ORIGINAL ARTICLE

Eur. J. Anat. 20 (3): 215 - 220 (2016)

Morphometry of the suprascapular nerve in the supraspinous fossa

Ana Pérez*, Irene Navas*, Alejandra Herencias*, Fernando Marco[1], José Sañudo, Clara Simón[2], Teresa Vázquez

Department of Human Anatomy and Embryology, Faculty of Medicine, Universidad Complutense, Madrid, Spain, [1]Shoulder and Elbow Unit, Department of Orthopedics, Hospital Clínico San Carlos, Universidad Complutense, Madrid, Spain, [2]Statistics and Operative Investigation Department, Universidad Rey Juan Carlos, Madrid, Spain

SUMMARY

We describe the supraescapular region's anatomy providing distances between osseous landmarks (supraglenoid tubercle, suprascapular notch, glenoid rim, scapular spine) and measuring the total length of the suprascapular nerve (ssn), to determine ideal places or safe zones for shoulder surgery. Fifty shoulders from cadavers belonging to the Human Anatomy and Embryology donated under consent of the Spanish law were studied. The course of the nerve in each shoulder has been defined by measuring the distances from the supraglenoid tubercle to the suprascapular notch and to the scapular spine, the distance from the midpoint of the posterior glenoid rim to the base of the scapular spine, and finally the total length of the nerve.

After leaving the suprascapular notch, the ssn courses posteriorly and laterally deep to the supraspinatus muscle to reach the base of the scapular spine. The distance from the supraglenoid tubercle to the notch averaged 3.54 cm (range 3 - 4.1 cm) and the distance to the base of the spine averaged 2.51 cm (range 1.9 - 3 cm). The distance from the midline of the posterior glenoid rim to the scapular base ranged from average 2.42 (range1.9 - 3.1 cm). The total length of the nerve along the supraspinous fossa averaged 4.22 cm (range 3.6 - 5 cm). A surgical safe zone could be established taking into account these measurements.

Key words: Shoulder – Arthroscopy – Nerve entrapment – Spinoglenoid ligament – Suprascapular notch

INTRODUCTION

The supraescapular nerve is a mixed nerve, which originates from the brachial plexus' superior trunk containing roots from C5 and C6. It runs laterally, deep to the trapezius, entering the supraspinous fossa trough the supraescapular notch, under the transverse scapular ligament. It continues its course to the infraspinatus fossa passing through the spinoglenoid notch, under the spinoglenoid ligament. Along its route the nerve gives motor branches for the supraspinatus and infraspinatus muscles and sensory branches for the acromioclavicular and glenohumeral joints, subacromial bursa, coracoacromial and coracohumeral ligaments (Callahan et al., 1991; Molony et al., 2011) and a cutaneous branch for the upper lateral parts of the arm (Ajmani, 1994). Its relationship with the supraescapular vessels must be highlighted due to its great variability (Yang et al., 2012).

Anatomical knowledge of the supraescapular nerve is essential for correct clinical and surgical practice. The nerve suffers frequent entrapment by the transverse scapular and spinoglenoid ligaments producing pain and shoulder dysfunction (Reider and Inglis, 1982). Between 1 and 2% of the total shoulder pain is caused by entrapment of the suprascapular nerve (Van Meir et al., 2011) the suprascapular notch being the most common place (0.4%) (Demirhan et al., 2011). Since the first description of these types of entrapment was

Corresponding author: Teresa Vázquez. Department of Human Anatomy and Embryology, Faculty of Medicine, Universidad Complutense, 28040 Madrid, Spain. Phone / Fax: +3491 394 1374. E-mail: tvazquez@ucm.es

*These authors have contributed equally to this work

Submitted: 30 March, 2016. *Accepted:* 24 May, 2016.

made by Thompson and Kopell (Thompson and Kopell, 1959), many authors have reported similar investigations associating them to iatrogenic injuries due to posterior shoulder approaches, insertion of arthroscopic devices, transverse ligament anomalies, ganglias, cysts, tumors, trauma, fractures of scapula or ligament calcification (Warner et al., 1992). Neuropathy may also occur by traction injuries due to excessive overhead sports practice, or as a result of a massive retracted rotator cuff tear. In addition to this, there is a new study that defines another case of entrapment due to varicose enlargement of the suprascapular veins at the spinoglenoid notch (Van Meir et al., 2011). The main symptoms of supraescapular entrapment are pain, weakness, paralysis, and atrophy of supra and/or infraspinatus muscles.

Several arthroscopic techniques have been described for nerve release such as resection of the ligament (Morgan and Bodenstab, 1987; Soubeyran et al., 2008; Yang et al., 2012). These, as well as suprascapular nerve blockade procedures (Chan and Peng, 2011; Nam et al., 2011) and screw insertion in shoulder arthroplasty for instability (Molony et al., 2011), require acquaintance with the nerve's pathway in relation with anatomical landmarks. Locating the nerve during surgical interventions by establishing surgery safe zones can help us to avoid iatrogenic damage and to improve the approach during nerve decompression (Bigliani et al., 1990; Kim et al., 2010). The clinical importance of this knowledge has also been shown in the management of massive rotator cuff tears (Warner et al., 1992). If nerve decompression is not possible, the use of damaging techniques such as pulsed radiofrequency and neurotization of the suprascapular nerve and the axillary nerve in C5, C6 brachial plexus injuries has also been described in the literature (Chan and Peng, 2011; Jerome, 2011).

The aim of this study was therefore to describe the supraescapular region's anatomy by providing distances between osseous landmarks (supraglenoid tubercle, suprascapular notch, glenoid rim, scapular spine) and by measuring the total length of the nerve, in order to determine ideal places or safe zones for shoulder surgery including arthroscopic procedures, joint instability, decompression and nerve blocks. A reduction in iatrogenic damage, technical improvements and better surgical results are searched.

MATERIAL AND METHODS

Fifty cadaveric shoulders donated to the Department of Human Anatomy and Embryology of the Complutense University of Madrid (Spain) were dissected in accordance to the national law for this procedure in the course of our study. Of these, 27 were male and 19 female, their mean age being 62.30. 22 were right shoulders and 24 left.

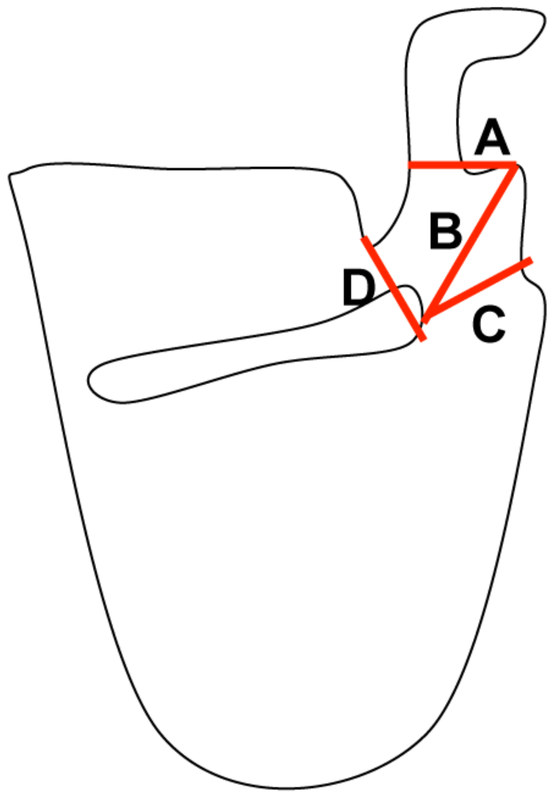

Fig. 1. Scheme representing a right shoulder posterior view showing measuring distances (A) from the supraglenoid tubercle to the suprascapular notch; (B) from the supraglenoid tubercle to the scapular spine; (C) from the midline of posterior glenoid rim to the base of the scapular spine; (D) the total length of the nerve, between the suprascapular and spinoglenoid notches.

To expose the supraescapular nerve a careful dissection was performed. Firstly, the deltoid muscle and the trapezium muscle were rejected to expose the supraspinatus and infraspinatus muscles, which were then elevated from their origins, exposing the supraescapular nerve without disturbing its location. The spinoglenoid ligament and the supraescapular and spinoglenoid notches were identified. The supraescapular nerve was identified passing under the transverse scapular ligament and followed proximally and distally. It was accompanied by the suprascapular artery and vein, respectively.

Nerve course and its distance from standard bony landmarks in each shoulder were recorded measuring the following distances: (Fig. 1)

A - from the supraglenoid tubercle to the suprascapular notch.

B - from the supraglenoid tubercle to the scapular spine.

C - from the midline of posterior glenoid rim to the base of the scapular spine.

D - the total length of the nerve (between the suprascapular and spinoglenoid notches).

All measurements were repeated three times by two different observers using fine calipers graduated to 0.1 mm to reduce error rate. We also ana-

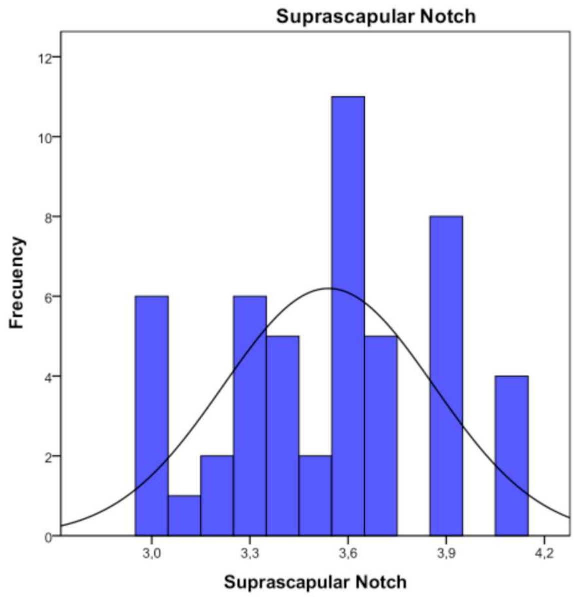

Fig. 2. Histogram for the variable measure of the Supraescapular Notch.

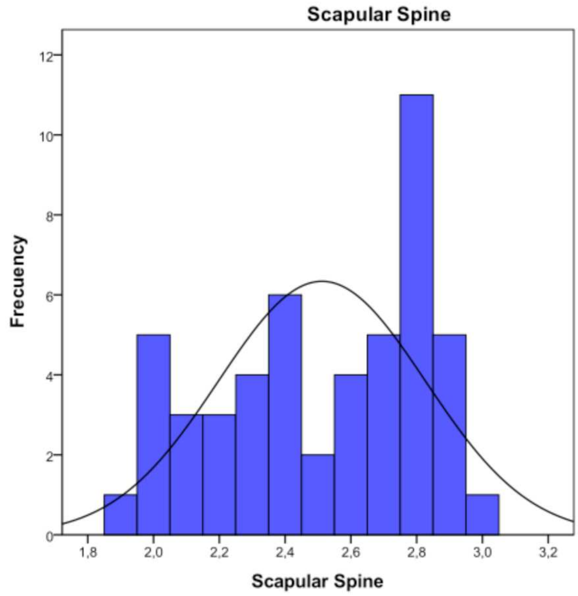

Fig. 3. Histogram for the variable measure of the Scapular Spine.

Table 1. Descriptive statistics of the suprascapular notch, scapular spine, base of the scapular spine and the run along supraspinatous fossa measures

Statistics		Suprascapular Notch	Scapular Spine	Base of the Scapular Spine	Run along supraspinatous
N	Valid	50	50	50	50
	Missing Values	0	0	0	0
Average		3,540	2,512	2,424	4,222
Median		3,600	2,600	2,500	4,100
Estándar Dev.		,3220	,3147	,3034	,3565
Minimum		3,0	1,9	1,9	3,6
Maximum		4,1	3,0	3,1	5,0
Percentile	10	3,000	2,000	2,010	3,800
	90	3,900	2,900	2,890	4,700

lysed the presence or absence of the spinoglenoid ligament.

RESULTS

The anatomical variation of the relationship of the supraescapular vessels and the spinoglenoid ligament was noted in several cadavers, passing the vessels over the ligament or below it and after through the spinoglenoid notch.

Table 1 shows the descriptive statistics of the Supraglenoid Tubercle (Suprascapular notch and scapular spine), the midline of posterior glenoid rim (base of the scapular spine) and the run along supraspinatous fossa. We can observe that the variation range in cm. from the supraglenoid tubercle to suprascapular notch measure is [3.0; 4.1] with an average value of 3.54 cm. Data are concentrate in the average with relevant concentration of data at the beginning and the end of the variation range interval (Fig. 2). The 95% confidence interval for the average is $IC_{95\%}(\mu)=[3.44; 3.63]$. The Kolmogorov – Smirnoff normality test assumes a normal distribution for the data with a confidence level $\alpha=0.05$ (p-value 0.331).

In relation to the distance from the supraglenoid tubercle to the scapular Spine, the variation range in cm. is [1.9; 3.0] with an average value of 2.51 cm. Data are concentrate in the average with relevant concentration of data at the beginning and the

Table 2. Frequency and percentages for the variables spinoglenoid ligament, artery over and hand side

	Spinoglenoid Ligament		Artery position			Side	
	Frecuency	Percentage	Frecuency	Percentage		Frequency	Percentage
Artery below	3	6.0	48	96.0	Left	26	52.0
Artery over	47	94.0	2	4.0	Right	24	48.0
Missing Values					Missing Values		
Total	50	10.0	50	100.0	Total	50	100.0

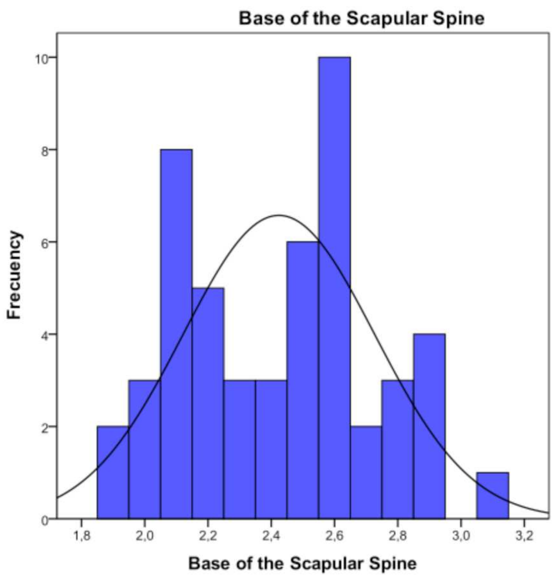

Fig. 4. Histogram for the variable measure of the base of the Scapular Spine.

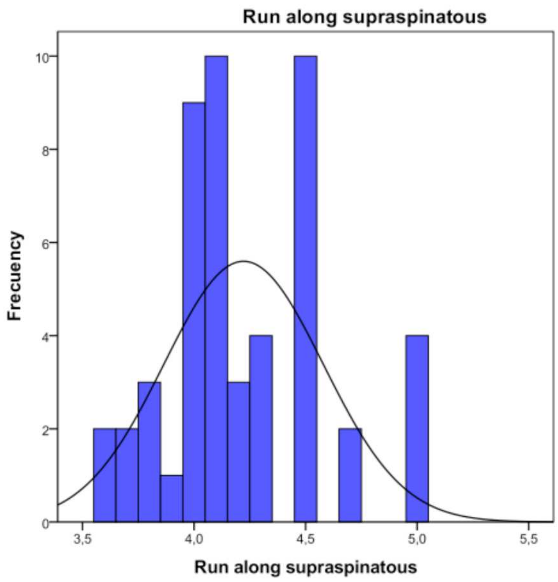

Fig. 5. Histogram for the variable measure of the run along the Supraspinous.

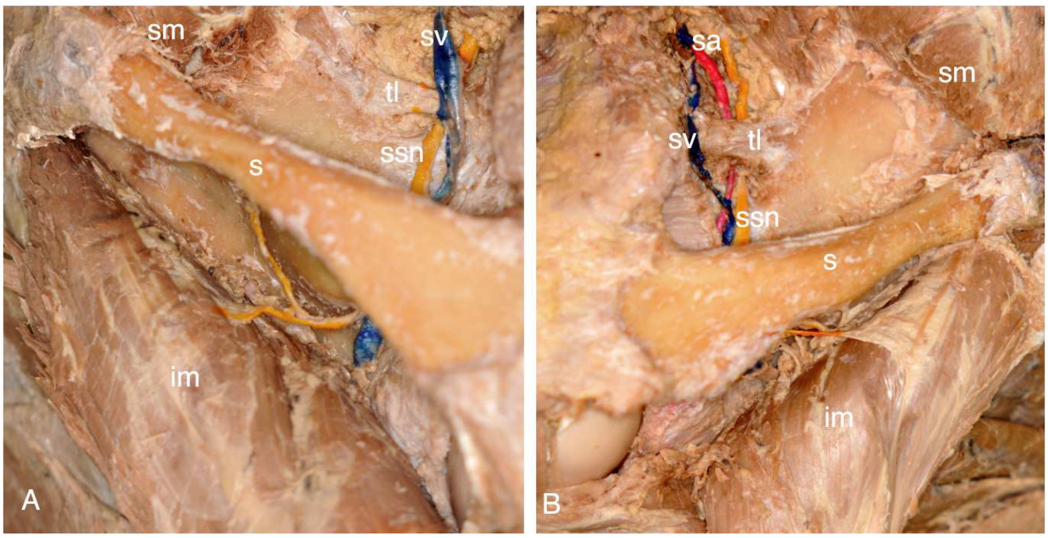

Fig. 6. Right (**A**) and left (**B**) shoulders dissections showing suprascapular nerve (ssn) passing below the transverse scapular ligament (tl). (**A**) This figure shows the most common situation in which suprascapular vessels cross over the ligament; suprascapular artery has been removed to visualize the nerve. (**B**) suprascapular artery (sa) and suprascapular vein (sv) pass to the supraspinatus fossa with the ssn below the ligament. Infraspinatus muscle (im); supraspinatus muscle (sm); scapular spine (s).

end of the variation range interval (Fig. 3). The 95% confidence interval for the average is $IC_{95\%}(\mu)$ =[2.42; 2.60]. The Kolmogorov-Smirnoff normality test assumes a normal distribution for the data with a confidence level α=0.05 (p-value 0.132). Regarding the distance from the midline of posterior glenoid rim to the base of the Scapular Spine, the variation range in cm. is [1.9; 3.1] with an average value of 2.42 cm. Data are concentrate in the average with relevant concentration of data at the beginning and the end of the variation range interval (Fig. 4). The 95% confidence interval for the average is $IC_{95\%}(\mu)$=[2.33; 2.51]. The Kolmogorov-Smirnoff normality test assumes a normal distribution for the data with a confidence level α=0.05 (p-value 0.368).

Finally, the measure between the suprascapular and spinoglenoid notches have a variation range in cm. of [3.6; 5.0] with an average value of 4.22 cm. Data are concentrate in the average with relevant concentration of data at the beginning and the end of the variation range interval and a big spread (Fig. 5). The 95% confidence interval for the average is $IC_{95\%}(\mu)$=[4.12; 4.32]. The Kolmogorov-Smirnoff normality test cannot conclude in the hypothesis of normality with a confidence level α=0.05 (p-value 0.09).

Table 2 represents the frequencies of the spinoglenoid ligament. In these cases the artery was over or below the ligament and the hand side and the sex of the shoulder. We can observe that the spinoglenoid ligament was present in the majority of the cases (94%), the artery was over in the 96% of the cases and the hand sides where balanced between right and left (48% and 52% respectively) (Fig. 6).

DISCUSSION

Entrapment of the suprascapular nerve and iatrogenic injury due to arthoscopic procedures such as the arthroscopic *Bankart Procedure* produce shoulder dysfunction, pain, weakness, paralysis, and atrophy. These are well known and described in previous studies (Viek and Bell, 1959; Reider and Inglis, 1982; Duparc et al., 2010). Other investigations mention the most common entrapment points along its tour (suprascapular and spinoglenoid notch) and many arthroscopic techniques for its decompression (Morgan and Bodenstab, 1987; Soubeyran et al., 2008).

Nevertheless, for clinical practice its relationship with osseous landmarks is the most useful. Taken all these distances into consideration, we can establish a safe zone and obtain the patterns of the most frequent distances for the surgical approach. Surgical pins, inserted from the anterior side for glenohumeral ligament reconstructions, could emerge in this safe zone without damaging the suprascapular nerve, and could be employed to facilitate the administration of analgesia to block the nerve in arthroscopic shoulder surgery.

On the other hand, we also studied the presence or absence of the spinoglenoid ligament and the nerve's relationship with the suprascapular artery and vein, looking out for anatomical variations, which might be important for surgical techniques in order to avoid iatrogenic damages. Although spinoglenoid ligament is not easily observed, it was seen in all cases, in some of them calcified, being this situation a possible cause of nerve entrapment.

The suprascapular nerve was observed passing inferior to the transverse scapular ligament in all cases. Most times the suprascapular artery reaches supraspinatus fossa passing over the ligament although sometimes (6% of cases) it does so accompanying the suprascapular nerve below the ligament.

Measurements carried out in this study are similar to those previously published (Bigliani et al., 1990) and, in agreement with most authors, the spinoglenoid ligament has been observed in all cases.

Conclusion: A thorough description of the region's anatomy, providing osseous landmarks (supraglenoid tubercle, suprascapular notch, glenoid rim, scapular spine) and the total length of the nerve are provided, which help establish ideal places or safe zones for shoulder surgery including arthroscopic procedures, joint instability, decompression and nerve blocks. Knowledge of the anatomical course of the nerve may be used in future surgical approaches in order to reduce iatrogenic damage and improve surgical results.

REFERENCES

AJMANI ML (1994) The cutaneous branch of the human suprascapular nerve. *J Anat*, 185 (Pt2): 439-442.

BIGLIANI LU, DALSEY RM, MCCANN PD, APRIL EW (1990) An anatomical study of the suprascapular nerve. *Arthroscopy*, 6(4): 301-305.

CALLAHAN JD, SCULLY TB, SHAPIRO SA, WORTH RM (1991) Suprascapular nerve entrapment. A series of 27 cases. *J Neurosurg*, 74(6): 893-896.

CHAN CHW, PENG PWH (2011) Suprascapular nerve block. A narrative review. *Reg Anesthesia Pain Med*, 36(4): 358-373.

DEMIRHAN M, IMHOFF AB, DEBSKI RE, PATEL PR, FU FH, L-Y WOO S (2011) The spinoglenoid ligament and its relationship to the suprascapular nerve. *J Shoulder Elbow Surg*, 7(3): 238-243.

DUPARC F, COQUEREL D, OZEEL J, NOYON M, GEROMETTA A, MICHOT C (2010) Anatomical basis of the suprascapular nerve entrapment, and clinical relevance of the supraspinatus fascia. *Surg Radiol Anat*, 32: 277-284.

JEROME JT (2011) Long head of the triceps branch transfer to axillary nerve in C5, C6 brachial plexus injuries: anterior approach. *Plastic Reconst Surg J*, 128(3): 740-741.

KIM SH, KOH YG, SUNG CH, MOON HK, PARK YS (2010) Iatrogenic suprascapular nerve injury after repair of type II SLAP lesion. *Arthroscopy*, 26(7): 1005-1008.

MOLONY DC, CASSAR GHEITI A, KENNEDY J, GREEN C, SCHEPENS A, MULLETT HJJ (2011) A cadaveric model for suprascapular nerve injury during glenoid component screw insertion in reverse-geometry shoulder arthroplasty. *J Shoulder Elbow Surg*, 20(8):1323-1327.

MORGAN CD, BODENSTAB AB (1987) Arthroscopic Bankart suture repair. *Arthroscopy*, 3: 111-122.

NAM YS, JEONG JJ, HAN SH, PARK SE, LEE SM, KWON MJ, JI JH, KIM KS (2011) An anatomic and clinical study of the suprascapular and axilary nerve blocks for shoulder arthroscopy. *J Shoulder Elbow Surg*, 20(7): 1061-1068.

REIDER B, INGLIS AE (1982) The Bankart procedure modified by the use of Prolene pull-out sutures. *J Bone Joint Surg*, 64: 628.

SOUBEYRAN M, BAUER T, BILLOT N, LORTAT-JACOB A, GICQUELET T, HARDY P (2008) Original portals for arthroscopic decompression of the suprascapular nerve: an anatomic study. *J Shoulder Elbow Surg*, 17: 616-623.

THOMPSON WA, KOPELL HP (1959) Peripheral entrapment neuropathies of the upper extremity. *N Engl J Med*, 260(25): 1261-1265.

VAN MEIR N, FOURNEAU I, DEBEER P (2011) Varicose veins at the spinoglenoid notch: an unusual cause of suprascapular nerve compression. *J Shoulder Elbow Surg*, 20(7): e21-e24.

VIEK P, BELL BT (1959) The Bankart shoulder reconstruction. The use of pull-out wires and other details. *J Bone Joint Surg*, 41: 236-242.

WARNER JP, KRUSHELL RJ, MASQUELET A, GERBER C (1992) Anatomy and relationships of the suprascapular nerve: anatomical constraints to mobilization of the supraspinatus and infraspinatus muscles in the management of massive rotator-cuff tears. *J Bone Joint Surg Am*, 74(1): 36-45.

YANG HJ, GIL YCH, JIN JD, AHN SV, LEE HY (2012) Topographical anatomy of the suprascapular nerve and vessels at the suprascapular notch. *Clin Anat*, 25 (3): 359-365.