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Wakeboarder's arm - complete tear of the short head of the biceps brachii and coracobrachialis: a case report and review of the literature

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Injuries involving the conjoint tendon or its attached muscles, the short head of the biceps brachii (SHB) and the coracobrachialis (CB), are extremely rare, particularly in both muscles simultaneously. Taking a broad view, to the best of our knowledge, there are only five published reports of SHB/CB injuries.[5,6,8,15,22] Of these, only three have documented complete tears of both muscles.[5,6,15] Additionally, this is the first case to describe concomitant lateral antebrachial nerve injury. Furthermore, there are no published reports of conservative treatment in cases of complete SHB/CB tear as each of the previously published reports attempted surgical management. Thus, the natural history of this condition and the role of nonoperative management is not defined. Consistent with two[5,6] out of three previously reported cases, our case had a mechanism of injury involving a tow-rope while wakeboarding. Therefore, the purpose of this report is to outline the unique presentation of this uncommon pattern of injury and to detail both the reasoning behind and the results of the nonoperative treatment approach that was employed. The consensus based clinical case reporting guidelines[18] were followed on the writing of this article.

Patient information

A 26-year-old male presented after developing left medial-sided arm pain following an injury while wakeboarding. The patient reported that he was holding the rope with his left hand standing in "regular stance" (left foot forward). He performed a jumping maneuver over a wake getting nearly five feet in the air, and subsequently felt severe pain in his left shoulder upon landing. The patient reported no previous injuries to that arm and had a fully functional, painless extremity prior to this incident.

The patient initially presented to an urgent care following the injury where, given the impressive amount of swelling, compartment syndrome was considered, but ruled out based on clinical exam. The patient was placed in a simple sling and provided resources for follow-up.

Clinical findings

The patient subsequently presented to follow-up four days later. At this visit, he reported forearm numbness in the distribution of the lateral antebrachial cutaneous nerve. Extensive medial arm swelling and ecchymosis were still considerably prominent (Fig. 1, *A* and *B*). He had very limited elbow range of motion (ROM) due to severe pain in the medial arm with attempts at passive extension or active elbow flexion.

Diagnostic assessment

Plain radiographs of the left elbow and shoulder demonstrated no fracture or dislocation. A magnetic resonance image (MRI) of the Left elbow and humerus without contrast confirmed rupture of the SHB and CB (Fig. 2). This rupture had an apparent intramuscular extension in what we named a "mop end" appearance, based on the fraying and displacement of the muscle fibers of both muscles.

Institutional review board approval was not required for this case report.

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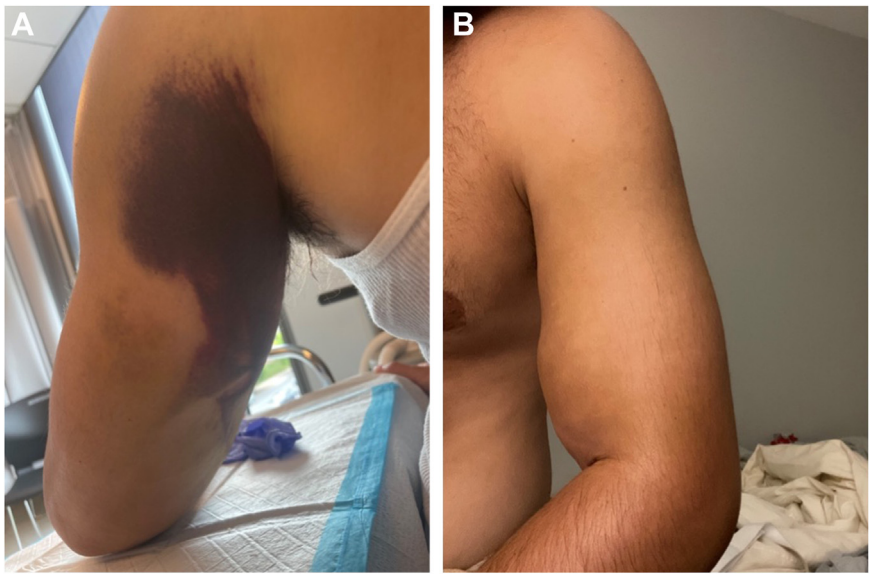

Figure 1 (**A**): Photograph of the posterior aspect of the arm and axilla upon initial presentation, large ecchymosis is observed. (**B**): The anterior aspect of the arm with swelling and notable deformity.

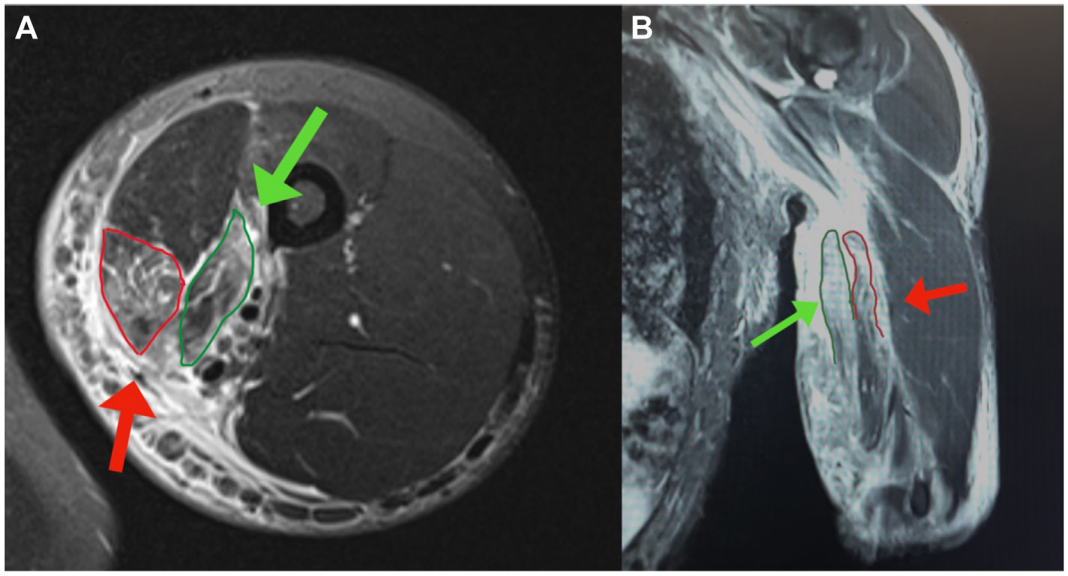

Figure 2 MRI axial image (**A**) demonstrating the short head of the biceps (*red arrow*) and coracobrachialis (*green arrow*). MRI coronal image (**B**) showing the short head of the biceps (*red arrow*) and coracobrachialis (*green arrow*) with notable distal retraction. Fraying of the muscle fibers can be observed in what we described as a "mop end" pattern. *MRI*, magnetic resonance image.

Figure 3 Photograph of upper extremity, 12 days after injury. Significant edema and ecchymosis are evidenced.

Therapeutic intervention

Considering the intramuscular injury pattern, which could compromise the capacity of surgical repair, and discussing options with the patient, given the limited data on this injury pattern, and considering the patient's level of functional limitation and individual expectations, a shared decision was reached between the patient and physician to pursue nonoperative treatment following careful discussion of the potential risks and benefits of both operative and nonoperative approaches. A well-padded long-arm splint was applied to immobilize and assist with swelling.

Follow-up and outcomes

The patient returned two weeks later for a repeat evaluation. On physical exam, significant ecchymosis of the forearm was still apparent, now involving the posterior axilla and volar forearm (Fig. 3). The proximal arm swelling had subsided slightly which made a prominent anteromedial arm swelling more evident (Fig. 3). Patient-reported outcomes (PROs) were collected at this visit: American Shoulder and Elbow Surgeons score (ASES), Visual Analog Scale (VAS), and Single Assessment Numeric Evaluation (SANE) were collected and scored 33.33, 4, and 24 respectively. A bulky, padded compressive wrap was reapplied for assistance with swelling but to allow elbow motion. The patient was told to wear a sling but to remove it frequently to allow gentle elbow extension.

The patient returned for clinical evaluation five weeks following the injury. At that time, he reported significant improvement in swelling (Fig. 4). He continued to experience lateral forearm numbness. The ecchymosis had resolved but the anteromedial bulging deformity was still detectable. Elbow motion was found to be 20 degrees shy of full extension to 140 degrees of flexion, full pronation and supination, and shoulder forward elevation to 125 degrees. PROs at that time had improved to ASES 71.67, VAS 1, and SANE 20. To continue improving ROM, formal outpatient physical therapy was initiated. By six weeks postinjury, the patient was permitted to lift, push, and pull up to five pounds and to begin active elbow ROM.

At a six-month follow-up visit, he was back to all activities including golf and high-intensity upper-body workouts without difficulty (Fig. 5). He had full elbow ROM from 0-140 degrees of flexion. He did still endorse some ongoing numbness in his forearm, though he noted this was improved. PROs improved further to ASES 90.00, VAS 1, and SANE 90. After the six-month follow-up, the patient experienced an ipsilateral shoulder injury (Acromioclavicular dislocation) from an unrelated snowboarding accident, resulting in the inability to accurately assess specific arm function and strength following CB and biceps tear. Table I summarizes the

Figure 4 Photograph of upper extremity, 4 weeks after injury. *Red arrows* show an abnormal bulge of the muscle mass.

PROs evolution during the follow-up, including the Patient-Reported Outcomes Measurement Information System pain interference (PROMIS-PI) scale.

Discussion

The SHB and the CB are conjoint at their proximal origin. The conjoint tendon originates from the tip of the coracoid process as a thick tendinous aponeurosis over the anterior coracoid surface.[17] Anatomically, the CB is the medial of the two ultimately inserting on the medial mid-humeral shaft while the SHB is more lateral and blends with the long head to insert on the bicipital tuberosity and the bicipital aponeurosis. The SHB essentially has a muscular origin at the coracoid and increases in muscular fibers/thickness progressing distally prior to blending with the long head.[4,7,10]

In this report, we describe the case of a complete tear of the CB and SHB muscles while wakeboarding. Wakeboarding can often lead to injuries due to the interaction of high-velocity forces involved in trailing a boat, performing extreme aerial maneuvers, and traction mechanisms via the tow rope,[1] with 15%-30% of wakeboarding injuries involving the upper extremity.[1,9] We believe that this injury was caused by a traction mechanism in the upper arm or forearm after entrapment with the rope. Injuries from a traction mechanism had been reported by other authors leading to isolated biceps brachii tears,[11,13,14,16,19,20] associated with parachuting,[8,14,15,22] traffic accidents,[19] gymnastics[13] and wakeboarding[5,6,11,16,21] (Table II).

Few authors have previously published on SHB and CB injuries. Fox et al[6] reported the case of a 41-year-old male with a CB and SHB tear after a wakeboarding incident. The mechanism of trauma was the entrapment of the antecubital region of the forearm in the rope and rope bar, leading to abrupt traction of the shoulder and elbow. The patient presented with weakness in elbow ROM, associated with an ulnar styloid fracture. He later underwent reconstruction of the conjoined tendon utilizing semitendinosus allograft. He had regained full elbow ROM and returned to activities with minor limitations at six months postoperation. That patient reported an ASES score of 91.66 and SSV (Subjective Shoulder Score) of 85%.

Similarly, Epstein et al[5] presented a case of a 15-year-old male who sustained a CB and SHB tear while “skurfing”, a tow-rope water sport that closely resembles wakeboarding. The injury was also described as a traction mechanism of the upper arm following entrapment with the tow rope. This patient presented with an associated tear of the brachioradialis and extensor carpi radialis at the level of the elbow. He underwent open suture repair following the injury. He regained full ROM and function at 3 months post-surgery and was able to return to most activities. No PROs were recorded.

Pascual-Garrido et al[16] reported on two patients with a proximal muscle rupture of both the short and long head biceps brachii while wakeboarding. Although the CB was uninjured in both patients, the authors suggested that patients may be at risk for similar injuries as the rope handle is held in the antecubital fossa, making one more prone to traction injury at that level. Both patients in the series underwent surgical management: one was repaired with suture and the other required muscle débridement as there was marked muscle necrosis. Both reported no limitations at four years follow-up, although were noted to have marked atrophy with diminished elbow flexion strength. No PROs were recorded. Similarly, Kozak et al[11] also reported on 2 patients with isolated biceps brachii tears during wakeboarding, both of those cases were also treated operatively with suture repair. Both patients returned to baseline activities 1 year after surgery.

Our case is the first to describe concomitant lateral antebrachial nerve neuropathy. Noniatrogenic, traumatic lateral antebrachial cutaneous neuropathy is relatively rare but is reported in the literature.[2,12] It is believed that the nerve palsy in this case is related to traction injury given the distal retraction of the muscle following the tear.[3]

All prior cases of “Wakeboarder’s Arm” were treated operatively.[5,6,15] In our case we observed a muscle tear pattern in which the muscle fibers were frayed and separate (Fig. 2, *B*). Given the tension at the repair site and the poor tissue quality, we felt that repair, even with graft augmentation and diligent technique, would be highly likely to fail. After reviewing the fibrillated, “mop end” appearance of the intramuscular rupture and discussing options with this patient, we proceeded nonoperatively. Regarding his

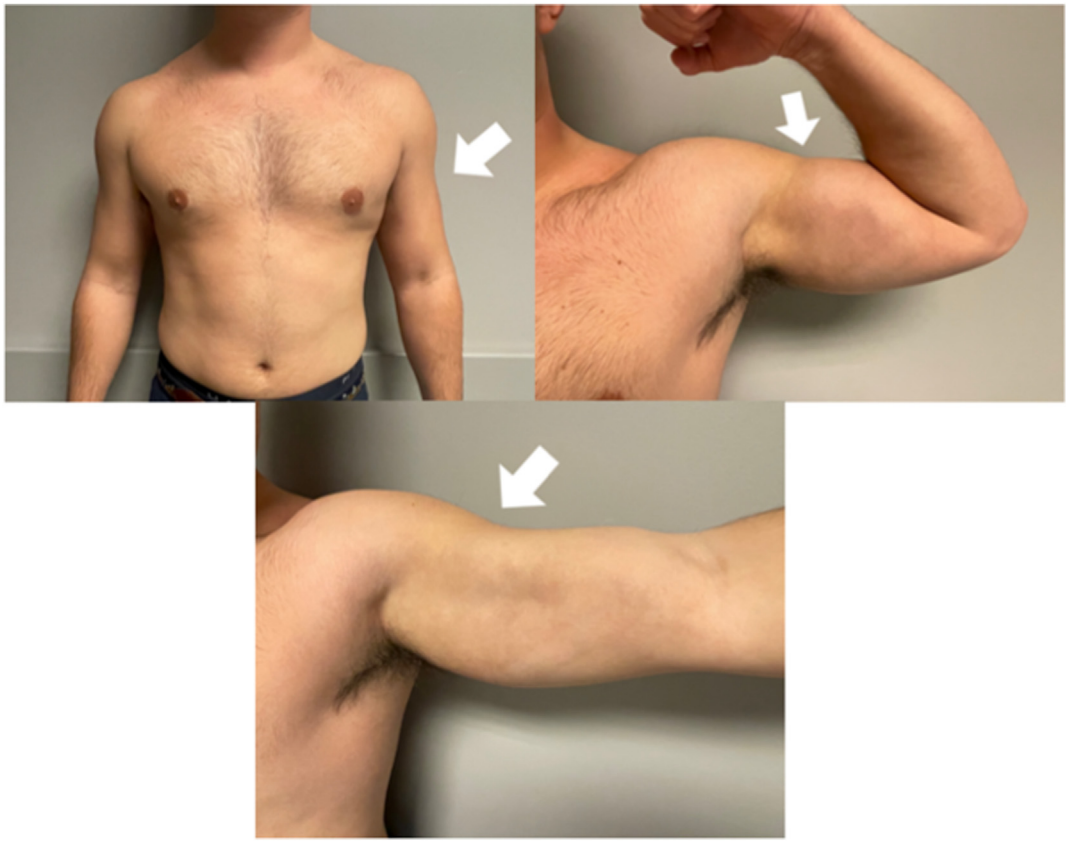

Figure 5 Photographs of *Upper* extremity with 5 months after injury. White arrows indicate a reduction of swelling of the arm while a slight deformity of the arm is still present.

Table I
Patient-reported outcomes during follow-up.

Timepoint	ASES	VAS	SANE	PROMIS-PI
2 Weeks	33.33	4	24	65.86
5 Weeks	71.67	1	20	61.38
10 Weeks	86.67	1	88	52.57
5 Mo	90.00	1	90	38.67

ASES, American Shoulder and Elbow Surgeons; *VAS*, visual analog scale; *SANE*, single assessment numeric evaluation; *PROMIS-PI*, Patient-Reported Outcomes Measurement Information System-pain interference.

numbness, he similarly elected for a "wait and see" approach. Ultimately, when the sensation did not return, he felt this was not troublesome.

Conclusion

This case report and literature review describe a rare shoulder injury from a specific mechanism of traction with entrapment of the upper arm or elbow by the tow rope or rope handle—hence the name "Wakeboarder's Arm." This is the first time that the nonoperative treatment is described, revealing acceptable outcomes and apparently comparable to current surgical options. Our patient's ASES score of 90.0 at 5 months was similar to another case at 7 months (91.66) treated with a semitendinosus allograft.[6] In distinction to prior authors who advocated surgical repair[5,6] the results presented in this report provide valuable insights into the effectiveness of nonoperative treatment of this injury pattern. It is important to note that, while large comparative studies will be challenging with such a rare injury, continued reporting of cases is needed to elucidate the appropriate treatment. We believe that nonoperative treatment should at least be strongly considered in selected patients.

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Table II
Reports of similar injuries in the reviewed literature.

Author.	Year	n=	Diagnosis	Mechanism	Associated injury	Treatment	Outcome
Tobin et al[22]	1941	1	Coracobrachialis and short biceps brachii muscle tear.	Parachuting	None	Not reported	Not reported
Shah et al[19]	2004	1	Short biceps brachii muscle tear.	Car accident (Arm outside of window).	None.	Muscle suture 12 d after injury.	Full strength and ROM at 5 mo postop.
Moon et al[14]	2010	1	Short biceps brachii muscle tear	Parachuting	None	Muscle suture 3 weeks after injury.	79% elbow strength at last follow-up (time not reported).
Pandit et al[15]	2011	1	Bíceps brachii and coracobrachiallis muscle tear.	Parachuting	None	Bíceps brachii reconstruction with allograft. Coracobrachialis not repaired.	Not reported.
Mizuno et al[13]	2011	1	Short biceps brachii muscle tear.	Gymnastics (Still rings).	None.	Muscle suture 10 d after injury.	Return to sport activities at 3 mo postop.
Pascual-Garrido et al[16]	2012	2	Bíceps brachii muscle belly tear.	Wakeboarding	None.	Muscle belly suture in one case and biceps débridement in one case.	Full ROM of shoulder and elbow, marked hypotrophy at 4 y postop.
Spiegl et al[21]	2014	1	Distal coracobrachialis muscle tear.	Wakeboarding	Traction neuropathy of musculocutaneous and lateral antebrachial cutaneous nerves.	Tenodesis of the distal coracobrachialis with adjacent biceps muscle.	Full ROM of shoulder and Elbow at 4 mo postop.
Helton et al[8]	2014	1	Partial coracobrachialis and short biceps brachii muscle tear.	Parachuting	None	Physiotherapy	Isokinetic test with 39.1% decrease in elbow flexion peak torque and a 60.8% decrease in elbow flexion at 6 mo follow-up
Epstein et al[5]	2019	1	Coracobrachialis and short biceps brachii muscle tear.	Skurfing	Brachioradialis and extensor carpi radialista longus muscle tear.	Muscle suture 8 d after injury.	Full ROM and return to activities 14 weeks postop.
Kozak et al[11]	2019	2	Short biceps brachii tear	Wakeboarding	One undisplaced distal radius fracture.	Muscle suture. (Time not reported).	Return to baseline level of activity 1 y postop.
Fox et al[6]	2020	1	Coracobrachialis and short biceps brachii muscle tear.	Wakeboarding	Ulnar styloid fracture.	Tendon reconstruction with allograft 7 weeks after injury.	85% SSV, QuickDASH 6.8 at 3 y postop.
Current report	-	1	Coracobrachialis and short biceps brachii muscle tear.	Wakeboarding	Concomitant Lateral Antebrachial Nerve Injury	Conservative	Returned to full activity, full elbow ROM, ASES 90.00, VAS 1, and SANE 90.

Number of cases (n=), Range of Motion (ROM).

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