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Clavicular Fracture in a Collegiate Football Player: A Case Report of Rapid Return to Play

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Objective: To present the case of surgical treatment and rehabilitation of a midshaft clavicular fracture in a National Collegiate Athletic Association Division I football athlete.

Background: While attempting to catch a pass during practice, the athlete jumped up and then landed on the tip of his shoulder. On-the-field evaluation was inconclusive, with a sideline evaluation diagnosis of clavicular fracture. Postinjury radiographs revealed a midshaft clavicular fracture.

Differential Diagnosis: Spiral oblique midshaft clavicular fracture.

Treatment: The sports medicine staff discussed surgical and nonsurgical options. A surgical procedure of internal fixation with an 8-hole plate was performed.

Uniqueness: Surgical treatment for clavicular fractures is becoming increasingly common. This is the first report of an advanced rehabilitation protocol for surgical repair. We suggest that new rehabilitation protocols for clavicular repairs be investigated now that surgical treatment is being pursued more frequently.

Conclusions: More aggressive treatment procedures and rehabilitation protocols for clavicular fractures have evolved in recent years. With these medical advancements, athletes are able to return to play much more quickly without compromising their health and safety.

Key Words: athletic injuries, upper extremity injuries, accelerated rehabilitation

Fractures of the clavicle are very common, accounting for between 2% and 12% of all fractures sustained and as many as 44% of all shoulder injuries.[1–6] Based on the anatomy of the clavicle, the midshaft region is the most susceptible to fracture, accounting for more than 70% of clavicular fractures.[4,7] In the past, clavicle fractures have traditionally been treated nonoperatively due to concerns about infection, hardware prominence, and a potential increase in the risk of nonunion.[7] The traditional conservative protocol provides positive results in more than 90% of athletes treated with a figure-8 sling.[8–10] However, recent reports[11–14] have discussed decreased union rates of displaced midshaft clavicular fractures treated nonoperatively. Closed treatment may lead to significant deficits, whereas surgical management results in an earlier and more reliable return to full function with a low complication rate.[9,14,15]

Operative management of clavicular fractures includes external fixation, intramedullary fixation, and osteosynthesis with a plate and screws. External fixation has been effective in open fractures and nonunions.[16] Intramedullary fixation has been described as the simplest of the 3 procedures, limiting the exposure involved. However, intramedullary fixation should not be used if a plate would better maintain clavicular length.[17] Plate osteosynthesis has the benefit of offering much more rigid fixation with more rotational control of the fracture.[17] Shen et al[18] reported a union rate of 97% in 232 athletes who underwent plate osteosynthesis, with only 1 deep infection and 4 superficial infections. No deformities or deficits in strength or range of motion were noted, and the satisfaction rate was 94%.[18] In reviewing nonrandomized, noncomparative data of 635 plated fractures versus nonoperative treatment, the plated fractures had a nonunion rate of 2.5% and nonoperative treatment had a nonunion rate of 5.9%.[19] With respect to displaced fractures, plating of 460 resulted in a nonunion rate of 2.2% compared with a nonunion rate of 15.1% in 159 patients treated nonoperatively.[19]

Although nonoperative treatment of midshaft clavicular fractures is still the standard of care, we are seeing positive results from surgical advances.[14] In 2007, the Canadian Orthopaedic Trauma Society[6] reported that early plate fixation for displaced clavicular fractures resulted in improved outcomes, early return to function, and decreased rates of nonunion and malunion. When nonoperative protocols were compared with operative measures such as elastic stable intramedullary nailing, the operative groups had faster return to daily activities and better overall functional outcomes.[14] However, in a retrospective study of 80 patients (40 nonoperative, 40 operative), return to sport activity was quicker for the patients treated nonoperatively: 2.6 months versus 3.2 months, respectively.[10] Thus, our purpose is to present the case of a National Collegiate Athletic Association Division I football player who sustained a midshaft clavicular fracture and underwent advanced surgical repair and rehabilitation. Combining the surgical repair and rehabilitation protocol allowed the athlete to return to the starting lineup for competition 6 weeks postinjury.

CASE REPORT

In September 2009, a 23-year-old male collegiate football athlete fractured his right clavicle during preseason football practice. The athlete was completing a pass route when he went airborne and fully extended his body and shoulder in attempt to catch the pass; he landed on the tip of his shoulder, sustaining a direct blow. Unable to support himself, the athlete was escorted off the field by the sports medicine staff for injury evaluation.

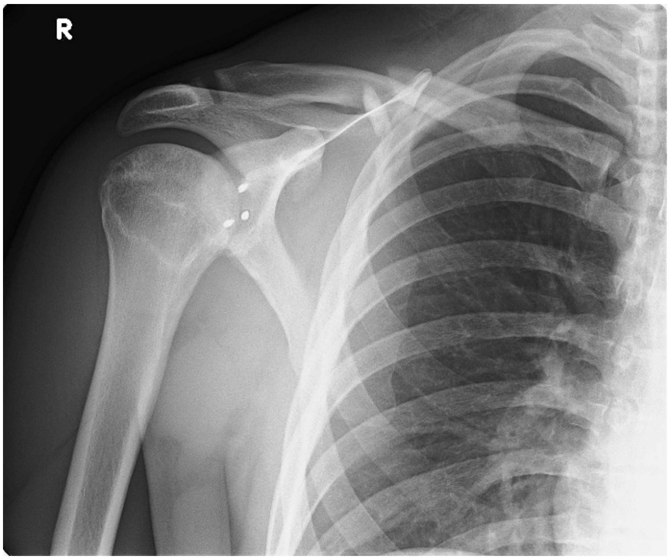

Figure 1. Anterior-posterior radiograph showing midshaft clavicular fracture. Note surgical anchors related to previous shoulder stabilization.

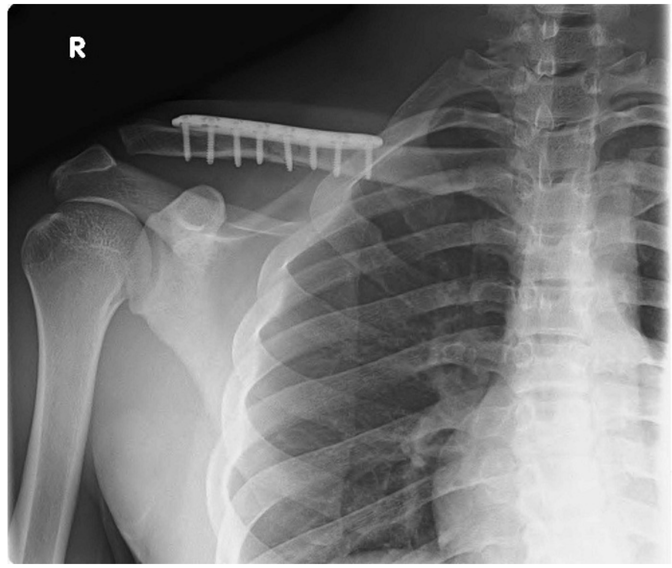

Figure 2. Radiograph showing plate osteosynthesis.

Field evaluation by the athletic trainer ruled out a shoulder dislocation, which the athlete had reported in his medical history. Point tenderness and gross deformity along the medial shaft of the clavicle and crepitus and swelling over the fracture site were apparent. The clavicle was elevated medially due to sternocleidomastoid muscle spasm and depressed laterally as a result of the pull of gravity on the glenohumeral joint as well as pectoralis muscle spasm.[20] Neurologic examination was within normal limits for both motor and sensory nerves. The patient was then referred to the team orthopaedic physician for further evaluation. Radiographic examination revealed a closed midshaft, comminuted fracture of the right clavicle (Figure 1) with shortening of 2 cm. Operative and nonoperative options were carefully discussed, and surgery was elected.

Internal fixation of the right clavicle with plate osteosynthesis was performed. Plate osteosynthesis was chosen over intramedullary pins due to the plate's ability to resist greater torsion and no risk of pin migration.[20] Also, plate osteosynthesis results in less displacement at fixed loads and provides a stronger construct, allowing early rehabilitation.[21]

At the time of surgery, a large butterfly fragment of approximately 2 cm off the anterior aspect of the midclavicle and a spiral oblique fracture were noted. The butterfly fragment was fixed with a 3.5-mm interfragmentary screw, reducing the fracture to 2 parts. The fracture was reduced and secured with the superior plate. Given the length of the fracture, the superior plate was used to maximize strength and stability. Allograft demineralized bone matrix was applied along the fracture line to promote healing (Figures 2 and 3).

REHABILITATION

The rehabilitation process began immediately postsurgery under the direction of the medical and athletic training staff. Two days after surgery the patient was performing range-of-motion pendulum exercises and strengthening through bicep curls and triceps extensions with lightweight dumbbells. In addition, cardiovascular fitness was maintained using a stationary bicycle. The rehabilitative and cardiovascular exercises are shown in Tables 1 and 2, respectively. As is routinely the case, our focus was the entire kinetic chain throughout the entire rehabilitation period. Lightweight dumbbells and sport cords were implemented for initial strengthening. Repetitions and sets were increased as tolerated. Range of motion progressed from active assistive to full active exercises with the patient performing all motions independently. By postoperative day 4, the patient had achieved 170° to 173° of shoulder flexion and abduction and 19° to 22° of shoulder extension and adduction. The primary modalities used were bone stimulation, thermotherapy, and soft tissue massage (Table 3).

Weekly radiographs were taken to ensure that no complications were occurring during the healing process. One week postsurgery, the patient progressed from the

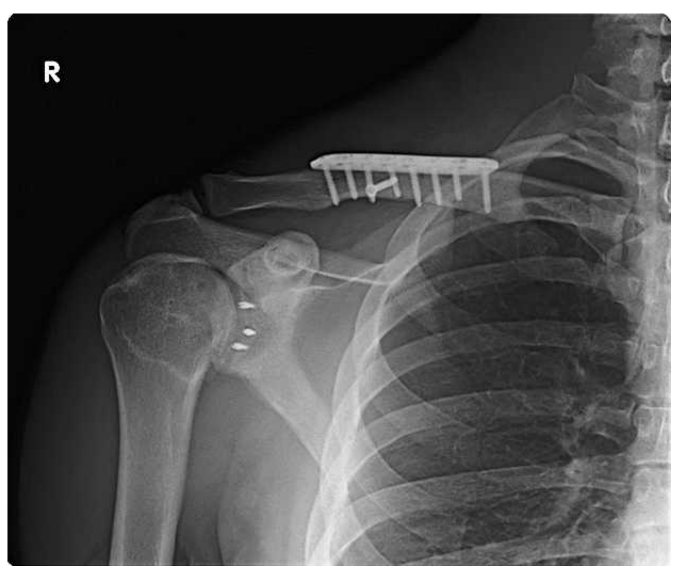

Figure 3. Radiograph showing 3.5-mm interfragmentary screw.

Table 1. Accelerated Rehabilitation Program for Clavicle Fracture

Activity	Exercises by Week 1	2	3	4	5
Range of motion	Codman pendulum (clockwise, counterclockwise, forward, backward, side to side), 2 × 1 min each	Codman pendulum (clockwise, counterclockwise, forward, backward, side to side), 2 × 1 min each			
Stretching		Passive range of motion	Passive range of motion	Passive range of motion	Passive range of motion
Bicep curls	Dumbbell (2 lb [0.9 kg]) or SportCord,[a] 3 × 12 reps	Dumbbell (6 lb [2.7 kg]) or SportCord, 4 × 12 reps			
Triceps extension	Dumbbell (2 lb [0.9 kg]) or SportCord, 3 × 12 reps	Manual resistance or dumbbell (5 lb [2.3 kg]), 4 × 12 reps			
Hand	Webbing or TheraBall[b] squeezes, flexion/extension, 3 × 1 min each	Webbing or TheraBall squeezes, flexion/extension, 3 × 1 min each; Rice bucket squeezes, 4 × 1 min each	Webbing or TheraBall or putty squeezes, flexion/extension, 4 × 1 min each		
Shoulder		Isometric progressing to SportCord, flexion/extension, abduction/adduction, 2 × 10 reps, and internal/external rotation, 3 × 10 reps	SportCord or manual resistance, flexion/extension, abduction/adduction, internal/external rotation, 3 × 10 reps	SportCord standing on Airex[c] mat, flexion/extension, abduction/adduction, internal/external rotation, 3 × 12 reps (fast)	
		Bodyblade[d] (arm at side), 4 × 45 s	PhysioBall[e] wall dribbles, 4 × 1 min each	Wall push-ups with PhysioBall	
		Shrugs 3 × 12	PhysioBall abduction, 4 × 30 s	Wall dribbles with MedBall,[f] 4 × 1 min each	
			PhysioBall with dumbbell, internal/external rotation; arms form letters I, T, Y, and W, 3 × 15 reps	Bodyblade, flexion, abduction, forward abduction, 2 × 1 min each	
			Seated flexion, abduction, 3 × 10 reps with 3-s holds		
			Dynamic hugs, 4 × 12 reps		
			Bodyblade, flexion, abduction, forward abduction, 2 × 1 min each		
			Table push-ups, 3 × 10 reps; Dynamic stabilization, 4 × 1 min each		
Scapula		Active protraction/retraction, scaption, 3 × 10 reps	SportCord retraction on Airex mat	SportCord protraction/retraction, scaption, 3 × 12 reps	
Neck		Manual 4-way, 3 × 10 reps			

Abbreviation: reps, repetitions.
[a] STI, Baton Rouge, LA.
[b] Theraballs.com, Vancouver, BC, Canada.
[c] Magister Corp, Chattanooga, TN.
[d] Madd Dog Athletics, Venice, CA.
[e] Ball Dynamics International, LLC, Longmont, CO.
[f] Ideal Fitness, Inc, Boynton Beach, FL.

Table 2. Cardiovascular Rehabilitation Protocol[a]

Activity	Week 1	2	3	4	5
Bicycle	20 min	20 min	Upper body ergometer, 10 min	Upper body ergometer, 10 min	
Elliptical machine		Begin at 10 min, build to 25 min			
Running			Running with team	Running pass routes with team (no contact)	Full practice with limited repetitions

[a] The athlete was discharged from rehabilitation at the end of week 5.

stationary bicycle to an elliptical machine, on which he moved his arms while conditioning. Two weeks after surgery, shoulder extension and adduction had improved to slightly greater than 30° and muscle strength was 80%. He was allowed to discontinue the use of his sling and begin jogging. At week 3, a more dynamic rehabilitation protocol was implemented, including ball dribbling, Bodyblade (Madd Dog Athletics, Venice, CA) exercises, upper body ergometer, and participation in team conditioning drills. Increased activity during week 3 resulted in trapezius muscle tightness; however, modalities and soft tissue massage were successful in alleviating this tightness. At week 4, the patient began push-up progressions off a table and dynamic stabilization and advanced scapular exercises, strengthening exercises, and participation in noncontact practices. By week 5, full strength and range of motion were achieved, and the athlete was released to full contact during practice. A clavicle pad with extra padding around the clavicle was inserted into his shoulder pads for additional protection. A computed tomography scan at week 6 revealed adequate healing, and the athlete was released to return to full competition.

DISCUSSION

The fracture sustained in this case was a type I, middle third of the clavicle, which is considered the most common site for clavicular fractures.[22] Midshaft clavicular fractures account for 69% to 82% of all clavicular fractures.[5,7] In the past, nonoperative treatment was the norm, based on reports of rare nonunion episodes[1,23]: The recommendation for type I clavicular fractures with shortening was a conservative approach for 6 weeks and then, if no callus had formed, surgery was indicated.[23] However, the treatment of clavicular fractures has changed drastically in recent years. Due to the current trend of nonunion rates in nonsurgical management, open reduction and internal fixation (ORIF) has become readily accepted in clavicular fracture management.

The athlete in this case sustained a fracture to the middle third of his clavicle secondary to a direct impact on his right shoulder while diving to catch a pass. He opted for surgery instead of nonoperative treatment consisting of sling immobilization for 2 to 6 weeks.[20] The ORIF was performed immediately, and the athlete returned to full, competitive contact within 6 weeks. Previous timelines for regaining full range of motion and function after surgery were unclear.[24,25] We present a successful ORIF surgical repair and specific timeline for return to functional, competitive activity.

CONCLUSIONS

Traditionally, an athlete undergoing traditional treatment of a clavicular fracture would have been immobilized for 3 to 6 weeks before any range-of-motion exercises were started. However, in the past few years, more aggressive treatment protocols for clavicular fractures have become popular. Success rates of 94% to 100% with low rates of infections and complications have been reported with plate fixations of acute midshaft clavicular fractures,[19,26,27] and intramedullary nailing using titanium elastic nails has also evolved.[14,28] With surgical treatment and appropriate rehabilitation, our athlete was able to return to competition at 6 weeks without compromising his health or safety.

Table 3. Therapeutic Modality Protocol

Modality	Week 1	2	3	4	5
NormaTec PCD[a]		Shoulder setting, 15 min			
Bone stimulation[b]	20 min	20 min	20 min	20 min	20 min
Cryotherapy	Ice bag or GameReady,[c] 20 min prerehabilitation and postrehabilitation	Ice Bag or GameReady, 20 min postrehabilitation			
Thermotherapy		Hydrocollator pack, 15 min prerehabilitation	Hydrocollator pack, 15 min prerehabilitation		
Manual therapy			Soft tissue massage	Soft tissue massage	Soft tissue massage

Abbreviation: PCD, pneumatic compression device.
[a] NormaTec, Newton Center, MA.
[b] Exogen 400+ Ultrasound Bone Healing System (Smith & Nephew, London, UK), 30 mW/cm^2.
[c] CoolSystems, Inc, Alameda, CA.

The rehabilitation protocol implemented in this case was advanced, yet evidence on validated accelerated rehabilitation protocols for clavicular fractures is currently lacking. As surgical repair for clavicular fractures becomes more frequent, we need to investigate new rehabilitation protocols.

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REFERENCES

1. Neer CS II. Nonunion of the clavicle. *JAMA*. 1960;172:1006–1011.
2. Eskola A, Vainionpaa S, Myllynen P, Patiala H, Rokkanen P. Outcome of clavicular fracture in 89 patients. *Arch Orthop Trauma Surg*. 1986;105(6):337–338.
3. Craig EV. Fractures of the clavicle. In: Rockwood CA, Matsen FA III, eds. *The Shoulder*. Vol 1. Philadelphia, PA: WB Saunders; 1990: 367–401.
4. Nordqvist A, Petersson C. The incidence of fractures of the clavicle. *Clin Orthop Relat Res*. 1994;300:127–132.
5. Postacchini F, Gumina S, De Santis P, Albo F. Epidemiology of clavicle fractures. *J Shoulder Elbow Surg*. 2002;11(5):452–456.
6. Canadian Orthopaedic Trauma Society. Nonoperative treatment compared with plate fixation of displaced midshaft clavicular fractures: a multicenter, randomized clinical trial. *J Bone Joint Surg Am*. 2007;89(1):1–10.
7. Smekal V, Oberladstaetter J, Struve P, Krappinger D. Shaft fractures of the clavicle: current concepts. *Arch Orthop Trauma Surg*. 2009; 129(6):807–815.
8. Post M. Current concepts in the treatment of fractures of the clavicle. *Clin Orthop Relat Res*. 1989;245:89–101.
9. Robinson CM, Court-Brown CM, McQueen MM, Wakefield AE. Estimating the risk of nonunion following nonoperative treatment of a clavicular fracture. *J Bone Joint Surg Am*. 2004;86(7):1359–1365.
10. Grassi FA, Tajana MS, D'Angelo F. Management of midclavicular fractures: comparison between nonoperative treatment and open intramedullary fixation in 80 patients. *J Trauma*. 2001;50(6):1096–1100.
11. Chan KY, Jupiter JB, Leffert RD, Marti R. Clavicle malunion. *J Shoulder Elbow Surg*. 1999;8(4):287–290.
12. McKee MD, Pedersen EM, Jones C, et al. Deficits following nonoperative treatment of displaced midshaft clavicular fractures. *J Bone Joint Surg Am*. 2006;88(1):35–40.
13. McKee MD, Wild LM, Schemitsch EH. Midshaft malunions of the clavicle. *J Bone Joint Surg Am*. 2003;85(5):790–797.
14. Smekal V, Irenberger A, Struve P, Wambacher M, Krappinger D, Kralinger FS. Elastic stable intramedullary nailing versus nonoperative treatment of displaced midshaft clavicular fractures: a randomized, controlled, clinical trial. *J Orthop Trauma*. 2009;23(2): 106–112.
15. Hill JM, McGuire MH, Crosby LA. Closed treatment of displaced middle-third fractures of the clavicle gives poor results. *J Bone Joint Surg Br*. 1997;79(4):537–539.
16. Schuind F, Pay-Pay E, Andrianne Y, Donkerwolcke M, Rasquin C, Burny F. External fixation of the clavicle for fracture or non-union in adults. *J Bone Joint Surg Am*. 1988;70(5):692–695.
17. Preston CF, Egol KA. Midshaft clavicle fractures in adults. *Bull NYU Hosp Jt Dis*. 2009;67(1):52–57.
18. Shen WJ, Liu TJ, Shen YS. Plate fixation of fresh displaced midshaft clavicle fractures. *Injury*. 1999;30(7):497–500.
19. Zlowodzki M, Zelle BA, Cole PA, Jeray K, McKee MD. Evidence-Based Orthopaedic Trauma Working Group. Treatment of midshaft clavicle fractures: systemic review of 2144 fractures: on behalf of the Evidence-Based Orthopaedic Trauma Working Group. *J Orthop Trauma*. 2005;19(7):504–507.
20. Moonot P, Ashwood N. Clavicle fractures. *Trauma*. 2009;11(2): 123–132.
21. Golish SR, Oliviero JA, Francke EI, Miller MD. A biomechanical study of plate versus intramedullary devices for midshaft clavicle fixation. *J Orthop Surg Res*. 2008;3:28.
22. Swanson KE, Swanson BL. A minimally invasive surgical technique to treat distal clavicle fractures. *Orthopedics*. 2009;32(7):509.
23. Wick M, Müller EJ, Kollig E, Muhr G. Midshaft fractures of the clavicle with a shortening of more than 2 cm predispose to nonunion. *Arch Orthop Trauma Surg*. 2001;121(4):207–211.
24. Mizue F, Shirai Y, Ito H. Surgical treatment of comminuted fractures of the distal clavicle using Wolter clavicular plates. *J Nippon Med Sch*. 2000;67(1):32–34.
25. Mueller M, Burger C, Florczyk A, Striepens N, Rangger C. Elastic stable intramedullary nailing of midclavicular fractures in adults: 32 patients followed for 1–5 years. *Acta Orthop*. 2007;78(3):421–423.
26. McKee MD, Seiler JG, Jupiter JB. The application of the limited contact dynamic compression plate in the upper extremity: an analysis of 114 consecutive cases. *Injury*. 1995;26(10):661–666.
27. Poigenfurst J, Rappold G, Fischer W. Plating of fresh clavicular fractures: results of 122 operations. *Injury*. 1992;23(4):237–241.
28. Frigg A, Rillmann P, Perren T, Gerber M, Ryf C. Intramedullary nailing of clavicular midshaft fractures with the titanium elastic nail: problems and complications. *Am J Sports Med*. 2009;37(2):352–359.

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