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Case Report

Pediatric Forearm Muscle Herniation Treated With an Acellular Dermal Allograft

Shelby R. Smith, MD, * Tyler A. Luthringer, MD, * Monica Kogan, MD, * Xavier Simcock, MD *

* Department of Orthopaedic Surgery, Rush University Medical Center, Chicago, IL

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Muscle herniations occur through acquired fascial defects in the lower extremities; upper-extremity herniations are rare. The affected patients are typically adult men engaging in strenuous exercise or with injury; pediatric cases are infrequent. We a pediatric patient with a symptomatic, forearm herniation treated with fascial defect closure using an acellular dermal allograft. This case report highlights not only the presence of this rare condition in pediatrics but also a safe and viable treatment option for this patient population. The patient presented with pain and soft-tissue swelling of the forearm, was diagnosed with muscular herniation, and was surgically treated with fascial defect closure using an acellular dermal allograft. All symptoms resolved, without the recurrence of herniation and with return to sport. Upper-extremity muscle herniations are rare but should be considered in pediatric patients following trauma/surgery and can be treated successfully with acellular dermal allografts.

Muscle herniation involves muscle protrusion through an acquired or congenital fascial defect. The causes of acquired fascial defects are trauma, strenuous exercise, or iatrogenic. This is more common in the lower extremities; upper-extremity muscle herniation is relatively rare, and as few as 30 cases have been reported in the literature.[1–8] The infrequency of this diagnosis may be related to absent or mild associated symptoms. These symptoms, if present, include soft-tissue swelling, pain, and cramping. Pain and size of the herniation may be provoked by elbow, forearm, and wrist motion as the muscle herniates through the defect during contraction. Rarely, herniation may irritate local traversing nerves, resulting in paresthesia or hypesthesia. The diagnosis can be made clinically, using ultrasound, or with magnetic resonance imaging (MRI).[9]

Nonsurgical management of muscular hernias includes reassurance, observation, and physiotherapy. Muscular hernias that fail nonsurgical treatment may be treated surgically in the form of primary repair, reconstruction, or release of the remaining fascia. Primary repair may not be possible in the setting of large defects or difficulty mobilizing the local fascia; secondary reconstruction may be a viable alternative option. Successful reconstruction with local or distant fascial flaps, mesh grafts, and acellular dermal matrixes has been reported for upper-extremity muscle herniations.[4–7] However, there are no reports of treatment of symptomatic volar forearm muscle herniation with acellular dermal allografts in pediatric patients. We report a case of median neurolysis and reconstruction of a volar forearm fascial defect with an acellular dermal allograft in a pediatric patient and review of the literature regarding this rare clinical scenario.

Case Report

A 10-year-old healthy female sustained a closed right both-bone forearm fracture due to a gymnastic injury. Because of displacement and unacceptable alignment of the radius, the patient was indicated for open reduction internal fixation by a pediatric orthopaedic surgeon (M.K.). Successful open reduction and flexible intramedullary nailing of the radius were performed 3 days after the date of injury. During the surgery, the interval between the flexor carpi radialis and brachioradialis was used to identify and reduce the radial shaft fracture. The patient was immobilized in a cast for 6 weeks after the surgery, with uneventful and appropriate fracture healing. The patient underwent removal of a flexible nail at

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Corresponding author: Shelby R. Smith, MD, Department of Orthopaedic Surgery, Rush University Medical Center, 1620 W. Harrison St., Chicago, IL 60612.
E-mail address: shelby_smith@rush.edu (S.R. Smith).

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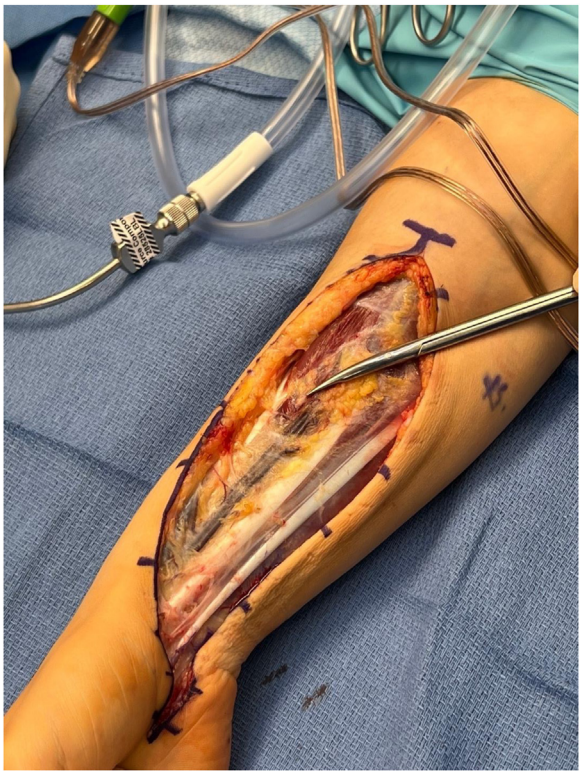

Figure 1. A 5-cm fascial defect between the brachioradialis and deep flexor muscles.

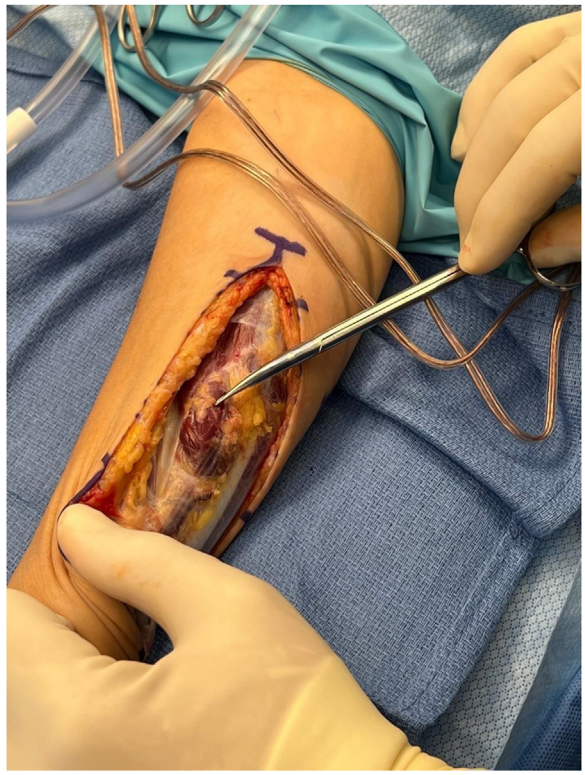

Figure 2. Dynamic herniation of the muscle belly in pronation.

the distal radius 8 months after the primary surgery, with full range of motion at that time.

Two and a half years following the initial surgery, the patient represented to the treating surgeon (M.K.) for a soft-tissue mass in the volar forearm along the prior surgical incision. The soft-tissue mass had grown progressively larger over a span of months, causing pain in the area with flexion and extension of the wrist during gymnastics. Magnetic resonance imaging of the forearm yielded unremarkable results, with no identifiable muscle herniation. The patient was referred to a fellowship-trained hand and upper-extremity orthopedic surgeon (X.S.) for further evaluation and treatment. Physical examination revealed a 2–3-cm volar soft-tissue mass along the prior incision that increased in size with forearm pronation and wrist flexion. Paresthesia in the median nerve distribution was elicited with compression of the mass. Continued nonsurgical treatment versus median nerve neurolysis and fascial defect reconstruction were discussed. The patient failed a 7-week trial of nonsurgical treatment and ultimately elected to proceed with surgery 5 years following her initial fracture fixation. The pre-existing volar forearm incision was extended, and median neurolysis was performed distally from the carpal tunnel to the antecubital fossa. A 5-cm fascial defect was identified between the brachioradialis and the deep flexor muscles (Fig. 1). Intraoperative forearm pronation demonstrated pronator teres herniation through the fascial defect that resolved with full supination (Fig. 2; Video 1). Because of the size of the defect and limited local donor tissue, an acellular dermal allograft (ArthroFLEX; Arthrex, Inc) was contoured and sutured in a simple, interrupted fashion with a 2-0 braided, absorbable suture (Vicryl, ETHICON, Raritan, NJ) using an inlay technique (Fig. 3). Following reconstruction, the muscular herniation provoked by pronation resolved (Fig. 4; Video 1). The subcutaneous tissue and skin were closed in layers using Monocryl (ETHICON, Raritan, NJ). A volar-based splint was maintained for 7 days, and then, the patient was transitioned to a volar-based orthoplast splint with initiation of physical therapy. After the surgery, the patient had complete resolution of the muscle herniation, pain, and median nerve symptoms. At the time of follow-up 6 weeks after the surgery, all symptoms resolved, with no recurrence of herniation, and the patient returned to gymnastics. Written informed consent was obtained from the patient and guardian for the publication of this case report and its accompanying images.

Discussion

Lower-extremity muscle herniations are far more common than upper-extremity muscle herniations, which can be explained by higher baseline intracompartmental pressures with standing, walking, and exercise.[10] Muscle herniations are often noticeable but typically asymptomatic; however, symptoms may progress to pain and cramping during exercise as the muscle herniates along the fascial edge during contraction. Olch and Watson[2] reported two requirements for symptoms to occur in forearm muscle herniations based on anatomic location. Proximally, the fascial defect must overly the muscle and not tendon. The distal aspect of the fascial defect must also allow the proximal edge of the muscle to migrate against the fascial edge during contraction, which elicits inflammation and pain.[2] Paresthesias and hypesthesia in the distribution of traversing nerves in the region of fascial defects are infrequently reported. This finding was apparent in a case presented by Khalid and Mah,[3] with a positive Tinel sign and altered sensation in the median nerve distribution as a result of muscle herniation. This finding was also present in our patient, specifically, paresthesia of the median nerve distribution with compression of the herniation, which resolved after the surgery.

Advanced imaging modalities for the workup of muscle herniations include ultrasound and MRI. Dynamic imaging studies

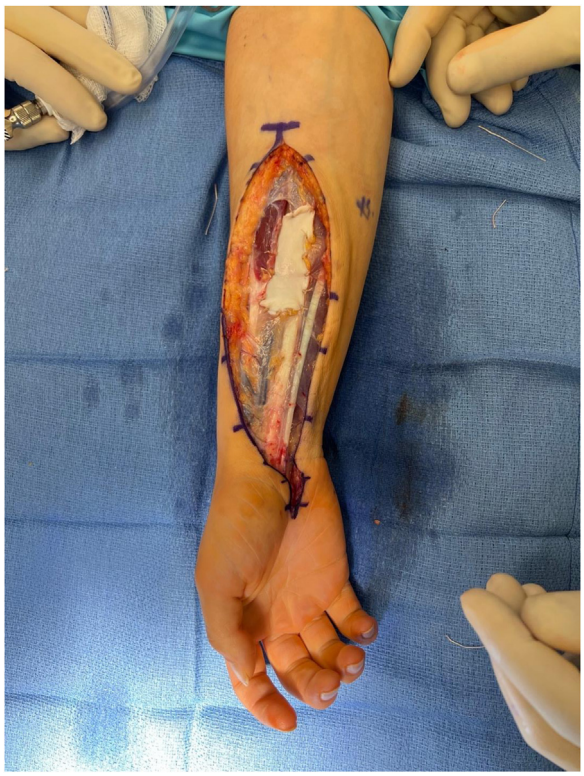

Figure 3. Repair of the fascial defect with an acellular dermal allograft using the inlay technique.

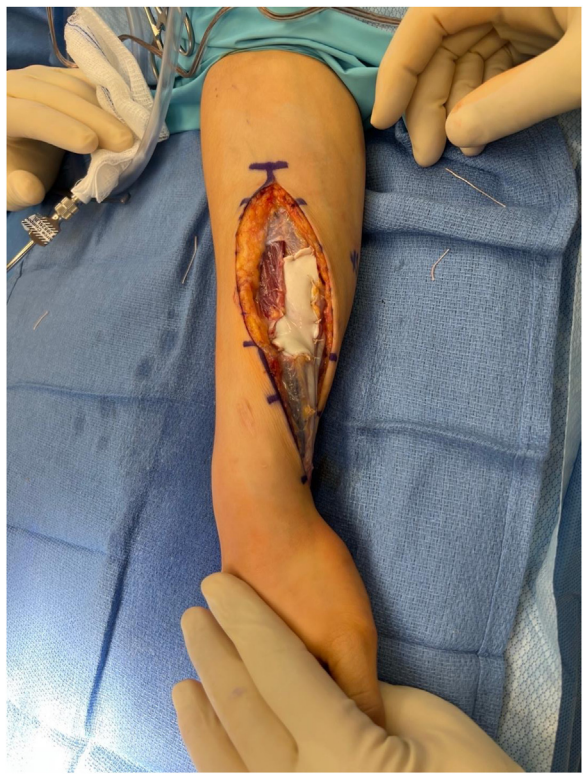

Figure 4. Resolution of muscle herniation in pronation following fascial reconstruction.

can assist with diagnosis in patients with vague or occult findings. Dynamic ultrasound is available at low costs; however, its reliability is user dependent. Kendi et al[9] demonstrated that dynamic MRI could also be used to determine the size of muscle herniation and extent of fascial defects. Interestingly, MRI did not demonstrate a muscle herniation in the presented case. During surgery, however, muscle herniation was observed to occur in pronation and resolve in supination. This clinical scenario emphasizes the value of dynamic MRI because it is not uncommon for muscle herniations to occur only with contraction of the affected muscle belly.

The majority of muscle herniations can be treated with rest, compression wraps/sleeves, and physiotherapy. Surgical options that fail nonsurgical management include fasciotomy, direct closure, local and distant fascial flaps, or defect closure using grafts.[2] Primary repair is simple and ideal for small defects; however, it may increase the risk of compartment syndrome.[2,8] Olch and Watson[2] demonstrated that treatment with fasciotomy alone for forearm herniation resolved symptoms in less than half of the included patients ($n = 3/7$, 43%). Although fasciotomy is a reliable option for the lower extremities, outcomes are less predictable in the upper extremities and may be cosmetically unappealing.

Local fascial flaps can be harvested and mobilized for small defects in areas with expendable donor tissue.[7] Autogenous tissue can be harvested from distant donor sites (ie, fascia lata or palmaris longus tendon) for defect closure.[1,3] Different techniques have been described for the use of fascia lata, including both inlay, onlay, and wrap-around, with successful results in individual cases.[3] The disadvantage of autogenous tissue harvest is donor site morbidity, which we believe should be avoided when possible, especially in the pediatric patient population, as in our case.

The use of allograft or synthetic material has been successful in upper-extremity herniations in a small number of cases.[4–6] The safety profile of acellular dermal allografts has been established in humans, and their utilization continues to grow across many surgical subspecialties. Acellular dermal allografts are widely available and can be used successfully for both large and small fascial defects to avoid donor site morbidity.[4] For these reasons, we chose to use an acellular dermal allograft to reconstruct the defect, provided this was a small, isolated fascial defect.

The benefit of using acellular dermal allografts in isolated defects allows for smaller incisions, less dissection, and minimal morbidity in pediatric patients. Treating muscle herniations with fasciotomy for smaller, isolated fascial defects requires an increase in incision size and dissection, which may not be ideal for this population. Incomplete release of the fascia in an effort to minimize dissection may result in persistent or recurrent muscle herniation. Furthermore, cosmetically unappealing muscle herniation may remain or become more apparent following fasciotomy alone. Although fasciotomy would be cost-efficient compared with acellular dermal allografts, we believe that the increased morbidity associated with fasciotomy in smaller, isolated defects, including incomplete release, persistent herniation, and larger incision justifies the use of grafts.

Many novelties exist in the presented case. The majority of upper-extremity muscle herniations reported in the literature are cases in adult men following strenuous activity or injury. Very few reports of pediatric upper-extremity muscle herniations exist. To our knowledge, we present the first case of pediatric muscle herniation that was successfully reconstructed using an acellular dermal allograft. The use of grafts for pediatrics is valuable in isolated defects to minimize morbidity associated with other techniques. The patient achieved resolution of symptoms, demonstrating this technique as a viable option for pediatric patients with symptomatic, volar forearm muscle herniations.

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