ORIGINAL ARTICLE

Is tennis a predisposing factor for degenerative shoulder disease? A controlled study in former elite players

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Background: High demands imposed to the shoulder during tennis activity can decrease the efficiency of static and dynamic constraints. Subtle or frank instability of the glenohumeral joint may occur, and long term degenerative changes may be expected.
Objective: To determine and compare the prevalence of primary glenohumeral osteoarthritis in senior tennis players and matched controls.
Study design: Cross sectional controlled study.
Methods: 18 asymptomatic senior tennis players were studied (17 male; mean (SD) age, 57.2 (8.8) years) with no history of shoulder surgery or major trauma. There were 18 matched controls. Radiographs were used to determine glenohumeral osteoarthritic changes: joint space narrowing, humeral and glenoid subchondral sclerosis, humeral and glenoid juxta-articular cysts, osteophytes, humeral and glenoid flattening, humeral posterior displacement and glenoid posterior erosion. Findings were classified as normal, minimal, moderate, or severe changes.
Results: 33% of the players (95% confidence interval (CI), 13% to 59%) had osteoarthritic changes in their dominant shoulder (n = 6; five with minimal changes, one with moderate changes), and 11% of the controls (95% CI, 1% to 34%) had articular degeneration on their dominant side (n = 2; both minimal changes) (p = 0.04, Wilcoxon test). The osteoarthritic group was significantly older than the players without degenerative changes (p = 0.008).
Conclusions: The prevalence of glenohumeral osteoarthritis in the dominant shoulder was greater in former elite tennis players than in sedentary controls. Prolonged intensive tennis practice may be a predisposing factor for the development of mild degenerative articular changes in the dominant shoulder.

The relation between shoulder lesions and sports involving overhead activities is well established. The tennis player who repeatedly hits overhead produces high forces and large movements that place extreme demands on the shoulder.[1] The large forces developed in the proximal links are funnelled through the shoulder constraint systems (bony, ligamentous, muscular) to the hand and racquet.[2]

Osteoarthritis consists of the progressive loss of articular cartilage which begins with fraying or fibrillation of the articular surface and progresses to exposure of the subchondral bone.[3] Primary glenohumeral osteoarthritis (GH-OA) is diagnosed when no predisposing factors that could lead to joint malfunction are present (that is, systemic arthritis, chronic rotator cuff tear, trauma, congenital malformation). Primary GH-OA is mainly characterised by joint space narrowing, subchondral sclerosis, cystic changes, and marginal osteophytes.

Joint instability has been mentioned as a predisposing factor for osteoarthritis. The high demands imposed to the shoulder during throwing movements can cause fatigue of the dynamic stabilisers as well as increased stretching of the static constraints, and consequently may decrease their efficiency. Increased translation of the glenohumeral joint could occur, leading to subtle or frank instability.[1] Thus shoulder osteoarthritic changes may be expected. To the best of our knowledge, GH-OA has not been yet investigated in tennis players.

Our aim in this study was to determine and compare the prevalence of primary glenohumeral osteoarthritis in senior tennis players and matched controls.

METHODS

We studied 18 asymptomatic senior tennis players (17 male; mean (SD) age, 57.2 (8.8) years, range 51 to 75) and 18 matched controls (17 male; 59.8 (6.4) years, range 51 to 76). Inclusion criteria for the study group were: age older than 50 years; previous professional level and continuous activity (practising, teaching); no history of surgery or major trauma (that is, fracture or dislocation) to either shoulder; and no history of systemic arthropathy. All players were right handed and they hit one-handed backhand. They had begun playing the sport at a mean age of 8.0 (2.6) years. Inclusion criteria for the control group were: age older than 50 years; no history of shoulder surgery, trauma, or systemic arthropathy; and sedentary habits and lack of heavy working tasks. Seventeen subjects were right handed and one male subject was left handed.

The study was undertaken after approval from the institutional research and ethics committee, and all subjects signed their informed consent to participate in the study.

Radiographic images were obtained of both shoulders. The true anteroposterior scapular view and axillary lateral view were used to determine GH-OA radiographic changes. Adequate plain radiographs provide substantial information about bone and soft tissue pathology in patients with shoulder osteoarthritis. Thus it is often unnecessary to pursue more advanced imaging studies.[4] The true anteroposterior view of the glenohumeral joint is a 40° posterior oblique projection taken in the plane of the scapula and it projects an accurate definition of the joint space. The axillary lateral projection is an essential component of the evaluation of the glenohumeral joint. Glenoid anatomy, including version and bone deficiency, can be assessed; the position of the humeral head can be determined; and posterior displacement of the greater tuberosity can be demonstrated.[4]

The various aetiologies of glenohumeral osteoarthritis have characteristic plain radiographic findings. In all cases,

Table 1 Radiographic classification of glenohumeral osteoarthritis according to Koss *et al*[7]

Grade	Stage	Joint narrowing	Osteophytes	Joint sclerosis	Cysts
Grade 0	Normal	No joint space narrowing	No osteophytes	No sclerosis	No cysts
Grade I	Minimal changes	Less than 1 mm space narrowing	No osteophytes	Slight sclerosis	No cysts
Grade II	Moderate changes	Narrowing less than or equal to 2 mm	Mild-to-moderate osteophytes	Moderate sclerosis	No cysts
Grade III	Severe changes	Severe joint space narrowing	Abundant osteophytes	Severe sclerosis	Cyst formation

narrowing of the glenohumeral joint space indicates loss of hyaline cartilage from the articular surface of the humeral head and the glenoid. Primary osteoarthritis of the shoulder is characterised by subchondral sclerosis, cystic changes in the proximal humerus and glenoid, and marginal osteophytes around the anatomic neck.[4] Static posterior subluxation of the humeral head has also been pointed out as an early sign of GH-OA.[5 6]

The medial calcar osteophyte and inferior margin of the humeral head can be prominent. The head flattens and enlarges with disease progression; the glenoid gradually flattens and its posterior portion erodes with head posterior displacement. At this time, internal rotation contracture increases progressively.

Radiographic criteria used for the identification of secondary osteoarthritis included a distance of less than 5 mm between the humeral head and the acromial process (which suggests cuff tear arthropathy), chondrocalcinosis, and signs of trauma or osteonecrosis.[7]

Images were analysed by two experienced musculoskeletal radiologists. All evaluations were made with the radiologists blinded to the age and sex of the subjects, and nine radiographic signs of GH-OA were sought: joint space narrowing, humeral and glenoid subchondral sclerosis, humeral and glenoid juxta-articular cysts, osteophytes, humeral and glenoid flattening, posterior humeral displacement, and posterior glenoid erosion (fig 1). Acromioclavicular joint degeneration, subacromial calcification, and superior migration of the humeral head were also recorded. Findings were classified according to the rating scale of Koss *et al*[8]: grade 0, normal; grade I, minimal changes; grade II, moderate changes; grade III, severe changes (table 1).

Figure 1 Anteroposterior x ray view of an asymptomatic 51 year old tennis player showing a small "teardrop" osteophyte and glenoid sclerosis of the dominant shoulder.

Statistica™ significance level was established: $\alpha = 0.05$ and $\beta = 0.20$. Statistics for Windows software (Statsoft Inc, 1993) was used for analysis.

RESULTS

Six players (33.3%, 95% confidence interval (CI), 13.3% to 59.0%) had osteoarthritic changes (grade I, n = 5; grade II, n = 1) in their dominant shoulder, and two control subjects (11.1%; 95% CI, 1.1% to 34.7%) had degenerative changes (grade I, n = 2) (p = 0.043, Wilcoxon test for non-parametric paired samples). Within the study group, the prevalence of osteoarthritic changes of dominant shoulder was higher than on the non-dominant side: 33.3% (13.3% to 59.0%) and 0% (0% to 18.5%), respectively; p = 0.027, Wilcoxon test.

Degeneration of the acromioclavicular joint was greater in the dominant shoulder in the study group (55.5% (n = 10), 95% CI, 30.8% to 78.5%) than in the control group (27.7% (n = 5), 95% CI, 9.7% to 53.5%) (p = 0.048, one sided). The same difference was found between the shoulders within the study group (n = 10 dominant; n = 5 non-dominant; p = 0.048).

Radiographic findings of this series are summarised in table 2. The glenoid articular surface was more often affected than the humeral side. Within the study group, players with radiographic changes of GH-OA were significantly older than players with no changes (n = 6, age 63.5 (8.3) years, and n = 12, age 54.0 (6.3) years, respectively) (p = 0.008).

DISCUSSION

Our results showed that asymptomatic senior tennis players had a greater prevalence of radiographic osteoarthritic changes in their dominant glenohumeral joint than sedentary control subjects. Jobe *et al*,[9] Plancher *et al*,[1] and other investigators[10] have suggested the pathogenic role of occult anterior instability in chronic shoulder articular damage. GH-OA following frank glenohumeral instability, such as dislocation or post-surgical repair, has been reported previously,[11 12] but there is lack of knowledge about the long term consequences of potential subtle instability. Secondary impingement syndrome and internal impingement—usually related to subtle shoulder instability, rotator cuff tears, and labral injury—form a common pathological complex in the overhead athlete. In contrast, Sonnery-Cottet *et al*[13] disagreed with this theory because they have failed to demonstrate inferior glenohumeral ligament injury in patients suffering from posterosuperior glenoid impingement. However, they reported a high percentage of bone degenerative changes in a series of tennis players who had undergone surgery for posterosuperior glenoid impingement.[13] Results of the present study cannot provide an answer to this controversy but they support the hypothesis of Mow *et al*,[14] that prolonged use may alter the joint loading pattern, producing detrimental changes in articular cartilage. We did not find posterior subluxation associated with GH-OA changes in this series. Similar results were published by Nakagawa *et al*[7] in an epidemiological study of primary GH-OA in patients with shoulder disorders.

Table 2 Radiographic degenerative changes of shoulder joint in asymptomatic senior tennis players and controls

Radiographic changes	SG-Dom	SG-Non-D	CG-Dom	CG-nonD
Joint space narrowing	1	0	0	0
Humeral subchondral sclerosis	0	0	0	0
Glenoid subchondral sclerosis	5	0	2	0
Humeral subchondral cysts	1	0	0	0
Glenoid subchondral cysts	3	0	0	0
Osteophytes	1	0	0	1
Humeral flattening	0	0	0	0
Glenoid flattening	0	0	0	0
Posterior humeral displacement	0	0	0	0
Posterior glenoid erosion	0	0	0	0
Acromioclavicular degeneration	10	5	5	2
Subacromial calcification	1	0	0	0
Humeral superior displacement	1	0	0	0

CG, control group; Dom, dominant shoulder; Non-D, non dominant shoulder; SG, study group.

Acromioclavicular arthritis is a common entity accompanying impingement syndrome in overhead athletes. Symptoms may be severe enough to inhibit performance in tennis, especially with backhand shots, which require arm adduction.[1] In the present study, the prevalence of acromioclavicular joint degeneration of the dominant shoulder was significantly higher in the tennis players (55%) than in the controls (27%). Furthermore, the prevalence of arthritic changes of the acromioclavicular joint was higher on the dominant side than on the non-dominant side in the study group of senior players. Using magnetic resonance imaging, Shubin Stein *et al*[15] found a 93% incidence of acromioclavicular arthritis in asymptomatic patients at an average age of 42 years. Though many investigators have reported a high incidence of acromioclavicular joint pathology in asymptomatic subjects and this should be not necessarily be considered clinically significant, accurate diagnosis of acromioclavicular joint arthritis is important in the treatment of athletes with shoulder pain.

The relation between sports activity, aging, and osteoarthritic changes remains controversial. However, there is good evidence for the association of occupational risk factors with osteoarthritis. In athletes, GH-OA is usually secondary, and individuals at risk are weightlifters, baseball and softball players, and those involved in racquet sports.[16] The population of this series comprises players with maximal unilateral overhead demands as they have played professionally, they have been continuously active, and they have hit one-handed strokes.

All reports on osteoarthritis epidemiology consistently show an exponential increase in prevalence with increasing age.[17] The mean age of the present population was similar to that of patients with severe GH-OA who have undergone replacement surgery.

Radiographic evaluation is often sufficient to diagnose GH-OA but it can identify only the late stages of the degenerative process. Magnetic resonance imaging and even arthroscopic evaluation may be capable of showing earlier changes. Ellman *et al*[18] reported a small series of patients who had undergone shoulder arthroscopy for impingement syndrome. They identified coexisting GH-OA which was not apparent preoperatively. Thus the prevalence of osteoarthritic changes in the glenohumeral joint may be greater if more sensitive diagnostic methods are used. Although GH-OA changes in the dominant shoulder of tennis players are mild, this entity should not be underestimated during clinical examination of overhead senior athletes. Shoulder osteoarthritis is not an uncommon medical problem.[19]

The cross sectional design of our study imposes some limitations on the analysis of the results. Ideally, the natural history of joint loading and age related changes should be observed by longitudinal studies. Despite such limitations, this remains the first study specifically evaluating glenohumeral osteoarthritis in tennis players. Furthermore, the results of the study can serve as a standard to compare longitudinal studies in this selected population.

In conclusion, the prevalence of glenohumeral osteoarthritis in the dominant shoulder was greater in former elite tennis players than in sedentary controls. Prolonged intensive tennis practice may be a predisposing factor for the development of mild degenerative articular changes in the dominant shoulder.

What is already known on this topic

- There is a significant relation between overhead sports and shoulder injuries
- High demands imposed to the shoulder during tennis activity can decrease the efficiency of constraint systems leading to subtle or frank instability

What this study adds

- Prevalence of glenohumeral osteoarthritis of dominant shoulder is greater in former elite tennis players than in controls
- Prolonged intensive tennis practice may be a predisposing factor for the development of mild degenerative articular changes in the dominant shoulder

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ELECTRONIC PAGES

Online review

The following electronic only article is published in conjunction with this issue of *BJSM*

Carbohydrate intake and tennis: are there benefits?

M S Kovacs

Carbohydrate supplementation in prolonged aerobic exercise has been shown to be effective in improving performance and deferring fatigue. However, there is confounding evidence with regard to carbohydrate supplementation and tennis performance, which may be due to the limited number of studies on this topic.This evidence based review, using database searches of Medline and SPORTDiscus, summarises the limited relevant literature to determine if carbohydrate supplementation benefits tennis performance, and, if so, the appropriate amounts and timing. Although more research is required, it appears that it may be beneficial in tennis sessions lasting more than 90 minutes.

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