Surgical anatomy of the axillary nerve within the quadrangular space

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Object. There is a paucity of literature regarding the surgical anatomy of the quadrangular space (QS), which is a potential site of entrapment for the axillary nerve. Muscle hypertrophy of this geometrical area and fascial bands within it have been implicated in compression of the axillary nerve.

Methods. Fifteen human cadavers (30 sides) were dissected for this study. Measurements of the QS and its contents were made. The mean height of this space was 2.5 cm and the mean width 2.5 cm; its mean depth was 1.5 cm. The axillary nerve was always the most superior structure in the space, and in all cases the nerve and artery hugged the surgical neck of the humerus just superior to the origin of the lateral head of the triceps brachii muscle. This arrangement placed the axillary nerve in the upper lateral portion of the QS in all cadaveric specimens. The nerve branched into its muscular components within this space in 10 sides (33%) and posterior to it in 20 sides (66%). The cutaneous component of the axillary nerve branched from the main trunk of the nerve posterior to the QS in all specimens. Fascial bands were found in this space in 27 (90%) of 30 sides.

Conclusions. Knowledge of the anatomy of the QS may aid the surgeon who wishes to explore and decompress the axillary nerve within this geometrical confine.

Key Words • neurosurgery • peripheral nerve • surgery • quadrangular space

Isolated axillary nerve injuries make up as many as 6% of all brachial plexus injuries.21 The axillary nerve, or circumflex nerve, is one of the two terminal branches of the posterior cord of the brachial plexus; the radial nerve is the second. Usually, the axillary nerve contains fibers from C-5 and C-6 ventral rami. This nerve innervates the teres minor and deltoid muscles, skin over the shoulder (upper lateral brachial nerve), and the glenohumeral joint.22 Traveling posteriorly, the axillary nerve enters and traverses the QS, foramen of Velpeau.23 This geometrical structure is formed medially by the long head of the triceps brachii muscle, laterally by the surgical neck of the humerus, and superiorly and inferiorly by the teres minor and teres major muscles, respectively (Figs. 1 and 2). The motor fascicular portion of the nerve for the deltoid muscle is said to be located most superiorly in the QS.2 The QSS, that is, the lateral axillary hiatus and quadrilateral space syndromes, was first described by Bateman in 1955 and is uncommon.16,20 This space and its neurovascular bundle can be compromised by fractures of the humerus or scapula, glenohumeral joint dislocation, hematomas, iatrogenic injury, or tumors of this region.22-24 The true pathophysiology of QSS often remains unclear, however.16,21 Patients present with point tenderness over the QS and dysfunction of the deltoid and teres minor muscles. These individuals may also have a sensory deficit over the lateral shoulder and upper posterior arm region.2 If conservative treatment is unsuccessful in alleviating symptoms, surgical decompression is recommended.4 The goal of the present study was to provide the surgeon with measurements that may aid in the identification of this area so that potential entrapment of the axillary nerve can be addressed.

Materials and Methods

Fifteen (seven male and eight female) formalin-fixed adult (mean age 74 years, range 61–83 years) cadavers (30 sides) were dissected in this study. With the cadaveric specimens situated in the prone position, the skin and superficial fascia were removed from the posterior shoulder. Next, the deltoid muscle was disconnected from its scapular origin (spine) and retracted laterally. The neurovascular bundle of the deltoid muscle was then followed into the QS and its relationship to this region observed. No specimen had been subjected to previous dissection or obvious surgery in this area. Measurements of the boundaries of the QS were obtained. All measurements were made using calipers. The contents of, and their placement within, the QS were also documented.

Results

The QS was found in all sides and no obvious difference in its configuration was noted between sex or side. The mean height of the QS was 2.5 cm (range 1.3–3.3 cm) and...
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its mean width 2.5 cm (range 1–4 cm); the mean depth was 1.5 cm (range 1–3 cm). The axillary nerve was always the most superior structure in the QS, and in all cases the nerve and artery hugged the surgical neck of the humerus just superior to the origin of the lateral head of the triceps brachii muscle. Thus, the axillary nerve was placed in the upper lateral portion of the QS in all specimens. The nerve was noted to branch into its muscular components—teres minor and deltoid muscles—within the QS in 10 sides (33%) and posterior to the QS in 20 sides (66%). The cutaneous component of the axillary nerve, that is, upper lateral brachial nerve, branched from the main trunk of the nerve posterior to the QS in 20 sides (66%). These bands did not compress either the axillary nerve or the posterior humeral circumflex artery. Note that the posterior humeral circumflex artery sent an anastomotic branch to the profunda humeral artery in eight sides (27%; five left and three right) from within the QS.

Discussion

The true origin of QSS is unknown. Chautems, et al.,7 described a patient with QSS that was aggravated by forced abduction and external rotation of the arm. Others have reported that this space becomes narrowed when the arm is abducted.16 Furthermore, Kirby and Kraft11 have described simple hypertrophy of the teres muscles in paraplegics as the origin for axillary nerve compression or vascular compromise. Baker and Lin1 consider QSS one of the most commonly recognized neurovascular compression syndromes in athletes who throw. Perlmuter and Apruzzese18 have reported this phenomenon in various contact sports. Volleyball players may also have a higher incidence of entrapment of the axillary nerve at the QS.19 Note that QSS has been reported in a baseball pitcher and a tennis player.6,14 Abnormal sleeping positions have been found to narrow the QS with resultant paralysis of the axillary nerve.1,2,4 Indeed, axillary nerve injury has occurred in patients with anterior glenohumeral dislocation.21 Linker, et al.,22 have asserted that symptoms of QSS result from compression of the axillary nerve rather than the posterior humeral circumflex artery and recommended that patients undergo subclavian arteriography to confirm the diagnosis. Other researchers have considered arteriography unnecessary, however.7,13 The diagnosis of QSS may be confirmed on observing relief of symptoms following injection of a local anesthetic agent into the QS.2 Fibrous bands have been implicated as the cause of QSS.12,13,21 McKowen and Voorhies13 found bands in each of the patients in whom they performed surgery and in none of the cadaveric specimens they dissected. We routinely found fascial bands within the QS in our cadaveric specimens (90%). Horiguchi, et al.,8 have described the bilateral absence of the QS.

Surgical approaches to the QS have involved an incision made parallel and inferior to the spine of the scapula. The deltoid muscle is detached or split12 from the spine of the scapula and reflected inferiorly. The teres minor muscle is then detached at its insertion and rotated medially. Some authors have advocated not releasing the teres major muscle, whereas others have used this maneuver, for example, for muscle hypertrophy.21 The axillary nerve can then be found inferior to the teres minor muscle and evaluated for compression (that is, fibrous bands or muscle hypertrophy).15 Once the nerve and artery are released, palpation of the arterial pulse with the arm in abduction and external rotation will confirm adequate decompression.22 Kuang and Hou10 have followed three patients with QSS who had undergone surgery and found that motor and sensory losses were recovered fully in two cases and only partially in the other.

Rochwerger, et al.,20 have reported the results of a 5-year follow up in patients with axillary nerve repair. These authors found that functional improvement following decompression of this nerve can be expected up to 1 year after surgery. Performing surgery more than 1 year following injury in symptomatic patients is associated with a poorer prognosis for functional recovery.21

Conclusions

We have identified the surgical anatomy of the QS, a potential site of entrapment for the axillary nerve. Fascial bands appear to be a normal finding in cadaveric specimens, with none demonstrating gross muscle atrophy of the deltoid or teres minor muscles. The axillary nerve should be situated in the superior-most aspect of this anatomical region. Knowledge of this anatomy will, we hope, be useful.
to the neurosurgeon who operates in this region to repair a potentially entrapped axillary nerve.

References

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