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Original Research Article

CONTRIBUTION OF AXILLARY NERVE IN THE INNERVATION OF LONG HEAD OF TRICEPS BRACHII: A CADAVERIC STUDY

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ABSTRACT

Background: Traditionally the axillary nerve innervates the Deltoid and the Teres minor(TM) muscle. Axillary nerve injuries are common in shoulder dislocation, fracture surgical neck of humerus, brachial plexus injuries and neuropathies. Traumatic injuries of axillary nerve have also shown weakness of Long head of triceps and in surgical practice, the nerve to long head of triceps is utilized for nerve transfer to neurotise the deltoid muscle in patients with axillary nerve injuries. Hence the aim of the study was to find out the prevalence of contribution of axillary nerve to the innervation of Long head of triceps brachii (LHT).

Materials and Methods: Nine embalmed adult human cadavers (bilaterally) and twelve disarticulated upper extremities were dissected. Total of thirty upper extremities were dissected. The axillary nerve was observed emerging from the quadrangular space. Anterior and posterior branches of axillary nerve were noted. The muscular branches to deltoid, TM and LHT were traced to their point of innervation. The focus was on the branch of axillary nerve supplying the LHT. The branching configuration was classified into three types. Type I- posterior branch of axillary nerve supplying the LHT, Type II- Branch to TM supplying the LHT and Type III- A branch from the bifurcation of anterior & posterior branch of axillary nerve supplying LHT.

Results: The present study showed that axillary nerve innervated the LHT in 8 out of 30 limbs (26.66%). Amongst these, in 4 limbs(50%) posterior branch of axillary nerve supplied the LHT(type I), in 3 limbs(37.5%) branch to TM supplied the LHT(type II) and in 1 limb(12.5%) a branch from the bifurcation of axillary nerve into anterior and posterior branch supplied the LHT(type III). It was also observed that in 2 (6.66%) specimens, axillary nerve was the only supply to LHT and in 6 (20%) specimens both axillary nerve & radial nerve supplied the LHT and in the remaining 22 (73.3%) specimens, only the radial nerve supplied the LHT.

Conclusion: Awareness of the variation of axillary nerve supplying the LHT is important for surgeons, orthopaedicians and anaesthetists for surgical treatment of traumatic nerve injuries.

KEY WORDS: Axillary Nerve, Motor Innervation, Long Head Of Triceps, Variations.

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INTRODUCTION

The axillary nerve arises from the posterior cord of the brachial plexus (C5, 6). It traverses the quadrangular space along with posterior circumflex vessels and divides into anterior and posterior branches. The anterior branch curves

round the neck of the humerus with the posterior circumflex vessels deep to deltoid. The posterior branch gives off the nerve to Teres minor(TM) and upper lateral cutaneous nerve of arm and supplies the posterior part of Deltoid [1].

Most of the Anatomy text books state that the axillary nerve supplies the Deltoid and TM and the radial nerve innervates the Long head of triceps brachii (LHT). The aim of the present study was to find out the prevalence of contribution of axillary nerve to the innervation of LHT. It is important for surgeons, orthopaedicians and anaesthetists to be aware of this variation for surgical treatment of traumatic nerve injuries. Hence when examining patients with traumatic injury, involving the axillary nerve, it is important to search for paralysis of the LHT. If present, it is a sign of severe axillary nerve lesions requiring early repair at three months [2]. The commonest cause of axillary nerve lesions are trauma (dislocation of shoulder joint, fracture of surgical neck of humerus) and neuralgic amyotrophy. Injury to axillary nerve results in paralysis of deltoid and TM which results in flat shoulder deformity [1]. The variation of axillary nerve supplying the LHT is important in surgery of restoring the motor function of the deltoid muscle in patients with complete C5,C6 root injury (upper brachial plexus injury) by transferring the nerve to LHT to the anterior branch of axillary neve through a posterior approach [3] .Hence an understanding of the variation of axillary nerve supplying the LHT may influence the surgical approach and reconstructive options available in neuro muscular reconstructive practice.

MATERIALS AND METHODS

The study was conducted in the department of Anatomy, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, during the First year undergraduate dissection in the academic year Sep 2019. Nine embalmed adult human cadavers were dissected bilaterally. There were six male and three female cadavers with the average age of 65years (range 45-85 years). In addition twelve disarticulated upper extremities, stored in formalin tanks were also dissected. Total of thirty upper extremities were dissected. All the cadavers were embalmed as per standard procedures and the specimens having any shoulder pathologies or procedures were excluded. Our dissection was focussed on the investigation of motor branch of axillary nerve to the LHT. Shoulder regions were dissected, keeping the cadaver in prone position, as per the standard methods of dissection, using gross dissection tools. The posterior attachment of the deltoid was cut to expose the quadrangular space, the LHT and its relation with the axillary nerve. The axillary nerve was observed emerging from the quadrangular space. Anterior and posterior branches of axillary nerve were noted. The muscular branches to deltoid, TM and LHT were traced to their point of innervation. The focus was on the branch of axillary nerve supplying the LHT. The branching configuration was classified into 3 types. Type I- Posterior branch of axillary nerve supplying the LHT, Type II- Branch to TM supplying the LHT, Type III- A branch from the bifurcation of anterior & posterior branches of axillary nerve supplying LHT. All dissections were photographed and the data obtained were recorded in order and analysed.

RESULTS

Total of 30 upper extremities were dissected. Axillary nerve was traced emerging from the quadrangular space and its innervation to LHT was noted. The pattern of nerve supply to LHT by the axillary neve was determined according to the classification mentioned.

In the bilaterally dissected nine cadavers, seven sides showed axillary nerve supplying the LHT. In two cadavers the innervation was seen bilaterally, but different patterns were observed on both sides. Remaining specimens showed the finding on one side only. Out of the twelve disarticulated upper extremities, six were of right side & six of left side. Amongst these in one limb of right side, axillary was seen supplying the LHT which was of type II pattern.

It was also observed that amongst the eight LHT muscles supplied by axillary nerve in our study, six were also supplied by Radial nerve and only two LHT were supplied by the axillary nerve only. In one cadaver it was seen that axillary nerve supplied the Teres Major, from the posterior branch bilaterally, in addition to TM and thedeltoid muscle. The Teres major is classically innervated by the lower subscapular nerve [4]

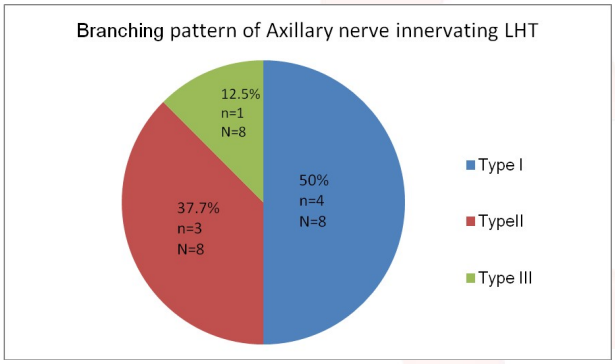
Table 1: Details of the eight dissected upper extremities in which axillary nerve innervated the LHT in addition to Deltoid & TM muscle.

S no.	Sex of cadaver	Side	Branch to LHT	Branching pattern of AN	LHT also supplied by RN /only AN
1	Male	L	LHT	Type I	AN & RN
2		R	LHT	Type II	AN & RN
3	Male	L	LHT	Type I	AN & RN
4		R	LHT	Type II	AN & RN
5	Female	L	LHT	Type I	AN & RN
6	Male	R	LHT	Type I	only AN
7	Male	R	LHT	Type III	only AN
8	Limb	R	LHT	Type II	AN & RN

Branching pattern of axillary nerve innervating the LHT: **Type I-** Posterior branch of axillary nerve supplying the LHT. **Type II-** Branch to TM supplying the LHT. **Type III-** A branch from the bifurcation of anterior & posterior branch of axillary nerve supplying the LHT.

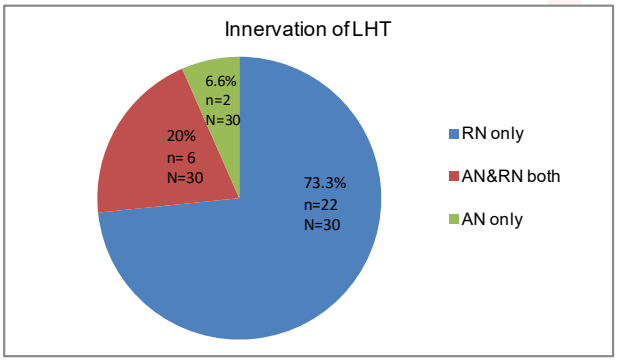
Abbreviations: R-Right side, L- Left side, M- Male, F- Female, AN- Axillary nerve, RN- Radial nerve, LHT- Long head of triceps brachii muscle,TM- Teres Minor

Fig. 1: Showing the percentage of the branching pattern of axillary nerve innervating the LHT muscle in the eight (26.6%) dissected upper extremities.



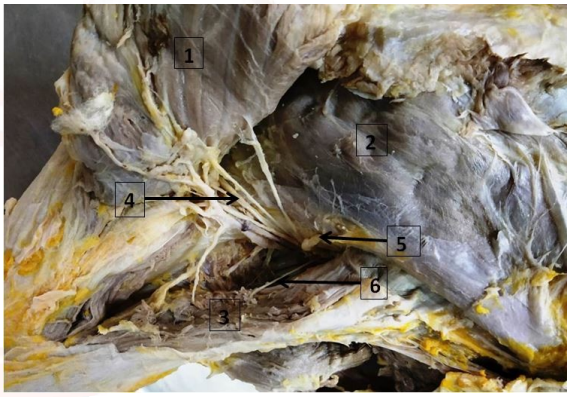
Type I- Posterior branch of axillary nerve supplying the LHT, Type II- Branch to TM supplying the LHT, Type III- A branch from the bifurcation of anterior & posterior branch of axillary nerve supplying the LHT. Abbreviations: LHT- Long head of triceps brachii muscle.

Fig. 2: Showing the percentage of the innervation of LHT by axillary and radial nerve in the thirty dissected upper extremities.



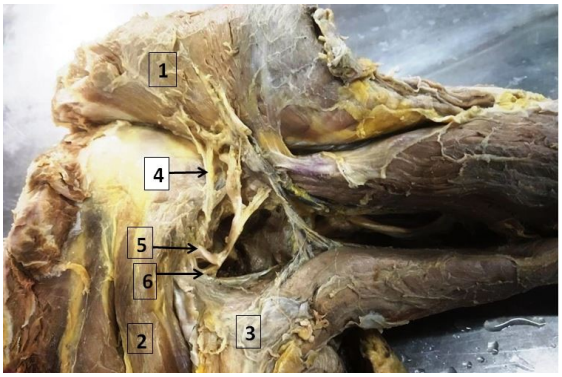
Abbreviations RN- Radial nerve, AN- Axillary nerve, LHT- Long head of triceps brachii muscle

Fig. 3: The photographic presentation of the dissected specimen in posterior view (Left side).



1- Deltoid muscle reflected, 2- Teres minor, 3- Long head of triceps brachii, 4- anterior branches of axillary nerve supplying Deltoid, 5- nerve to Teres minor with a pseudoganglion from the posterior branch of axillary nerve,6- nerve to Long head of triceps from the posterior branch of axillary nerve (Type I)

Fig. 4: The photographic presentation of the dissected specimen in posterior view (right side).



1- Deltoid muscle reflected, 2- Teres minor, 3- Long head of triceps brachii, 4- anterior branches of axillary nerve supplying Deltoid, 5- nerve to Teres minor from the posterior branch of axillary nerve,6- nerve to Long head of triceps from the branch to Teres minor(Type II)

DISCUSSION

Various anatomical & morphological studies on axillary nerve have been seen in literature [5-8]. These are of great clinical significance and academic interest. Few studies have been done on the anatomy and surgical relationships specific to posterior branch of axillary nerve [9].

The posterior branch of axillary nerve is more variant in course and distribution than the anterior branch [10].The posterior branch is intimately related to the inferior aspects of the glenoid and shoulder joint capsule which may place it at particular risk during capsular plication or thermal shrinkage procedure [1]. Standard Anatomy textbooks state that axillary nerve supplies the Deltoid & TM and the radial nerve supplies the LHT. The focus of the present study was to investigate, that, does the Axillary nerve play a role in the innervation of the LHT muscle.

Previous works have shown very controversial results in this aspect. Wade et al [11] showed in his study that Axillary nerve did not supply the LHT and in all the 27 specimens, the LHT was solely innervated by the Radial nerve. Another study on 22 cadavers (3 bilaterally) on the triceps innervation pattern, also supported that all the specimens were supplied by the radial nerve [12].

However de Seze MP [13] studied both cadaver anatomical dissections (groupI-20 specimens) and surgical cases (group II- 15 cases), to determine the exact origin of the motor branch of the LHT. In group I, 13out of 20 specimens were innervated by the axillary nerve, 5 from the posterior cord and 2 from the bifurcation of the posterior cord into axillary & radial nerve. In group II, 11 out of 15 cases were supplied by the axillary nerve & 4 from the bifurcation of the posterior cord. Hence none of the specimens of LHT were supplied by the radial nerve. A similar study by Rezzok J [2] of 44 specimens of LHT revealed that none were supplied by the radial nerve.

Such varied results inspired our study to find out whether axillary nerve has a contribution to the innervation of the LHT or not. The present study showed axillary nerve supplied the LHT in 8 out of 30 limbs (26.66%). Amongst these, in 4 limbs(50%) posterior branch of axillary nerve supplied the LHT(type I), in 3 limbs(37.5%) branch to TM supplied the LHT(type II) and in 1 limb(12.5%)a branch from the bifurcation of axillary nerve into anterior and posterior branch supplied the LHT(type III). One case report, during routine dissection study showed that the posterior branch of axillary nerve innervates the TM, posterior part of deltoid and LHT, which corresponds to the type I pattern of the present study [14].

In another case report of a single specimen showed that axillary nerve after emerging from the quadrangular space trifurcates into anterior branch, posterior branch and a branch to LHT, which corresponds to type III of our study [15].

In a cadaveric investigation by Erhardt AJ [16] it was found that 8 out of 22 (36.66%) specimens of LHT were supplied only by the radial nerve which was described as the classic innervation pattern. Of the remaining, 11out of 22(50%) revealed dual innervation by both radial nerve and axillary nerve and 3 out of 22 (13.63%) had axillary nerve supply only. None of the specimens showed innervation to LHT from the posterior cord.

In the present study of 30 specimens, axillary nerve was seen to innervate LHT in 8 limbs. Amongst these in 2 (6.66%) specimens, axillary nerve was the only supply to LHT and in 6 (20%) specimens both axillary nerve & radial nerve supplied the LHT and in the remaining 22 (73.3%) specimens, only the radial nerve supplied the LHT.

Many authors in their work have revealed a very small contribution of axillary nerve in the innervation of the LHT. A study of variations in the branching pattern of the axillary nerve showed that in 1 out of 60 limbs (1.66%), the posterior branch of axillary nerve supplied the LHT, in addition to TM& deltoid muscle [17]. Another study on variations in formation and branching pattern of brachial plexus showed that in only 4% of cases the axillary nerve supplied the LHT [18].

In a meta-analysis of 330 specimens of LHT by Wade et al [11] it was concluded that axillary nerve contributed to only 14.2% of innervation to LHT, 3.3% had dual innervation (axillary &

radial nerve), 0.6% from the posterior cord, 3.6% from the bifurcation of posterior cord and 78.2% by the radial nerve. These findings were supported by the embryological basis of the radial nerve supplying the LHT. The mesenchyme in the limb buds migrate into the limbs to differentiate into muscle. When the limb buds elongate the extensor and flexor compartments are separated, and the nerves start to enter the mesenchyme. The radial nerve is made of post segmental branches and penetrates the extensor muscle mesenchyme. As soon as the nerve enters the limb bud, it establishes a close contact with the differentiating condensation which is necessary for the completion of muscle differentiation [19].

Understanding the variations in the muscular branches of axillary nerve and innervation of LHT is critical to the clinical diagnosis of injury, surgical treatment options and rehabilitation of axillary nerve injuries [16]. Nerve transfer procedures have gained importance in the treatment of brachial plexus and axillary nerve injuries. The radial nerve branches to triceps brachii can be used either as nerve donor to axillary nerve to reinnervate shoulder abduction or as nerve recipient to reinstitute elbow extension [20].

In a study, when the nerve to LHT had been transferred to the axillary nerve, 45.5% of the original motor neuron pool could be reinnervated [3].

CONCLUSION

From the study of 30 dissected cadaveric axillary nerve specimens(6males & 3 females) , and 12 disarticulated upper extremities, in equal number of right & left sides, it was seen that in 8 specimens(26.66%) axillary nerve supplied the LHT in addition to TM & the Deltoid muscle. The branching configuration was such that, 50% was of type I (posterior branch of axillary nerve supplied LHT), 37.5% was of type II (branch to TM supplied LHT) and 12.5% was of type III (branch from the bifurcation of anterior & posterior branch of axillary nerve supplied LHT). It was also concluded that axillary nerve has a very small contribution to the innervation of LHT, as it was seen that in 6.6% specimens only the axillary nerve supplied the LHT, in 20% specimens both axillary nerve & radial nerve supplied the LHT and in 73.3% cases the radial nerve solely supplied the LHT.

Hence, awareness of such variations is useful for surgeons in dealing with nerve transfer procedure, reconstructive surgery, nerve entrapment surgery, compressive neuropathies and in pain management therapy [20].

Limitations: Limitations of our study were small sample size.

ABBREVIATIONS

TM- Teres minor,

LHT- Long head of triceps brachii

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