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## **Rotator Cuff Contusions of the Shoulder in Professional Football Players: Epidemiology and MRI Findings**

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**Abstract**

**Background:** No published reports in the literature have studied the epidemiology and MRI findings associated with rotator cuff contusions (RCC) of the shoulder in professional football players. The purpose of this study was to determine a single professional football team's incidence, treatment, and MRI appearance of players sustaining RCC of the shoulder.

**Hypothesis:** RCC are common injuries of the shoulder in contact athletes and have distinct appearance on MRI. Nonsurgical treatment of these injuries when specifically identified results in rapid return to play with no residual shoulder deficit.

**Study Design:** Case series

**Methods:** From 1999 – 2005, one North American professional football teams injury records were retrospectively reviewed for athletes who had sustained a RCC of the shoulder during in season participation. Those patients who had an MRI of the shoulder with a 1.5 Tesla magnet were reviewed by a musculoskeletal radiologist and graded according to the appearance and severity of clinical injury.

**Results:** Twenty-six players had a RCC. There was an average of 5.5 RCC per season (47% of all shoulder injuries). The predominant mechanism of injury was as a result of a direct blow in 70.3%. MRI findings included; peritendon edema at the myotendonous junction, critical zone tendon edema and subacromial bone bruises. Treatment consisted of a protocol involving modalities and cuff rehabilitation in all patients. Six patients had persistent pain and weakness for a minimum of 3 days and were given a subacromial corticosteroid injection. Overall, 3 patients (11.4%) required later surgical treatment on the shoulder.

**Conclusion:** RCC accounted for nearly half of all shoulder injuries in the football players in this study. MRI is an extremely useful tool to determine severity of injury and integrity of the rotator cuff. The majority of athletes are able to return to sports with conservative treatment, a minority of shoulders might progress to more severe pathology such as rotator cuff tears.

**Key Terms:** rotator cuff contusion, magnetic resonance imaging, contact athletes, epidemiology

## **Introduction**

There is a spectrum of injuries that occur as a result of direct trauma to the shoulder in contact athletes. As such, there may be fractures to the shoulder girdle (glenoid, humeral head, clavicle), glenohumeral dislocations (with associated labral and SLAP tears), acromioclavicular separations, and lesions of the rotator cuff (RC) (full or partial thickness tears, tendinopathy, or contusions). Rotator cuff contusions (RCC) of the shoulder occur as a result of a traumatic insult to the shoulder. Although previously mentioned in the literature [1], there are no published reports, which define the entity of contusions of the rotator cuff. In our experience, RCC occur commonly in contact athletes, specifically North American football players. As a result, significant time may be lost to games and practice following the injury due to weakness and altered shoulder function. In particular, defining the diagnosis of RCC can reduce time lost by ruling out an acute RC tear, allowing more aggressive rehabilitation and ensuring no operative treatment is necessary.

A RCC was defined clinically in this study as an acute direct or indirect shoulder injury in an athlete with prior normal RC function, which caused an acute loss of RC function, followed by subsequent rapid recovery of RC muscle function (including

strength and range of motion). This is distinguished from other RC injuries (tears) that result in protracted loss of RC function and strength after the acute injury. The key differential considerations in the diagnosis of acute RCC are: antecedent RC injury, preexisting or new shoulder instability, and the severity of the acute injury. A clinical history of the shoulder injury, a baseline exam of shoulder function and strength, and a baseline MRI exam can assist in sorting out preexisting RC disease (example: subacromial cysts, signs of impingement, tendonopathy or tears on MRI) from acute injuries (bone bruise, tendon edema, myotendinous junction or muscle edema, and subacromial / subdeltoid bursitis on MRI). Some injuries may present as acute on chronic with MRI appearance of enthesal partial or full thickness tears and tendonopathy along with subacromial / subdeltoid bursitis and focal bone bruises.

The purpose of this study was to document a single professional football team's incidence and treatment of players sustaining RCC of the shoulder. We hypothesized that nonsurgical treatment of these injuries when specifically identified results in rapid return to play with no residual shoulder deficit. In addition, a magnetic resonance imaging grading system was determined based on the appearance on MRI and severity of clinical injury / length of return to play.

## **Methods**

From 1999 – 2005, one North American professional football teams injury records were reviewed for athletes who had sustained a RCC of the shoulder during participation. Consent was obtained from each player, and the records were reviewed retrospectively to determine the date of injury and return, mechanism, type of treatment, and whether the athlete had a recurrence of injury. Additional data was obtained regarding the incidence rate of total injuries, total injuries involving the shoulder, and

number of days, practices or games missed. All data, as well as video analysis of the mechanism of injury, was collected prospectively by team athletic trainers and recorded for team and league injury reports. The players were initially evaluated by the athletic trainers and further referred with the diagnosis of the injury confirmed by the head team physician (JPB).

Those patients who had an MRI of the shoulder were reviewed by a musculoskeletal radiologist and graded according to the appearance and severity of clinical injury. An MRI was obtained in all athletes with a clinical history consistent with RCC and symptoms for greater than 3 days. Nineteen patients overall had MRI's of the shoulder, however only those 13 MRI's obtained on a 1.5 Tesla magnet were reviewed in this study for the consistent quality of a high power MRI magnet. Those remaining six patients had low field MRI's which did not allow for as reliable an evaluation for RCC. All studies were performed as either MR arthrograms or screening MRI's with the same parameters. All included fast spin echo (FSE) T2 fat suppressed sagittal images of the RC in addition to coronal plane T2 images. Examinations that included an arthrogram had axial T1 and sagittal fat suppressed coronal as well as sagittal T1 images, while screening exams had proton density images in the sagittal and coronal planes with intermediate TE fat suppressed axial images. A single observer (the chief of musculoskeletal radiology at our institution) evaluated the images with specific focus on the enthesis and subentheseal bone, mid RC tendon, myotendonous junction, and muscle on each study. Observational findings were recorded independent of knowledge on the clinical severity of injury.

## **Results**

### *Epidemiology*

Over a 7-season span (1999-2005), 26 players (28 shoulders) with an average age of 25.9 years (range: 22 – 31 years) were identified as having a RCC of the shoulder, 2 patients had bilateral injuries. The average follow-up after injury was 45 months (range: 8 – 77 months). A total number of 37 RCC occurrences were seen including 9 recurrences, as 6 players had 1 recurrence and 1 player had 3 recurrences of injury. A total of 7 players (26.9%) had at least one recurrent injury. The interval between recurrences was the same season in 2 players (average of 3 months), the next season in 4 players, and 3 seasons later in 1 player.

The average number of total reported injuries for the team per season was 213.7, and the average number of shoulder injuries per season was 11.7 (5.5%). Of the shoulder injuries, there was an average of 5.5 (47%) RCC per season. RCC accounted for 2.6% of all injuries per season. As a result of rotator cuff contusions, players missed an average of 3.8 days, 2.0 practices, and 0.35 games per season. Time missed from practice and games was analyzed based on treatment and is shown in **Table 1**.

Exam findings consistently showed a decrease in active range of motion (specifically elevation in the scapular plane (scaption) and external rotation at 90 degrees of abduction), with normal passive range of motion. Weakness of the rotator cuff was based on the injured muscle. The most common finding was weakness of scaption, which was graded as 4 out of 5 on manual muscle testing (MMT) in all patients except 2 which graded 3 out of 5. Following recovery all patients were able to achieve full 5 out of 5 strength on MMT

The predominant mechanism of injury was as a result of a direct blow in 26 shoulders (70.3%) and an indirect blow (fall on elbow or jamming shoulder) in 11 shoulders. All of the injuries were documented and analyzed by video, 27 (73%) of

which occurred in game situations (19 regular season games, 8 pre-season) and in practice in 10. The majority of the injuries occurred in defensive backs (26.9%), linebackers (23.1%), and offensive linemen (19.2%) (**Table 2**).

Treatment consisted of a specific protocol on all patients, which was initiated in 1999 based on clinical experience with these injuries. The first 3 days all patients were placed on Darvocet for pain control; passive range of motion to 90 degrees of forward flexion, scaption, and abduction was initiated; cryocuff cold therapy was utilized on the shoulder; and interferential stimulation was begun. No nonsteroidal anti-inflammatory medications (NSAIDs) were used during this period. On the second day, pulse ultrasound (1 mghz) was added for 5 minutes per day. At the end of the third day, if the physical exam and MRI were consistent with RCC and persistent shoulder dysfunction was present, a subacromial corticosteroid injection was given with 80 mg of Kenalog and 8 cc's of 0.5% marcaine (without epinephrine). Six patients had met this criterion and required an injection to assist in their recovery. Only 1 of the 6 patients who received a subacromial injection went on to later surgical treatment as described below. At an average of nearly 4 days, return of full active range of motion and full / symmetric strength on manual muscle testing was achieved. After the first week, continuous ultrasound was used for 15 minutes per day for all patients. Rehabilitation consisting of active range of motion, rotator cuff strengthening and scapular stabilizing exercises were continued for 4 to 6 weeks following injury. Return to play was allowed when complete symmetric active range of motion and full strength (5 out of 5 on MMT) was achieved.

Overall, 3 patients (11.4%) who sustained RCC required later surgical treatment on the shoulder, 2 who required repair of full thickness rotator cuff tears (1 supraspinatus, 1 infraspinatus), and one which required a labral repair / removal of loose bodies for

instability secondary to trauma and unrelated to his RCC (intact rotator cuff at surgery). The remaining athletes returned to full participation following the initial injury without restriction except those who sustained a recurrent injury. Neither of the 2 players who required surgery for rotator cuff tears had initial clinical or radiographic signs of a full thickness tear and each developed symptoms of a rotator cuff tear after a period of full recovery. The interval from time of initial injury to surgery in the three patients was the same season in 2 players and the following season in the other.

### *Magnetic Resonance Imaging*

Of the 13 high field MRI examinations analyzed, 7 were without contrast, and 6 were MR arthrograms. Arthrograms were performed in any patient with a question of instability to rule out any labral pathology. In general, we prefer young individuals (under 30) get an MRI arthrogram after a traumatic injury. Seventeen tendon injuries were identified, distributed mostly in the central cuff. Six infraspinatus, 5 supraspinatus, 4 subscapularis and 2 teres minor injuries were found. The findings were broken down by specific anatomy of the entire muscle tendon unit and by individual rotator cuff muscles (**Table 3**).

Individual findings (**figure 1**) at the enthesis were most commonly insertional hypertrophy with edematous tendonopathy (grey on short TE and low to intermediate on long TE sequences) seen in 8 cases, and subentheseal bone bruises seen in 6 cases. In the critical zone of the cuff tendons, hypertrophic tendonopathy (grey on short TE and low on long TE images with cross sectional enlargement) was seen in 15 tendons with edema also seen in 9 cases. Hypertrophic tendonopathy is a term used in MRI diagnosis to connote enlargement of the tendon cross section (critical zone being about 5mm to 15mm from the tendon footprint) with intermediate signal on short TE images. Most commonly

the tendon becomes black on T2 images but can have some remaining signal (not fluid equivalent) in higher grade tendonopathy.[3,4]

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At the myotendonous junction, 8 cases had peritendon edema consistent with an acute myotendonous junction injury. The remaining myotendonous junction was normal in 5 cases by MRI. There were three cases of diffuse muscle edema, while the remaining 10 cases had normal appearing muscle on MRI.

When analyzed by specific muscle, the supraspinatus (N=5)(**figure 2**) revealed abnormal enthesis in all 5 cases with evidence of 3 bone bruises, 2 humeral side partial tears, 2 bursal side partial tears, and 3 with hypertrophy / edema. In addition, there was myotendonous junction edema in 3 cases and tendon hypertrophy in all 5 cases (2 bursal partial tears, 1 humeral partial tear, 1 intrasubstance partial tear and 2 with tendon edema). Findings involving the infraspinatus (N=6)(**figure 3**) consisted of 2 of 6 with subentheseal cysts (only tendon with such finding), 1 of 6 with diffuse muscle edema, and 3 of 6 with myotendonous junction peritendon edema. Entheseal abnormalities were found in 4 of the 6 (1 each with bone bruise, hypertrophy, bursal partial tear, and humeral partial tear). All 6 tendons had hypertrophy while 2 had edema and 1 had a humeral partial tear. Review of the subscapularis contusions (N=4) revealed an abnormal enthesis in 3 of 4 with hypertrophy (**figure 4**) in 3 cases and bone bruise in 2 cases. There was critical zone hypertrophy or edema in all of the tendons. In the 2 cases of teres minor injuries, there was diffuse muscle belly edema extending to the myotendonous junction. Also, there was hypertrophy of the tendon and enthesis in 1 case.

Based on our clinical experience, the MRI findings identified in the study of peritendon edema at the myotendonous junction, critical zone tendon edema and subentheseal bone bruise were much more common in this group of individuals than in a

general population of individuals scanned for impingement or rotator cuff symptoms or in football players scanned for other injuries.[2-4] The MRI findings in this study group are considered suggestive of a RCC in the appropriate clinical setting.

## **Discussion**

There is a sparse amount of literature regarding RCC and its evaluation and treatment in the literature. This is the first report that we are aware of describing the epidemiology as it relates to contact sports and description of MRI findings. The cause of RCC is typically direct or indirect contact to the shoulder with subsequent development of loss of RC function consisting of weakness and pain. The short-term natural history of the injury is resolution after treatment with modalities and a cuff-strengthening program. However, a small subset of athletes maintain symptoms for more than just several days and were given a subacromial injection. The purpose of the injection is to decrease the inflammatory response to allow early motion and rehabilitation, which hastens the recovery of the muscle / tendon unit. An even smaller subset develop more persistent symptoms that are a result of larger partial thickness or even full thickness tears and need surgery to correct their functional disability. It is this group of patients in which MRI examination is critical to avoid under treatment of the injury. MRI evidence of an intact RC allows earlier, more aggressive rehabilitation and return to play.

There are 2 studies in the literature that focus on rotator cuff injuries in young athletes or contact athletes. Blevins et al reported on 10 contact athletes, all male football players, with rotator cuff injuries associated with their sport [1]. The age range was 24-36 years, and all 10 athletes had rotator cuff surgery. All had failed nonoperative treatment with an average interval from injury to surgery of 9 weeks. The findings at

surgery consisted of 3 full thickness (1 medium and 2 large) and 5 partial thickness supraspinatus tears and 2 contusions, which were evidenced by an intact cuff with, marked thickening and inflammation of the subacromial bursa. The partial thickness tears were classified as large in 1, medium in 3, and small in 1 while located on the articular side in 4 and bursal side in 1. The surgical procedures performed were 5 cuff repairs, 7 acromioplasty, and 10 subacromial decompressions. The MRI accuracy was 44% based on the surgical findings. Average follow-up after surgery was 21 months (range: 4-88 months). Nine of the 10 athletes returned to football at an average of 4 months (7 at preinjury level of play). All reported significant improvement in function and pain with only a mild residual weakness in 5 of the 10 athletes. They concluded that RC lesions in young patients were related to trauma, 2 patients with RCC responded well to surgical debridement, and surgical treatment can lead to high rate of return to sport following failure of a cuff rehab program. The surgical findings of a RCC were determined as a diagnosis of exclusion and no MRI criteria or clinic definition was determined as a result of this study.

Payne et al retrospectively reported on the arthroscopic treatment of partial rotator cuff tears in young patients with a subset of acute traumatic injuries [5]. The average age of the 14 patients in this subgroup was 29 years. All patients were put through a cuff-strengthening program and 50% had subacromial corticosteroid injection. All 14 patients failed nonoperative treatment with an average time from injury to surgery of 10.6 months. Preoperatively, 29% were diagnosed with mild instability. Treatment consisted of 2 mini-open cuff repairs, 12 cuff debridements, 2 labral repairs, and 2 labral debridements. All patients had inflammation of the subacromial space necessitating subacromial decompression. The outcome based on the American Shoulder and Elbow

Society (ASES) rating scale consisted of 86% excellent / good results. Sixty-four percent of the athletes returned to preinjury sports level. One patient required repair of full thickness tear 33 months following RC debridement. They concluded that direct contusion of cuff with acromion causes tendon degeneration at the critical zone. Additionally, if the injury occurs with arm at 90° of abduction, the articular side of the RC impinges on superior labrum, which results in partial articular side cuff tears and SLAP lesions.

The majority of patients in our study responded well with short recovery times following modalities and a cuff strengthening protocol. However those athletes who showed significant bone bruises and chronic tendonopathy had a protracted recovery necessitating a subacromial corticosteroid injection to decrease the inflammatory response and facilitate return to play. While the majority of the athletes in this study had minimum morbidity as a result of their injury, our follow-up is short term (range: 8–77 months). It is possible that there may be longer term effects on the shoulder and in particular the rotator cuff as time progresses, thus no statement can be made regarding the long term prognosis after RCC based on this study. We will however continue to follow these patients clinically to look for increased risk of recurrent RCC, partial-thickness RC tears, or full-thickness RC tears.

The present study is the first that the authors are aware of which is dedicated to the epidemiology and imaging of a common problem in contact athletes, contusions of the rotator cuff. This injury causes a short-term loss of shoulder function that may be difficult to discern from an acute RC tear. As a result, MRI (with arthrogram) is frequently used to assess the status of the RC when the clinical exam portrays the appearance of an acute tear.[6]

## **Conclusion**

Rotator cuff contusions of the shoulder accounted for nearly half of all shoulder injuries in the contact athletes in this study. MRI is an extremely useful tool to determine severity of injury and integrity of the rotator cuff. It may also assist in determining the length of recovery. The majority of athletes are able to return to sports with conservative treatment. Team physicians should be aware that a minority of shoulders might progress to more severe pathology such as rotator cuff tears.

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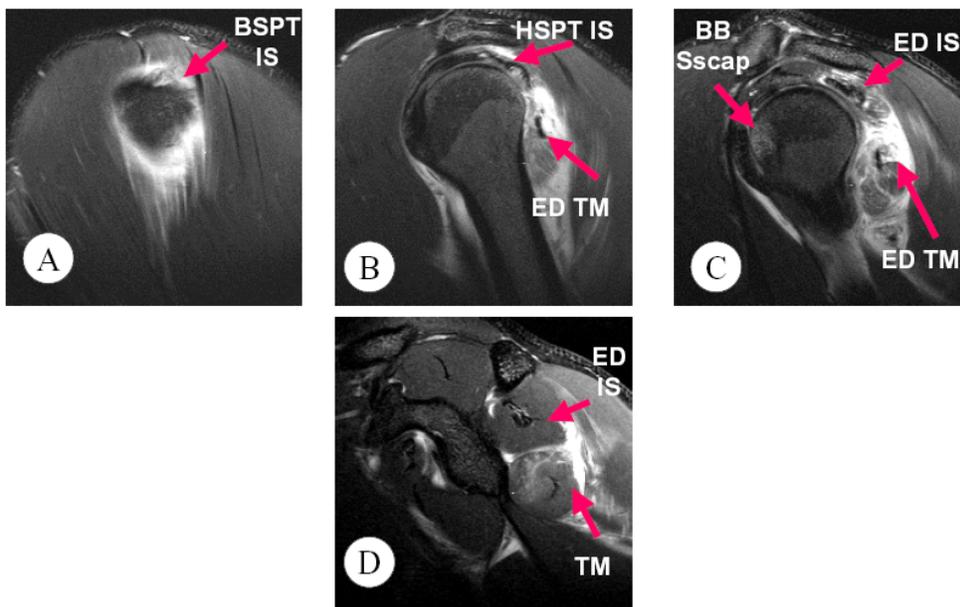
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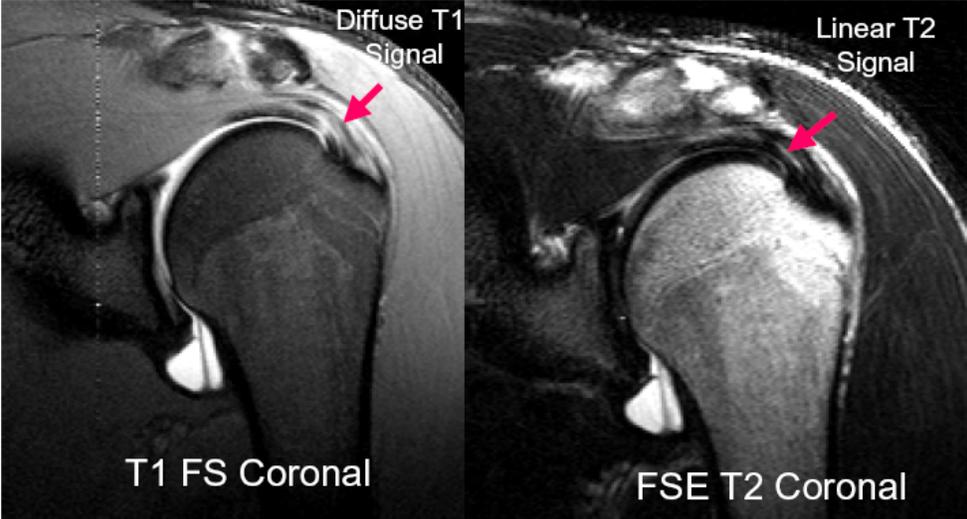
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## Figures

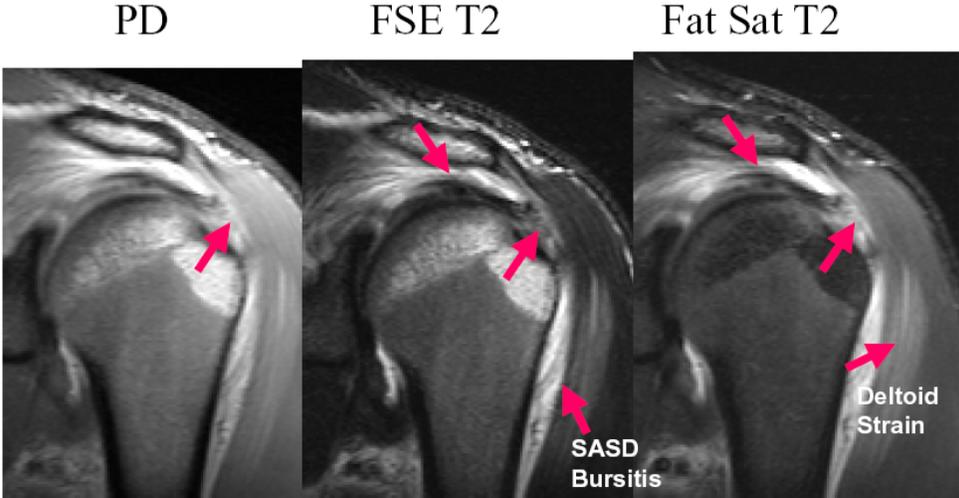
**Figure 1:** Abnormal MRI findings by anatomy on sagittal oblique T2 fat suppressed views. A) Enthesis (BS PT IS= bursal side partial tear of infraspinatus), B) Tendon (HS PT IS= humeral side partial tear of infraspinatus; ED TM = edema in teres minor), C) Myotendinous junction (BB Sscap = bone bruise of subscapularis; ED IS = edema of infraspinatus), D) Muscle belly (edema of infraspinatus and teres minor)



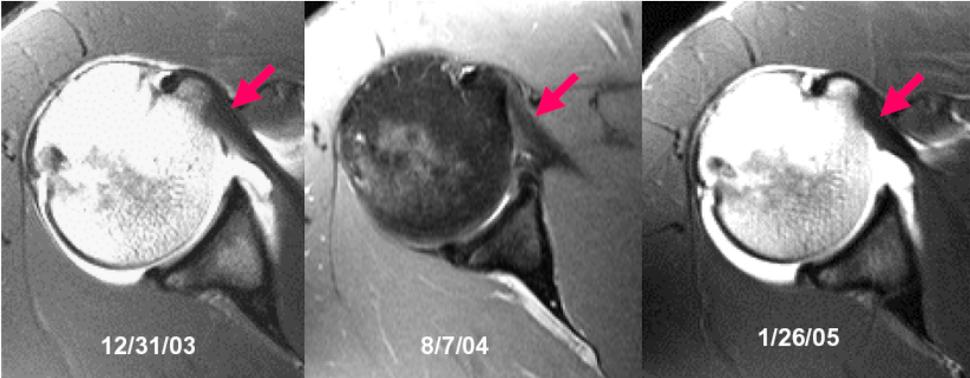
**Figure 2:** Sagittal T1 and T2 weighted images of the supraspinatus showing tendon hypertrophy and edema



**Figure 3:** Sagittal proton density, fast spin echo, and fat saturated T2 weighted images of the infraspinatus showing intratendinous edema (arrows), subacromial / subdeltoid bursitis (SASD), and deltoid strain.



**Figure 4:** Sequential axial plane images showing an initial subscapularis contusion and tendon hypertrophy (arrows) with interval healing after 13 months.



## Tables

**Table 1:** Football time missed from rotator cuff contusion of the shoulder associated with the treatment

<b>Treatment</b>	<b>Days Missed</b>	<b>Practices Missed</b>	<b>Games Missed</b>
No Surgery / No Injection	1.6	0.86	0.07
Injection / No Surgery	6.3	3.8	0.67
Surgery	19.0	8.0	2.3

**Table 2:** Position played by athletes sustaining rotator cuff contusions of the shoulder.

<b>Position</b>	<b>Number of Rotator Cuff Contusions (%)</b>
Defensive Back	7 (27)
Linebacker	6 (23)
Offensive Line	5 (19)
Wide Receiver	2 (7.7)
Defensive Line	2 (7.7)
Running Back	2 (7.7)
Quarterback	1 (3.8)
Tight End	1 (3.8)

**Table 3:** MRI findings of patients with rotator cuff contusions of the shoulder. SS = supraspinatus, IS = infraspinatus, Sscap = subscapularis, TM = teres minor

**Rotator Cuff Contusion MRI Findings**

<b>Tendon</b>	<b>SS</b>	<b>IS</b>	<b>Sscap</b>	<b>TM</b>	<b>Total</b>
<b>Number of Contusions</b>	<b>5</b>	<b>6</b>	<b>4</b>	<b>2</b>	<b>17</b>
<b>Enthesis</b>	<b>SS</b>	<b>IS</b>	<b>Sscap</b>	<b>TM</b>	<b>Total</b>
Bone Bruise	3	1	2	0	6
Humeral Partial Tear	2	1	0	0	3
Bursal Partial Tear	2	1	0	0	3
Hypertrophic Tendon/Edema	3	1	3	1	8
Subentheseal Cyst	0	2	0	0	2
Normal	0	0	1	1	2
<b>Tendon</b>	<b>SS</b>	<b>IS</b>	<b>Sscap</b>	<b>TM</b>	<b>Total</b>
Hypertrophic Tendon	5	6	3	1	15
Bursal Partial Tear	2	2	0	0	4
Humeral Partial Tear	1	1	0	0	2
Intrasubstance Partial Tear	1	0	0	0	1
Tendon Edema	2	2	3	2	9
Normal	0	0	1	0	1
<b>Myotendonous Junction</b>	<b>SS</b>	<b>IS</b>	<b>Sscap</b>	<b>TM</b>	<b>Total</b>
Peritendon Edema	3	3	0	2	8
Normal	2	3	4	0	9
<b>Muscle</b>	<b>SS</b>	<b>IS</b>	<b>Sscap</b>	<b>TM</b>	<b>Total</b>
Edema	0	1	0	2	3
Normal	5	5	4	0	14