Original article

Is there a relation between loss of shoulder external rotation and sternoclavicular joint disorders?

Francesco Pisanu[1], Vincenzo Verderosa[2], Stefano Perego[1], Rosario Cutaia[1], Corrado Ciatti[1], Andrea Fabio Manunta[1], Carlo Doria[1]

[1]Orthopedics and Traumatology Department, University of Sassari, Sassari, Italy; [2] Casa di Cura Policlinico Città di Quartu, Quartu Sant'Elena, Italy

Abstract.

Background and aim: Scapulothoracic movements are essential in shoulder kinematics and can partially compensate stiffness and loss of motion of glenohumeral joint. The scapulothoracic movement is strictly dependent on the translation and rotation of the clavicle at the sternoclavicular joint (SCJ), this being the only true joint between the axial and the upper appendicular skeleton. Aim of the study is to define a possible correlation between loss of shoulder external rotation following surgery for anterior shoulder instability and long-term sternoclavicular joint disorders. *Methods:* A group of 20 patients and a group of 20 healthy volunteers were studied. *Results:* In the statistical analysis of the patient group and of the two groups jointly, the association between the reduction of shoulder external rotation and the onset of disorder of SCJ appeared statistically significant. *Conclusions*: Our results provide support for an association between some disorders of the SCJ and the alterations of the shoulder kinematics associated with a reduction of ROM in external rotation. Our sample is too small to allow definitive conclusions to be drawn. These results, if confirmed by larger studies, could help us further clarify the complex kinematics of the shoulder girdle. (www.actabiomedica.it)

Key words: Sternoclavicular joint, shoulder instability repair, shoulder kinematics, scapulothoracic movements, scapulohumeral rhythm.

Introduction

Several complications can occur after anterior shoulder stabilization surgery including stiffness and loss of motion of the glenohumeral joint especially in external rotation (ER), strength decrease, functional deficit, and pain. Such complications have been described for both open surgery and arthroscopic assisted surgery (1,2). Scapulothoracic movements are essential in shoulder kinematics and can partially compensate stiffness and loss of motion of glenohumeral joint. (3,4)

The scapulothoracic junction is not a true anatomic joint but is rather considered as a functional unit that includes the sternoclavicular (SC) and acromioclavicular (AC) joints and the junction between the anterior surface of the scapula and the thoracic cage. The scapulothoracic movement is strictly dependent on the translation and rotation of the clavicle at the sternoclavicular joint (SCJ), this being the only true joint between the axial and the upper appendicular skeleton.

Imbalances in scapulohumeral and scapulothoracic kinematics can produce an increasing strain on the SCJ leading to its hypermobility or instability, and pain (5,6). Aim of the study is to define a possible correlation between iatrogenic glenohumeral stiffness in outcomes of surgery for anterior shoulder instability and long-term sternoclavicular joint disorders.

Methods

A retrospective study was carried out recruiting 20 patients who underwent open or arthroscopic shoulder stabilization surgery for a traumatic unidirectional instability (TUBS), and a control group of 20 healthy subjects with comparable demographic characteristics. Inclusion criteria: shoulder unilateral surgery for shoulder traumatic unidirectional instability with 8 years minimum follow-up; exclusion criteria: bilateral surgery, surgery for any other shoulder disorders (SLAP lesions/cuff tears, frozen shoulder), shoulder recurrent instability, traumatic dislocation of the SCJ, shoulder traumatic lesions after surgery, systemic ligamentous laxity, other atraumatic disorders of the SCJ (arthrosis, rheumatoid arthritis, seronegative arthritis, infectious pathologies, SAPHO syndrome, Friedrich syndrome, Paget's disease, benign cystic lesions, localizations of Ewing's sarcoma, secondary lesions of lymphoma, Tietze's syndrome), radical neck dissection. Patients' follow up data were assessed at mean 10 years (range 8-13 years). After signing an informed consent, all participants underwent clinical evaluation including Rowe Modified Scale (7,8), glenohumeral ER assessment, shoulder specific tests and provocative maneuvers to exclude the presence of any rotator cuff injuries, subacromial impingement, residual instability (9), SCJ disorders (deformity, swelling, pain) (10) (Figure 1), scapular dyskinesis and malpositioning through Kibler classification (11).

Patients with clinical disorders of the SCJ underwent radiographic evaluation with Rockwood's Serendipity view (patient in supine position and an incident beam inclined 40° at the front) (Figure 2) (12).

Glenohumeral ER was measured with a 90° abducted upper limb, with the patient in standing position leaning his back against the wall and repeated in a supine position with the feet resting on the bed to minimize the compensation of the rachis and the movements of the scapula.

Shoulder joint ROM was measured for each subject by visual evaluation and through a digital inclinometer for smartphones ("Clinometer", developed by ©Plaincode), previously validated and currently available for free (13) (Figure 3).

Figure 1. Deformity and swelling of a right painful SCJ.

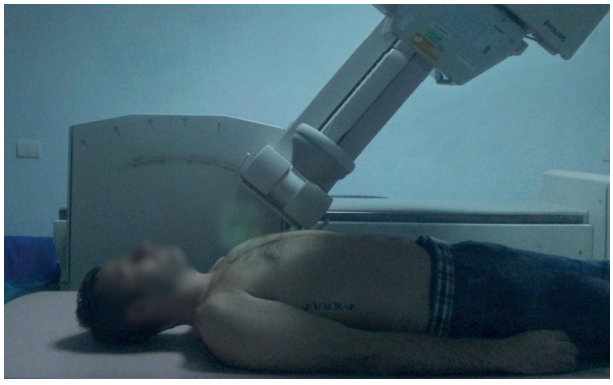

Figure 2. Rockwood's Serendipity view.

Figure 3. Clinometer app

The patients were assessed by two different examiners and the test were repeated 1 week later. The reliability of the measurements was assessed through an intraclass correlation index. Contingency tables and the exact Fisher test were used to test selected variables independence. P .05 was the selected significant level.

All procedures were performed following written informed patient consent and in accordance with the ethical standards of the institutional and/or national research committee and the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards.

Results

20 patients (16 males and 4 females; mean age 35 years, range: 29-40; 17 arthroscopic surgery and 3 open surgery) and 20 healthy subjects with comparable demographic characteristics (15 males and 5 females; mean age 32 years; range: 28-41), were included in the analysis.

The intraclass correlation coefficient for repeated measurements was 0.92.

The results of the long-term post-operative instrumental and clinical evaluations of the patient group were collected in the following table (Table 1):

No subjects included in the study showed an alteration of scapular positioning and movement in agreement with Kibler classification.

The categorical variables: disorders of the sternoclavicular joint (SCJ D) and reduction of the glenohumeral extrarotation (ER) are reported in the contingency tables, (Table 2) for the case group and in Table 3 for case group plus control group and are accompanied by the relative values of the Fisher Exact test (significance level p = .05).

Tables 2 e 3: SCJ D: sternoclavicular joint disorders; ↓ ER: external rotation deficit ≥ -5°; the signs + and – inside the tables indicate respectively the presence or the absence of a SCJ disorder and of a reduction of ER.

Discussion

The reliability of the measurements taken is demonstrated by the high intraclass correlation index observed (0.92), (greater than 0.70 guarantees the reliability of the tools used), the repeatability of the method has already been demonstrated in the literature. The values obtained in the modified Rowe score, for the post-operative functional evaluation, were good (89-75) to excellent (90-100) in 90% of cases, only 2 cases were fair (74-51), and no cases were poor (≤50). In our series a **≥ 5°** deficit of glenohumeral external rotation with 90° abducted arm has been observed in 14 of the

Table 1. Pt patient, SCJ D sternoclavicular joint disorders; 1 pain/tenderness, 2 swelling/subluxation, 3 popping; ROM= range of motion; ER: external rotation; Rowe M S= Rowe Modified score; Kibler= scapular static dyskinesia classification, no= normal; Surgery: A arthroscopy, O open surgery

Pt	SCJD	ER deficit	Rowe M S	Kibler	Surgery
1	No	No deficit	100	No	A
2	No	No deficit	100	No	A
3	2	No deficit	55	No	A
4	No	No deficit	95	No	A
5	**1-2**	**≥ -5° ER**	**95**	**No**	**A**
6	**1-2**	**≥ -5° ER**	**85**	**No**	**O**
7	**1**	**≥ -5° ER**	**95**	**No**	**A**
8	**1**	**≥ -5° ER**	**90**	**No**	**A**
9	**3**	**≥ -5° ER**	**75**	**No**	**A**
10	No	≥ -5° ER	60	No	A
11	**1-2**	**≥ -5° ER**	**95**	**No**	**O**
12	No	No deficit	100	No	A
13	**1**	**≥ -5° ER**	**90**	**No**	**A**
14	No	≥ -5° ER	95	No	O
15	No	No deficit	85	No	A
16	**1-2**	**≥ -5° ER**	**90**	**No**	**A**
17	**1**	**≥ -5° ER**	**90**	**No**	**A**
18	No	≥ -5° ER	95	No	A
19	**3**	**≥ -5° ER**	**80**	**No**	**A**
20	**1-2**	**≥ -5° ER**	**85**	**No**	**A**

Table 2. Case Group; The Fisher Exact Test value is P = 0.0181: the result is significant at p < .05

	SCJ D +	SCJ D -	tot.
↓ ER +	11	3	14
↓ ER -	1	5	6
tot.	12	8	20

Table 3. Case Group + control group; The Fisher Exact Test value is P < 0.0001: the result is significant at p < .05

	SCJ D +	SCJ D -	tot.
↓ ER +	11	3	14
↓ ER -	1	25	26
tot	12	28	40

20 patients operated for anterior shoulder instability in comparison to the contralateral healthy arm. This deficit, in accordance with the literature, was more pronounced and more frequent in patients operated through open surgery (3 out of 3 pcs) than through arthroscopic surgery (11 out of 17 pcs) (1,2). The ROM limitation, although perceived by the patient, was almost never considered disabling, as demonstrated by excellent results in Rowe's modified scale in 85% of the patients examined. Only one out of the 14 patients with a **≥ 5°** deficit of glenohumeral external rotation had a fair result on the Rowe's evaluation scale (case 10, Rowe's score 60) all the others had values, according to Rowe's data, between 80 and 95 points.

The loss of control of normal resting scapular position and dynamic scapular motion, which will produce scapular protraction, associated with a combination of anterior tilt, increased internal rotation, and decreased upward rotation has been termed scapular dyskinesias. On the one hand the altered scapular position and motion have multiple effects that can alter optimal shoulder function, on the other hand not all observed scapular dyskinesias are associated with shoulder symptoms and dysfunctions. Among the possible consequences of scapular dyskinesias is the reduction of gleno-humeral external rotation in abduction (11). The scapular dyskinesia may increase tensile strain on the anterior gleno-humeral ligaments and, theoretically, due to the stable acromioclavicular joint and the clavicular-scapulo-humeral system, can determine increased mechanical stress to the sternoclavicular joint. Regardless of the observation of a deficit of extrarotation and SC disorders, no case of evident scapulohumeral dyskinesias or static scapular malposition were observed. The latter qualitative measurement is not objectivable with our available tools, although it was tested separately by both examiners who agreed about the evaluation in all cases. The absence of scapular dyskinesia in all the subjects studied, allowed us to exclude a possible confounding factor in our study. Indeed, our findings do not support a correlation between scapular dyskinesias and the observed cases of SC disorders. Symptomatic SC disorder such as pain, tenderness, swelling, redness, subluxation or joint snap during movement, were present in 12 patients (tab 2) while it was not present in any of the healthy volunteers with similar demographic characteristics and with the same exclusion criteria. These disorders were perceived for almost all patient as not limiting in their daily life activities. The control group showed no external rotation deficit or SC disorders. The absence of SCJ abnormalities in the control group may suggest an increased incidence of such disorders (ever subclinical) in patients operated for TUBS, but the sample is far too small to draw these conclusions. The association between the reduction of external rotation and one disorder of SCJ (showed in 11 patients) was statistically significant (tab 2; Fisher Exact Test value 0.0181); this association was even more significant in the joint analysis of patients plus control group as reported in tab 3 (Fisher Exact Test value < 0.0001).

The study of glenohumeral joint kinematics is essential to understand the pathomechanics associated with conditions such as sternoclavicular joint dysfunction. Few studies have directly investigated glenohumeral, sternoclavicular, acromioclavicular, and scapulothoracic joint kinematics beyond scapulohumeral rhythm and glenohumeral translations. Descriptions of shoulder kinetics and recent three-dimensional in vivo kinematics studies (5,14-20) are ameliorating our understanding of shoulder function. Due to the ligamentous and capsular attachments of the scapula to the clavicle and clavicle to the thorax, scapulothoracic motion requires SC or AC joint motion, or some combination of motion at both joints (21) described as a single "scapulothoracic joint" motion (14,15,22,23). Current knowledge of normal clavicular motion and subsequently SC or AC joint motion is based on a small number of studies (3,5,21,24-27). The relationship between scapulothoracic, sternoclavicular and acromioclavicular joint motion, termed "coupling" (5,28,29) suggests that abnormal sternoclavicular or acromioclavicular joint motion may result from abnormal scapulothoracic motion. Consequently, the coupling theory is crucial to develop biomechanical theories for explaining pathology and potential causative or compensatory movement pattern (18,19). The well-known residual limitation of external rotation following surgery for shoulder instability, in our sample was strongly associated with SCJ disorders.

Conclusion

Our results provide support for an association between some disorders of the SCJ and the alterations of the shoulder kinematics associated with a reduction of ROM in external rotation. Our sample is too small to allow definitive conclusions to be drawn, furthermore we have not been able to find articles in the literature that present this association. These results, if confirmed by larger studies, could help us to further clarify the complex kinematics of the shoulder girdle.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

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Correspondence:
Corrado Ciatti
Orthopedics and Traumatology Department, University of Sassari, Sassari, Italy.
E-mail: dadociatti@icloud.com