

COMPARISON OF ANTERIOR AND POSTERIOR SURGICAL DECOMPRESSION APPROACHES IN QUADRANGULAR SPACE SYNDROME: A PILOT CADAVERIC STUDY

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Abstract

Introduction: Quadrangular space syndrome includes compression of the axillary nerve and posterior circumflex humeral artery and its administration in couple of cases, requires careful decompression.

Aim: To compare the anterior and posterior surgical decompression approaches and to determine the scoring for both the approaches in QSS.

Materials and methods: A pilot study was conducted from January 2020 to August 2021 academic session of the first-year medical students in the Department of Anatomy in which four human cadavers were dissected in the Axillae and the Scapular region by the senior residents of the Department of Anatomy and Department of Orthopedics, who dissected quadrangular space in the eight upper limbs, using anterior and posterior surgical approaches.

Results: Posterior approach to identify the quadrangular space and secure its contents was recognized as the easier and much quicker method by both the Anatomy and Orthopedic residents, but the incision/reflection of deltoid muscle in this approach results in increased postoperative morbidity. Whereas the anterior (Delto-pectoral) approach involves more skill but reduces post-operative morbidity.

Conclusions: Anterior (Delto-pectoral) approach with suggested modifications can prove as an effective method in surgical decompression of quadrangular space syndrome. The authors suggest more cadaveric studies to facilitate anatomists and surgeons with the opportunities to practice and evaluate older and newer surgical approaches.

Keywords: Invasive approach, Anatomical approach, axillary nerve, quadrilateral space.

Introduction

Quadrilateral Space Syndrome (QSS) is an uncommon neuro-vascular entrapment condition involving axillary nerve (AXN), or/and posterior humeral circumflex course (PHCA) in the quadrilateral space due to injury, fibrous bands, or hypertrophy of muscular border [1]. The management involves a decompression procedure which involves various approaches which remains unevaluated, especially in the Indian population

The syndrome usually affects the dominant arm of the young adults of 20 to 35 years old, particularly athletes involved in overhead sports like volleyball [2], baseball [3], swimming [4], and other activities with frequent abduction and external rotation, such as yoga [5] or window cleaning [6]. Neurogenic QSS is portrayed by paraesthesia, fasciculations, weakness, or neurogenic pain in a nonspecific manner. Indications of intense ischemia reminiscent of vascular QSS incorporate pain, pallor, absent pulses, thrombosis, or embolism (coolness or cyanosis of the hand or digits). Notwithstanding vascular and neurogenic indications, patients with QSS suffer from muscular atrophy and

associated weakness, due to denervation [7,8,9].

The intermuscular space (as shown in table/fig. 1) is bordered superiorly by subscapularis muscle and capsule of the shoulder joint and inferiorly by the teres major muscle. It is confined medially by the long head of the triceps and laterally by the surgical neck of the humerus [10]. It contains loose connective tissue, fat, veins, the AXN, and the PHCA.

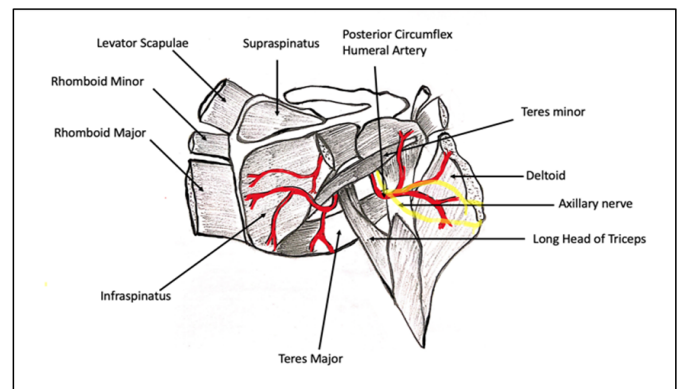


Figure 1: Boundaries of Quadrangular space

Typically, conservative measures such as physical therapy and physical activity modification are first recommended to patients [2]. Surgical decompression

is considered when patients are unresponsive to conservative measures for at least six months ^[11]. The current study aims to analyze all the various surgical approaches used in the decompression of neurovascular structures in QSS and present the reflections and recommendations.

Materials and Methods:

A pilot study was conducted from January to August month of the 2020-21 academic session of the first-year medical students in the Department of Anatomy at an Institute of National Importance. IEC approval was not required in this study as this cadaveric study was conducted during the routine dissection session of First-year medical students in the Department of Anatomy.

Inclusion criteria: The cadavers available in the department of Anatomy, with history of pectoral girdle pathologies or scapular region complaints were included for the study.

exclusion criteria: Cadavers without any history of pectoral girdle pathologies or scapular region complaints were excluded.

Sample size: Four cadavers (8 upper limbs) were used for dissection during the routine academic session.

This study shall be continued over the next few academic sessions using fresh cadavers as per the availability and feasibility and using new dissecting personnel till substantial quantity of statistically significant data is collected to enable its standardization. So, this pilot study is a part of our project and the results obtained are the proposed suggestions.

Parameters like anatomical ease of identifying involved neuro-vascular structures, technical expertise required to execute the procedure, probabilities of injury to neuro-vascular structures, probabilities of post-operative fibrosis and other complications, and time duration required to complete the procedure were noted. The grading system determined for every parameter studied is given in [table/fig-2]. The Anterior and Posterior surgical approaches involved in decompression procedure were confirmed and conducted on the cadavers by the residents and were assisted by the faculty from Orthopedic and Anatomy departments [12]. The observations noted by the faculty during the session were analyzed and documented.

Statistical analysis: Statistical analysis of the observations recorded is not required/applicable in this study. **Results:** All of the four cadavers (8 upper limbs) used for dissection during the routine academic session, all

were used for the study. The anterior surgical approach was conducted on 4 upper limbs and the posterior approach was performed on the other 4 upper limbs.

Newer approach:

The anterior approach which is the preferred approach for shoulder arthroplasty is proposed for QSS. In this approach, cadavers were placed in a supine position with the right-sided arm in 90-degree abduction. On the right side, using the bony and surface landmarks (acromion, clavicle, coracoid process, deltoid), a 12 cm long incision extending from the lateral margin of the coracoid process towards the proximal humeral shaft close to the del-

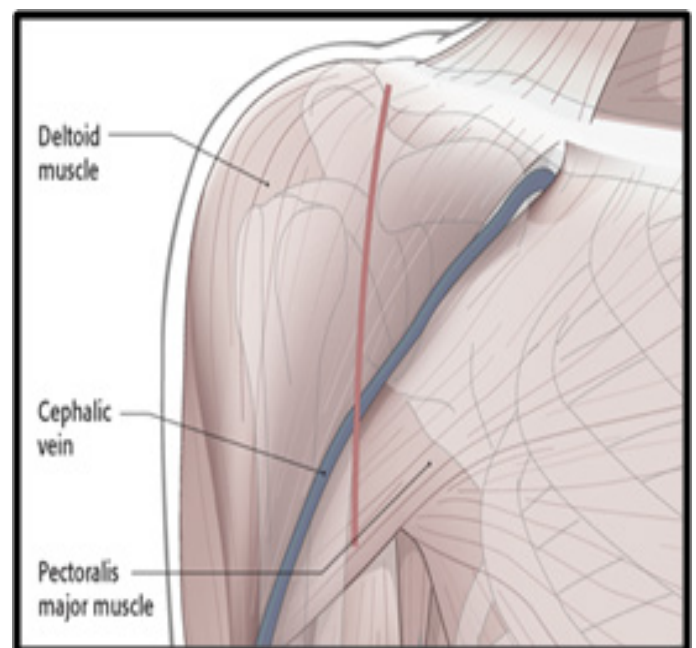


Figure 2: Surgical incision taken in Anterior (Delto-pectoral) approach (Courtesy: AO Surgery Reference: Jonas Andermahr, Michael McKee, Diane Nam. AO Surgery Reference. First edition. 2015. Deltopectoral approach [12].)

toid tuberosity is to be taken ^[12]. (table/fig. 3).

The residents exposed and incised the clavipectoral membrane within the Delto-pectoral groove. After retracting the deltoid muscle laterally and the conjoint tendon medially, the subscapularis muscle was exposed. The AXN was identified over the surface of the subscapularis muscle and it was traced close to its lower border.

The lower border of subscapularis muscle is the most critical point, as it is related intimately to the teres minor belly inferiorly.

The skin incision is then extended below, and lower border of teres minor is identified and using blunt dissection, quadrangular space is traced by inserting a

fingertip horizontally forwards along the plane of the lower border of the teres minor. After identifying the QS, the contents of the QS can be dissected by blunt dissection.

The teres major muscle need not be exposed and by using blunt dissection, the contents of the QS (AXN and PHCA) can be identified and traced within the QS.

The QS and its contents can be cleared of any fibrous strands or adhesions (table/fig. 4). No muscle is cut in this approach ^[12].

Currently preferred approach:

The contralateral left-sided axillae of the cadavers were approached posteriorly, during which the cadavers were placed in a lateral decubitus position, and a longitudinal incision of approximately 4 cm is made over the posterior shoulder. The posterior border of the deltoid is secured and reflected supero-laterally to reveal the underlying fat within the QS between the teres and also the teres major. The axillary nerve and the posterior circumflex humeral vessels will then be palpated as they exit the QS and the QS was identified and secured (table/fig. 5) ^[13].

Parameters like anatomical ease of identifying involved neuro-vascular structures, technical expertise required to execute the procedure, probabilities of injury to neuro-vascular structures, probabilities of post-operative fibrosis and other complications, and time duration required to complete the procedure

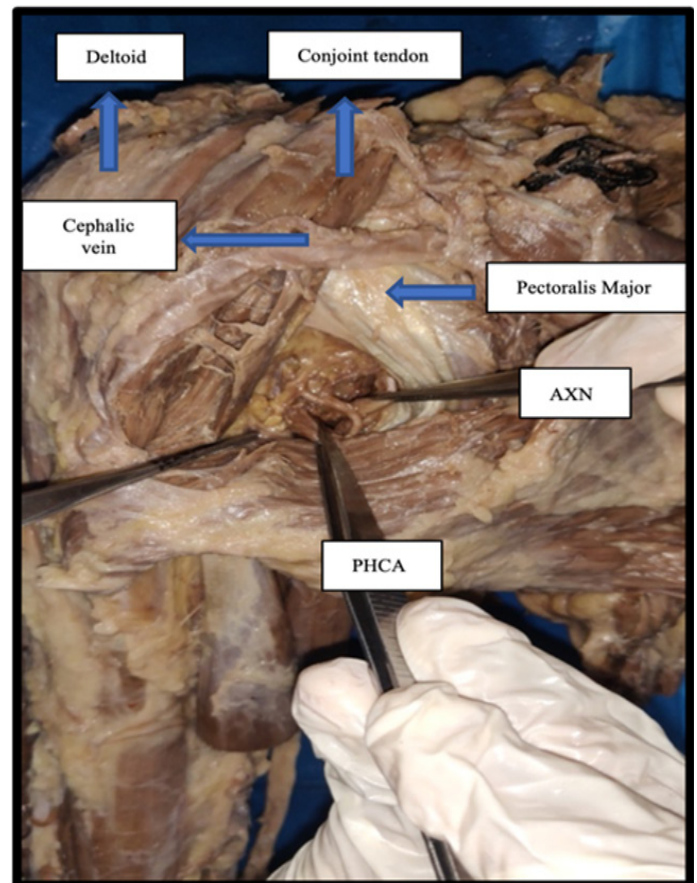


Figure 3:Anterior approach showing quadrangular space between Delto-pectoral groove along with the contents (AXN and PHCA) passing through it. (AXN: Axillary nerve; PHCA: Posterior Humeral Circumflex Artery)

were assessed and compared between both the procedures [table/fig-6]

Sr. No	Parameters on which the approach is tested	Anterior/ Delto-pectoral approach (Score : 10)	Posterior approach (Score : 10)
1	Anatomical ease of performing the procedure	06 (+++)	08 (++++)
2	Requirement to incise any structure like muscle, vessels, etc.	Nil	Yes
3	Anatomical ease in identifying involved neuro-vascular structures	06 (+++)	08 (++++)
4	Time duration required to complete the procedure	More than 15 min.	Less than 10 min.
5	Technical expertise required to execute the procedure	high++++)	Less (++)
6	Probability of injury to neuro-vascular structures	06 (+++)	08 (++++)
7	Probability of post-operative fibrosis and other complications	Minimal (+)	Significant (+++++)

Table 1: Assessment of parameters of both the approaches studied

Sl. No	Name of the parameter studied/ observed	The grades were given as a score of 10				
		2 points	4 points	6 points	8 points	10 points
1	Anatomical ease of performing the procedure	Significantly Easy +	Easy ++	Average +++	Difficult +++++	Significant Difficult +++++
2	Requirement to incise any structure like muscle, vessels, etc.	No requirement to incise any structure at all (Nil)			Requirement to incise either 1 or more neurovascular structures (Yes)	
3	Anatomical ease in identifying involved neuro-vascular structures	Very Easy +	Easy ++	Average +++	Difficult +++++	Very Difficult +++++
4	Time duration required to complete the procedure	Less than 10 minutes		10-15 minutes	More than 15 minutes	
5	Technical expertise required to execute the procedure	Minimal +	Less ++	Average +++	High +++++	Significant +++++
6	Probability of injury to neuro-vascular structures	Minimal+	Less ++	Average +++	High +++++	Significant +++++
7	Probability of post-operative fibrosis and other complications	Minimal +	Less ++	Average +++	High +++++	Significant +++++

Table 2: The grading system determined for every parameter studied is as follows [12,13]

Discussion: Before discussing the various surgical approaches used for decompression in QSS, and the studies conducted on it; an overview about the functional anatomy of AXN and PHCA needs to be taken.

Functional Anatomy of Axillary nerve:

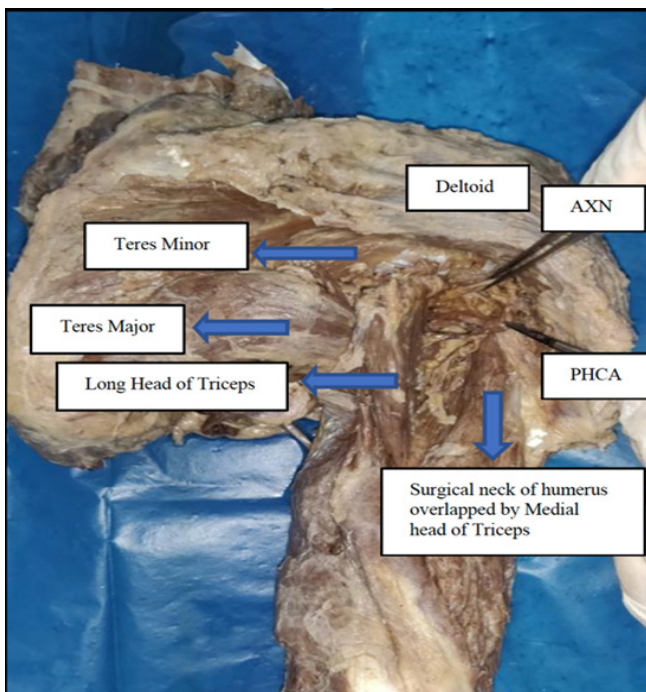


Figure 4: Posterior approach to the Axilla showing quadrangular space along with the contents (AXN and PHCA) passing through it. (AXN: Axillary nerve; PHCA: Posterior Humeral Circumflex Artery)

The AXN, is found anterior to the subscapularis, posterior to the brachial artery, and lateral to the radial nerve. At the inferior aspect of the subscapularis, the AXN runs posterior, close to the joint capsule, passing through the quadrangular space with the posterior circumflex humeral artery, sandwiched between the lateral and long heads of the triceps muscle.

The anterior branch of AXN innervates the deltoid muscle whereas its posterior branch innervates the teres minor and the deltoid. The posterior branch also innervates the skin over the inferior two-thirds of the deltoid muscle at its posterior aspect [14].

Functional Anatomy of Posterior Humeral Circumflex Artery (PHCA):

It enters the posterior scapular region by passing through the quadrangular space. It divides into anterior and posterior branches within the quadrangular space, wraps antecedently around the surgical neck of the humerus to give blood force to the superior, inferior, and side portions of the humeral head, the glenohumeral joint, and the surrounding shoulder muscles [15,16].

Cahill BR and Palmer RE (1983) in their study proposed a posterior approach in which a transverse incision was taken parallel and just inferior to the spine of the scapula,

and curved it inferiorly over the posterior aspect of the humerus. Later, the deltoid was removed from the spine of the scapula. Teres minor was detached at its insertion into the rotator cuff and reflected medially. Decompression of quadrangular space was conducted by blunt and sharp dissection. They reported satisfactory results in 16 out of 18 patients by this approach^[13]. Similar observations were confirmed by the authors while conducting this posterior approach in the present study.

Pitfalls of this technique:

1. Removal of Deltoid and Teres Minor resulted in excess bleeding intra-operatively^[13].
2. Division of teres minor weakened the rotator cuff and the lateral arm rotation^[13].
3. The post-operative wide scar may itself compress the neurovascular bundle^[13].
4. Post-operative chronic pain and formation of poor quality tissue^[17,18]

Thomas J. Francel, A. Lee Dellon and James N. Campbell (1991) in their study suggested another posterior approach in which a vertical or S-shaped incision was made on the point of maximum tenderness i.e. quadrangular space and skin flaps raised to expose the inferior border of the deltoid. The deltoid was retracted superiorly, after incising the deltoid fascia and the teres muscle bellies were exposed. The fascia between the teres muscle bellies was opened, and the quadrilateral space was entered. Deltoid and Teres Minor muscles were not divided during this technique. The AXN and the PHCA were identified and isolated. Nerve stimulation and the motor response of teres minor and deltoid were confirmed. Fibrous bands are divided and space is decompressed by finger insertion [18]. Similar observations were confirmed by the authors while conducting this posterior approach in the present study.

Advantages of this technique:

1. Intact Deltoid and Teres Minor reduced bleeding and quick postoperative shoulder movement is possible^[13].
2. Fibrous atrophy of the deltoid was prevented [13].
3. The postoperative scar was smaller^[13].

Jonas Andermahr, Michael McKee, Diane Nam (2015) in their study mentioned the (anterior) deltopectoral approach which was usually/regularly used for almost any shoulder fracture treatment and was often the pre-

ferred approach, especially in anterior glenoid fractures^[12]. Similar approach was followed by the author in the present study and similar observations/results were obtained. Refer to Table/Fig. 6.

G. Feigl et al. (2018) also used the (Anterior) Delto-pectoral approach to visualize the AXN anteriorly. In their cadaveric study, amongst 91 out of 92 limbs, AXN was identified at the inferolateral border of the subscapular muscle to enter the QS. In this approach, the insertion of the subscapular muscle at the lesser tubercle defines the roof of the space^[19]. The present study authors also achieved similar observations as those stated by G. Feigl et al.

Reflections and Recommendations:

The Anatomists commented that the posterior approach was a comparatively easier and quicker method (dissection-wise) to dissect the QS thereby identifying the AXN and PHCA. But it is associated with postoperative complications related to the innervation and detachment of Deltoid muscle. The functional deficits associated with these problems often result in chronic pain. During the cadaveric study, the Anatomists observed and Orthopedicians agreed that the anterior (Delto-pectoral) approach, which is the preferred approach for shoulder arthroplasty and proximal humeral pathologies, could be effectively used for decompression in QSS. The anterior approach can easily be combined with an ultrasound-guided anesthetic block to AXN. The authors suggest more cadaveric studies to facilitate anatomists and surgeons with increased opportunities to practice and appraise older and newer surgical approaches.

Limitations: The study was conducted on less number of cadavers and hence this study will be followed up every academic year with more cadavers to obtain generalizable findings.

Conclusions: From this pilot study conducted, it has been proposed that anterior approach is technically more easier to conduct and can be used for decompression in QSS. Moreover, this approach can easily be combined with an ultrasound-guided anesthetic block to AXN.

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