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The Neurovascular Structures in the Triangular Space of the Upper Limb: An Anatomical Study

Las Estructuras Neurovasculares en el Espacio Triangular del Miembro Superior: Un Estudio Anatómico

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SUMMARY: The aim of this study was to investigate the neuromuscular distribution after passing through the triangular space of the shoulder. Thirty-five specimens from 18 adult Korean cadavers (12 males and 6 females, age ranging from 42-102 years) were used in the study. This study analyzed the order in which the artery entered the muscle from that point the artery passed through the triangular space. The incidence of the first branch of the circumflex scapular artery was 11.4 % for infraspinatus, 5.7 % for teres major, 25.7 % for teres minor, 20.1 % for long head of biceps brachii, 25.7 % for subscapularis, and 11.4 % for subcutaneous tissue. This study investigated the incidence of lack of blood supply from the artery in the triangular space. This incidence was 27.8 % for infraspinatus, 13.0 % for teres major, 5.6 % for teres minor, 38.8 % for long head of triceps brachii, and 14.8 % for subscapularis. Four specimens showed arterial distribution in all surrounding muscles. One specimen identified the nerve branch to innervate teres minor of triangular space of shoulder. The results of this study will be helpful in clinical practice

KEY WORDS: Anatomy; Triangular space; Neurovascular structure; Blood supply.

INTRODUCTION

The boundaries of the triangular space (above by the teres minor, below by the teres major and laterally by the long head of the triceps brachii) of the upper limb are well known. However, in a previous report, the author mentioned that the structures passing through the triangular space are not the same and he opinionated about the structures passing through the triangular space or their distribution pattern (Wasfi & Ullah, 1985).

The circumflex scapular artery (CSA) passes through the triangular space (Wasfi & Ullah). The subscapular artery divides into 2 branches, the CSA and thoracodorsal artery (TDA). These arteries were investigated by some authors; however, they were not studied in view of the triangular space (Jesus *et al*., 2008; Dancker *et al*., 2015). This study assessed whether the artery passing through the triangular space supplied blood to the surrounding muscle or not.

Isolated teres minor atrophy is clinically important because the symptom includes posterior shoulder pain, weakness of abducted external rotation (Kruse *et al*., 2015). Based on this consideration, the axillary nerve to innervate teres minor, it passes through the quadriangular space of shoulder. In the anatomical aspect, the research on axillary nerve and the branch to teres minor not only have been limited but the variation have been existed (Friend *et al*., 2010). If the nerve had existed on the triangular space, the result would be important in clinical field.

The aim of this study was to investigate the neurovascular distribution after passing through the triangular space of the shoulder.

MATERIAL AND METHOD

Thirty-five specimens from 18 adult Korean cadavers (12 males and 6 females, age ranging from 42-102 years) were used in the study. Cases with pathological changes or shoulder trauma were excluded.

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The dissections were performed in the prone position and the upper limb was extended and abducted at 45°. The incision was made from the middle part of the trunk to the shoulder line on the posterior surface. After removing the skin around the shoulder region, the triangular space was identified. After that, any neurovascular structure was carefully identified. We investigated whether any nerve existed or not and then continued to dissect the arterial pattern with confirmation of the point at which it entered into the muscle belly after passing through the triangular space (Figs. 1 and 4).

This study finally analyzed the order in which the nerve or artery entered the muscle from that point the artery passed through the triangular space.

RESULTS

The muscles surrounding the triangular space were found to be subscapularis, teres minor, teres major, infraspinatus, and long head of triceps brachii.

The incidence of the first branch of the CSA after passing through the triangular space was 11.4 % (4 cases) for infraspinatus, 5.7 % (2 cases) for teres major, 25.7 % (9 cases) for teres minor, 20.1 % (7 cases) for long head of biceps brachii, 25.7 % (9 cases) for subscapularis, and 11.4 % (4 cases) for subcutaneous tissue (Table I, Figs. 1 and 3).

Table I. The incidence of the first branch of the circumflex scapular artery after passing the triangular space.

Branch to muscle	Case (%)
Infraspinatus	4 cases (11.4)
Teres major	2 cases (5.7)
Teres minor	9 cases (25.7)
Long head of triceps brachii	7 cases (20.1)
Subscapularis	9 cases (25.7)
Subcutaneous tissue	4 cases (11.4)=

The incidence of the last branch of the CSA after passing through the triangular space was 31.7 % (13 cases) for infraspinatus, 29.3 % (12 cases) for teres major, 29.3 % (12 cases) for teres minor, and 9.7 % (4 cases) for subscapularis. The subcutaneous tissue and long head of triceps brachii were not included (Table II, Figs. 1-3).

This study investigated the incidence of lack of blood supply from the artery in the triangular space. This incidence was 27.8 % (15 cases) for infraspinatus, 13.0 % (7 cases) for teres major, 5.6 % (3 cases) for teres minor, 38.8 % (21 cases) for long head of triceps brachii, and 14.8 % (8 cases) for subscapularis (Table III).

Table II The incidence of the last branch of the circumflex scapular artery after passing the triangular space.

Branch to muscle	Case (%)
Infraspinatus	13 cases (31.7)
Teres major	12 cases (29.3)
Teres minor	12 cases (29.3)
Long head of triceps brachii	0 case
Subscapularis	4 cases (9.7)
Subcutaneous tissue	0 case

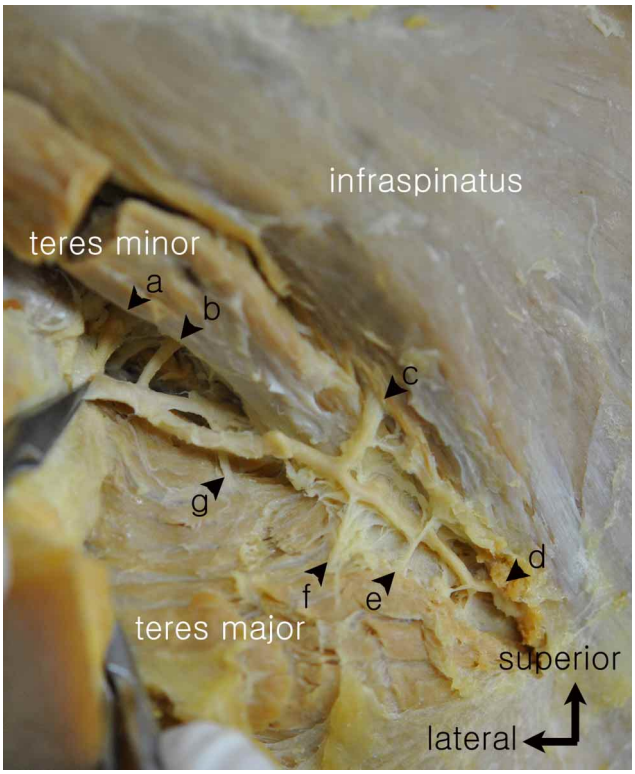

Fig. 1. Photographs of the dissected left shoulder region on the posterior view. Arrow-head a: Artery to subscapularis, b: teres minor, c,d: infraspinatus, e,f,g: teres major.

Table III The incidence of non-blood supply from the artery on triangular space

Branch to muscle	Case (%)
Infraspinatus	15 cases (27.8)
Teres major	7 cases (13.0)
Teres minor	3 cases (5.6)
Long head of triceps brachii	21 cases (38.8)
Subscapularis	8 cases (14.8)
Subcutaneous tissue	0 case

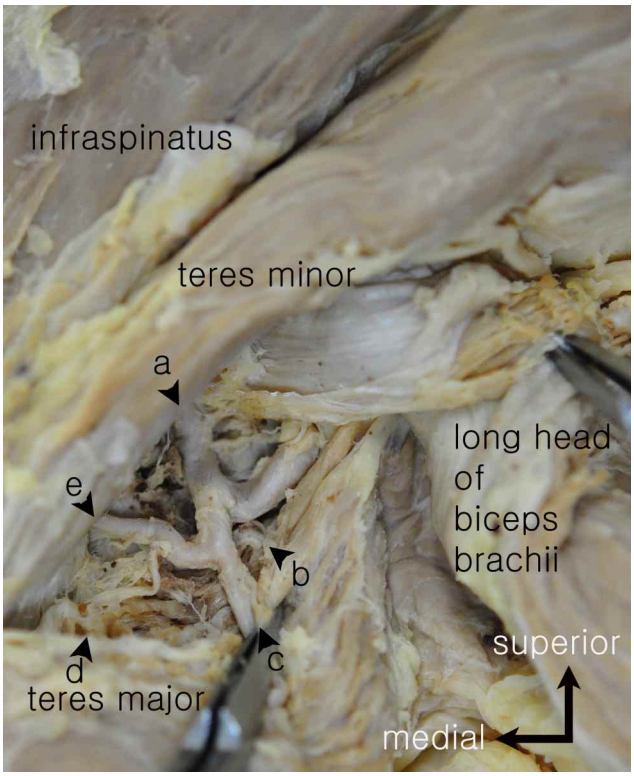

Fig. 2. Photographs of the dissected right shoulder region on the posterior view. Arrow-head a: Artery to subscapularis, b: teres major, c: subcutaneous tissue, d: teres major, e: infraspinatus.

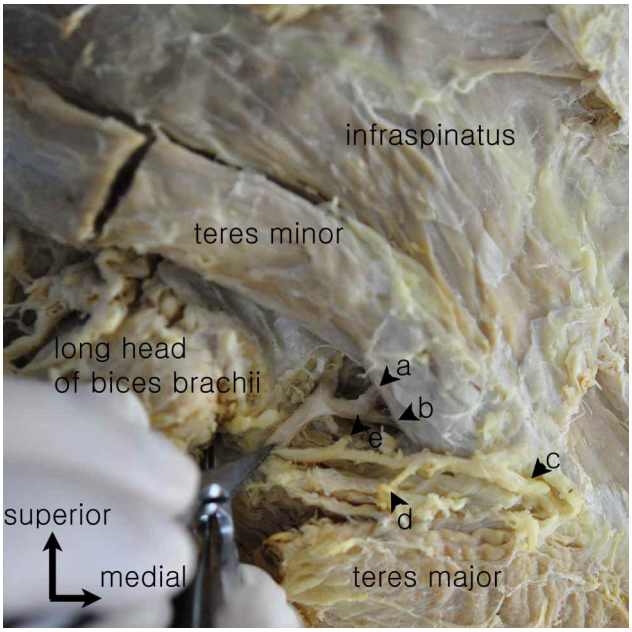

Fig. 3. Photographs of the dissected left shoulder region on the posterior view. Arrow-head a: Artery to teres minor, b: subscapularis, c: infraspinatus, d: teres major, e: subcutaneous tissue.

Four specimens showed arterial distribution in all surrounding muscles (subscapularis, teres minor, teres major, and infraspinatus). One specimen identified the nerve branch to innervate teres minor of triangular space of shoulder (Fig. 4).

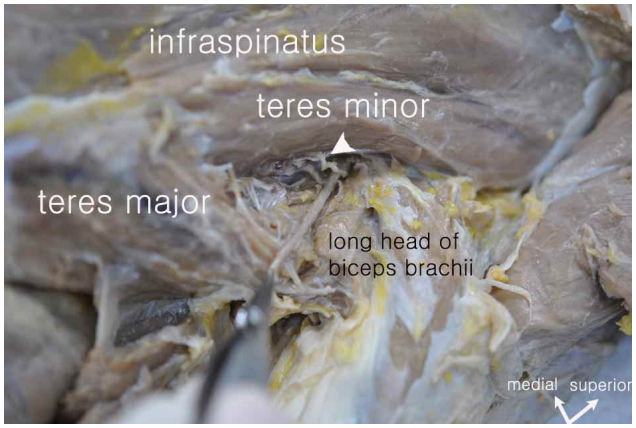

Fig. 4. Photographs of the dissected right shoulder region on the posterior view. Arrow-head: Nerve to teres minor.

DISCUSSION

An early study (Wasfi & Ullah) emphasized whether the structures pass through or traverse the triangular space. The author stated that in all cases, the CSA was identified and it traversed the triangular space. This study did not conclude whether the CSA just traverses or passes through the triangular space. This study focused on the arterial distribution in that space rather than such a view point.

The teres major is often used for reconstruction, hence, the arterial supply to the muscle is provided by the CSA in 66.6 % of cases and by the thoracodorsal artery in 33.3 % of cases (Dancker *et al.*). In this study, the CSA in 7 cases (13.0 %) did not branch out to the teres major, and the CSA in the triangular space on the dorsal view did not branch out in 13 % of cases (7 cases) in this study (Table III). In the remaining specimens, the artery branched out to the teres major, regardless of the branching order (Tables I and II).

The other earlier reports (Jesus *et al.*; Xhakaza & Satyapal, 2014) studied the arterial distribution of the thoracodorsal and subscapular arteries. They stated the importance of knowledge of blood supply to the muscles of the scapular region and that controversy still exists. This study also provided important information on the neurovascular structures of the triangular space, and it was considered to be useful for surgeons especially in reparative surgery.

The incidence of 61.2 % of the CSA after passing through the triangular space indicated that blood was supplied to the long head of triceps brachii, and in 20.1 % of the specimens, it branched out firstly (Tables I and III). Another report based on the anatomical method showed that the medial head of triceps brachii was supplied by the middle collateral artery (Piquilloud *et al*., 2011). Another report explained that the triceps brachii was supplied by the axillary artery (Gruionu *et al*., 2000). There is an anatomical study that assesses nerve innervations of the long head of triceps brachii, but we did not identify the vascular system (Rezzouk *et al*., 2002). The three heads of triceps brachii generally have different functions at movement (Ali *et al*., 2015), and among them, the long head of triceps brachii is more active than the medial and lateral heads during handgrip force exercise with full elbow extension (Ali *et al*., 2014). We assessed the blood supply to the long head of triceps brachii because it was difficult to find a reference. The result of this study provides important data because of different functions of each of the three heads.

The anatomical study targeting the osteotendinous junction of the subscapularis was reported previously, and the result that the arcuate artery supplied blood to this area was obtained (Papakonstantinou *et al*., 2012). They observed the insertion site, and our study also focused correctly on the subscapularis muscle, but we investigated around the triangular space. We found that lack of blood supply from the artery in the triangular space was observed in 8 cases. We can guess that if these cases were observed, the subscapularis muscle received its blood supply from other surrounding arteries like the subscapular or thoracodorsal artery. The first objective of this study was only the triangular space; hence, we did not attempt to confirm this assumption.

The axillary nerve passes through the quadrilateral space with the posterior circumflex humeral vessels then divides into anterior and posterior branches. These branches supplies deltoid and teres minor. This classically accepted course has been challenged in recent anatomical studies (Friend *et al*.). Prior evidence has not mentioned the nerve to innervate teres minor passing on triangular space. These results will be helpful in clinical field.

In this study, careful dissection in the triangular space of the shoulder was performed on the dorsal aspect. Nerves were identified and the arterial pattern will be helpful in clinical practice with the anatomical basis.

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RESUMEN: El objetivo de este estudio fue investigar la distribución neuromuscular después de pasar a través del espacio triangular del hombro. Para el estudio fueron utilizados treinta y cinco especímenes de 18 cadáveres adultos coreanos (12 varones y 6 mujeres, con una edad de 42-102 años). Se analizó el orden en que la arteria penetra en el músculo y continúa a través del espacio triangular. La incidencia de la primera rama de la arteria circunfleja escapular fue: 11,4 % en el músculo infraspinoso, 5,7 % en el músculo redondo mayor, 25,7 % en el músculo redondo menor, 20,1% en la cabeza larga del músculo bíceps braquial, 25,7 % en el músculo subescapular y 11,4 % en el tejido subcutáneo. Este estudio investigó la incidencia de la falta de suministro de sangre de la arteria en el espacio triangular. Se observó incidencia de 27,8 % para el músculo infraespinoso, 13,0 % para el músculo redondo mayor, 5,6 % para el músculo redondo menor, 38,8 %, para la cabeza larga del músculo tríceps braquial y 14,8 % para el músculo subescapular. Cuatro especímenes mostraron distribución arterial en todos los músculos circundantes. En un caso se identificó la rama nerviosa para el músculo redondo menor en espacio triangular del hombro. Los resultados de este estudio serán útiles en anatomía clínica.

PALABRAS CLAVE: Espacio triangular; Estructura neurovascular; Suministro de sangre.

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