Return to Play After Surgical Treatment of High-Grade Acromioclavicular Joint Injuries in the Australian Football League

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Background: Acromioclavicular joint (ACJ) injuries are the second most common upper limb injuries in the Australian Football League (AFL); however, there is little evidence on the return-to-sport results after surgical stabilization of the ACJ in this sporting population.

Purpose: To investigate the return-to-sport time, on-field performance, and patient-reported outcomes in a series of professional AFL players after undergoing ACJ stabilization.

Study Design: Case series; Level of evidence, 4.

Methods: We conducted a retrospective case series of all AFL players who had undergone open twin-tailed dog-bone ACJ stabilization by a single surgeon between September 2013 and April 2017. Outcome measures included time to return to sport, on-field performance indicators (handballs, tackles, kicks, and AFL Fantasy and Supercoach scores), the Nottingham Clavicle Score, Oxford Shoulder Score, and the Specific Acromioclavicular Score. Patient-reported outcomes were evaluated at a minimum follow-up of 12 months.

Results: Of 13 senior listed AFL players who underwent twin-tailed dog-bone surgery, 9 players were included. Mean follow-up was 24.8 months (range, 5-41 months) postoperatively. Mean return-to-sport time was 8.6 weeks for injuries that occurred within the season. The number of kicks, marks, handballs, and tackles as well as AFL Supercoach and Fantasy scores did not significantly change after surgery ($P > .05$). Outcome measures showed a high level of patient satisfaction after surgery, with a mean Nottingham Clavicle Score of 92.2, Oxford Shoulder Score of 47.7, and the Specific Acromioclavicular Score of 7.5.

Conclusion: In a collective of professional AFL players with ACJ injury, our twin-tailed dog-bone technique revealed return to competitive play could be achieved at a mean of 8.6 weeks without compromising on-field performance or patient-reported pain, function, and satisfaction.

Keywords: acromioclavicular joint; stabilization; surgery; twin-tailed dog bone; Australian rules football; Australian Football League

Australian rules football is a unique collision sport played widely in Australia and requires a mix of endurance, high-speed running, kicking, ball-handling skills (many overhead), and tackling.[30] The Australian Football League (AFL) is the highest playing league in Australian rules football (ARF). There are 756 senior listed professional players in the AFL at any time, and the season runs from March to the end of September. After glenohumeral dislocations, acromioclavicular joint (ACJ) injuries are the most common upper limb injuries in the AFL and occur because of the lateral contact and collision nature of this sport, which is played without shoulder padding (Figure 1).[30]

The Rockwood ACJ classification system is commonly used for categorizing ACJ injury[27] and grades the severity from I to VI based on the degree of soft tissue disruption and/or displacement of the clavicle. Type I injuries involve a minor sprain of the ACJ ligaments, type II injures can display horizontal instability and up to 25% vertical displacement of the clavicle, type III injuries 25% to 100% vertical displacement of the clavicle, type IV injuries have the addition of posterior displacement of the clavicle through the trapezius muscle, type V injuries display vertical displacement of the clavicle greater than 100%, and in type VI injures the clavicle is dislocated inferiorly.[27] Grading of ACJ injuries should be made in comparison with the

Figure 1. Typical lateral collision mechanism for acromioclavicular joint injury in Australian rules football.

uninjured side.[18] An addition to the Rockwood classification was introduced to distinguish between horizontally stable (type IIIA) and unstable (type IIIB) injuries in the anteroposterior plane.[5]

Basamania[39] has initiated discussion of so-called medial ACJ instability where the acromion is pushed in under the lateral clavicle in cross-body and resisted external rotation activities that are seen in sport with "fending away" movements, which are critical to AFL football. There is a consensus in the literature to treat acute Rockwood type I and II injuries conservatively and Rockwood type IV, V, and VI injuries operatively.[23] The treatment of acute Rockwood type III injuries remains controversial.[27] This is in part owing to discrepancies in the diagnosis and, hence, classification of Rockwood type III versus type IV injuries,[18,27] variations in upper limb demands within patient populations when surgery versus conservative management is compared, and the use of outcome measures that are not ACJ specific.[4] A recent survey of National Football League (NFL) physicians reported that most preferred to treat Rockwood type III ACJ injuries conservatively,[33] given recent studies that have reported a mean loss to play between 26.4[20] and 31.9 days[11] in NFL and National Collegiate Athletic Association (NCAA) football players with

type III ACJ injuries when the majority were treated conservatively. Conversely, some recent evidence suggests that outcomes of type III ACJ injures are superior with surgical fixation[7,17,28] and may therefore be a more appropriate treatment choice in patients who participate in physically demanding occupations and/or sports that require repetitive overhead motion or unprotected shoulder contact.[7,17,38]

To the best of the authors' knowledge, there is only 1 published study reporting return-to-sport results after ACJ stabilization in AFL players.[7] In 2002, Cardone et al[7] investigated surgical versus conservative management of Rockwood type III injuries in 14 players. Six players were initially treated operatively and 8 players conservatively. The operative technique was an absorbable suture passed around the coracoid and clavicle. Return to competitive football was 18.8 weeks for the operative group and 26.2 weeks for the nonoperative group, showing a long layoff in nonoperative treatment. Club financial pressures, relatively short playing careers, and premiership flag goals are some of the reasons that clubs and players have a vested interest in the safest yet shortest time possible that return to play can occur after ACJ stabilization surgery.[7]

With more modern and biomechanically stronger anatomic ACJ stabilization techniques, a quicker return to AFL football with no loss of performance seems feasible. Furthermore, no published data are available regarding postoperative patient-reported outcome measures (PROMs) or player performance evaluation post ACJ stabilization in AFL players. Early return to play, good shoulder function, and successful postoperative performance are of great interest to clubs, athletes, and the managing medical community.

The aim of this paper was to retrospectively review the return-to-sport time frame, performance levels, and PROMs after twin-tailed dog-bone ACJ stabilization in a series of professional AFL players. We hypothesize that most players will return to sport within the same season of being injured, without compromising on field performance or patient-reported pain, function, and satisfaction.

METHODS

After ethical approval was obtained, a retrospective analysis was performed of all consecutive ARF players who had undergone open twin-tailed dog-bone ACJ stabilization[15] by the senior author (G.H.) between September 2013 and April 2017. Only professional players listed at the highest

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Figure 2. Preoperative injury of Rockwood type borderline III to V (in this case with dynamic medial instability confirmed on clinical testing; resisted shoulder external rotation with arm at side).

level of ARF (the AFL) were included. The indication for surgery was clinical and radiological evidence of acute ACJ instability. This included high-grade instabilities classified as Rockwood type IV and V, as well as Rockwood type III injuries that displayed horizontal instability clinically (Rockwood type IIIB or medial instability) (Figure 2). We obtained a supraspinatus outlet view showing overriding of the distal clavicle.[5]

Players with chronic ACJ instability were excluded, as they are a different subgroup of ACJ instability[9] and significant controversy in the literature exists as to whether biological augmentation is required (eg, tendon grafting).[6,9] Therefore, inclusion of chronic ACJ injuries in this very specific sporting cohort would likely confound any treatment effects. Horizontal instability was assessed by performing glenohumeral-resisted external rotation with the arm by the side and the active compression (O'Brien's)[2] test while fixing the acromion with one hand. A significant distal clavicle shift posteriorly in comparison with the unaffected side indicated a component of horizontal ACJ instability.[35] Patients with additional injuries (eg, lateral clavicle fracture or associated shoulder joint pathology including glenohumeral joint instability) were excluded. Patient characteristics such as age, hand dominance, time to surgery, and Rockwood ACJ injury classification were extracted from the clinical file.

Our unique twin-tailed dog-bone technique using Fiber-Tape (by Arthrex, Naples, Florida, USA) has been published previously.[15] All operations were performed with an ultrasound-guided interscalene block and general anesthetic in an upright beach-chair position. A longitudinal superior approach was made in line with the lateral clavicle and ACJ. The deltotrapezial fascia and muscle were divided superior to the clavicle and elevated as a single layer off the clavicle anteriorly (deltoid) and posteriorly (trapezius) for subsequent double-breast closure. The distal clavicle was exposed, and if osteoarthritic changes (eg, osteophytes) were present, 5 mm of the distal clavicle was resected.

The anterior fascia was elevated off the clavicle, the coracoclavicular (CC) ligaments were identified, and along the ligaments the base of the coracoid was reached. First, a 2.4-mm drill hole was created as posterior as possible in the center of the coracoid base. This is narrower than that required for most other passing techniques (such as endo-buttons). Second, two 2.4-mm clavicular drill holes were marked out. The position of the clavicular drill holes was medial (to replicate the conoid ligament insertion point), with the lateral clavicle drill hole in a more lateral position than the traditional vertical position, which is closer to the true trapezoid center of attachment point but still achieves vertical control. The drills holes were placed as near to the anatomic centers for the conoid and trapezoid ligaments as possible (ie, close to vertical for the lateral implant and approximately 3 cm medial for the medial implant). Both holes were angled toward the coracoid hole to avoid excess "corners" of the tape at the hole margins.

Afterward, a FiberTape and a TigerTape (Arthrex, Inc) were shuttled through the coracoid drill hole and a dog-bone implant (Arthrex, Inc) was well seated on the undersurface of the coracoid, with the FiberTape and TigerTape linked to it before positioning. The 2 separate tapes were passed individually through each of the respective clavicular drill holes. Two dog-bone implants were then threaded over these separate limbs. Next, the ACJ was reduced and fixed by first tying the medial suture limb to medialize the scapula relative to the clavicle. The lateral suture limb was tightened, reducing the scapula and correcting the inferior placement of the acromion relative to the distal clavicle. Both tape limbs were tied off with a minimum of 6 square surgeon's knots to allow them to be laid down on the clavicle to minimize any lump.

There was no formal repair (such a direct suture) of the CC ligaments performed because indirect healing is facilitated by CC stabilization with the 2 FiberTape. The ACJ capsule was repaired in conjunction with the internal brace around the ACJ with a combined cerclage and figure-of-eight technique. The ACJ was separately stabilized with FiberTapes in a figure-of-eight fashion, with separate anteroposterior, 2-mm bone tunnels through the lateral clavicle and the acromion, between 5 and 10 mm from the ACJ surface.

Finally, attention was shifted to the imbrication and repair of the deltotrapezial sleeve. A double-breasting-type suture aided in tightening the sleeve over the clavicle and ACJ and thickening the tissue cover over the anchors and knots. Skin was then closed in a layered fashion with a dissolvable subcuticular suture to skin. Figure 3 displays an early postoperative radiograph of the twin-tailed dog-bone technique.

The postoperative rehabilitation protocol included immobilization in a neutral sling only until wound healing. Passive and active assisted mobilization was allowed without limitation from day 1 postoperatively and removal of the sling for active movement from 1 week postoperatively. No weightbearing or strengthening exercises were allowed on the affected extremity before 3 weeks. Radiographs were performed 8 to 12 weeks postoperatively; however, return to training and competition were based on clinical and not
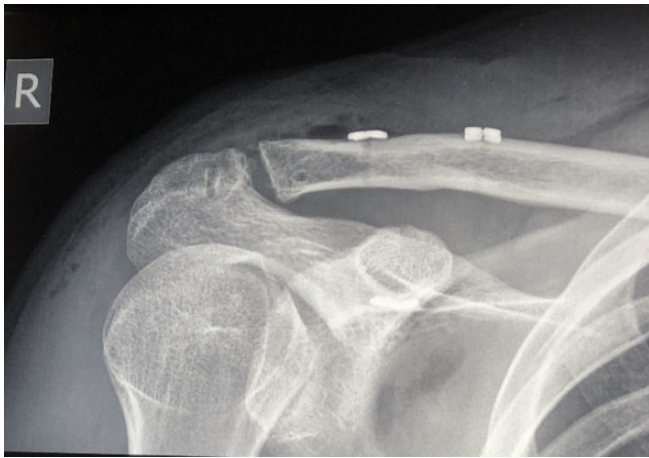
Figure 3. Early postoperative view of the twin-tailed dog-bone technique. Note the internal brace holes.

Figure 4. Flowchart of participant inclusion. ACJ, acromioclavicular joint; AFL, Australian Football League.

radiological findings. Return to noncontact training was permitted after 4 weeks, and contact (collision) training if the player had adequate shoulder strength after 5 weeks. Players were cleared to full-contact training and play from 6 weeks onward. This accelerated rehabilitation protocol is specific to professional AFL players and may not be appropriate for nonprofessional athletes.

Official AFL statistics compiled by an independent website (AFL Footywire Statistics[1]; https://www.footywire.com) were accessed to determine the time between surgery and return to match play for each patient. Return to play was defined as returning to a scheduled competitive match at the same level that was played by the athlete before surgery. Players were excluded from return-to-play analysis if they were injured during the off-season (October to February), as their earliest return to play could only be the first match in March, which would skew the results.

Data from the AFL statistics website were analyzed to identify differences in various player on-field performance indicators pre- and postoperatively. The performance indicators chosen reflect the high level of shoulder function required of professional AFL athletes and included the number of marks, kicks, handballs, and tackles made per game. A mark is made when a player catches a ball that has not touched the ground or another player after it has been kicked. The untouched ball must have travelled at least 15 m. A handball is the act of holding the football in 1 hand and disposing of it by hitting it with the clenched fist of the other hand. Kicks are similar to kicks in other codes of football, except that all players in any field position can take them. In addition, AFL Fantasy and Supercoach scores were recorded. These overall performance scores are subjective ratings from media organizations and the AFL, and they are published weekly to assess players' performance against their usual output. When available, each performance indicator was averaged over a consecutive 5-game period pre- and postoperatively, and the difference between these 2 averages were analyzed. Missing data were accounted for by restricted maximum likelihood estimation.[19]
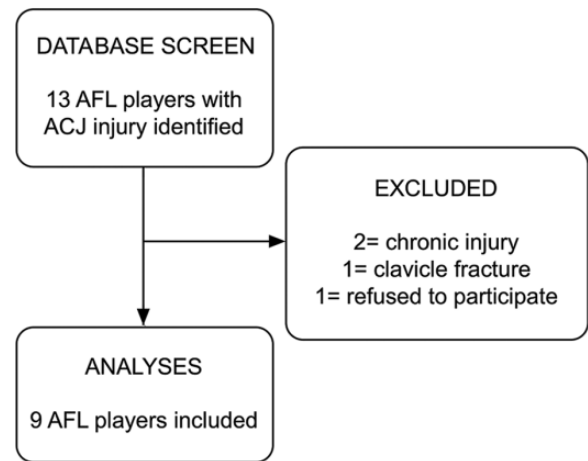
Players completed 3 online PROMs after a minimum of 12 months postoperatively, including the Oxford Shoulder Score (OSS; scores range from 0 [worst] to 48),[10] the Nottingham Clavicle Score (NCS; scores range from 0 [worst] to 100),[8] and the Specific Acromioclavicular Score (SACS; scores range from 0 [best] to 100).[4] The OSS is a measure of general shoulder function, and the NCS and SACS are scores that are specific and sensitive to measuring changes in the ACJ population.[4,8,32] The SACS includes a scale that allows the participant to rate their overall perceived level of shoulder function from 0% (very poor function) to 100% (normal shoulder). This rating was not included in the overall SACS score.

Statistical analysis was performed using SPSS statistics software (version 22.0; IBM). All authors had access to the raw data to enable cross-checking and to ensure data transparency. Continuous variables measured at a single time-point postsurgery (ie, time to return to play and PROM data) were expressed as means, ranges, and standard deviations. Postsurgery performance data were compared with presurgery performance data using paired sample t tests. A P value $<.05$ was considered statistically significant.

RESULTS

We identified 13 AFL players who underwent open ACJ stabilization from our surgical database; of those, 9 patients were included in the study. Two players were excluded because they had chronic injuries (ie, lasting more than 6 weeks after trauma) and therefore an additional Weaver-Dunn procedure was performed. One player had an additional lateral clavicle fracture and was therefore excluded. One player refused to participate (Figure 4).

Player characteristics and return-to-play results are listed in Table 1. All players injured their ACJ traumatically, via a fall to the ground or forceful tackle with an opponent. The dominant shoulder was involved in 7 of 9 included patients (78%). The mean age of the players at time of

TABLE 1
Player Characteristics and Return-to-Sport Results[a]

Player	Age at Injury, y	Level of AFL at Injury	Month Injured	Side Affected	Time to Surgery (d)	Rockwood Classification	Time to Return (wk)
1	21	VFL	May	Dominant	2	IV	8
2	23	AFL	April	Nondominant	3	V	9
3	23	AFL	November[b]	Dominant	6	V	12
4	23	AFL	April	Dominant	2	V	6
5	19	AFL	July	Nondominant	2	IIIB	10
6	20	AFL	April	Dominant	3	V	8
7	22	AFL	June	Dominant	2	IIIB	8.5
8	27	AFL	April	Dominant	3	V	6
9	24	AFL	April	Dominant	5	V	13
Mean ± SD (range)	22.4 ± 2.4 (19-27)	—	—	—	3 (2-7)		8.6 ± 2.3 (6-13)

[a]AFL, Australian Football League; VFL, Victorian Football League.
[b]Player 3 was injured at the end of the AFL season and so was not included in the within-season return-to-play analyses.

TABLE 2
Patient-Reported Outcome Measures Post-ACJ Stabilization in AFL Players[a]

Player	SACS[b]				SSV, %[c]	NCS[c]	OSS[d]
	Pain	Function	QOL and Satisfaction	Overall Score			
1	1	15	7	11.5	95	90	48
2	5	15	10	15.0	90	82	48
3	0	2	4	3.0	100	94	48
4	7	12	2	10.5	98	96	48
5	0	0	8	4.0	95	86	48
6	0	2	9	5.5	98	100	48
7	1	3	8	6.0	95	96	48
8	9		6	11.5	90	86	45
9	0	0	1	0.5	100	100	48
Mean ± SD (range)	2.6 ± 3.5 (0-9)	6.3 ± 6.3 (0-15)	6.1 ± 3.1 (1-10)	7.5 ± 4.8 (0.5-15)	96 ± 4 (90-100)	92.2 ± 6.5 (82-100)	47.7 ± 1.0 (45-48)

[a]ACJ, acromioclavicular joint; AFL, Australian Football League; NCS, Nottingham Clavicle Score; OSS, Oxford Shoulder Score; QOL, quality of life; SACS, Specific Acromioclavicular Joint Score; SSV, Subjective Shoulder Value.
[b]Overall score graded on a scale from 0 (worst) to 100.
[c]Graded on a scale from 0 (best) to 100.
[d]Graded on a scale from 0 (worst) to 48.

surgery was 22.4 years (range, 19-27 years). The grade of ACJ instability was Rockwood type IIIB in 2 patients, type IV in 1 patient, and type V in 6 patients. The mean time from injury to surgery was 3 days (range 2-6 days).

All players had returned to their previous level of competitive play after surgery. Commonly, players initially returned to the second highest ARF league called the Victorian Football League (VFL) for a couple of games to ensure they were physically and psychologically ready to return to the AFL. One player was AFL listed but played in the VFL at the time of injury. He also returned to that level after surgery within the season. One of the 9 included players (player 3 in Table 1) was injured in the off-season and so was not included in the within-season return-to-play analyses. Average time of return to play was 8.6 weeks

(range, 6-13 weeks) for injuries that occurred during the season.

All PROMs revealed a low level of pain and high level of shoulder function and satisfaction (Table 2). The mean follow-up time for PROMs was 24.8 months (range, 5-41 months) after surgery. At that time, the mean OSS was 47.7 ± 1 (range, 45-48), the mean NCS was 92.2 ± 6.5 points (range, 82-100), and the mean overall SACS was 7.5 ± 4.8 (range, 0.5-15). The mean overall perceived level of shoulder function on the SACS was 96% ± 4% (range, 90%-100%).

Performance scores are listed in Table 3. There was no significant difference in the mean number of kicks, handballs, marks, or tackles for each player before versus after ACJ surgery ($P > .05$). AFL Supercoach and AFL

TABLE 3
Performance Scores Before Versus After ACJ Surgery[a]

Performance Indicator	Preoperative	Postoperative	P (2-tailed)
Kicks	6.3 ± 2.5	8.4 ± 3.3	.056
Handballs	7.3 ± 3.7	7.4 ± 3.8	.936
Marks	3.1 ± 1.3	4.9 ± 3.4	.057
Tackles	3.3 ± 2.0	2.9 ± 0.9	.536
AFL Supercoach	69.9 ± 24.5	73.4 ± 24.2	.575
AFL Fantasy	59.7 ± 21.6	66.9 ± 20.3	.334

[a]Scores were calculated over 5 consecutive games before and after surgery. Data are reported as mean ± SD. ACJ, acromioclavicular joint; AFL, Australian Football League.
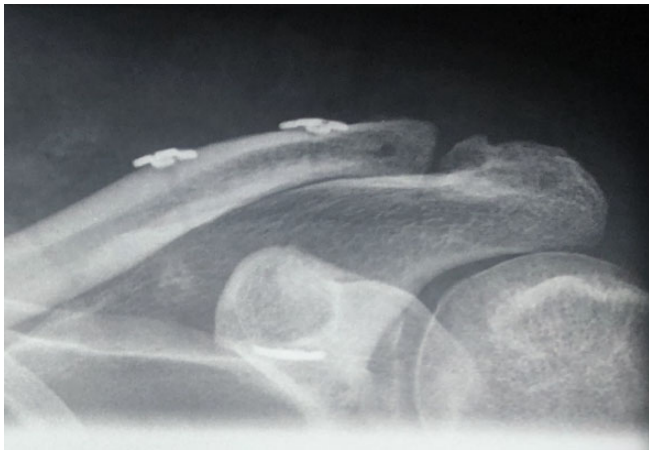

Figure 5. Maintained acromioclavicular joint correction (12 weeks postoperatively).

Fantasy scores did not significantly change after surgery ($P > .05$).

None of the players developed subsequent postoperative ACJ subluxation (Figure 5) or suffered any other surgical complications (eg, coracoid or clavicle fractures, displaced anchors, or tape failures). One player had a prominent anchor that was irritating under a seatbelt, and this was removed at 10 months without any further issues.

DISCUSSION

ACJ joint injury is the second most common upper limb injury in ARF, which costs players and teams owing to time out of competitive play. In this study, the mean within-season return-to-play time of elite AFL players was 8.6 weeks, with no significant effect on on-field performance and no postoperative complications. This result is despite most players having had a Rockwood type V injury.

Our return-to-sport time frame is much shorter compared with previously published post–ACJ surgery data in collision athletes.[20,21,36] The only previously published study of post-ACJ surgical outcomes in AFL players reported an average return-to-sport–specific training and

return to competitive matches at 13.6 and 18.8 weeks, respectively.[7] Marcheggiani Muccioli et al[21] compared the outcomes of professional and nonprofessional athletes after open ACJ reconstruction with a Ligament Augmentation and Reconstruction System (LARS) ligament.[21] Nineteen of the 22 professional athletes were rugby players. The average return-to-sport time was 4 months for professional and 5 months for nonprofessional athletes. No significant differences could be found for PROMs or complication and failure rates between the groups, although professional athletes had superior radiological outcomes. Saier et al[29] published return-to-sport data in 42 patients after arthroscopically assisted anatomic ACJ reconstruction with 2 independent suture button devices (TightRope; Arthrex) of acute Rockwood type V injuries. All patients returned to sport, with 62% returning to their preinjury level of competition. None of the included participants were professional athletes. According to their postoperative protocol, return to overhead and/or contact sports was prevented for 6 months. Porschke et al[26] reported on the proportion of 55 patients who returned to sporting activities after a mini-open stabilization with a TightRope for acute Rockwood type V injuries.[26] At final follow-up, 95.3% of patients who performed any sports could return to those sports; however, 37.2% had to change their sport to reduce the demand of participation. None of the patients were professional athletes. Similarly, the postoperative rehabilitation protocol prevented unrestricted sports for 6 months after surgery. Porschke et al[26] also reported a high rate of wound complications (9.1%) after the mini-open technique, whereas we did not see any wound-healing problems with an open technique. We hypothesize that using the deltoid muscle flap to cover the fixation material minimizes this possible mechanical irritation. Triantafyllopoulos et al[36] recently reported on the proportion of 10 professional athletes who returned to sport after an open anatomic ACJ reconstruction with a synthetic polyester tape (JewelACL, Neoligaments, Xiros Ltd) for an acute Rockwood type V ACJ injury.[36] The athletes participated in a variety of sport activities, such as mountain biking, bike racing, triathlon, kickboxing, basketball, and goalkeeping. Again, the rehabilitation program prevented unrestricted return to sport until 6 months after surgery. All the athletes returned at that time to their individual sports. In the aforementioned studies,[25,29,36] only the outcome of whether or not a participant returned to sport was evaluated and not the average time taken to return.

Our group of AFL players may have achieved an earlier return to play because of the strength and reliability of the TightRope ACJ techniques. Biomechanically, compared with other ACJ techniques, it has been shown that the TightRope techniques yield superior load-to-failure rates.[22,31] In addition, a recent systematic review[40] comparing various surgical techniques for the dislocated ACJ reported reconstruction of CC ligaments using TightRope techniques achieved the safest and most predictable results for acute ACJ separation, with only 5% of patients displaying a recurrent dislocation on radiographs. The strength and reliability of this technique may have allowed players

to be comfortable with earlier shoulder movement and a faster progression through their rehabilitation program, instilling confidence for early return. This rationale for early return is speculative, as players' perspective of their recovery experience was not measured.

The surgical management of Rockwood type III injuries remains controversial, which is, in part, owing to the evaluation of heterogeneous populations across the literature. Some of the discrepancies on how to manage Rockwood type III ACJ injuries are due to previous studies failing to subgroup their cohorts. Contact and noncontact sporting populations or sedentary and active populations are often evaluated as an entire cohort, which can mitigate treatment effects for a particular subgroup.[13] In addition, a myriad of factors contribute to an athlete's outcome post-ACJ surgery, including the type of sport in which they participate. ACJ injuries are common in sports such as American football and rugby where outcomes of conservative management of Rockwood type III injures are generally good. Lynch et al[20] reported on data of ACJ injuries in the NFL over 12 seasons. Unexpectedly, all ACJ injuries were classified as Rockwood grade III or less, despite 3 ACJ injures classified as "clavicle acromioclavicular dislocation," which seems to describe more severe ACJ injuries. The authors acknowledged that low intraobserver and interobserver reliability of the Rockwood classification system may have misdiagnosed type V for type III injures and/or high-grade ACJ injuries may be rare because of the protective shoulder padding worn by NFL players. Most ACJ injures were managed conservatively with a mean return to sport of 9.8 days. The 3 players classified with "clavicle acromioclavicular dislocation" had an average return to play after 77.7 days. Only 1.7% of athletes had surgery and, surprisingly, were all classified as Rockwood type I, II, or III injuries. However, details of the surgical procedures were not available, so it was unknown whether ACJ stabilization or another type of procedure was performed.

Similar to Lynch et al, Dragoo et al[11] reported that 77.8% of ACJ injuries in NCAA football players of Rockwood type III and higher were managed conservatively with a mean return to play of 31.9 days. In contrast to the relatively short return-to-sport time frames reported in the NFL in the aforementioned studies, the only study to specifically investigate the effect of surgery versus conservative management of grade III ACJ injures in AFL players found that players with type III injuries who were treated conservatively had longer return-to-play time frames and poorer functional outcomes compared with those who were treated surgically.[7] This highlights the differences between NFL and AFL sports. Most AFL players on-field are subjected to repetitive overhead motions for marking the ball as well as repetitive high-velocity shoulder contact without padding. This is in contrast to NFL players, who do not perform such a degree of repetitive overhead movements and wear protective shoulder padding. The treatment of Rockwood type III ACJ injures should be based on patient-specific and sport-specific demands.

The mean time from injury to surgery in our cohort was 3 days (range, 2-7 days). Early surgical intervention was chosen for these AFL players owing to ACJ injury

Rockwood type, level and type of sporting participation, and current best evidence. Seven of our 9 AFL players had Rockwood type IV or V ACJ injuries and current evidence indicates that these grades have better outcomes with surgical management.[23] Two players had Rockwood type IIIB injuries, and although there are discrepancies in how to manage Rockwood type III injures, some recent literature suggests that outcomes of Rockwood type III ACJ injures are superior with surgical fixation,[7,17,28] especially for those who participate in physically demanding occupations and/or sports that require repetitive overhead motion or unprotected shoulder contact.[7,17,38] Given the physical upper limb demands placed on AFL players as mentioned previously, pain-free, high-level upper limb function for sporting performance would be difficult to maintain in the setting of repetitive trauma to an ACJ with Rockwood type III instability. AFL clubs and players have a vested interest in early return to play after injury as well as optimizing upper limb function for performance. Given these competition pressures, the contact nature of AFL, and available evidence on the management of ACJ injuries in AFL players, the decision for early surgical intervention is justified.

A systematic review[16] investigating the effect of surgical management for ACJ dislocations has found that many papers present excellent return-to-sport rate but at longer times that may affect career goals. This resulted in an editorial[18] that suggested publication bias may be affecting the outcomes and that the outcome of interest often goes unreported. For this reason, we not only investigated the time taken to return to sport and on-field performance but also used an outcome measure that was sensitive and specific to measuring changes in the ACJ-injured population.[4] We used the SACS score that has sections to measure pain, function, and satisfaction in our AFL population. The functional section includes questions specifically related to ACJ function such as overhead movement and horizontal adduction, as well as questions on return to sport. This is in contrast to previously published studies[34] that use outcome measures such as the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, Constant Score, and Simple Shoulder Test that make it difficult to detect change at a higher level of function, such as in an elite sporting population.

Return to sport was an outcome of interest in only a small number of studies in a recent Cochrane review[34] comparing surgical stabilization with conservative management post ACJ injury. Using a CC screw fixation, Bannister and colleagues[3] reported that return to sport was significantly quicker in the conservative treatment group at 7 weeks versus 16 weeks in the operative group, who had to undergo screw removal after 6 weeks. No clear classification of ACJ dislocation was applied and the operative method is no longer commonly used.[34] Using a TightRope surgical method, Murray et al[24] reported that 85% of the nonoperative group and 73% of the operative group have returned to sport at 1 year. However, a substantial proportion of patients from the nonoperative group were dissatisfied and had delayed surgical fixation. Both these studies had high levels of bias, and the evidence to support conservative over surgical

management for return to sport was rated low in the review.[34] Importantly, the populations studied were not specifically professional collision athletes who require a high level of ACJ stability to withstand repetitive and high forces due to contact with the ground and opponents. Future research needs to investigate the effect of surgery versus conservative management in particular subgroups with definitive ACJ injury classifications so that treatment effects can be determined more accurately.[12,37]

Our results show that the mean number of kicks, marks, handballs, and tackles remained unchanged after surgery, indicating that player on-field performance was not affected by early return to play. These results may indicate that players' confidence in their shoulder postsurgery was also very high, although psychological aspects related to return to play were not measured directly. In addition, AFL Fantasy and Supercoach scores did not significantly change, indicating that media projections of the players' value did not diminish postsurgery. Lastly, PROMs showed a high level of patient satisfaction, low levels of pain, and a high level of function.

Our results suggest that our open twin-tailed dog-bone technique has the advantage of a sufficient early primary ACJ stability that appears to allow an earlier return to play without a higher complication rate in an elite ARF population. We propose that by separating the divergent clavicular limbs widely, the overall construct strength of the reconstruction will be increased, aiding stability in all planes, including the mediolateral plane. In addition, the smaller-than-usual drill holes[14,15] are likely to reduce risk of drill hole fracture.

Limitations and Strengths

The current study has several limitations. It is of retrospective design with no control group and a small number of participants. However, the small sample size is a reflection of a very specific subgroup we were investigating. Another limitation is the range of follow-up, which was 5 to 41 months (mean, 24.8 months). Complications such as clavicle or coracoid fractures could possibly be seen later than 12 months; however, an AFL career is considerably short and the short-term results in these professional athletes are of interest for both players and teams. PROMs data taken after 30 weeks may not have been the most accurate reflection of function at return to play and no radiological examination was performed at final follow-up.

A strength of this study is our investigation of a very specific patient population. We only included players with high-grade ACJ injury who were on the senior list of clubs at the highest or second highest level of professional ARF, and 1 experienced shoulder surgeon (G.H.) classified the degree of ACJ injury. This homogeneous patient population makes evaluating the effect of our intervention more conclusive with less impact from variations in a sample. Another strength is that to the best of the authors' knowledge, this study is the first to use an outcome measure that is sensitive and specific to measuring change in the ACJ population.[4]

CONCLUSION

In a group of professional ARF players with ACJ injury, our TightRope technique revealed return to competitive play could be achieved at a mean of 8.6 weeks without compromising on-field performance or patient-reported pain, function, and satisfaction. The return-to-sport time of these professional collision athletes is shorter than reported previously in the literature for other surgical techniques.

ACKNOWLEDGMENT

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