Original Article

Morphological and Morphometrical Study of the Long Thoracic Nerve – A Guidance in Supraclavicular Nerve Block

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Abstract

Background: The long thoracic nerve (LTN), which is an essential part of the brachial plexus, supplies the Serratus anterior muscle. The fact that it passes through anatomical structures and that these structures vary has clinical implications, including in supraclavicular nerve blocks, where unintentional injury can result in side effects. To enhance the safety and precision of regional anaesthesia procedures, the morphology and morphometry of the LTN are therefore of important understanding. **Material and Methods:** Ethical clearance and consent were obtained, and the study was carried out in the Department of Anatomy, SABVMCRI, Bengaluru. There were 30 formalin-preserved cadavers (60 specimens: right and left) dissected systematically. Normal axillary dissections were done, and the long thoracic nerve was viewed with respect to the Scalenus medius muscle. Its course and morphometric measures varied. **Results:** This was a long thoracic nerve consistently detected in all specimens. The nerve was found in the supraclavicular area, which was about 1 cm behind the scalenus medius muscle, and it was above the upper trunk of the brachial plexus. These results demonstrate its exposed state when supraclavicular nerve blocks are used. There were morphometric differences, indicating that one should accept differences in the anatomy of different people. **Conclusion:** The current morphological and morphometric analysis highlights the clinical significance of the long thoracic nerve during supraclavicular nerve block procedures. Close familiarity with its course, regional anatomical differences, and size is necessary to minimise iatrogenic injury and achieve the best anaesthetic outcome. With this anatomical knowledge added to clinical practice, patient safety and the effectiveness of supraclavicular nerve blocks can be significantly increased.

Keywords: Serratus anterior, supraclavicular nerve block, anatomical differences, morphometry, long thoracic nerve, brachial plexus.

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Introduction

Long thoracic nerve (LTN): It is a peripheral nerve whose origin is mostly C5, C6, and C7 spinal nerve ventral rami and is the only motor nerve that supplies the Serratus anterior muscle.[1,2] The Serratus anterior is extremely essential in the stability of the scapula in relation to the thoracic wall and in the overhead lifting of the upper arm.[3] Damage to the LTN leads to functional deficiency of the Serratus anterior muscle, resulting in a typical clinical picture of winged scapula, shoulder pain, and functional impairment.[4]

A range of anatomical reports have shown significant variability in the origin, formation, and path of the LTN, with some people having contributions from C4 or C8.[5,6] Reports of cadaveric investigations have indicated that the nerve commonly disseminates either through or behind the scalenus medius muscle that then proceeds on to the lateral thoracic wall.[7] The LTN is especially susceptible to the supraclavicular block of the brachial plexus, as well as during cervical surgery, as it is closely associated with the brachial plexus trunks in that area.[8,9]

There is metainformational evidence that the canonical origin of the LTN from C5, C8, and C7 occurs in about 7580 cases, with almost a quarter of individuals showing atypical root contributions.[10] High-resolution ultrasonography surveys were recently carried out to confirm the possibility of visualizing the LTN in the supraclavicular region and to provide morphometric data of clinical relevance to enhance regional anaesthesia methods.[11]

Considering these anatomical differences and their clinical significance, a complex morphological and morphometrical analysis of the LTN is needed to improve the safety and precision of the supraclavicular nerve block. This work also aims to examine the origin, course, morphometry, and branching pattern of the LTN in relation to surrounding anatomical landmarks.

Aims and Objectives

This paper examines the morphological and morphometric features of the long thoracic nerve in the supraclavicular region to provide pertinent anatomical information that could improve the reliability and safety of supraclavicular nerve blocks. The

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objectives are the course and variations of the long thoracic nerve; its relation to anatomical landmarks in its vicinity; measurement of the length and distance between the long thoracic nerve and fixed bony points; and analysis of its clinical relevance in the prevention of nerve diseases during regional anaesthesia.

Materials and Methods

Study design: This was an observational, descriptive cadaveric study conducted in the Department of Anatomy at SABVMCRI, Bengaluru. The total number of fresh formalin-embalmed cadavers was 30 (n=30), and bilateral dissections were carried out to yield 60 specimens to be analyzed. The study aimed to examine both morphological and morphometrical features of the long thoracic nerve and the anatomical features of the scalenus medius muscle.

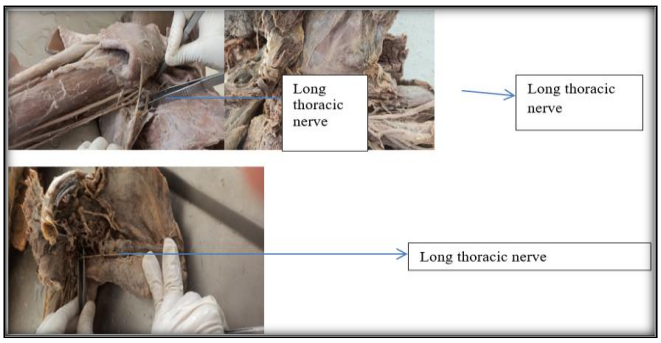
Inclusion and Exclusion criteria

The participants were fresh formalin-preserved adult cadavers whose anatomical structures were well maintained and whose necks, axillary, and thoracic areas had no history of undergoing surgery or having any trauma. Male as well as female cadavers were taken into consideration as long as they were anatomically sound to be dissected. Cadavers were excluded in case there were any indications of the previous surgical interventions, deformities, traumas, or pathological alterations, and poor preservation that would interfere with determining or measuring the long thoracic nerve and anatomical correlations.

Data Collection Procedure

The bilateral dissections that were performed on the axillary region followed standard anatomical dissection procedures. The long thoracic nerve was thoroughly assessed on the right and left sides of the two cadavers. The special concern was to determine the origin, course, bifurcation, and interaction with the scalenus medius muscle. Systematic morphometric data were collected, including nerve length and distances along the line of anatomical landmarks. All results were captured as photographs and tabulated for analysis.

Statistical Analysis: The frequency and percentage distributions of each morphological type and the related morphometric parameters were presented using descriptive statistics.



Results

[Table 1] shows the classification and frequency of different morphological variations in the formation of the long thoracic nerve. Type 2 was the most common pattern, which was observed in 66.7% of specimens, followed by Type 1, while Types 3 and 4 were rare.

Table 1: Distribution of Morphological Types of Long Thoracic Nerve Formation

Type	No. of Specimens	Morphological Contribution
1	14 (23.3%)	1 branch from C5 & 1 from C6 united behind scalenus medius muscle to form upper division of the long thoracic nerve
2	40 (66.7%)	1 branch from C5 & 1 from C6 united behind scalenus medius muscle to form upper division, with a third smaller branch noted
3	2 (3.3%)	Direct contribution from C5 & C6 to the long thoracic nerve
4	4 (6.7%)	A branch from C4 joined the C5 branch to form the upper division of the long thoracic nerve
Total	60	

Table 2: Morphometric Relationship of Long Thoracic Nerve to Scalenus Medius Muscle

Type	Distance Posterior to Scalenus Medius Muscle	Relative Position to Brachial Plexus
1	1 cm	Superior to upper trunk formation
2	1 cm	Superior to upper trunk formation
3	1 cm	Superior to upper trunk formation
4	1.5 cm	Higher level than upper trunk formation

[Table 2] highlights the morphometric observations regarding the long thoracic nerve's position relative to the scalenus medius muscle and brachial plexus. The majority of the specimens showed the nerve 1 cm posterior to the scalenus medius, which is superior to the formation of the upper trunk of the brachial plexus, except in Type 4, where it was slightly farther (1.5 cm) and at a higher level.

Table 3: Branching of Long Thoracic nerve to Serratus anterior Muscle.

Type	Branching Pattern
1	To upper part of serratus anterior muscle Two injected into formation site.
2	Branch to serratus anterior develops out of C5 nerve.
3	Branch to serratus anterior emerging out of C5 nerve.
4	Branch to serratus anterior Innervation of C4 and C5 nerve.

[Table 3] is devoted to the difference in the branching pattern of the long thoracic nerve to the upper end of the serratus anterior

muscle. The majority of the branches were a result of the C5 root, and the special contribution of both C4 and C5 nerves characterized Type 4.

Discussion

Long thoracic nerve (LTN) is different in the sense that the nerve is long and surface-level and hence is highly vulnerable to any damage during surgery and during anesthesia within the cervical and supraclavicular regions. Current cadaveric research provides detailed morphological and morphometric information about the LTN, with particular focus on its formation, connection to the scalenus medius muscle, branching, and clinical relevance in supraclavicular nerve blocks.

The most common pattern of LTN formation in this study was Type 2 (66.7%), in which the C5 and C6 branches formed posterior to the scalenus medius muscle and had an additional, smaller branch. This observation is similar to that of Yazar et al., who stated that the C5 and C6 roots often fuse behind or within the scalenus medius muscle, with some inconsistent accessory contributions.[5] Correspondingly, Wang et al. reported that the uniting nature made of C5 and C6 roots near the middle scalene muscle is the most constant characteristic of the LTN formation that enhances the dependability of the anatomical landmark.[6]

The second most frequent pattern in the current research was Type 1 (23.3%), which involved merging one branch of C5 and C6 with no auxiliary branches. Such a pattern is consistent with the classical descriptions of the anatomy observed in cadavers and in standard anatomy texts.[2,3] Nevertheless, it is worth noting that a purely textbook explanation might not reflect the reality of variation frequency, which recent meta-analyses note is particularly important.

Types 3 and 4 displayed atypical LTN formations, which together accounted for at least 15% of the total. Type 4 resulted in the contribution of the C4 root. The discovery confirms earlier reports that variation in cervical roots, especially C4, although not prevalent, is clinically significant.[10] A large meta-analysis conducted by Benes et al. showed abnormal root contributions in almost one-fifth of cases, suggesting that the occurrence of such variations may vary across populations and methodologies.[10] The frequency of atypical roots is also relatively low in the current research, which could be attributed to the anatomical peculiarities of the region under investigation or to insufficient sample sizes.

The current morphometric evidence indicates that the LTN, in most specimens, is located approximately 1 cm behind the scalenus medius muscle and above the formation of the upper trunk of the brachial plexus. Such a spatial relationship has significant clinical implications, especially in supraclavicular brachio-plexal blocks. The tight posterior localization of LTN to the scalenus medius muscle was also highlighted by Wang et al., who noted that accidentally stepping on needles in this area could increase the risk of nerve damage.[6] Tubbs et al. also emphasized that the LTN is located at the surface and relatively immobile; thus, it is susceptible to iatrogenic effects during neck-related invasive procedures.[7]

In the current research, the nerve showed a marginally more posterior placement in the specimens with a C4 contribution (Type 4). This position difference is a clinical consideration because it can explain why nerve involvement or blocks are not predicted from readings or do not occur when regional anesthesia is used, and why the landmark-based method has been used.[8,9]

There was also a significant variation in the pattern of branching of the LTN to the serratus anterior muscle. The C5 component formed branches to the upper part of the serratus anterior in most specimens, directly or at the site of the formation of upper divisions. These results should be added to the cadaveric studies by Hamada et al., who have shown that the upper digitations of the serratus anterior are early motor branches, mainly of C5.[12] Such an early separation pattern in the proximal lesions of the LTN can render scapular stabilization disproportionate in cases where the nerve continues distally.

Clinically, these anatomic differences have a direct implication for supraclavicular nerve blocks. The position of LTN near the brachial plexus trunks puts this area at risk in both landmark and ultrasound-guided techniques. Choi and McCartney have stressed that detailed anatomical understanding is necessary to prevent collateral injury to the nerve during a brachial plexus block.[9] Moreover, practice guidelines on ASRA emphasize that anatomical variability is also a major cause of nerve damage in regional anesthesia.[8]

Recent high-resolution ultrasound imaging has confirmed that the LTN can consistently be seen in the supraclavicular area, with reported mean diameters of 1.5-1.7 mm, providing an important tool for nerve location and injury prevention.[11] Adding morphometric evidence, as in the current study, can also increase the accuracy of ultrasound-guided methods.

On the whole, the results of the present research support the idea that the long thoracic nerve exhibits significant anatomic variations in its formation, course, and branching pattern. Knowledge of these differences, especially regarding the scalenus medius muscle and the upper trunk of the brachial plexus, is vital to anatomists, anesthesiologists, and surgeons to reduce iatrogenic damage and maximize the results of the procedure.

Conclusion

The current morphological and morphometrical research of the long thoracic nerve shows that there are significant differences in its formation, route, and branching order, and that the most common origin is between the C5 and C6 roots, which merge behind the scalenus medius. Less of this was not contributed by C4 or its accessory branches, a still smaller sub-group of them. The nerve was situated morphometrically (on average) 1-1.5cm behind the scalenus medius and above the upper trunk of the brachial plexus. These results play a significant role in enhancing the reliability and safety of supraclavicular nerve blocks because the nerve sources and the anatomy framing the nerve routes can alter the effect of a block and complicate the risk of accidental nerve damage.

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Conflicts of interest

There are no conflicts of interest.

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