, **Figure 14**). Anterior and lateral compartments were both released and superficial peroneal nerve was seen and protected in the lateral compartment (**Figure 15**). A larger incision was used for release, to allow visualization of the nerve and to release both lateral and anterior compartments (**Figure 15**). Findings at surgery reveal that using ultrasound to find herniations is not foolproof when the defect is small and demonstrated the importance of pursuing compartment checks prior to surgery because multiple compartments may be involved.

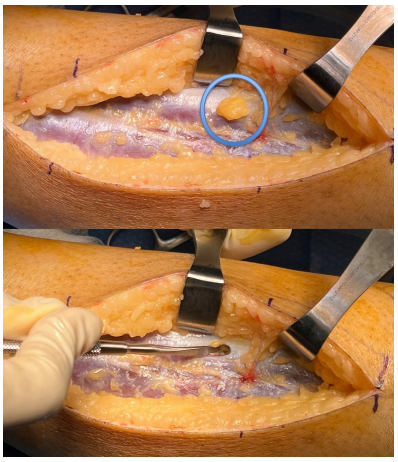

Figure 13. 5 mm defect in the anterior fascia with fat protruding.

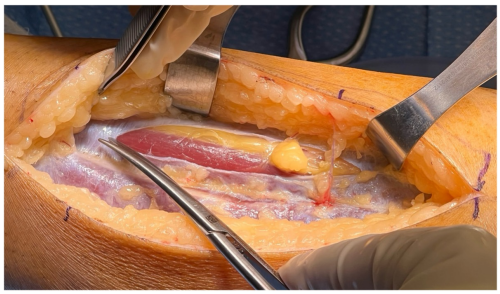

Figure 14. Fascia released within 3 cm of the level of the tibia tuberosity and 10 cm proximal to the fibula.

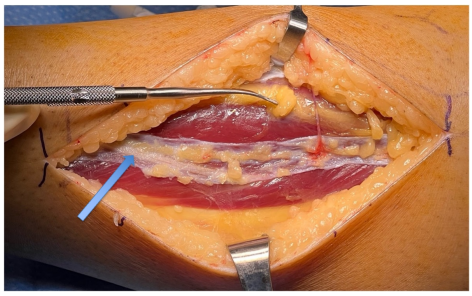

Figure 15. Lateral compartment released the same distance, and the superficial peroneal nerve is protected (arrow).

Following compartment release for anterior and lateral compartments on the left, the patient experienced complete resolution of pain on the left. Given this symptomatic improvement she was able to start walking and moving more, which triggered an aching pain to start in the right calf. There was consideration at this time for working her up for additional exertional compartment syndrome on the right side, but after undergoing gastric bypass surgery for morbid obesity and losing weight as a result of gastric bypass surgery, the aching pain on the right resolved. Resolution of symptoms suggests that weight loss following gastric bypass surgery likely relieved pressure in lower extremity compartments, allowing patient to be more active without pain.

Laparoscopic sleeve gastrectomy was performed 8 months after the right anterior compartment release and 5 months after the left anterior and lateral compartment release. One year after initial surgery, the patient had full range of motion and strength of both legs. Both scars were well healed. The patient had no complaints and was able to walk and run without pain.

Fasciotomy is the preferred method of treatment because compartmental pressure is expected to remain low in the future without recurrence of herniation. The patient will be monitored for cosmetic complications in the future related to adhesions between the scar from the wound and the tissue in the region where the fascia was released. Presently, there appear to be no videos documenting the surgical technique using fasciotomy to release muscle herniation in pediatric patients. The most recent article is from 2016 which was a retrospective study. [1] Paper 7 from the literature review (**Table 1**) indicates that previous cases of bilateral hernias in the anterior compartment of the lower extremity have only been treated by direct closure and mesh repair. Fasciotomy is a reliable procedure for muscle herniations in the anterior compartment of the lower extremity in pediatric patients. Because lower extremity muscle herniation in the pediatric population is a relatively rare occurrence, more cases need to be documented in the literature for there to be consensus on optimal surgical technique.

5. Clinical Message

An important clinical note from this case is that one cannot fully depend on a single mode of technology for diagnosing patients and in fact, normal imaging

may be misleading. The initial muscle herniation was missed by MRI and could not be fully explained without ultrasound. In fact, the patient had surgery for the herniation of the right lower extremity prior to testing compartment pressures because the defect was clearly seen on ultrasound. If compartment pressures had been checked prior to surgery, additional compartments may have been elevated, which would have changed the procedure to include release of additional compartments. The second leg presented with pain, but no obvious herniation on ultrasound, which triggered measurement of compartment pressures. Elevated compartments necessitated release of both anterior and lateral compartments at which time the muscle herniation was appreciated. This patient likely had congenitally weak fascia, which was further weakened by obesity, also leading to elevated compartment pressures. In conclusion, clinicians should not rely on a single imaging modality to diagnose muscle herniation and whenever possible, should perform testing of compartment pressures prior to surgery for muscle herniation or whenever exertional compartment syndrome is suspected.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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