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Anatomy

AXILLARY NERVE SUPPLYING MOTOR BRANCH TO LONG HEAD OF TRICEPS BRACHII MUSCLE: A CASE REPORT AND REVIEW OF LITERATURE

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ABSTRACT All three heads of the triceps brachii are classically described as being innervated by the radial nerve in the textbooks. Some clinical observations of traumatic injuries of the axillary nerve with associated paralysis of the long head of triceps and cadaveric studies have suggested that the axillary nerve may innervate the long head of triceps. During routine dissection to undergraduate M.B.B.S students, we found axillary nerve giving a motor branch to long head of triceps brachii on right side, in an adult male cadaver aged about 60 years. We conducted extensive literature search to analyse the previous studies reporting such variations and the studies conducted on the radial nerve or triceps brachii innervation pattern. This variation is clinically important for surgeons, orthopedicians and anaesthetist while performing surgeries and pain management therapies on the upper limb.

KEYWORDS : axillary nerve, triceps brachii, radial nerve.

INTRODUCTION:

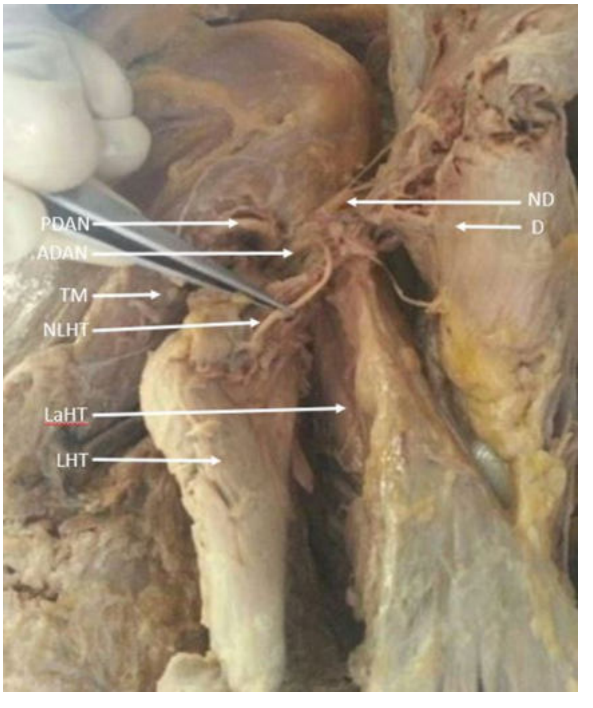
Axillary nerve also known as circumflex nerve is a smaller terminal branch of posterior cord of brachial plexus. The nerve divides into anterior and posterior branches. The anterior branch is accompanied by the posterior circumflex humeral vessels and supplies the deltoid muscle and the antero-inferior part of the skin over it. The posterior branch supplies the teres minor and the posterior part of the deltoid (1). Few studies have shown that, the posterior aspect of the deltoid has a more consistent supply from the anterior branch of the axillary nerve (2).

Radial nerve is the largest terminal branch of the posterior cord of brachial plexus, with the root value C5-C8, T1. In the inferior part of the axilla it is related to the axillary vessels and nerve, in the upper part of arm it lies posterior to the brachial artery, later it passes posteriorly accompanied by the profunda brachial vessels through the lower triangular space, inferior to the teres minor and in between the long head of triceps and the humerus. It then enters the radial groove, passes downwards by piercing the intermuscular septum to reach the front of arm and later terminates by dividing into superficial and deep branch. The nerve provides motor innervation to triceps brachii, before entering the spiral groove it supplies the long and medial head, in the groove it gives motor innervation to the lateral and the medial head (3). Triceps brachii is a muscle of the extensor compartment of the arm. It has three heads, long head, lateral head and the medial head. Long and the lateral head converge to form the flattened superficial tendon which covers the medial head and gets inserted to the posterior surface of the olecranon process. Medial head is inserted partly into the superficial tendon and partly into the olecranon process (1, 3). Most of the anatomy textbooks describe that the long head of triceps is innervated by radial nerve but investigations have shown that the pattern of innervation of triceps brachii is complex (4). Awareness of such variations are important for surgical interventions involving the axilla, shoulder and arm.

CASE REPORT:

During the routine dissection for undergraduate first M.B.B.S students of Employees' State Insurance Corporation Medical College & Post Graduate Institute of Medical Science and Research (ESIC MC & PGIMSR), Bangalore, on the right upper limb of embalmed male cadaver of age around 60 years we observed that axillary nerve giving the motor branch to the long head of triceps. The axillary nerve wound around the inferior border of subscapularis muscle to reach the quadrangular space accompanied by the posterior circumflex humeral vessels. It terminated by diving into two branches, anterior and posterior. The anterior branch (upper branch) travelled around the humerus accompanied by posterior circumflex humeral vessels, deep to the deltoid, reached up to the anterior border of the deltoid giving motor innervation to it. In our cadaver the long head of triceps is supplied by the branch from the anterior division as seen in the figure 1. The posterior branch (lower branch) supplied the teres minor and the posterior part of deltoid. The variation was found out after thorough and meticulous dissection of both the limbs. The left side did not show any variations, the long head of triceps was supplied by radial nerve. There was no variation in the arterial pattern on both the sides.

Figure 1: Showing anterior division of axillary nerve supplying the long head of triceps.



PDAN- posterior division of axillary nerve; ADAN- anterior division of axillary nerve; TM- teres minor; NLHT- nerve to long head of triceps; LaHT- lateral head of triceps; LHT- long head of triceps muscle; ND- nerve to deltoid; D- Deltoid muscle.

DISCUSSION:

The innervation of triceps brachii muscle is complex. We have found 11 studies and 4 case reports including the present study addressing the innervation of triceps brachii and its variation. Innervation pattern from the studies and case reports has been represented in table 1. The case reports have not been included to analyse the overall prevalence as they present only the abnormal variation (deviation of the normal pattern) and will overestimate the prevalence. Studies by de Seze et al. and Aszmann et al. have also been excluded from the analysis, the details of which has been explained in the discussion later (16, 17).

Table 1: Studies and case reports on the innervation pattern of long head of triceps brachii.

Studies	Sample size	Radial nerve	Axillary nerve	Dual supply	At bifurcation	Posterior cord
Al-Meshal and Gilbert	25	25	0	0	0	0
Bertelli et al.	20	19	1	0	0	0
Chaware et al.	36	34	1	1	0	0
Erhardt and Futterman	22	8	3	11	0	0
Lim et al.	23	23	0	0	0	0
Mehta et al.	30	22	2	6	0	0
Nimje and Bhuiyan	114	114	0	0	0	0
Rezzouk et al.	44	0	30	0	12	2
Seema and Gangadhar	50	48	2	0	0	0
Wade et al.	27	27	0	0	0	0
Total (percentage)	391 (100%)	320 (81. 84%)	39 (9.97%)	18(4.6 0%)	12(3.07%)	2 (0.51%)
Case Reports						
Studies	Sample size	Radial nerve	Axillary nerve	Dual supply	At bifurcation	Posterior cord
McClelland and Hoy	1	0	1	0	0	0
Nanjundaiah et al.	2	0	2	0	0	0
Sawant et al.	2	1	1	0	0	0
Dasegowda and Rangappa	2	1	1	0	0	0

On comparing all the studies conducted, no consistent findings have been found. Al-meshal and Gilbert performed cadaveric investigation on 25 specimens to analyse the innervation pattern of triceps and to investigate the preferred3 triceps nerve for nerve transfer to deltoid. They concluded that 2 had a single branch and 2 cases had double branch supply from radial nerve, suggesting the supply to the LHT was solely from the radial nerve (5). Wade et al. in their study dissected 27 specimens and reported that all the cadaveric dissection showed radial nerve innervating LHT (13). Similar results were also obtained in the studies conducted by Lim et al. (23 specimens), who also studied the vascular pattern of supply to the LHT, and Nimje and Bhuijan (114 specimens) (8, 10).It is interesting to note that in all of these studies, no variation is noted.

Chaware at al. performed 36 dissections. In 31 specimens they found a single branch of radial nerve supplying LHT, 3 specimens had two branches from radial nerve, one specimen having dual supply from both radial nerve and axillary nerve and one specimen showing exclusive innervation from axillary nerve alone (7) . Bertelli et al. performed dissection of 20 axillae and noted the variation of axillary nerve supplying LHT in only one specimen while radial nerve supplying LHT in others (n=19). The study also discusses the variation in division of axillary nerve and posterior circumflex humeral vessels as noted in their specimens (6). Seema and Gangadhar in their study of 50 specimens have found only 2 specimens where axillary nerve was supplying the LHT (12). The above studies had minimal variation from the normal pattern of innervation.

Erhardt and Futterman in their study analysed 22 specimens and found innervation by only radial nerve in 8, by only axillary nerve in 3 and the rest 11 specimens had dual innervation by both the nerves(4) . Mehta et al. in their study of 30 dissections found 6 specimens having a dual innervation from both the axillary nerve and the radial nerve, 22 of them had radial nerve alone and the rest 2 specimens had axillary nerve alone (9) . These studies show variation from the normal pattern of innervation as described in many anatomy textbooks.

Only one study by Rezzouk et al. found exclusive innervation by axillary nerve to LHT in all the samples studied. They divided the study into three groups. The first group included traumatic injuries of the axillary nerve with associated deficit of LHT. The second group consisted of 20 cadaveric dissections of the posterior trunks. The third group included 15 infraclavicular dissections and neurostimulation to identify the motor branch to LHT. In the first group they found the injury located on the axillary nerve in 6 individuals and at the bifurcation in 3 individuals. In the second group analysing cadaveric dissection, the branch to LHT was found from axillary nerve in 13 cases, at the bifurcation in 5 specimens and from the posterior cord itself in 2 cases. In the third group 11 specimens had motor innervation to LHT from axillary nerve and 4 specimens at the bifurcation (11). It is important to note that on comparing de Seze et al. to the Rezzouk et al. study we found that the group included in de Seze et al. (Group I and Group II) was same as that of Rezzouk et al (Group II and Group III) with same no. of cases, similar methods, two authors were same in both the studies and both studies were published from the same university; details regarding if a different study with same cadaver no. and methods was conducted by de Seze et al is necessary. Hence, de Seze et al. has been excluded from the analysis in this review of literature. This has also been pointed out by Wade et al., who conducted their study inspired by de Seze et al (13). Several previous studies have used both (de Seze et al and Rezzouk et al.) studies as to justify their data (3, 4, 9, 10, 12).

Aszmann et al. conducted cadaveric dissection to analyse the innervation of shoulder joint and its implication, they dissected 25 shoulder joints. In 7 of their specimens they could find the muscular branch innervating the teres minor also provided a smaller branch to the tendinous insertion of the LHT and adjacent capsular region was identified (17). As the scope of their study was to analyse shoulder joint details on the innervation of radial nerve to the triceps brachii innervation could not be found in their study. If the 7 specimens they identified receiving smaller branches from axillary nerve also received radial nerve supply is not commented upon in their study. Due to these drawbacks the study has been excluded from the analysis. Wade et al. describes this branch could be a sensory branch based on its description.

McClelland and Hoy present a case of 26 year old international swimmer who presented with twitching of the left triceps muscle. He was found to have quadrangular space syndrome suggesting the impingement of axillary nerve which also supplied LHT (14). Nanjundaiah et al. reported a case with bilateral innervation of LHT by axillary nerve in a cadaveric specimen (3). The present study reports a cadaver with anterior division of axillary nerve innervating of the LHT on the right side while Sawant et al. reported a posterior division of axillary nerve innervating the LHT (15).

There are few explanations proposed to justify this variation observed. Embryologically, limb musculature is derived from the dorsolateral somites that migrate into the limb to form muscles. With elongation of the limb buds, the muscle tissue splits into ventral (flexor) and dorsal (extensor) component (18). The LHT muscle is derived from the dorsal muscle mass. The branches of the posterior cord of the brachial plexus supplies the muscles derived from the dorsal muscle mass and as the axillary nerve is the branch of the posterior cord of the brachial plexus, there might be a variation in its motor innervation (13, 15).

The population dependent / race could be another possibility for these variations observed. Studies in Indian and Brazilian population (Mehta et al., Seema and Gangadhar, Chaware et al., Bertelli et al.) have shown minimal variation with axillary nerve supply while majority of the LHT was supplied by radial nerve. Studies in French population (Rezzouk et al.) observed only axillary nerve supplying LHT and studies conducted in USA (Wade et al., and Al-Meshal and Gilbert) observed only radial supplying LHT. The above findings cannot be generalised as two studies: Erhardt and Futterman (USA), and Nimje and Bhuiyan (India) did not fit the above explanation.

The proximal part of LHT receives vascular supply from the posterior circumflex humeral vessels in 80% of the specimens (8, 13). Wade et al. proposes that as posterior circumflex humeral vessels are in close proximity to axillary nerve, during shoulder dislocations, fracture of humeral head and other injuries, posterior circumflex humeral vessels could be damaged along with axillary nerve leading to lack of blood supply to proximal LHT and thus its weakness (13).

All these neurological variations that are observed in these studies could provide significant information in diagnoses and management of traumatic shoulder injury patients. In patients presenting with glenohumeral dislocation, due to its close proximity, axillary nerve is commonly injured. Axillary nerve provides motor innervation to the deltoid and teres minor and sensory innervation to the antero-inferior part of the skin over deltoid. Deltoid is a powerful abductor of the arm from 150 to 900. Therefore, compression or traction of axillary nerve in shoulder dislocations can present with inability to abduct above 150, flat shoulder deformity and loss of sensation of skin over deltoid (13, 19). Considering the above variations although might be small, we propose the clinicians to examine for the function of triceps brachii in all patients presenting with shoulder injuries with axillary nerve involvement.

Witoonchart et al. in their study propose that the no. of axons, size and anatomic proximity of the nerve to the LHT makes it a source for reinnervation of the anterior branch of axillary nerve for deltoid muscle by direct nerve transfer without requiring nerve grafting (20). Thus these anatomical variations provide knowledge to clinicians such as orthopaedicians, neurologists and surgeons performing surgical interventions involving axilla, shoulder joint; nerve transfer surgeries for deltoid and managing glenohumeral dislocation, humeral head fractures or blunt trauma to shoulder joints.

CONCLUSION:

From our literature review (n=391) we conclude that, radial nerve supplied motor branch to LHT in 81.84% (n=320). In 18.15% (n=71) there was deviation from normal pattern, axillary nerve alone supplied motor branch to LHT in 9.97% (n=39). Dual supply from both axillary nerve and radial nerve was found in 4.60% (n=18). From posterior cord and at the bifurcation of posterior cord in 0.51% (n=2) and 3.07% (n=12) respectively. As no consistent findings have been found when all the studies are compared, further studies are required to obtain a true incidence of these variations. Nevertheless, these variations provide significant information to clinicians for management of injuries affecting shoulder, arm and axilla.

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Abbreviations:

LHT – Long head of triceps.

REFERENCES:

1. Standring S. 2008. Gray's Anatomy: The Anatomical Basis of Clinical Practice. 40 Ed. New York: Churchill. Livingstone, Elsevier.
2. Ball CM, Steger T, Galatz LM, Yamaguchi K, The posterior branch of the axillary nerve: an anatomic study. J Bone Joint Surg. 2003, 85; 1497- 1501.
3. Nanjundaiah K, Jayadevaiah SM, Chowdapurkar S. Long head of triceps supplied by axillary nerve, a case Report, International Journal of Anatomical Variations (2012) 5: 35–37.
4. Erhardt AJ, Futterman B. Variations in the Innervation of the Long Head of the Triceps Brachii: A Cadaveric Investigation. Clin Orthop Relat Res. 2017 Jan;475(1):247-250.
5. Al-Meshal O, Gilbert A. Triceps innervation pattern: implications for triceps nerve to deltoid nerve transfer. Biomed Res Int.2013.
6. Bertelli JA, Ghizoni MF. 2014. Nerve transfer from triceps medial head and anconeus to deltoid for axillary nerve palsy. J Hand Surg 39: 940– 947.
7. Chaware PN, Santoshi JA, Patel M, Ahmad M, Rathinam BAD. Surgical Implications of Innervation Pattern of the Triceps Muscle: A Cadaveric Study. J Hand Microsurg. 2018;10(3):139-142.
8. Lim AY, Pereira BP, Kumar VP. 2001. The long head of the triceps brachii as a free functioning muscle transfer. Plastic Reconstr Surg 107: 1746– 1752.
9. Gyata M, Rani GBG, Mokhasi V. Contribution of axillary nerve in the innervation of long head of triceps brachii: a cadaveric study. Int J Anat Res. 2020;8(1.3):7350-7355.
10. Nimje BP, Bhuiyan P. 2014. A study of muscular branches of radial nerve: significance in treatment of humeral fracture. Int J Cur Res Rev 6: 1– 8.
11. Rezzouk J, Durandeau A, Vital J, Fabre T. 2002. Long head of the triceps brachii in axillary nerve injury: anatomy and clinical aspects. Rev Chir Orthop 88: 561– 564.
12. Seema SR. Gangadhar 2015. Variations in the formation and branching pattern of brachial plexus. Rev Argent Anat 6: 1– 3.
13. Wade MD, Mcdowell AR, Ziermann JM. Innervation of the Long Head of the Triceps Brachii in Humans—a fresh Look. The Anatomical Record. 2018; 301:473-483.
14. McClelland D, Hoy G. 2008. A case of quadrilateral space syndrome with involvement of the long head of the triceps. Am J Sports Med 36: 1615– 1617.
15. Sawant SP, Shaikh ST, More RM. 2012. The axillary nerve giving motor branch to the long head of the triceps muscle—a case report. Int J Analyt Pharma Biomed Sci 1: 15– 19.
16. de Sèze M– P, Rezzouk J, De Sèze M, Uzel M, Lavignolle B, Midy D, Durandeau A. 2004. Does the motor branch of the long head of the triceps brachii arise from the radial nerve?. Surg Radiol Anat 26: 459– 461.
17. Aszmann OC, Dellon AL, Birely BT, McFarland EG. 1996. Innervation of the human shoulder joint and its implications for surgery. Clin Orthop Relat Res 330: 202– 207.
18. Sadler T. 2006. Langman's Medical Embryology. 10 ed. Philadelphia, Baltimore: Lippincott Williams & Wilkins.
19. Avis D, Power D. Axillary nerve injury associated with glenohumeral dislocation: A review and algorithm for management. EFORT Open Rev. 2018;3(3):70-77.
20. Witoonchart K, Leechavengvongs S, Uerpairojkit C, Thuvasethakul P, Wongnopsuwan V. Nerve transfer to deltoid muscle using the nerve to the long head of the triceps, part I: an anatomic feasibility study. J Hand Surg Am. 2003;28(04):628–632.