Scapular Body Fracture in the Athlete: A Systematic Review

Mithun Neral, MD · Derrick M. Knapik, MD · Robert J. Wetzel, MD · Michael J. Salata, MD · James E. Voos, MD

Received: 26 February 2018/Accepted: 25 June 2018/Published online: 13 August 2018
© Hospital for Special Surgery 2018

Abstract *Background:* Scapular body fractures generally occur as a result of high-energy, direct trauma to the shoulder sustained in automobile accidents. While such mechanisms have been well described, little is known about scapular body fractures sustained during sporting activities. *Questions/Purposes:* We sought to systematically review the literature on scapular body fracture sustained during sporting activity, recording rates and mechanisms of injury, management strategies, and return-to-sport times. *Methods:* Following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, we performed a systematic review of studies conducted between 1985 and 2017. Inclusion criteria were studies examining scapular body fractures sustained during sporting activity, fracture management, and patient outcomes. Exclusion criteria were studies on non-sporting-related fractures and those not reporting fracture management or patient outcomes. *Results:* Nine studies encompassing ten cases of scapular body fracture sustained during sporting activity were identified, with acute trauma responsible for 70% of fractures. No patient sustained any associated injuries. Fractures were treated conservatively in 90% of cases, with no reported

complications. Mean overall time to return to sport was 2.5 months, while no significant difference in return to sport was appreciated in athletes with acute versus fatigue fractures. *Conclusion:* Scapular body fractures in athletes occur primarily from muscle contraction against a resisted force in the upper extremity during contact sports. Unlike non-sporting fractures, these fractures usually involve low-energy mechanisms without associated injury and conservative treatment is usually successful.

Keywords scapula fracture · athlete · treatment · outcomes · scapular body · management

Introduction

Scapular body fractures represent less than 1% of all skeletal fractures [6, 12, 24] and generally occur secondary to high-energy, direct trauma to the shoulder sustained during motor vehicle accidents [9, 10, 12]. While high-energy mechanisms have been well described for scapular body fractures, little literature exists on scapular body fractures sustained during sporting activities. One recent review systematically examined the prevalence and impact of coracoid fractures in athletes [15], but reports of other injuries to the shoulder girdle and specifically the scapular body in athletes have been limited to small case series and individual case reports [8–16].

The purpose of this study was to systematically review the literature to better understand scapular body fractures sustained during sporting activities. The study sought to define (1) the reported injury rate of scapular body fractures sustained during sporting activities, (2) the mechanisms and sports responsible for injury, (3) fracture management and outcomes, and (4) timing for return to sport. We hypothesized we would find a low reported rate of injury, occurring primarily during contact sports and treated successfully with non-operative approaches.

Level of Evidence: Level IV: Systematic Review.

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s11420-018-9624-6>) contains supplementary material, which is available to authorized users.

M. Neral, MD · D. M. Knapik, MD · R. J. Wetzel, MD ·
M. J. Salata, MD · J. E. Voos, MD
University Hospitals Cleveland Medical Center, Case Western
Reserve University School of Medicine,
Cleveland, OH, USA

M. Neral, MD (✉)
University Hospitals Sports Medicine Institute, University Hospitals
Cleveland Medical Center Case Western Reserve University School
of Medicine,
Cleveland, Ohio, USA
e-mail: neral.mithun@gmail.com

Methods

A systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines using a PRISMA checklist [16]. The goal was to identify all studies related to scapular body fractures sustained during sporting activities published between January 1985 and June 2017. We considered a sporting activity as any physical activity in which the athlete was in competition against fellow athletes. Two reviewers independently conducted the search in June 2017 using the following databases: PubMed, Biosis Previews, SPORTDiscus, PEDro, and Embase. Each search included the following terms: *sport AND athlete AND scapular body AND fracture*.

Inclusion criteria were articles with English language or English translations, human subjects with documented scapular body fractures with reported sporting activity as causing injury, treatment (operative versus non-operative), and patient outcome. Exclusion criteria were non-English language, fractures secondary to non-sporting activities (falls, motor vehicle accidents, or any activity not meeting the definition of sport), and studies without reports of fracture management or patient outcomes.

Following the two independent authors' search of the databases, a total of 47 citations were identified (Fig. 1). Following title and abstract assessment, a total of 37 full-text articles were selected for further evaluation. Of these studies, 19 were excluded due to fractures being sustained during non-sporting activities, the absence of data regarding sporting activity ($n=4$ studies), or absence of data regarding fracture management ($n=3$ studies). Following application of inclusion/exclusion criteria, a total of nine studies were identified for analysis. All references in each identified article were cross-referenced for inclusion to ensure all available studies were evaluated. Studies were grouped based on whether the injuries occurred secondary to acute trauma or chronic injury resulting in fatigue fracture.

Statistical analysis was utilized to compare mean time to return to sport in athletes based on injury mechanism (acute versus fatigue fractures). Due to small sample size, a Fisher's exact test was performed with a p value of <0.05 used to determine statistical significance. Statistical analysis was performed using SPSS Statistics 23 (IBM, Armonk, NY, USA).

Results

Nine studies meeting inclusion criteria documented a total of ten cases of scapular body fracture sustained during sporting activity (Table 1). Mean patient age at the time of injury was 25.1 ± 7.5 years, and all patients were male. The mean final follow-up time was 5.6 ± 5.6 months, while final follow-up was not reported in two cases [2, 25].

Acute trauma to the shoulder was responsible for seven of ten cases (70%) of scapular body fracture. Injuries occurred secondary to contact and non-contact mechanisms during American football, ice hockey, wrestling, boxing,

badminton, and water skiing [2–4, 17, 19, 26]. Forceful maximal internal or external rotation of the upper extremity against resistance was responsible for acute fractures in athletes participating in American football, wrestling, and water skiing [2–4]. Forceful swinging movements were responsible for fracture in those involved in ice hockey, boxing, and badminton [3, 4, 17]. Fatigue fractures to the scapular body were identified in three athletes. Mechanisms included repetitive stress across the shoulder from pitching in a baseball player, batting in an extended season in a cricket player, and jogging with hand weights in a runner [7, 11, 25]. No associated injuries to the remaining shoulder girdle were reported in any study.

Conservative management involving immobilization, activity cessation or modification, and physical therapy with progressive range-of-motion and strengthening exercises were reported in nine of ten athletes (90%). All patients with acute fractures treated conservatively were initially immobilized in a sling followed by early therapy (range-of-motion and strengthening exercises). All patients with stress fractures were initially immobilized in a sling and restricted from sport until there was radiographic evidence of healing and resolution of pain. Fracture healing was determined using serial radiographs in all patients except for the baseball pitcher with a stress fracture [15], for whom a CT scan showed healing. No complications following conservative management were reported. None of the studies mentioned the use of pharmacologic or non-pharmacologic adjuncts such as vitamin D, calcium, or teriparatide. Operative management was performed in one athlete sustaining a fracture during badminton utilizing a tension band construct three days after injury [24]. By 4 months post-operatively, the fracture was noted to be well-healed and the athlete was able to return to sport without restrictions. The athlete underwent planned removal of internal fixation 8 months following surgery, with no reported complications at final follow-up.

Mean time for return to sport was 2.5 ± 1.1 months (range, 0.75 to 4 months), while return was not recorded in two studies [2, 25]. Athletes sustaining acute fractures returned to sport 2.6 ± 1.3 months following injury, while those with fatigue fractures returned at an average of 2.3 ± 0.4 months. No significant difference was detected in return to sport based on fracture mechanism ($p=0.72$). Mean time to return to sport in athletes treated conservatively was 2.3 ± 1.0 months, compared to 4 months for the single athlete treated with fixation.

Discussion

The principle findings from this review were that scapular body fractures are rare and sustained primarily due to acute trauma during sport. Conservative treatments were successful without complications in 90% of fractures. No significant differences in mean time to return to sport were reported in athletes sustaining acute versus fatigue fractures. This study represents the largest review of athletes sustaining scapular body fractures during sporting activities.

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart of study.

This study was not without limitations. The small sample size was related to the strict inclusion/exclusion criteria. No meaningful statistical analysis could be performed on return-to-play timing between athletes treated operatively and conservatively due to the small sample size of athletes treated operatively ($n = 1$) [12]. Due to the inherent heterogeneity of reported data, studies varied in the degree of detail offered regarding injury mechanism, fracture pattern, treatment method, and outcomes, which limited our ability to conduct meaningful statistical analysis assessing these variables. Finally, the outcomes reported in this review are derived exclusively from case reports in athletes, limiting the generalizability of these findings to a larger population and those sustaining scapular body fractures from high-energy mechanisms. However, this limitation also speaks to the rarity of this injury and the associated paucity of evidence on treatment.

Scapular body fractures generally occur from direct trauma to the shoulder girdle from high-energy mechanisms such as motor vehicle accidents and falls from height [9, 10, 12]. As a result, a reported 80 to 96% of patients sustaining scapular body fractures possess associated injuries to the ipsilateral limb, shoulder girdle, or thorax [1, 5, 8, 14, 18, 20–23]. Concomitant injuries most commonly include rib fracture, hemothorax, pulmonary contusion, head injury, and clavicle fracture [1]. No patient in this investigation was found to possess additional injuries, likely due to injuries occurring from low-energy mechanisms secondary to vigorous muscle contractions against a resisted force in the upper extremity. However, due to the close proximity of the scapula to vital structures, all patients

with scapula fractures require careful evaluation for additional injuries.

A number of classification schemes for scapula fractures have been proposed. Hardegger et al. proposed a scheme in which fractures are classified on eight anatomic categories based on involvement of the scapular body, glenoid rim, glenoid fossa, anatomical neck, surgical neck, acromion, scapular spine, or coracoid process [10]. Meanwhile, the fracture classification proposed by Ada and Miller stratifies fractures into four anatomic locations: (1) fractures of the acromion, coracoid, and scapular spine; (2) fractures of the scapular neck; (3) intra-articular fractures of the glenoid rim and glenoid fossa; and (4) fractures of the scapular body [1]. Scapular avulsion fractures caused by vigorous muscle contraction against a resisted force have been described by Heyes-Moore and Stoker in their case series of seven patients, leading the authors to suggest avulsion-type fractures be classified as a separate group [13]. In our study, three of seven (43%) acute fractures were described as avulsions from the muscular insertions off the scapula [2, 3, 19]. Consistent with the injury mechanism proposed by Heyes-Moore and Stoker, avulsion fractures in our study were all sustained from muscle contraction against a resisted force in the upper extremity.

Fatigue fracture of the scapular body is unique to the sporting population. These injuries occur from repetitive trauma across the bone or secondary to muscular contractions causing microfractures to the scapula [13]. While bony callus formation may be seen on radiographs weeks or months after the onset of symptoms, advanced imaging such as computed tomography, magnetic resonance imaging, or

Table 1 Summary of studies included in review

Authors	Journal (year)	Level of evidence	Sex (age)	Sporting activity	Injury mechanism
Memisoglu et al. [17]	<i>Ann Med Surg</i> (2015)	5	M (23)	Ice hockey	Acute trauma
Brown et al. [4]	<i>Am J Sports Med</i> (2004)	4	M (27)	Football	Acute trauma
Brindle et al. [3]	<i>J Orthop Sports Phys Ther</i> (1998)	5	M (17)	Wrestling	Acute trauma
Wyrsh et al. [26]	<i>J Shoulder El Surg</i> (1995)	5	M (25)	Boxing	Acute trauma
Mugikura et al. [19]	<i>J Shoulder El Surg</i> (1993)	5	M (40)	Badminton	Acute trauma
Banerjee et al. [2]	<i>Br J Radiol</i> (1985)	5	M (15)	Water skiing	Acute trauma
Herickhoff et al. [11]	<i>Am J Sports Med</i> (2007)	5	M (28)	Baseball	Fatigue fracture
De Villiers et al. [7]	<i>S Afr Med J</i> (2005)	5	M (21)	Cricket	Fatigue fracture
Veluvolu et al. [25]	<i>Clin Nucl Med</i> (1988)	5	M (30)	Jogging with hand weights	Fatigue fracture

Authors	Fracture pattern	Treatment	Return to sport (months)	Complications
Memisoglu et al. [17]	Transverse scapular body fracture	Conservative	3	None
Brown et al. [4]	Bilateral longitudinal scapula fractures through glenoid neck in consecutive seasons	Conservative	4, 2.5	Anterior labral tear requiring arthroscopic debridement
Brindle et al. [3]	Inferior angle scapula avulsion fracture with serratus anterior insertion injury causing scapular winging	Conservative	0.75	None
Wyrsh et al. [26]	Minimally displaced, slightly comminuted, extra-articular fracture proximal to glenoid	Conservative	1.5	None
Mugikura et al. [19]	Scapular spine avulsion fracture at deltoid insertion	Internal fixation with tension band wiring	4	None
Banerjee et al. [2]	Central scapular avulsion fracture at periphery of infraspinatus fossa at infraspinatus insertion	Conservative	NR	NR
Herickhoff et al. [11]	Lateral scapular body stress fracture at teres minor insertion	Conservative	2.5	Elbow pain requiring arthroscopy
De Villiers et al. [7]	Lower border of scapular neck-body junction	Conservative	2	None
Veluvolu et al. [25]	Superomedial supraspinatus fossa	Conservative	NR	NR

NR not recorded

bone scan is necessary for diagnosis of scapular fatigue fracture. Our investigation identified three reports of fatigue fracture for which conservative management was successful without complications [7, 11, 25].

Studies examining treatment of scapular body fractures have generally reported favorable outcomes with non-operative management [1, 8, 10, 13]. Both Goss et al. and Hardegger et al. acknowledge that the vast majority of scapular body fractures are minimally displaced due to the thick, strong support provided by surrounding muscle masses [8, 10]. Reported treatment guidelines for scapular body fractures recommend short-term immobilization in a sling and swathe for comfort, followed by early progressive range-of-motion exercises as pain subsides [1, 8, 10]. Even with widely displaced scapular fractures, this symptomatic treatment approach produces reliable fracture healing with restored shoulder function [23]. Operative management is generally reserved for glenoid fracture/dislocation, unstable fracture of the scapular neck, and significantly displaced apophyseal fracture, for which non-union, malunion, and late disability are reported with conservative management [10, 23]. Results from this study corroborate the use of non-operative management for scapular body fractures, as 90% of fractures were managed conservatively with favorable outcomes.

In conclusion, scapular body fractures secondary to sporting activities are rare, occurring primarily from muscle contraction against a resisted force in the upper extremity during contact sports. Unlike fractures in the non-sporting population, scapular body fractures in athletes occur primarily from low-energy mechanisms without associated injury; conservative management is often successful. No difference in return-to-sport time was appreciated, regardless of fracture mechanism.

Compliance with Ethical Standards

Conflict of Interest: Mithun Neral, MD, Derrick M. Knapik, MD, and Robert J. Wetzel, MD, declare that they have no conflicts of interest. Michael J. Salata, MD, reports being a paid consultant for Smith and Nephew, Stryker, and Linvatec, outside the current submission. James E. Voos, MD, reports being a paid consultant for Arthrex, outside the current submission.

Human/Animal Rights: N/A

Informed Consent: N/A

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

References

1. Ada JR, Miller ME. Scapular fractures: analysis of 113 cases. *Clin Orthop Relat Res*. 1991;(269):174–180.
2. Banerjee AK, Field S. An unusual scapular fracture caused by a water skiing accident. *Br J Radiol*. 1985;58(689):465–467.
3. Brindle TJ, Coen M. Scapular avulsion fracture of the high school wrestler. *J Orthop Sports Phys Ther*. 1998;27(6):444–447.
4. Brown MA, Sikka RS, Guanche CA, Fischer DA. Bilateral fractures of the scapula in a professional football player. *Am J Sports Med*. 2004;32(1):237–242.
5. Butters KP. The scapula. In: Rockwood CA Jr., Matsen FA II, eds. *The Shoulder*. Philadelphia: WB Saunders; 1990:335–366.
6. Cain TE, Hamilton WP. Scapular fractures in professional football players. *Am J Sports Med*. 1992;20(2):363–365.
7. De Villiers RV, Pritchard M, De Beer J, Koenig J. Scapular stress fracture in a professional cricketer and a review of the literature. *S Afr Med J*. 2005;95(5):312–317.
8. Goss TP. Scapular fractures and dislocations: diagnosis and treatment. *J Am Acad Orthop Surg*. 1995;3(1):22–33.
9. Gottschalk HP, Browne RH, Starr AJ. Shoulder girdle: patterns of trauma and associated injuries. *J Orthop Trauma*. 2011;25(5):266–271.
10. Hardegger FH, Simpson LA, Weber BG. The operative treatment of scapular fractures. *J Bone Joint Surg (Br)*. 1984;66(5):725–731.
11. Herickhoff PK, Keyurapan E, Fayad LM, Silberstein CE, McFarland EG. Scapular stress fracture in a professional baseball player: a case report and review of the literature. *Am J Sports Med*. 2007;35(7):1193–1196.
12. Herscovici D, Sanders R, DiPasquale T, Gregory P. Injuries of the shoulder girdle. *Clin Orthop Relat Res*. 1995;(318):54–60.
13. Heyse-Moore GH, Stoker DJ. Avulsion fractures of the scapula. *Skelet Radiol*. 1982;9(1):27–32.
14. Imatani RJ. Fractures of the scapula: a review of 53 fractures. *J Trauma*. 1975;15(6):473–478.
15. Knapik DM, Patel SH, Wetzel RJ, Voos JE. Prevalence and management of coracoid fracture sustained during sporting activities and time to return to sport: a systematic review. *Am J Sports Med*. 2018;46(3):753–758.
16. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *J Clin Epidemiol*. 2009;62(10):e1–e34.
17. Memisoglu S, Yilmaz B, Aktas E, Komur B. Isolated scapula fracture: Ice hockey player without trauma. *Ann Med Surg*. 2015;4(3):235–237.
18. Miller ME, Ada JR. Fractures of the scapula, clavicle, and glenoid. In: Browner BD, Jupiter JB, Levine AM, et al., eds. *Skeletal Trauma: Fractures, Dislocations, Ligamentous Injuries*. Philadelphia: WB Saunders; 1992:1291–1310.
19. Mugikura S, Hirayama T, Tada H, Takemitsu Y. Avulsion fracture of the scapular spine: a case report. *J Shoulder Elb Surg*. 1993;2(1):39–42.
20. Neer CS II, Rockwood CA Jr. Fractures and dislocations of the shoulder. In: Rockwood CA Jr., Green DP, eds. *Fractures in Adults*, 2nd ed. Philadelphia: JB Lippincott; 1984:713–721.
21. Norris TR. Fractures and dislocations of the glenohumeral complex. In: Chapman MW, Madison M, eds. *Operative Orthopaedics*. Philadelphia: JB Lippincott; 1988:203–220.
22. Rowe CR. Fractures of the scapula. *Surg Clin North Am*. 1963;43:1565–1571.
23. Ruedi T, Chapman MW. Fractures of the scapula and clavicle. In: Chapman MW, Madison M, eds. *Operative Orthopaedics*. Philadelphia: JB Lippincott; 1988:197–202.
24. Thompson DA, Flynn TC, Miller PW, Fischer RP. The significance of scapular fractures. *J Trauma*. 1985;25(10):974–977.
25. Veluvolu P, Kohn HS, Guten GN, et al. Unusual stress fracture of the scapula in a jogger. *Clin Nucl Med*. 1987;13(7):531–532.
26. Wyrsh RB, Spindler KP, Stricker PR. Scapula fracture in a professional boxer. *J Shoulder Elb Surg*. 1995;4(5):395–398.