Journal of Hand Surgery Global Online 4 (2022) 295–298

Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Case Report

Repair of Subacute Intrasubstance Rupture of the Biceps Brachii in a 16-Year-Old Patient

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A R T I C L E I N F O

Article history:
Received for publication October 3, 2021
Accepted in revised form May 31, 2022
Available online June 20, 2022

Key words:
Arm injuries
Muscle rupture
Pediatrics

A 16-year-old boy sustained a complete, closed, intrasubstance rupture of both heads of the biceps brachii after a rope swing accident. The patient was managed with open direct repair of the muscle belly. After the surgery, he underwent an extensive physical therapy regimen and regained full range of motion and strength. To our knowledge, this is the youngest reported case of a subacute intrasubstance rupture of the biceps brachii muscle treated surgically in the literature. There is no consensus in the literature regarding the optimal management of these injuries. Given the satisfactory outcome, we suggest that open direct repair of the muscle belly is a reasonable option for the pediatric population.

Traumatic, closed, intrasubstance ruptures of the biceps brachii are uncommon because most injuries are located at tendinous insertions. The case reports of this closed muscle belly injury date back to the early 1900s.[1] The most commonly reported mechanism for closed, intrasubstance rupture is static line injury by parachutists, described as a sudden, localized force on the anterior upper arm.[2] Biceps ruptures lead to bulging of the muscle because of loss of tension, which creates a cosmetic and visible defect in the arm, often referred to as the “Popeye” deformity. Injuries tend to occur in the third and fourth decade of life.[3] The treatment of these injuries ranges from nonsurgical management to surgical repair. Most descriptions of surgical repair occur in the acute period after injury, and there are very few reports of subacute or chronic injuries treated surgically.[2,3] To the best of our knowledge, there is no documented case of subacute intrasubstance rupture of the biceps brachii muscle in patients younger than 18 years. We present the case of a 16-year-old patient with a subacute intrasubstance rupture of the biceps brachii muscle, which was treated with direct surgical repair.

Case Report

A 16-year-old boy presented to our office 18 days after his right upper arm became entangled in a rope swing while jumping off it. He noted an immediate associated deformity of his upper arm. The medical history was otherwise unremarkable. He was a high school student and did not participate in organized recreational sports. His examination was significant for a superficial abrasion around his upper arm (Fig. 1) and a visible defect in the muscle belly. His elbow rested in a flexed position, with significant pain with any attempted elbow extension, which was limited to 70° passively. He had preserved sensibility in the upper extremity. His distal pulses were palpable. Plain radiographs demonstrated no fracture. Magnetic resonance imaging of his right upper arm demonstrated an intrasubstance rupture of the biceps brachii with a 6-cm gap (Fig. 2).

Before presentation to our clinic, 2 hand surgeons had recommended nonsurgical treatment with a cast. At his initial visit to our clinic, the patient and his family were counseled that the literature suggests that nonsurgical treatment would likely result in a 50% decrease in flexion strength.[2] Given that the patient’s injury had occurred 18 days prior, he was significantly beyond the 3-day time period for acute injury characterized by Heckman and Levine,[2] likely making its repair more difficult. Despite no longer being in the acute phase of injury, the patient continued to have significant pain and difficulty moving his elbow. He and his family desired intervention. The risks and benefits of surgical repair were discussed, including wound breakdown, infection, nerve injury, and

Declaration of interests: No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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https://doi.org/10.1016/j.jhsg.2022.05.013

Figure 1. A preoperative photograph demonstrates a linear abrasion on the patient's upper arm from a rope swing.

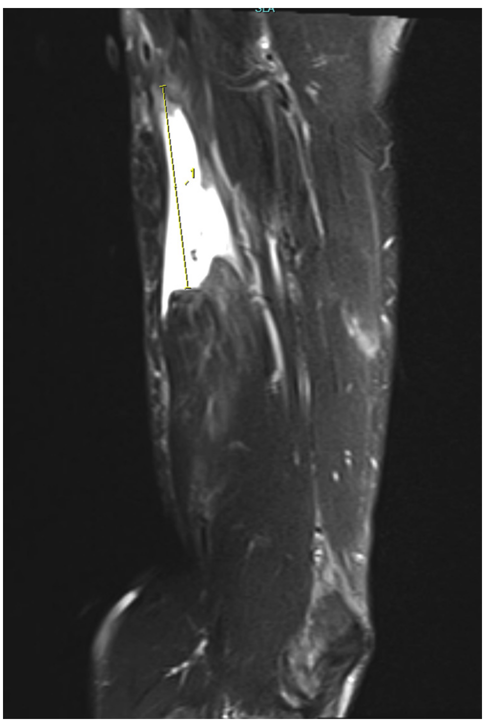

Figure 2. A T2 sagittal magnetic resonance image of the upper arm demonstrates an intrasubstance biceps brachii muscle rupture with a 6-cm gap.

rerupture.[3] The patient and his parents wished to proceed with surgical repair in an attempt to avoid the cosmetic and functional deficits associated with nonsurgical management.

The patient was taken to the operating room 21 days from the date of the injury. He was positioned supine on the operating table, and a curvilinear incision was made on the anterior aspect of his arm. Skin flaps were developed medially and laterally. The plane between the biceps brachii and the brachialis was entered laterally. The lateral antebrachial cutaneous nerve was identified and traced proximally until a branch of the musculocutaneous nerve to the brachialis and biceps brachii was visualized (Fig. 3). The epimysium was incised, which exposed the gap in the muscle belly (Fig. 4). Early fibrous tissue was noted in the gap, which was excised to facilitate end-to-end repair. A bone marrow aspirate concentrate (BMAC) was obtained from the exposed humeral shaft using a

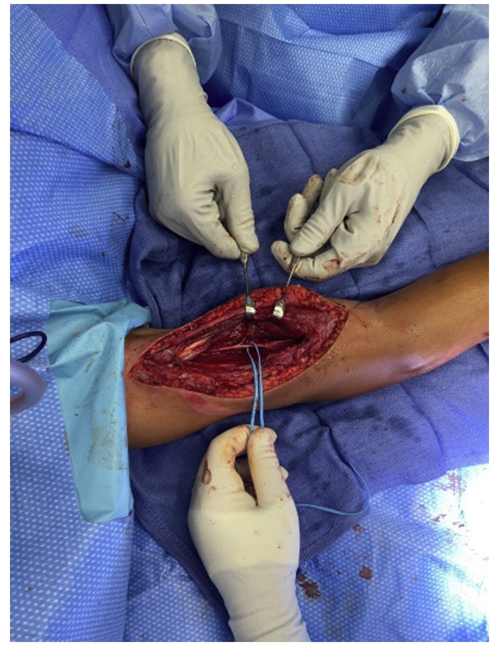

Figure 3. During surgery, the lateral antebrachial cutaneous nerve was identified and traced back to the musculocutaneous nerve (identified with the blue vessel loop in the photograph).

Figure 4. A complete rupture of the muscle belly of the biceps brachii.

Jamshidi needle. The elbow was flexed to approximately 90°, and #2 and 0-Prolene sutures were used to reapproximate the muscle belly. The suture configuration consisted of a Bunnell stitch in conjunction with a perimeter Krackow stitch to avoid the pullout of the sutures (Fig. 5). Then, BMAC was injected into the repair site. The skin was closed, and the patient was placed into a posterior slab plaster splint with the elbow flexed to 100°.

The patient was seen 7 days after the surgery, when he was transitioned into a long-arm cast at 100° elbow flexion. He was transitioned to a hinged elbow brace at 4 weeks after the surgery.

Figure 5. Suture repair of the biceps brachii muscle rupture with a polydioxanone suture placed in a Bunnell stitch configuration in conjunction with a perimeter-running locking stitch to prevent pullout of the sutures.

Figure 6. A clinical image 1 year after surgery demonstrates no Popeye deformity.

Physical therapy consisting of passive and active-assist range of motion exercises was initiated. Increasing the extension from 90° to 60°, 30°, and 0° each week was allowed over the next 4 weeks. At 8 weeks, he had a range of motion of 30°−140°, with full pronation and supination, compared with that in the contralateral extremity. At 15 weeks after the surgery, the range of motion improved to 0°−140°. He began strengthening exercises, and the use of the brace was discontinued. At 6 months, the patient was released to full activity without restrictions. At 1 year, the patient completed the Disabilities of the Arm, Shoulder, and Hand questionnaire, which scored 0, reflecting no disability. An examination revealed no residual deformity (Fig. 6). Repeat magnetic resonance imaging of the arm demonstrated a healed biceps brachii muscle (Figs. 7, 8). Written informed consent was obtained from the patient and his parents for the publication of this case report and accompanying images.

Figure 7. A sagittal magnetic resonance image 1 year after surgery demonstrates the intact biceps brachii muscle belly.

Discussion

The regenerative capacity of muscle after transection is limited, and fibrosis of the damaged muscle is likely.[4] Muscle regeneration proceeds through predictable, time-dependent stages, which peak at 2 weeks after injury and decline thereafter.[5] Fibrosis begins 2 weeks after injury.[5] Minimizing fibrosis after muscle injury is paramount to improving muscle function after the injury.[5] The methods to minimize fibrosis include the following: (1) decreasing the volume of the defect and (2) augmenting the regenerative potential of the muscle using biological factors.[5]

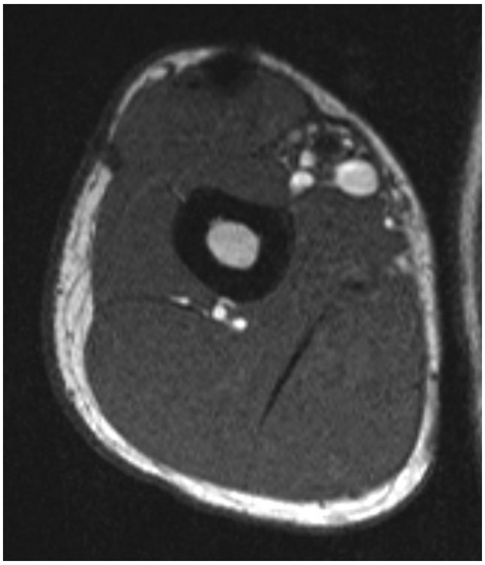

Figure 8. A coronal magnetic resonance image 1 year after surgery demonstrates the intact biceps brachii muscle belly.

Compared with the surgical apposition of tendinous injuries, the surgical apposition of intramuscular injuries is technically challenging because of the lack of reliable suture fixation.[4] Multiple suture techniques have been reported in the literature, with no consensus on the best method.[2,6] All reports of biceps brachii repair used nonabsorbable sutures.[2,3,6,7] Kragh et al[8] demonstrated that repair should include the endomysium, epimysium, and perimysium to improve the tensile strength of the repaired muscle. He et al[9] found that multiple core stand suture techniques had superior pullout strength in a rabbit gastrocnemius model, especially when suture techniques were combined. Our patient underwent direct repair using Bunnell sutures through the endomysium, epimysium, and perimysium. This repair was augmented with a perimeter Krackow stitch to decrease the risk of the failure of the Bunnell suture.

Many biological adjuncts have been described in the literature to improve the regenerative potential of skeletal muscle.[4] The use of biological scaffolds and recombinant proteins to prevent muscle fibrosis has also been described; however, these techniques are not widely available because of their cost and the lack of clinical evidence.[4,5,10] A recent study suggested that bone marrow mesenchymal stem cells are beneficial for promoting muscle regeneration and preventing fibrosis.[10] In our practice, BMAC is widely available and used for numerous orthopedic applications. Based on the recent literature, we injected BMAC into the injury site once the repair was completed. We chose to obtain BMAC from the humeral shaft to avoid donor site morbidity. However, this theoretically decreases the concentration of stem cells compared with when it is obtained from the iliac crest because of the decreased volume of the bone marrow.[11] However, to our knowledge, there are no studies comparing the concentration of mesenchymal stem cells obtained from the humeral shaft with that of mesenchymal stem cells obtained from the iliac crest.

There is relative paucity of evidence regarding the treatment of intrasubstance ruptures of the biceps brachii, especially involving pediatric patients and subacute injuries. Heckman and Levine[2] reported a series of 20 surgically and 28 nonsurgically treated cases. All surgical repairs were performed within 3 days of injury.[2] The surgically treated patients had an average elbow flexion strength of 76% after the surgery relative to that on the uninjured side, whereas the nonsurgically treated patients had an average flexion strength of 53%.[2] Kragh and Basamania[6] reported a series of 9 surgically and 3 nonsurgically treated cases of rupture of the intrasubstance biceps. At 2 years, the surgically treated patients had higher satisfaction scores and improved supination strength compared with those treated nonsurgically.[6] Salmons et al[7] reported the surgical repair of a biceps transection after 6 months of conservative management. At 11 months after surgery, the patient had a range of motion of 15°–150° in the elbow.

Another factor to consider is the potential for injury to the musculocutaneous nerve, both from the original injury and from iatrogenic causes. Salmons et al[7] described a case of compression of the musculocutaneous nerve after an intrasubstance rupture of the biceps brachii, which resolved after the surgical repair of the muscle belly. Heckman and Levine[2] demonstrated temporary, abnormal electromyography results for the biceps brachii in 7 of 9 patients, suggesting that the contusion of the nerve is common. Iatrogenic injuries to the nerve are possible during surgical repair, and thus, it is essential to identify and protect the musculocutaneous nerve before suture fixation of the muscle. If injured, the denervation of the biceps brachii muscle would impair the functional results of surgical repair and alter the rehabilitation course.

In conclusion, our patient sustained a rare intrasubstance biceps brachii muscle rupture, presented in a subacute fashion, and was successfully treated with direct end-to-end repair. To our knowledge, this is the first reported pediatric case of this type of injury. While evaluating patients with similar injury mechanisms, the upper extremity surgeon must have a high index of suspicion for this type of injury. Our case demonstrated that satisfactory results can be obtained from the surgical repair of this type of injury and can be considered by the evaluating surgeon.

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