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CASE REPORT

Rotator cuff tear following long-standing axillary neuropathy in a female motocross racer

John G Skedros,^{1,2} Tanner R Henrie,¹ Mitchell D Peterson¹

¹Department of Orthopaedic Surgery, The University of Utah, Salt Lake City, Utah, USA
²Orthopaedic Surgery, Intermountain Medical Center, Murray, Utah, USA

Correspondence to
 Dr John G Skedros,
 jskedrosmd@uosmd.com

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SUMMARY

A 'terrible triad' of anterior shoulder dislocation, axillary nerve damage and rotator cuff tear has been previously described. However, we are unaware of any report of anterior shoulder dislocation, humeral fracture, axillary neuropathy and subsequent rotator cuff tear requiring surgery when the axillary neuropathy was deemed permanent. We report the case of a 20-year-old woman who fell in a motocross accident and had an anterior shoulder dislocation, humeral fracture and axillary neuropathy. The fracture was treated surgically with open reduction and internal fixation. The axillary nerve injury was ultimately permanent. Thirteen months after the motocross accident, the patient sustained a rotator cuff tear from seemingly minor trauma. However, several months of aggressive physical therapy preceded the rotator cuff tear. The tear was repaired and the patient was followed for 5 years after the initial injury. She returned to competing in motocross, even though the axillary neuropathy remained complete and permanent.

BACKGROUND

Major shoulder injuries (dislocations and fractures) can cause varying degrees of neuropathy, with the axillary nerve being most commonly affected.^{1 2} Fractures of the proximal humerus can also cause axillary neuropathy which can significantly impair recovery of shoulder strength and motion.² A traction type of injury is what usually causes the axillary neuropathy seen with an anterior shoulder dislocation or proximal humerus fracture.^{3 4} A 'terrible triad' of anterior shoulder dislocation, axillary nerve injury and rotator cuff tear has been described.⁵⁻⁷ A glenoid rim fracture may be associated with this triad, thereby forming a 'terrible tetrad'.⁸

Complete/permanent axillary neuropathy caused by anterior shoulder dislocation with proximal humerus fracture in association with a subsequent (ie, many months later) rotator cuff tear has, to our knowledge, not been reported in the literature. We report the case of a 20-year-old woman who suffered an anterior shoulder dislocation, proximal humerus fracture and axillary nerve damage after a motocross accident. Thirteen months after successful open reduction internal fixation (ORIF) to repair this fracture, she sustained a posterior-superior rotator cuff tear from a seemingly minor traumatic event. In the perspective that the deltoid muscle (supplied by the axillary nerve) is an important stabiliser of the humeral head,⁹ we surmised that shoulder subluxations during

aggressive exercise and physical therapy probably contributed to intrinsic weakening of her posterior-superior rotator cuff, making it prone to additional injury.

CASE PRESENTATION

A 20-year-old, left-hand dominant woman (height 167 cm, weight 63 kg, body mass index 22.6 kg/m²) was in a motocross accident in June 2012 when she sustained a three-part fracture dislocation of the left proximal humerus¹⁰ (figure 1) in addition to axillary nerve injury on the ipsilateral side. Using conscious sedation, the dislocation was reduced in an emergency department on the same day and without difficulty. Three days later an MRI scan was performed and showed no evidence of rotator cuff tears. One week later, she underwent ORIF, which included a metal plate and screws (figure 2) and was performed by JGS. The rotator cuff was found to be intact by gross examination. Numbness in the axillary field was noted before and after surgery.

A nerve conduction study with electromyography was done 6 months after the shoulder trauma. The results of this study showed severe left axillary neuropathy with ongoing denervation and no evidence for reinnervation and possible additional mild injury to the suprascapular nerve.

In May 2013 (11 months after her initial injury), she had increasing shoulder subacromial crepitus and anterior glenohumeral stiffness, which was treated with arthroscopic debridement of subacromial bursitis with acromioplasty, arthroscopic anterior capsular release and open deep metal removal. Gross examination showed that the supraspinatus insertion was intact and the metal plate was not seen to be causing subacromial impingement. However, supraspinatus tendon thinning was seen but was not given any special consideration at that time.

Nine weeks later, she sustained acute left shoulder pain and motion loss after she pushed herself upward on her arms to lift herself up while sitting on the back of a pickup truck. Her shoulder motion decreased from 120° to 80° of active overhead elevation. MR images showed a full-thickness tear of the supraspinatus and upper infraspinatus tendons (figure 3) and a full-thickness tear of the intra-articular biceps tendon. This injury was preceded by several months of aggressive physical therapy and shoulder strengthening and exercise. We speculated these activities, coupled with glenohumeral subluxations from chronic deltoid atrophy, had intrinsically weakened her upper rotator cuff and biceps tendon. An open repair of the rotator



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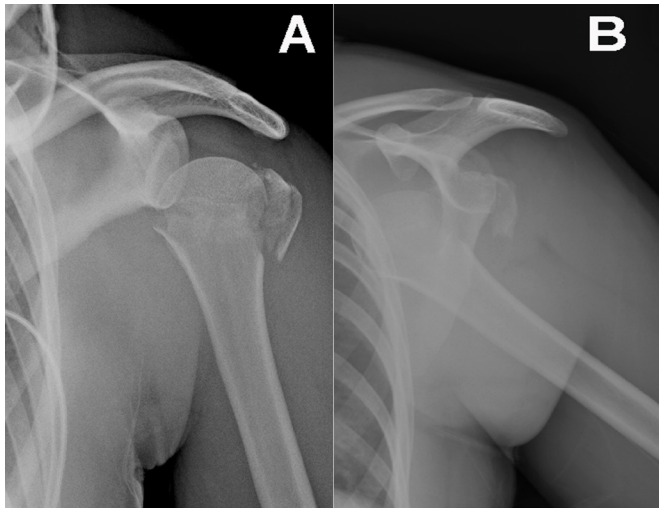


Figure 1 Radiographs from the emergency department showing (A) the postreduction view and the three-part fracture and (B) the dislocation view prior to reduction, which shows the widely displaced greater tuberosity part of the fracture.

cuff tear with biceps tenodesis was performed in July 2013 by JGS.

OUTCOME AND FOLLOW-UP

At 5 years after the motocross injury to the shoulder of her dominant side and just over 3 years after the rotator cuff repair, the patient’s deltoid function had not returned. The patient’s shoulder functions and health status before the rotator cuff repair and 3–5 years later are listed in table 1. Despite complete and permanent axillary neuropathy, there was substantial improvement in both pain and ability to perform shoulder-specific tasks. Active flexion and abduction were both 135° (figure 4). There was also no scapular winging and a negative lift off test. At that time, she had continued mild achy pain of the shoulder with use, but this did not require pain medication other than occasional non-steroidal anti-inflammatory drugs. She had a positive demeanour about the function of her shoulder injury. The patient

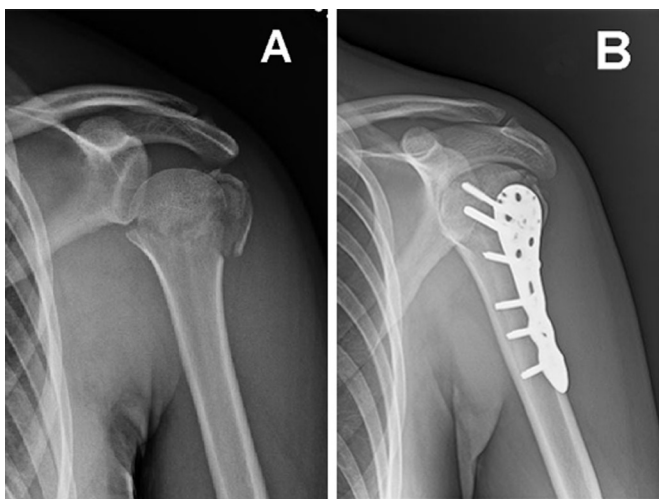


Figure 2 Radiographs showing (A) the patient’s proximal humerus fracture, shown here 1 week after the closed reduction of the anterior glenohumeral dislocation and (B) treatment of the fracture with a metal plate and screws.

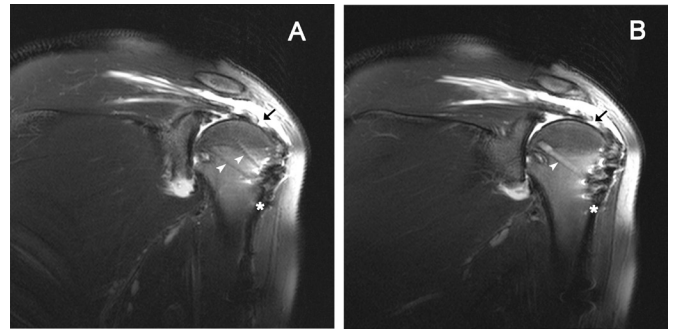


Figure 3 MR images of the patient’s rotator cuff tear. The white arrow heads indicate metal screws that traverse from the plate (*) that is on the lateral surface of the upper humerus. The back arrows indicate the area of the supraspinatus tendon tear.

had essentially the same follow-up data at her 4-year and 5-year follow-ups; she had a lowered ability to perform in the ‘sports/performing arts module’ of the Disabilities of the Arm, Shoulder and Hand (DASH). This was due to an inability to return to the same elite level of motocross performance as before. The limitation of motion was secondary to deltoid atrophy and was not attributable to fracture malunion (figure 5). However, she had made several adjustments to continue motocross racing including using a steering stabiliser on her motorcycle to reduce handlebar shaking and a foam-filled EVS (Walworth, Wisconsin, USA) brace to protect her left shoulder in case of falls during racing. She also regularly exercised with a BOSU ball (meaning BOTH Sides Up; Hedstrom, Ashland, Ohio, USA) that she modified by

Table 1 Surveys and range of motion scores

	Before RCR*	3 years after RCR*	
10 cm VAS score for pain	0	2	
ASES score	75	65	(Best is 100)
Simple shoulder test	nine out of 12	11 out of 12	(12 is best)
DASH score			(Best is 0, worst is 100)
Total	23.3	16.7	
Work	0	0	
Sports/performing arts	37.5	50	
Short-Form 36 (SF-36)			
Physical functioning	80	85	(Best is 100 for all)
Role physical	25	100	
Bodily pain	74	72	
General health	80	100	
Vitality	50	80	
Social functioning	100	100	
Role emotional	0	100	
Mental health	76	88	
Date	Action	Active range of motion	
4 years after injury	Forward flexion	135	
	Abduction	135	
	External rotation	65	
	Internal rotation	60	
	Extension	45	
	Adduction	45	

ASES, American Shoulder and Elbow Surgeons; DASH, Disabilities of the Arm, Shoulder and Hand; RCR, rotator cuff repair; VAS, Visual Analogue Scale.



Figure 4 Photographs of our patient at the 4-year follow-up.

adding a motorcycle handlebar attachment. The BOSU ball is meant to create an unstable surface for resistance training.¹¹

DISCUSSION

Although a triad of shoulder dislocation/fracture, axillary nerve injury and rotator cuff tear has been described as occurring during one traumatic event, our patient's rotator cuff tear occurred 13 months after her initial shoulder injury. The characteristics and timeframe of our patient's shoulder injuries and the long-term follow-up makes her case unique. There are studies that report long-term follow-up of patients with permanent complete or partial axillary neuropathy. One study showed that 11 out of 11 athletes with axillary nerve damage caused by tackling opposing players in football (9 out of 11) and hockey collisions (2 out of 11) never regained full nerve function (range of follow-up: 31–276 months).¹² Although these patients never regained full nerve function, the majority (10 of 11) were able to return to their preinjury levels of activities, including professional athletics. Unlike our case, none of the 11 patients were reported to have

sustained a RCT during the time that their axillary neuropathy was deemed permanent. Another study described three cases of axillary nerve palsy (one of which occurred from a traumatic high speed motorcycle accident) in which all three patients eventually regained significant improvements in range of motion, even though there was complete denervation of the deltoid in all three cases.¹³ But unlike our patient, these three patients did not have a subsequent rotator cuff tear.

For patients with brachial plexus palsy and deltoid paralysis, trapezius transfer is a way to regain shoulder elevation.¹⁴ This procedure has been shown to increase range of motion and strengthen abduction and flexion. In addition, the trapezius transfer increases shoulder stability. Elhassan *et al*¹⁵ suggest that transfer of the lower trapezius is a potential solution for an irreparable posterosuperior rotator cuff tear. Although considered in our case, these types of procedures were not performed because our patient had already achieved superior ranges of flexion, abduction and external rotation compared with Elhassan and co-workers'¹⁵ patients who underwent lower trapezius transfer. Furthermore, she did not have evidence of shoulder instability.

Our patient's better than expected range of active motion may be partially explained by her use of a modified BOSU ball. The literature on using unstable surfaces for resistance training and rehabilitation shows that while unstable surfaces may be the optimal exercise for athletes, they may be favourable for rehabilitation after shoulder injuries that result in significant weakness.¹¹ Our patient created a BOSU ball with handlebar attachments to simulate motocross activity, and this may have enhanced her ability to fully return to motocross activities in addition to gaining shoulder motion and strength. This innovative approach to resistance training simulates the rough, uneven surfaces and the wobble or shimmy felt in the handlebars by an off-road motorcyclist.

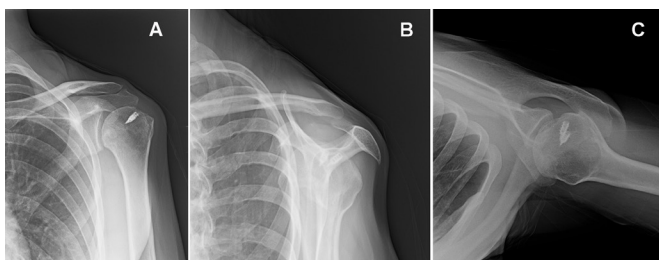


Figure 5 Radiographs obtained at 4-year follow-up. Metal suture anchors can be seen from the rotator cuff repair that was done 3 years prior.

While our patient showed significant improvement in shoulder function, she still utilises several modifications that allow her to ride off-road motorcycles. These include a steering stabiliser that decreases the amount of wobble or shimmy felt by the rider and an EVS brand brace to protect her shoulder during motocross activity.

Our patient gained substantial improvement in shoulder function at 4-year and 5-year follow-ups despite having surgical repair of a subsequent full-thickness rotator cuff tear in the setting of permanent and complete axillary neuropathy. She has regained significant range of motion and was able to return to competing in motocross.

Patient's perspective

Although I have weakness raising my arm over my head, I have been able to work hard with my exercises and participate in motocross and other sports. I am also now a nurse, and I have no problem working in this capacity.

Learning points

- ▶ A full-thickness rotator cuff tear in the setting of permanent axillary nerve deficit can still be treated surgically with an acceptable outcome.
- ▶ Specialised exercises with the BOSU ball can help these patients achieve an acceptable result.
- ▶ A permanent axillary nerve deficit does not preclude participation in motocross racing.

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