SOCIEDADE BRASILEIRA DE ORTOPEDIA E TRAUMATOLOGIA

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Original article

Safety zone for posterosuperior shoulder access: study on cadavers☆

Miguel Pereira Costa, Sandro Baraldi Moreira, Gustavo Costalonga Drumond, Fernanda de Marchi Bosi Porto, Fabiano Rebouças Ribeiro, Antonio Carlos Tenor Junior*

Hospital do Servidor Público Estadual de São Paulo, São Paulo, SP, Brazil

ARTICLE INFO

Article history:
Received 21 May 2014
Accepted 30 June 2014
Available online 8 June 2016

Keywords:
Shoulder/anatomy and histology
Shoulder/innervation
Acromioclavicular joint/surgery
Operative surgical procedures

ABSTRACT

Objective: The posterosuperior shoulder access used in surgical treatment for acromioclavicular dislocation was constructed through dissection of 20 shoulders from 10 recently chilled adult cadavers, and the distances from this route to the nearby neurovascular structures were analyzed.

Methods: A Kirschner wire was introduced into the top of the base of the coracoid process through the posterosuperior shoulder access, in the area of the origin of the conoid and trapezoid ligaments, thus reproducing the path for inserting two anchors for anatomical reconstruction of the coracoclavicular ligaments. The smallest distance from the insertion point of the Kirschner wire to the suprascapular nerve and artery/vein was measured.

Results: The mean distance from the suprascapular nerve to the origin of the coracoclavicular ligaments at the top of the base of the coracoid process was 18.10 mm (range: 13.77–22.80) in the right shoulder and 18.19 mm (range: 12.59–23.75) in the left shoulder. The mean distance from the suprascapular artery/vein to the origin of the coracoclavicular ligaments was 13.10 mm (range: 9.28–15.44) in the right shoulder and 14.11 mm (range: 8.83–18.89) in the left shoulder. Comparison between the contralateral sides did not show any statistical difference.

Conclusion: The posterosuperior shoulder access route for anatomical reconstruction of the coracoclavicular ligaments in treating acromioclavicular dislocation should be performed respecting the minimum limit of 8.83 mm medially.

☆ Study conducted at the Hospital do Servidor Público Estadual de São Paulo, Serviço de Ortopedia e Traumatologia, Grupo de Ombro e Cotovelo, São Paulo, SP, Brazil.

* *Corresponding author.*
E-mails: gustavocdrumond@gmail.com, marateko@hotmail.com (G.C. Drumond).

http://dx.doi.org/10.1016/j.rboe.2016.06.001

Zona de segurança no acesso posterossuperior do ombro: estudo em cadáver

Palavras-chave:
Ombro/anatomia e histologia
Ombro/inervação
Articulação acromioclavicular/cirurgia
Procedimentos cirúrgicos operatórios

RESUMO

Objetivo: Os autores fizeram o acesso posterossuperior do ombro usado no tratamento cirúrgico da luxação acromioclavicular, a partir da dissecção de 20 ombros de 10 cadáveres adultos recém-resfriados, e analisaram as distâncias da via às estruturas neurovasculares próximas.

Métodos: Introduziu-se um fio de Kirschner no topo da base do processo coracoide pelo acesso posterossuperior do ombro, na área de origem dos ligamentos conoide e trapezoide, para reproduzir o trajeto da inserção de duas âncoras para reconstrução anatômica dos ligamentos coracoclaviculares. Mediu-se a menor distância do ponto de inserção do fio de Kirschner ao nervo e à artéria/veia supraescapular.

Resultados: A média da distância do nervo supraescapular até a origem dos ligamentos coracoclaviculares no topo da base do processo coracoide foi de 18,10 mm (13,77 a 22,80) no ombro direito e 18,19 mm (12,59 a 23,75) no ombro esquerdo. A média da distância da artéria/veia supraescapular até a origem dos ligamentos coracoclaviculares foi de 13,10 mm (09,28 a 15,44) no ombro direito e 14,11 mm (08,83 a 18,89) no ombro esquerdo. Não houve diferença estatística comparativa entre os lados contralaterais.

Conclusão: A via de acesso posterossuperior do ombro para reconstrução anatômica dos ligamentos coracoclaviculares no tratamento das luxações acromioclaviculares deve ser feita com respeito ao limite de 08,83 mm medialmente.

Introduction

Acromioclavicular dislocation is a common injury in orthopedic practice.[1] The most common mechanism of injury is falling on the adducted shoulder, with force being applied directly to the acromion.[2] This injury occurs more frequently among young individuals and is associated with impact sports and high speed vehicles accidents.[3,4] Rockwood, *apud* Lemos[2] and Mouhsine et al.,[5] classified acromioclavicular dislocations in six types: types I and II, considered as mild, with non-operative treatment; types IV, V, and VI, severe, with surgical treatment[6]; and type III, moderate, which has controversial treatment, dependent on factors such as age, sports activity, and deformity.

There are over 75 described techniques for the surgical treatment of acromioclavicular dislocations, but none is considered to be the gold standard.[7] The techniques include the following: acromioclavicular joint fixation with wire or plate[8,9]; coracoacromial ligament transfer[10]; coracoacromial interval fixation with screw; use of anchors at the top of the base of the coracoid process or subcoracoid suture loop[11,12]; and tendon reconstruction with autograft from the coracoclavicular and acromioclavicular ligaments.[13] The modifications of the techniques that secure the clavicle to the coracoid process range from the use of screws (or subcoracoid loops) to the use of anchors and materials such as the Endobutton™ (flip-button™). These techniques can be done through open, minimally invasive,[14] or arthroscopic surgery.[15,16] The advantage in the use of anchors is its placement closer to the anatomical insertion site of the coracoclavicular ligaments.[17]

The posterosuperior shoulder approach for the treatment of acromioclavicular dislocations was presented during the 34th Brazilian Congress of Orthopedics and Traumatology (2002) and received the Professor Orlando Pinto de Souza Award for Creativity. Developed by the Shoulder and Elbow Group of our department, this approach aims to facilitate the access to the top of the base of the coracoid process; more anatomically reduce the acromioclavicular joint; and preserve the anterior portion of the deltoid muscle, allowing for a better functional recovery of the shoulder.

This study aimed to reproduce the posterosuperior shoulder access for the surgical treatment of acromioclavicular dislocations in cadavers and to evaluate the risk of neurovascular injury.

Methods

The study dissected 20 shoulders in 10 recently-chilled adult cadavers (three women and seven men), mean age of 61 years (43–79), with no congenital abnormalities, signs of trauma, or previous surgery on the shoulder. Data on height, gender, and age were collected. The same group of researchers was responsible for all dissections. A pilot study (using two shoulders from two cadavers) was made in advance before the start of data collection, for better understanding and assessment of the local anatomy.

The procedures were performed with the cadaver in the supine position and a pad under the ipsilateral scapula. A surgical pen marker was used for marking of bone protrusions of the distal clavicle, the coracoid process of the acromioclavicular joint, the acromion, and the scapular spine,

Fig. 1 – Marking of bone protusions of the distal clavicle, the coracoid process, the acromioclavicular joint, the acromion, the scapular spine, and posterosuperior shoulder approach.

and for marking the posterosuperior shoulder approach (Fig. 1).

Then, the skin incision was made and the superficial plane was dissected, exposing the deltotrapezial fascia. The fascia was detached from the distal clavicle and scapular spine, making it possible to expose the deep plane, comprising the supraspinatus muscle belly inferiorly, the acromioclavicular joint laterally, and the top of the base of the coracoid process anteriorly. Following the exposure of this area and good visibility of the base of the coracoid process, the coracoclavicular and acromioclavicular ligaments as well as the clavicle could be identified and detached. With the clavicle still reduced to the acromion, a Kirschner wire was introduced into the top of the base of the coracoid process, posteriorly to the clavicle, to simulate the introduction of anchors in the insertion spot of the coracoclavicular ligaments (Fig. 2).

After anterior dislocation of the distal clavicle, dissection continued from the base of the coracoid process to the scapular notch, identifying the suprascapular artery/vein, the suprascapular ligament and the suprascapular nerve (Fig. 3). The structures were marked with colored markers and the distances from them to the Kirschner wire were measured. The measurements were made with a Kingtools® 150 mm digital caliper.

For each shoulder, two measures were made and recorded (Table 1). The first corresponded to the smallest distance from the Kirschner wire to the suprascapular nerve and the second, to the distance from the wire to the suprascapular artery/vein. Statistical analysis was performed using the paired Wilcoxon test. The significance level was set at 5%, and SAS software, version 9.2, was used.

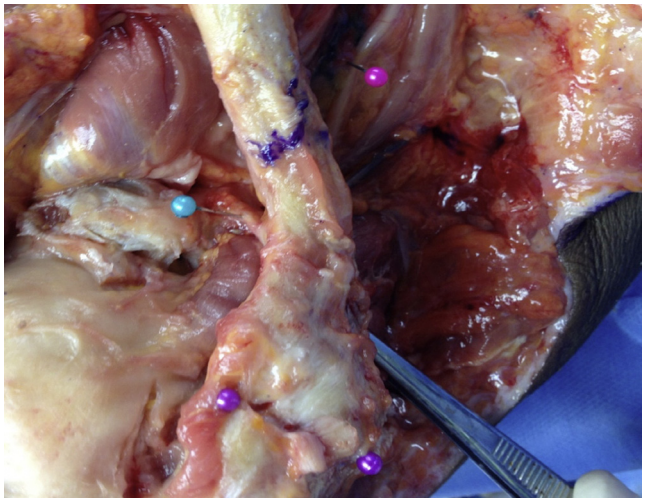

Fig. 2 – Marking of the distal third of the clavicle. Pink marker: suprascapular nerve; blue marker: trapezoid ligament; purple marker: borders of the acromioclavicular joint. The pincer indicates the direction and the insertion of the Kirschner wire into the coracoid process.

Results

The mean distance from the Kirschner wire to the suprascapular nerve was 18.10 mm in the right shoulder and 18.19 mm in the left shoulder. The mean distance from the Kirschner wire to the suprascapular artery/vein was 13.10 mm in the right shoulder and 14.11 mm in the left shoulder (Table 1).

In all dissected shoulders, no anatomic variations were observed regarding the location and route of the neurovascular structures relative to the superior transverse ligament of

Fig. 3 – Marking of shoulder superolateral structures with the clavicle posteriorly dislocated. Pink marker: suprascapular nerve; blue marker: trapezoid ligament; yellow marker: conoid ligament; navy blue marker: suprascapular artery; white marker: suprascapular notch ligament.

Table 1 – Shortest distance from the Kirschner wire to the suprascapular nerve (first value) and the distance from the Kirschner wire to the suprascapular artery/vein (second value).

Cadaver	Right shoulder	Left shoulder
1	20.20/15.44 mm	23.75/18.89 mm
2	16.30/13.08 mm	12.59/8.83 mm
3	22.80/13.60 mm	18.90/14.62 mm
4	13.77/12.03 mm	15.45/12.36 mm
5	17.60/11.79 mm	19.96/13.97 mm
6	16.44/14.54 mm	17.82/15.65 mm
7	15.43/13.65 mm	16.65/15.54 mm
8	15.08/9.28 mm	18.22/12.52 mm
9	15.55/10.87 mm	16.65/14.77 mm
10	18.78/12.65 mm	17.46/14.98 mm

Measures taken with a Kingtools® 150 mm digital caliper.

the scapula: the suprascapular nerve was under the ligament and the suprascapular artery/vein, above it.

Discussion

The neurovascular structures closest to the shoulder posterosuperior approach and to the introduction of anchors at the top of the base of the coracoid process were the suprascapular nerve and the suprascapular artery/vein. The suprascapular nerve arises from the upper trunk of the brachial plexus, passes underneath the omohyoid muscle toward the superior notch of the scapula, and then under the superior transverse scapular ligament, which connects its two bone edges. At this level, it sends nerve motor branches to the supraspinatus muscle and follows toward the spinoglenoid notch, where it innervates the infraspinatus muscle.[18]

The suprascapular artery originates from the thyrocervical trunk, a branch of the subclavian artery in the neck, and passes behind the clavicle to supply the muscles of the posterior aspect of the scapula. The suprascapular artery follows the suprascapular nerve, but separates from it near the superior transverse ligament of the scapula and passes above the ligament. It anastomoses to the dorsal scapular and circumflex scapular arteries, forming a collateral circulation around the scapula. Therefore, the superior transverse ligament of the scapula separates the artery suprascapular from the suprascapular nerve.[18]

The goal of the surgical treatment of acromioclavicular dislocation is to obtain anatomical reduction to allow soft tissue healing and recovery of prior joint function. Biomechanical studies have demonstrated that the conoid and trapezoid ligaments are important static stabilizers of the acromioclavicular joint. They have also indicated that, among the different reconstruction techniques of these ligaments, anatomical reconstruction has biomechanical properties superior to those of non-anatomic techniques.[19–25] The fixation of the clavicle to the coracoid process with suture anchors has facilitated the surgical technique. However, the anterior approach requires dissection of the anterior portion of the deltoid muscle and maintains residual subluxation of the clavicle, as it does not restore the force vector of the coracoclavicular ligaments. The shoulder posterosuperior approach provides a direct access to the top of the base of the coracoid process not damaging the anterior deltoid muscle, and can maintain the joint reduction more anatomically, restoring joint stability by positioning the anchors in the anatomical location of the torn coracoclavicular ligaments.

Molin et al.[26] presented 84 cases of patients treated with the posterosuperior shoulder approach for placement of suture anchors at the base of the coracoid process. The technique was shown to be easy to learn and reproduce, yielding results similar to the techniques described in the literature, with a low rate of postoperative complications.

Dieter Kohn et al.[14] reproduced in cadavers a minimally invasive endoscopic technique for the anatomical reconstruction of coracoclavicular ligaments and analyzed the potential risk of neurovascular injury. The anchors were correctly positioned at the center of the base of the coracoid process and the suture force vector neared the anatomical position. The mean distance from the coracoid process to the suprascapular nerve was 1.8 cm (1.5–2.2), and from the coracoid process to the suprascapular artery was 1.5 cm (1.3–1.9). However, those authors did not compare to the contralateral side.

In the present study, the mean distance from the coracoid process to the suprascapular nerve reached 1.81 cm (1.37–2.28) in the right shoulder and 1.81 cm (1.25–2.37) in the left shoulder. From the coracoid process to the suprascapular artery/vein, the mean distance reached 1.31 cm (0.92–1.54) in the right shoulder and 1.41 cm (0.83–1.88) on the left shoulder. No significant differences from the left to the right sides were observed. None of the twenty shoulders dissected presented damage to neurovascular structures and supraspinatus muscle with the introduction of the Kirschner wire.

Conclusion

It can be concluded that the insertion of anchors at the base of the coracoid process through the posterosuperior shoulder approach for anatomical reconstruction of coracoclavicular ligaments in the treatment of acromioclavicular dislocations should respect the limit of 8.83 mm, medially.

Conflicts of interest

The authors declare no conflicts of interest.

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