

# Os Acromiale in Professional Tennis Players

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**Background:** Os acromiale is a rare condition mostly reported in the literature through case reports, imaging studies, or reports of surgical treatment. This condition is the result of nonunion of growth plates of the acromion during the natural developmental process that occurs between 15 and 25 years of age. Its incidence is low, and few studies are available in the literature on athletes with high functional demands, and particularly on athletes within a specific sport.

**Purpose:** To collect epidemiological data and to report the amount of time out of play as well as the type of treatment and its efficiency in professional tennis players.

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

**Methods:** We performed a retrospective study using the medical data of athletes within our national tennis league who complained about their shoulder between 2011 and 2016. Nine professional tennis players (mean age, 20 years) with painful shoulders were diagnosed with os acromiale; 3 of them played at an international level, with the other 6 playing at a national level. The diagnosis was confirmed using radiography, including the axillary view, and magnetic resonance imaging (MRI). One female player had associated subacromial bursitis.

**Results:** All cases of os acromiale were classified as involving the mesoacromion, following the Lieberman classification. No patient underwent surgery, and no patient was treated with local or subacromial infiltration. Patients stopped competition and training throughout the rehabilitation period. All patients received medical treatment with nonsteroidal anti-inflammatory drugs (NSAIDs), ice, and physical therapy with a specific rehabilitation program. All athletes returned to their former level of play after a mean of 37 days. No patient suffered from recurrent pain. One patient underwent MRI after 2 years, showing a normal bone signal and complete healing of the acromion.

**Conclusion:** Conservative treatment including NSAIDs, rest, ice, and physical therapy allowed for good recovery and return to the former level of play. Surgical treatment is usually not indicated for os acromiale in the professional tennis player.

**Keywords:** os acromiale; athletes; tennis; conservative treatment; shoulder

Os acromiale is a rare condition mostly reported in the literature through case reports, imaging studies in nonathletic patients, or reports of surgical treatment. It is caused by nonunion of growth plates of the acromion during the natural developmental process that occurs between 15 and 25 years of age. Few data are reported about os acromiale in

athletes. For those patients with high functional demands, it is important to know which treatment to recommend.

Because of its low incidence, few studies have focused on the occurrence of os acromiale within a specific sport. Roedel et al<sup>11</sup> reported radiological data in throwing athletes. Burkhart<sup>2</sup> reported one case in a professional tennis player, and Frizziero et al<sup>5</sup> reported a case in a professional swimmer. We performed a retrospective study using the medical data of athletes in our national tennis league who were evaluated with shoulder pain between 2011 and 2016. The aim of the current study was to identify epidemiological data, length of time away from play, and efficiency of treatment.

## METHODS

We collected the data of professional tennis players who came to the training center of our national tennis federation (Centre National d'Entrainement de la Fédération Française de Tennis). This place is dedicated to the training and treatment of professional or future professional

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Ethical approval for this study was waived by the ethics committee of Ramsay Générale de Santé.

TABLE 1  
Os Acromiale Data for Each Patient<sup>a</sup>

Player	Year of Birth	Age Began Playing Tennis	Age at Onset of Symptoms	Years of Practice Before Pain	Sex	Dominant Side	Affected Side	VAS (0-10)	Level (Int/Nat)	Painful Move	Associated Lesion	Infiltration OA, Y/N	Rest, Y/N	Rest Duration, Days	Trauma	Physical Therapy, Y/N	Other Treatments	Equipment Change, Y/N	Technique Modified, Y/N	Symptoms Resolved, Y/N	Time to Resolution of Symptoms, Days	Recurrent Pain, Y/N	Surgery, Y/N	OA Classification Type	Diagnostic (US, Rx, CT, MRI)	Subacromial or Joint Infiltration, Y/N	
1	1999	6	15	9	M	L	L	2	Nat	Serve		N	Y	15	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
2	1986	5	28	23	M	R	R	4	Int	Serve		N	Y	10	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
3	1996	7	15	8	M	R	R	2	Nat	Serve		N	Y	30	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
4	1995	5	18	13	F	L	L	1	Nat	Serve	Bur	N	Y	180	uT	Y	NSAID + Ice	N	N	Y	90	N	N	Meso	MRI	N	
5	1996	5	19	14	M	R	R	3	Nat	Serve		N	Y	15	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
6	1988	6	26	20	M	R	R	4	Nat	Serve		N	Y	30	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
7	2000	5	15	10	M	R	R	2	Int	Fhd & Drive		N	Y	15	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
8	2004	6	12	6	F	L	L	2	Int	Serve		N	Y	30	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
9	2000	5	16	11	F	L	L	2	Nat	Fhd & Serve		N	Y	15	uT	Y	NSAID + Ice	N	N	Y	30	N	N	Meso	MRI	N	
Avg		5.6	18.2	12.7				2.4						37.8													

<sup>a</sup>Bur, bursitis; CT, computed tomography; F, female; Fhd, forehand; Int, international; L, left; M, male; Meso, mesotherapy; MRI, magnetic resonance imaging; N, no; Nat, national; NSAID, nonsteroidal anti-inflammatory; OA, osteoarthritis; R, right; Rx, prescription med; US, ultrasound; uT, microtrauma; VAS, visual analog scale; Y, yes.

tennis players in France. The medical information of patients consulting for os acromiale was extracted from the global database.

Medical data were available to analyze the level of the athletes, the quality of their pain, its duration, factors responsible for the onset of symptoms, and specific aspects of the game that caused the pain, such as technical movements. Time away from play, total time to recovery, and medical and surgical treatments proposed were also analyzed. Painful acromial palpation, tenderness, and bone edema at the level of os acromiale on magnetic resonance imaging (MRI) were used for the diagnosis of symptomatic os acromiale. The Lieberson classification was used to classify os acromiale.<sup>7</sup> A visual analog scale (VAS) was used to evaluate pain (score range, 0-10; 10 indicates severe pain).

Between 2011 and 2016, a total of 9 professional tennis players with a painful shoulder were diagnosed with symptomatic os acromiale. Three of them played at the international level, with the others playing at the national level. There were 6 men and 3 women, with a mean age of 20 years (range, 16-28 years). The mean age at the start of tennis activity was 5.6 years (range, 5-7 years), the mean time of tennis practice before the onset of symptoms was 12.7 years (range, 6-23 years), and the mean age at the onset of symptoms was 18.2 years (range, 12-28 years). Seven of the athletes were right-handed and 2 left-

handed. No patient suffered from direct or indirect trauma on the shoulder. The diagnosis was confirmed in each case with radiography, including the axillary view, as well as with MRI.

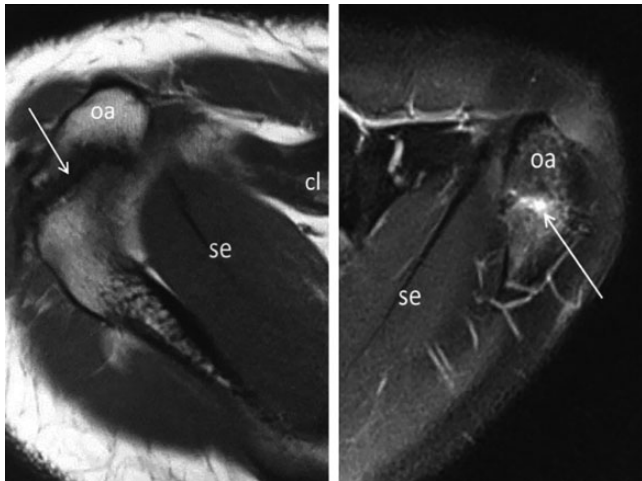
## RESULTS

Os acromiale data are reported in Table 1. In all cases, the painful shoulder was on the dominant side. The mean VAS score was 2.4 (range, 1-4). The precise painful movement was the serve in 7 patients and the forehand in 2 patients. Subacromial bursitis was diagnosed in 1 female patient after undergoing MRI. No rotator cuff tear was found in the athletes. All cases of os acromiale were classified as involving the mesoacromion (Figures 1-3), following the Lieberson classification.<sup>7</sup> All imaging examinations confirmed the os acromiale diagnosis. All patients interrupted competition and training for a mean of 37.8 days (range, 30-90 days).

All patients received medical treatment with nonsteroidal anti-inflammatory drugs (NSAIDs), ice, and physical therapy with a specific rehabilitation program. The treatment was based on a full interruption of tennis practice for 15 days, oral NSAIDs for 10 days, and local cryotherapy. The rehabilitation program focused on shoulder stabilizing muscles: the serratus anterior and



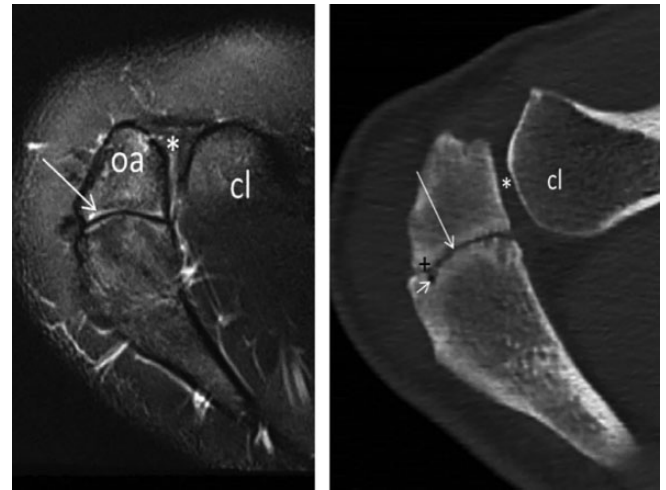
**Figure 1.** Axillary view radiograph of a 16-year-old tennis player with a mesoacromion.



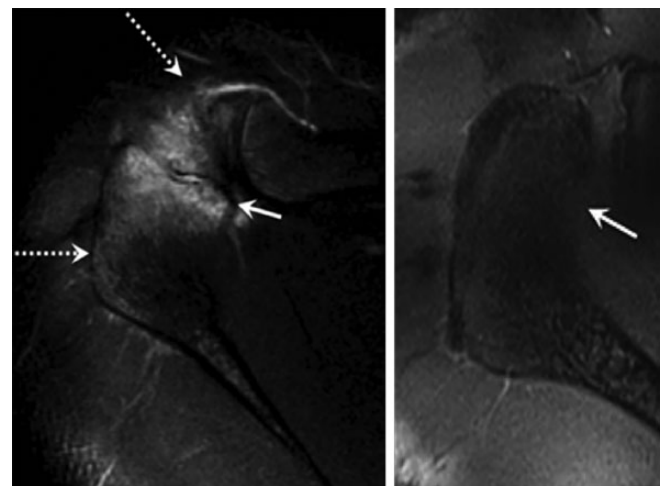
**Figure 2.** Magnetic resonance imaging of 2 mesoacromions from 2 different tennis players, both male (aged 16 years on the left and aged 18 years on the right). Arrows show nonunion. cl, clavicle; oa, os acromiale; se, supraspinatus.

external rotators. Humeral head-centering rehabilitation was used if necessary. Return to sport started with progressive increased strength on the forehand and backhand strokes. After that, progressive work over the scapula and over 90° of abduction was authorized. If necessary, tennis equipment was modified by loosening the strings or switching to a smaller racquet.

No patient was treated with local or subacromial infiltration. No patient underwent surgery. Rest and rehabilitation provided excellent clinical outcomes, with no pain recurrence at the end of the follow-up, which occurred at a mean of 2 years (range, 1-3 years). All athletes were observed at the training center of our national tennis federation, and none of the athletes were lost to follow-up. All athletes returned to their former level of play after a mean



**Figure 3.** Magnetic resonance imaging of a mesoacromion (left) and computed tomography of global nonunion (right). Asterisk indicates acromioclavicular joint; arrows and + sign show nonunion. cl, clavicle; oa, os acromiale.



**Figure 4.** Magnetic resonance imaging (MRI) of a mesoacromion during a painful period (left image). Painful acromial palpation, tenderness, and bone edema at the level of os acromiale on MRI were used for the diagnosis of symptomatic os acromiale. The male patient underwent the first MRI examination at the age of 16 years. Two years later, the acromion is perfectly healed (right image). Dashed arrows show acromion on each side. Solid arrows point to nonunion that disappeared.

period of 38 days, initially returning to regular practice and then competition. One patient agreed to undergo MRI 2 years after, which revealed a normal signal from the acromion (Figure 4). None of the other patients underwent any other imaging examination because their shoulder became totally asymptomatic.

## DISCUSSION

Acromial bone can be seen as early as 6 weeks in the embryo, and the center of ossification appears between 15 and 18 years of age, healing between the ages of 22 and 25 years. This healing gives the final shape of the acromion. From distal to medial, there are 4 healing zones as described by Follissasson<sup>4</sup>: preacromion, mesoacromion, meta-acromion, and basiacromion. Edelson et al<sup>3</sup> demonstrated that in most cases, the location of nonunion was between the mesoacromion and meta-acromion. The fusion is total in most cases; abnormal fusion comprises partial fusion, fibrous union, or a new joint as reported by Nicholson et al.<sup>9</sup> On each segment of the acromion, the deltoid is inserted on the lateral aspect and the trapezius muscle is inserted on the medial aspect. The coracoacromial ligament is inserted at the anterior and inferior aspects of the acromion. In most cases, the acromioclavicular ligament stabilizes os acromiale medially.

Currently, there are 2 theories regarding the development of symptomatic os acromiale. The first theory is mechanical. Pressure and traction seem to be responsible for abnormal fusion, producing significant stresses on the healing zone. Stirland,<sup>13</sup> in a paleopathological study, reported a high rate of nonunion in archers during the 15th and 16th centuries. Roedl et al<sup>11</sup> reported that 2.6% of 2371 MRI scans of recreational throwing athletes showed edema of the acromion. In 69% of these athletes, edema was the only lesion, but in 31%, it was associated with nonunion.<sup>11</sup> The same authors underlined the correlation between the number of throws every week: more than 100 throws a week was correlated with 40% of the abnormal signal, and fewer than 100 throws was related to 2% of the signal. Regarding the athletes in our study, the mean age at the onset of symptoms corresponds to the age of appearance of the center of ossification of the acromion. These data are compatible with the mechanical theory of the development of os acromiale.

The second theory for the development of os acromiale is genetic. Sammarco<sup>12</sup> reported 8% of os acromiale in a cadaveric study, with 33% involving bilateral cases. This rate of bilaterality increased to 62% in a study by Lieberman.<sup>7</sup> Edelson et al<sup>3</sup> showed that the incidence is 6.8% in white male patients and 3.2% in women. African people are more predisposed (18.2%), whereas the Korean population shows a lower incidence (0.7%) of os acromiale.<sup>3</sup> We did not look for bilateral os acromiale in our athletes.

Several aspects of the clinical presentation must be considered before linking os acromiale and shoulder pain. The theory of Warner et al<sup>15</sup> involving subacromial impingement as induced by the inferior migration of os acromiale is no longer considered. There are cases of os acromiale with high or no mobility, but from our point of view, it seems that os acromiale with slight mobility is more painful. The efficiency of local infiltration inside the mobility area, and surgical stabilization for pain relief are 2 major arguments for the origin of pain inside the nonunion area itself. Pain is revealed during palpation and is only mechanical. The clinical presentation is close to subacromial impingement, and there is no loss of mobility. Pain increases over 90° of forward elevation, and the acromioclavicular joint is pain-free. Imaging will confirm the diagnosis. Simple radiographs with an axillary view are,

in our practice, not enough to confirm the diagnosis because it is not always easy to see nonunion correctly. All of our athletes underwent MRI to confirm the diagnosis.

We were able to differentiate whether our patients had symptoms due to their tennis activity during the normal evolution of os acromiale or due to nonunion of growth plates of the acromion. Painful acromial palpation, tenderness, and bone edema at the level of os acromiale on MRI were used for the diagnosis of symptomatic os acromiale.

In the literature, several musculoskeletal injuries have been reported in tennis players. A review by Abrams et al<sup>1</sup> showed that most tennis injuries occur in the lower extremity, followed by the upper extremity and finally the trunk. Upper extremity injuries most commonly involve the elbow and shoulder, with lateral epicondylitis being prevalent.<sup>1</sup> Another study showed that shoulder pain was reported to be present in 24% of high-level tennis players aged 12 to 19 years, with the prevalence increasing to 50% for middle-aged players.<sup>6</sup> Other studies have associated shoulder pain in tennis players with repetitive use, and there is a possible correlation with scapular dyskinesia, rotator cuff tears, or glenohumeral internal rotation deficit leading to internal impingement and/or labral lesions. In general, these studies associated shoulder symptoms in young, high-level tennis players with subtle instability, while the rotator cuff was more commonly involved in older players.<sup>8,10,14</sup>

Other authors have shown that infraspinatus muscle atrophy was present in 52% of 125 professional female tennis players, all ranked in the top 200 of the Women's Tennis Association.<sup>16</sup> In that study, the authors associated atrophy with irritation of the suprascapular nerve at the spinoglenoid notch, distal to the innervation of the supraspinatus muscle. However, the authors did not find this to have any effect on player performance.<sup>16</sup> During the past 5 years of our international competition the French Open [Roland-Garros], shoulder pain represented 13% of patients evaluations. Tendinopathies of the superior and posterior rotator cuff represented 63% of the causes of pain, joint disorders represented 15%, neurological disorders represented 13%, muscular disorders represented 5%, and an unknown diagnosis accounted for less than 5%. Unfused os acromiale in this last group was felt to be the cause of shoulder pain because none of the other causes of pain were identified on MRI or other evaluations. No other study, to our knowledge, has shown the implications of os acromiale in a series of professional tennis players.

There are a few limitations of our study. Although we had specific criteria for the diagnosis of symptomatic os acromiale, it was sometimes difficult to specifically attribute all symptoms to unfused os acromiale. The incidence of os acromiale in tennis players between the ages of 15 and 30 years is yet unknown. Finally, 8 of our players had no follow-up MRI to show os acromiale union.

## CONCLUSION

The current study reports the largest series to date of professional tennis players evaluated for os acromiale. It is a rare condition, and in all cases, the mesoacromion was

diagnosed. Treatment was not surgical and was based on a rehabilitation program, rest, and NSAIDs. All players returned to the same competitive level, and 8 of 9 patients achieved return to competitive tennis in less than 3 months.

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