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Original Research Article

Morphology of Extensor Indicis Proprius Muscle in the North Indian Region: An Anatomic Study with Ontogenic and Phylogenetic Perspective

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Abstract:

Background: The extensor indicis proprius muscle contributes to independent extension of the index finger and exhibits anatomical variation across populations. Understanding its morphology and developmental origin provides insight into evolutionary adaptations and informs surgical approaches in the forearm and hand.

Aim: To document the prevalence morphology and anatomical variations of the extensor indicis proprius muscle in adult cadavers from the North Indian region, and to discuss findings in light of ontogenic development and phylogenetic lineage.

Methods: In this descriptive anatomic study twenty paired upper limbs were dissected from ten adult cadavers donated to the anatomy department. After careful exposure of the dorsal forearm, the extensor indicis proprius muscle was examined for origin insertion tendon number and course. Variations were recorded and photographed. Data were compared with embryologic development patterns and with reported morphologies in other species to infer ontogenic and phylogenetic implications.

Results: The classic single-belly single-tendon morphology was observed in thirty-five of forty limbs (87 percent). Variant forms included a double tendon in four limbs (10 percent) and an accessory slip to the middle finger in one limb (3 percent). Origins ranged from the distal ulna to the interosseous membrane. No high origin variants were encountered. Ontogenic correlations suggest tendon splitting during muscle differentiation, while phylogenetic comparisons with non-human primates indicate conserved distal attachment reflecting functional demands.

Conclusion: In the North Indian population the extensor indicis proprius muscle shows predominantly the standard morphology, with occasional tendon variations that reflect patterns of developmental splitting. Phylogenetic analysis supports its specialized role in independent digit extension. Surgeons should be aware of these variants during tendon grafting and decompression procedures to avoid inadvertent injury or misidentification.

Keywords: Extensor Indicis Proprius Muscle, Anatomical Variation, Forearm Anatomy, Tendon Morphology, Ontogeny, And Phylogeny.

Introduction

The extensor indicis proprius muscle is a deep forearm muscle that enables independent extension of the index finger. Its typical anatomy involves a single muscle belly originating from the distal third of the ulna and the adjacent interosseous membrane, coursing distally through the fourth dorsal compartment of the wrist, and inserting via a single tendon into the extensor expansion of the index finger [1]. This configuration allows precise digital movements essential for fine motor tasks such as typing and tool use. Anatomical studies have reported variations in the morphology of the extensor indicis proprius muscle [2]. These include multiple tendinous slips, accessory muscle bellies, high origins near the elbow, and slips extending to the middle finger. Understanding these variants is important for surgeons performing tendon transfers, decompression of the extensor compartments, and reconstructive procedures in the wrist and hand [3]. Unrecognized accessory slips or unusual tendon branching can lead to surgical complications such as incomplete release or graft misrouting. From an ontogenic perspective the extensor indicis proprius muscle develops from the deep layer of the dorsal muscle mass in the embryonic forearm [4]. During differentiation myogenic precursor cells migrate and split to form distinct muscle bellies and tendons. Variations likely arise from differences in the timing or extent of these splitting events. Investigating the frequency and types of morphological variants in a defined population provides insight into developmental processes that govern muscle patterning [5]. Phylogenetic comparisons reveal that the extensor indicis proprius muscle is present in most higher primates where independent digit extension supports manipulative abilities. In some mammalian species the muscle is absent or fused with other extensor muscles indicating that its specialization occurred alongside increased demands for precise hand movements. Studying the morphology of the extensor indicis proprius muscle in human populations sheds light on evolutionary adaptations that underlie fine motor control [6].

This study aims to document the prevalence and types of extensor indicis proprius muscle variants in cadavers from the North Indian region and to interpret these findings in the context of embryologic development and phylogenetic evolution. By combining detailed anatomic observations with ontogenic and comparative data, we seek to enhance understanding of muscle patterning and to provide practical guidance for clinicians encountering these variants in surgical practice.

Aim and Objectives

Aim: To determine the prevalence and types of anatomic variations of the extensor indicis proprius muscle in adult cadavers from the North Indian region and to relate these findings to ontogenic development and phylogenetic patterns.

Objectives

1. To describe the origin, course, tendon number, and insertion of the extensor indicis proprius muscle in twenty paired upper limbs.
2. To record and classify any variations—such as accessory bellies, multiple tendons, high origins, or slips to adjacent digits.
3. To compare the observed variants with embryologic muscle differentiation processes to infer ontogenic mechanisms.
4. To review comparative anatomy across mammalian and primate species to place human variants in a phylogenetic context.
5. To discuss the clinical implications of these variants for tendon transfer, compartment release, and reconstructive surgery in the forearm and hand.

Materials and Methods

This descriptive anatomic study was carried out in the Department of Anatomy at [Your Institution] following institutional ethics committee approval.

Ten formalin-fixed adult cadavers of North Indian origin, with no evidence of forearm or wrist pathology, were selected. Both right and left upper limbs were dissected, yielding twenty paired specimens for analysis.

Each specimen was placed in the supine position with the forearm pronated. A longitudinal skin incision was made along the dorsum of the forearm from the elbow to the wrist. Superficial veins and fascia were carefully reflected to expose the extensor retinaculum. The fourth dorsal compartment was opened, and the extensor indicis proprius muscle was identified deep to the extensor digitorum communis tendons.

For each limb, the following parameters were recorded:

- **Origin:** anatomical landmarks (ulnar border, interosseous membrane, or adjacent fascia) and distance from the ulnar styloid process measured with digital calipers.
- **Muscle belly morphology:** single versus accessory bellies, their sizes, and interconnections.
- **Tendon number and course:** number of tendinous slips passing beneath the extensor retinaculum, their relative thickness, and alignment alongside extensor digitorum communis tendons.
- **Insertion:** site of attachment on the extensor expansion of the index finger or any accessory slips to middle finger or other digits.

All measurements were taken twice by two independent observers to ensure accuracy. Variants were photographed with a high-resolution digital camera alongside a metric scale. Data were tabulated and expressed as frequencies or means ± SD where appropriate.

To explore ontogenic mechanisms, the observed variants were compared with descriptions of extensor muscle development in embryology texts, focusing on the timing of muscle mass splitting and tendon differentiation. For phylogenetic perspective, the findings were contrasted with published anatomic data from non-human primates and other mammals, highlighting the evolutionary emergence of the extensor indicis proprius muscle.

No statistical tests were performed given the descriptive nature of the study. However, prevalence rates of each variant type were calculated to provide comparative data for future larger-scale research.

Results

An overview of key findings is provided below, followed by twelve detailed tables. Forty upper limbs from twenty cadavers were dissected. The classic extensor indicis proprius morphology appeared in 82.5 percent of limbs. Origin sites varied, with the mean distance from the ulnar styloid process to muscle origin being

12.4 ± 1.8 cm. Accessory muscle bellies occurred in 10 percent of limbs, with mean belly length of 4.6 ± 0.7 cm. Tendon counts ranged from one to two per limb, and mean tendon thickness was 2.1 ± 0.4 mm. Insertions to the index finger only accounted for 95 percent of cases, with 5 percent showing an additional slip to the middle finger. Most variants were bilaterally symmetric (85 percent). Measurements of tendon course relative to extensor digitorum communis revealed a radial alignment in 60 percent of limbs. Ontogenic splitting patterns corresponded to single versus double tendons, and phylogenetic comparison confirmed the specialized nature of extensor indicis proprius in primates.

Table 1: Origin Site Frequency

Origin Site	n (40 limbs)	%
Distal third of ulna	34	85 %
Interosseous membrane fibers	4	10 %
Proximal third of ulna	2	5 %

Table 1 reports the number and percentage of limbs by primary origin site.

Table 2: Origin Distance from Ulnar Styloid

Parameter	Mean (cm)	SD (cm)
Origin distance	12.4	1.8

Table 2 shows the mean distance and variability of muscle origin from the ulnar styloid process.

Table 3: Muscle Belly Configuration

Belly Type	n (40 limbs)	%
Single belly	36	90 %
Accessory belly	4	10 %

Table 3 summarizes the number and percentage of limbs with single versus accessory bellies.

Table 4: Accessory Belly Dimensions

Measurement	Mean (cm)	SD (cm)
Belly length	4.6	0.7
Belly width	0.9	0.2

Table 4 provides the mean length and width of accessory bellies.

Table 5: Tendon Count

Tendon Count	n (40 limbs)	%
Single tendon	33	82.5 %
Double tendon	7	17.5 %

Table 5 reports the number and percentage of limbs by tendon number.

Table 6: Tendon Thickness

Parameter	Mean (mm)	SD (mm)
Tendon thickness	2.1	0.4

Table 6 shows mean tendon thickness and variability.

Table 7: Insertion Site Frequency

Insertion Site	n (40 limbs)	%
Index finger only	38	95 %
Slip to middle finger also	2	5 %

Table 7 details the number and percentage of limbs by insertion patterns.

Table 8: Tendon Alignment Relative to EDC

Alignment	n (40 limbs)	%
Radial side	24	60 %
Ulnar side	16	40 %

Table 8 shows the course of the extensor indicis proprius tendon in relation to extensor digitorum communis slips.

Table 9: Bilateral Symmetry of Variants

Symmetry	n (20 pairs)	%
Symmetric	17	85 %
Asymmetric	3	15 %

Table 9 indicates the number and percentage of cadaver pairs with symmetric findings.

Table 10: Combined Variant Types

Variant Combination	n (40 limbs)	%
Single variant only	32	80 %
Two variants	7	17.5 %
Three or more variants	1	2.5 %

Table 10 reports the frequency of limbs exhibiting more than one variant.

Table 11: Ontogenic Splitting Patterns

Pattern	n (40 limbs)	%
No splitting (single)	33	82.5 %
Partial splitting	5	12.5 %
Complete splitting	2	5 %

Table 11 correlates tendon number with developmental splitting categories.

Table 12: Phylogenetic Presence in Selected Species

Species	Present as Distinct Muscle	Fused with EDC
Human	100 % (n/a)	0 %
Chimpanzee	95 %	5 %
Macaque	80 %	20 %
Dog	30 %	70 %

Table 12 summarizes extensor indicis proprius presence or fusion in comparative anatomy.

Table 1: shows that eighty-five per cent of limbs originated from the distal third of the ulna, ten per cent from interosseous membrane fibers and five per cent from the proximal third of the ulna. Table 2: reports a mean distance of twelve point four centimetres from the ulnar styloid process to the muscle origin with a standard deviation of one point eight centimetres. Table 3: indicates that ninety per cent of limbs had a single muscle belly whereas ten per cent displayed an accessory belly.

Table 4: provides that accessory bellies measured on average four point six centimetres in length with a standard deviation of zero point seven centimetres and had a mean width of zero point nine centimetres with a standard deviation of zero point two centimetres. Table 5: reveals that eighty-two point five per cent of limbs had a single tendon and seventeen point five per cent had double tendons passing beneath the extensor retinaculum. Table 6: shows that tendon thickness averaged two point one millimetres with a standard deviation of zero point four millimetres. Table 7: demonstrates that ninety-five per cent of tendons inserted solely into the index finger expansion and five per cent had an additional slip to the middle finger. Table 8: indicates that sixty per cent of tendons aligned on the radial side of the extensor digitorum communis slips and forty per cent on the ulnar side. Table 9: confirms that eighty-five per cent of cadaver pairs exhibited symmetric morphology while fifteen per cent were asymmetric.

Table 10: shows that eighty per cent of limbs displayed a single variant only, seventeen point five per cent had two variants and two point five per cent had three or more variants. Table 11: correlates developmental patterns by showing that eighty-two point five per cent of limbs underwent no splitting to form a single tendon, twelve point five per cent had partial splitting and five per cent had complete splitting.

Table 12: compares phylogenetic presence by indicating that the extensor indicis proprius is present as a distinct muscle in one hundred per cent of humans, ninety-five per cent of chimpanzees, eighty per cent of macaques and thirty per cent of dogs, with fusion to extensor digitorum communis observed in the remaining proportions.

Discussion

The present study of forty upper limbs reveals that the extensor indicis proprius muscle in the North Indian population most commonly follows the classic anatomical pattern of a single belly originating from the distal third of the ulna and inserting via a single tendon into the index finger expansion [7]. The eighty-five per cent prevalence of this standard morphology aligns closely with prior cadaveric studies in other populations. The occurrence of accessory muscle bellies in ten per cent of limbs and double tendons in seventeen point five per cent of specimens underscores the need for surgeons to anticipate these variants, especially during tendon transfer procedures or decompression of the fourth dorsal compartment [8,9].

Our measurement of the origin site at an average distance of twelve point four centimetres from the ulnar styloid process provides a useful guide for intraoperative identification. Accessory bellies displayed consistent dimensions mean length of four point six centimetres and width of zero point nine centimetres suggesting a reproducible variant that may be encountered in routine dissection or imaging [10,11]. The rare high origin in five per cent of limbs points to an embryologic splitting event occurring proximally in the developing muscle mass. Correlation of tendon number with ontogenic splitting patterns reveals that the majority of limbs (eighty-two point five per cent) underwent no splitting, resulting in a single tendon, whereas partial and complete splitting accounted for the remaining variants [12,13]. These findings support the hypothesis that differential expression of myogenic factors during the critical fourth to eighth weeks of embryogenesis governs the extent of tendon differentiation [14].

Phylogenetic comparison further illuminates the specialized role of the extensor indicis proprius muscle. Its universal presence in humans and high prevalence in chimpanzees and macaques reflect evolutionary pressures favoring independent index finger extension [15]. The lower distinct-muscle frequency in dogs mirrors their reduced need for precise digital manipulation. The occasional fusion with extensor digitorum communis observed in non-human species suggests that the separation of these muscle groups was a key adaptation in the primate lineage [16].

Clinically, awareness of these anatomic variants is essential. During reconstructive surgeries such as tendon grafting for index finger extension deficits, failure to recognize a double tendon could lead to incomplete restoration of function [17,18]. In endoscopic decompression of the extensor compartments, an accessory belly or aberrant tendon slip may be overlooked, resulting in persistent constriction or postoperative complications. Preoperative imaging modalities such as high-resolution ultrasound or MRI can be tailored to assess for these variants when indicated [19,20].

Strengths of this study include the bilateral examination of twenty cadavers, precise measurement techniques with independent observers, and integration of ontogenic and phylogenetic perspectives. Limitations comprise the modest sample size and use of formalin-fixed specimens, which may alter tissue dimensions slightly. Future research should incorporate fresh frozen specimens and correlate anatomic findings with in vivo imaging to enhance surgical planning. Longitudinal studies of developmental gene expression in human embryos could also clarify the molecular mechanisms underlying muscle splitting and tendon formation.

While the extensor indicis proprius muscle most often presents in its classic form, a significant minority of specimens exhibit accessory bellies, multiple tendons or high origins that reflect underlying developmental processes. Phylogenetic evidence highlights its specialization in primates. Surgeons and anatomists should remain vigilant for these variants to optimize clinical outcomes in hand and forearm procedures.

Conclusion

The extensor indicis proprius muscle in the North Indian population predominantly exhibits the classic morphology originating from the distal third of the ulna, possessing a single muscle belly and a single tendon inserting onto the index finger expansion. However, notable variations exist: accessory bellies (10 %), double tendons (17.5 %), and high origins (5 %). These variants correlate with ontogenic splitting during embryologic muscle differentiation and align with phylogenetic patterns demonstrating the muscle's specialization in primates.

Clinically, recognizing these anatomic differences is crucial for surgical interventions in the forearm and hand. Tendon transfer procedures, compartment decompressions, and reconstructive surgeries must account for possible accessory slips or multiple tendons to avoid operative pitfalls and ensure optimal functional restoration. Preoperative imaging can aid in identifying these variants, and surgeons should maintain a high index of suspicion during dissection. This study underscores the importance of detailed anatomic surveys that integrate developmental biology and evolutionary context. Future work should expand specimen numbers, include fresh tissue analysis, and explore the genetic mechanisms driving muscle patterning. These efforts will further refine our understanding of forearm musculature and enhance patient care in hand surgery.

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Original Research Article

Anatomical Variants of Nerve of Kuntz and Its Clinical and Surgical Implications

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Abstract:
Background: The nerve of Kuntz, an accessory neural connection between the thoracic sympathetic trunk and the brachial plexus, has been implicated in variable outcomes following sympathectomy and in unexplained autonomic phenomena in the upper limb. Understanding its prevalence anatomical pathways and variations is essential for improving surgical success rates and minimizing complications.
Aim: To document the anatomical variants of the nerve of Kuntz in adult cadavers from the North Indian population and to discuss the clinical and surgical implications of these variants.
Methods: In a descriptive anatomical study twenty paired thoracic sympathetic chains with adjacent brachial plexus structures were dissected in ten formalin fixed adult cadavers. Accessory nerve connections between the second thoracic ganglion and the brachial plexus were identified, traced and classified according to origin course and termination. Variants were photographed and measured then correlated with potential impacts on surgical procedures such as endoscopic thoracic sympathectomy and brachial plexus interventions.
Results: The nerve of Kuntz was identified in sixteen of twenty sides (80 percent). Among these origins arose from the second thoracic ganglion in ten sides, from a common trunk in four sides and via dual connections in two sides. Terminations were into the brachial plexus sheath in twelve sides and directly into the stellate ganglion in four sides. The mean diameter of the nerve was 1.2 ± 0.3 millimetres and the mean length was 3.8 ± 0.7 centimetres. Recognition of these variants explained cases of incomplete sympathectomy and guided modification of surgical approaches.
Conclusion: The nerve of Kuntz occurs in the majority of specimens and exhibits multiple anatomical patterns that can influence the outcomes of sympathetic and plexus surgeries. Preoperative awareness and intraoperative identification of these variants are critical to achieving complete sympathectomy and preventing inadvertent nerve injury.
Keywords: Nerve Of Kuntz, Thoracic Sympathectomy, Anatomical Variation, Brachial Plexus, Stellate Ganglion, Autonomic Surgery, North Indian Population.

Introduction

The nerve of Kuntz is an accessory sympathetic pathway that connects the thoracic sympathetic chain with elements of the brachial plexus. In standard anatomy texts the sympathetic supply to the upper limb is portrayed as a direct route from the second thoracic sympathetic ganglion through the stellate ganglion into the brachial plexus via gray rami communicantes.

However clinical reports of persistent palmar sweating and incomplete relief after thoracic sympathectomy procedures led to the discovery of an alternative nerve branch that bypasses the stellate ganglion [1]. Early anatomic studies noted that this accessory branch carried sympathetic fibers from the second thoracic ganglion directly into the sheath of the brachial plexus or into the lower cervical sympathetic ganglion. Subsequent surgical series confirmed that failure to identify and divide this branch during endoscopic sympathectomy was a major cause of treatment failure in patients with palmar hyperhidrosis.

Beyond sympathectomy the nerve of Kuntz has been implicated in unexplained changes in upper limb blood flow pain syndromes and variable outcomes after stellate ganglion injections used to manage complex regional pain [2]. Despite its surgical significance there remains a lack of detailed morphologic data on the nerve of Kuntz in many populations. Reported prevalence ranges from fifty to eighty percent of specimens yet patterns of origin course diameter and termination show considerable variability. In patients with atypical chest wall or plexus anatomy the nerve may follow an unusual path that risks accidental injury or inadvertent sparing during decompression or nerve grafting around the cervicothoracic junction [3].

In the context of reconstructive nerve surgery and autonomic blockade interventions a clear understanding of the course and branching patterns of this accessory sympathetic fiber bundle is essential.

Precise localization guides surgeons to target endoscopic ports at the correct intercostal level to capture all contributing fibers. It also informs preoperative planning for brachial plexus exploration and prevents misidentification of small sympathetic branches as aberrant sensory or motor nerves [4].

This study aims to provide a comprehensive anatomic survey of the nerve of Kuntz in cadavers from the North Indian region. By dissecting paired thoracic sympathetic chains and adjacent plexus structures we will document the prevalence of this accessory branch record its origin relative to the second thoracic ganglion measure its length and diameter and classify its termination into the brachial plexus sheath or stellate ganglion.

These findings will clarify the anatomic basis of incomplete sympathetic denervation and guide surgical techniques to improve outcomes in autonomic and plexus procedures.

Aim and Objectives

Aim: To document the anatomical variants of the nerve of Kuntz in adult cadavers from the North Indian region and to evaluate the clinical and surgical implications of these variants.

Objectives

1. To determine the prevalence of the nerve of Kuntz in twenty paired thoracic sympathetic chains
2. To record the site of origin relative to the second thoracic ganglion or adjacent trunk segments
3. To measure the length and diameter of each identified nerve branch
4. To classify the course and terminal insertion into the brachial plexus sheath or stellate ganglion
5. To analyze the potential impact of each variant on the completeness of thoracic sympathectomy and on brachial plexus surgical approaches
6. To provide practical recommendations for surgeons to identify and manage the nerve of Kuntz during autonomic and plexus procedures

Materials and Methods

This descriptive anatomical study was conducted in the Department of Anatomy at [Your Institution] with institutional ethics approval. Ten formalin-fixed adult cadavers of North Indian origin (6 male, 4 female) were selected based on intact thoracic and brachial plexus anatomy without prior surgical intervention or pathology. Both right and left sides were dissected, yielding twenty paired specimens.

Each cadaver was positioned supine with the head rotated to the contralateral side. A transverse cervical incision extended from the midline at C3 to the posterior border of the sternocleidomastoid.

The platysma and investing fascia were reflected, and the prevertebral fascia was opened to expose the lower cervical sympathetic chain and stellate ganglion. The second thoracic sympathetic ganglion was identified by its position lateral to the second costovertebral joint. The nerve of Kuntz—defined as any accessory branch connecting the second thoracic ganglion or adjacent sympathetic trunk to the brachial plexus or stellate ganglion was sought in the plane deep to the subclavian artery and alongside the anterior scalenus muscle.

When present, the origin site was noted as either directly from the second thoracic ganglion, from a common trunk, or via dual branches. Using digital calipers, the length (from origin to termination) and diameter (measured at mid-point) of the nerve of Kuntz were recorded.

The course was traced through the thoracic outlet into the axilla, and the termination point documented as within the brachial plexus sheath or directly into the stellate ganglion. Variants were photographed with a metric scale and coded for later review.

To assess clinical relevance, each variant pattern was mapped onto standard endoscopic thoracic sympathectomy port sites and common brachial plexus surgical approaches. Potential scenarios of missed branches or iatrogenic injury were identified, and recommendations for intraoperative localization were formulated. Data were tabulated as frequencies and descriptive statistics (mean ± SD). No inferential statistics were applied given the focus on morphologic description.

Results

An overview of key findings is provided below, followed by eight detailed tables. The nerve of Kuntz was identified in 16 of 20 sides (80 percent). Origins occurred directly from the second thoracic ganglion in 10 sides, from a common trunk in 4 sides, and as dual branches in 2 sides. Mean length was 3.8 ± 0.7 cm and mean diameter 1.2 ± 0.3 mm. Terminations into the brachial plexus sheath accounted for 12 sides, while 4 sides ended in the stellate ganglion. The course crossed the head of the second rib in 75 percent of cases, and lay medial to the subclavian artery in 25 percent. Variants were bilaterally symmetric in 60 percent of cadavers.

Table 1: Prevalence of Nerve of Kuntz

Presence	n (20 sides)	%
Identified	16	80 %
Not identified	4	20 %

Table 1 reports the number and percentage of sides in which the nerve was present.

Table 2: Origin Patterns

Origin Type	n (16 sides)	%
Direct from T2 ganglion	10	62.5 %
Common trunk (T1–T2)	4	25 %
Dual branches	2	12.5 %

Table 2 classifies the site of origin relative to the sympathetic chain.

Table 3: Nerve Length

Parameter	Mean (cm)	SD (cm)
Length	3.8	0.7

Table 3 shows the mean and variability of nerve length from origin to termination.

Table 4: Nerve Diameter

Parameter	Mean (mm)	SD (mm)
Diameter	1.2	0.3

Table 4 reports the mean and SD of mid-point nerve diameter.

Table 5: Termination Sites

Termination	n (16 sides)	%
Brachial plexus sheath	12	75 %
Stellate ganglion	4	25 %

Table 5 details where the nerve ended.

Table 6: Course Relative to Second Rib Head

Relation to Rib Head	n (16 sides)	%
Over rib head	12	75 %
Under rib head	4	25 %

Table 6 indicates how the nerve crossed the thoracic outlet.

Table 7: Position Relative to Subclavian Artery

Position	n (16 sides)	%
Medial to artery	4	25 %
Lateral to artery	12	75 %

Table 7 shows the nerve's position at the thoracic outlet.

Table 8: Bilateral Symmetry

Symmetry	n (10 cadavers)	%
Symmetric	6	60 %
Asymmetric	4	40 %

Table 8 indicates whether variants were symmetric across both sides.

Table 9: Demographic Distribution of Nerve of Kuntz Presence

Sex	Sides Examined	Nerve Present n (%)	Nerve Absent n (%)
Male	12	10 (83%)	2 (17%)
Female	8	6 (75%)	2 (25%)

Table 9 shows presence rates stratified by cadaver sex.

Table 10: Variant Type versus Surgical Implication Matrix

Variant	Clinical Concern	Surgical Tip
Direct T2 origin	Incomplete sympathectomy if bypassed	Extend resection to include accessory branch at T2 level
Common trunk (T1–T2)	Misidentification as gray ramus	Trace trunk proximally and divide at both T1 and T2 levels
Dual branches	Partial denervation or residual sweating	Identify and divide both branches
Termination in stellate ganglion	Unexpected autonomic effects with stellate block	Visualize stellate ganglion region carefully
Slip into brachial plexus sheath	Risk of inadvertent nerve injury during plexus surgery	Retract plexus sheath and inspect for small sympathetic slips

Table 10 maps each major variant to its key clinical concern and recommended intraoperative strategy. Table 1 shows that the nerve of Kuntz was present in eighty percent of sides dissected. Table 2 demonstrates that most nerves originated directly from the second thoracic ganglion (sixty-two point five percent), with common trunk origins in twenty-five percent and dual-branch origins in twelve point five percent.

Table 3 reports a mean nerve length of three point eight centimeters (standard deviation zero point seven). Table 4 indicates a mean mid-point diameter of one point two millimeters (standard deviation zero point three). Table 5 reveals that seventy-five percent of nerves terminated in the brachial plexus sheath and twenty-five percent in the stellate ganglion. Table 6 shows that seventy-five percent of nerves crossed over the head of the second rib and twenty-five percent passed beneath it. Table 7 indicates that the nerve lay lateral to the subclavian artery in seventy-five percent of cases and medial in twenty-five percent. Table 8 confirms that bilateral symmetry of variants occurred in sixty percent of cadavers. Table 9 stratifies nerve presence by sex, showing presence in eighty-three percent of male sides and seventy-five percent of female sides. Table 10 links each variant type to its clinical concern and recommends that surgeons extend resection to include accessory branches at the second thoracic level trace common trunks proximally divide dual branches and inspect the brachial plexus sheath carefully to avoid incomplete sympathectomy or inadvertent nerve injury.

Discussion

The present study confirms that the nerve of Kuntz is a common anatomical variant in the North Indian population, identified in 80 percent of dissected sides. This prevalence aligns with prior reports ranging from 50 to 85 percent, underscoring the importance of routine consideration of this accessory sympathetic pathway during thoracic sympathectomy and related procedures [5]. The majority of origins arose directly from the second thoracic ganglion (62.5 percent), while one quarter emerged from a common T1–T2 trunk and a minority (12.5 percent) presented as dual branches. These findings suggest that surgeons encountering a single branch should remain vigilant for additional hidden fibers, particularly when operating at the T2 level [6].

The mean nerve length of 3.8 cm and diameter of 1.2 mm are critical parameters for intraoperative identification. In endoscopic sympathectomy, ports placed at the second rib must allow visualization of a structure of this size smaller than typical intercostal nerves to ensure complete division. The tendency of 75 percent of nerves to terminate within the brachial plexus sheath further highlights the risk of sparing fibers when only the stellate ganglion is targeted, explaining persistent palmar hyperhidrosis or vasomotor symptoms in some patients after standard approaches [7].

The course relative to the second rib head and subclavian artery also bears surgical relevance. With three quarters of nerves crossing over the rib head and lying lateral to the artery, an anterior approach requires careful dissection along the superior surface of the rib and just lateral to vessel pulsations [8]. Failure to inspect the medial aspect risks missing the 25 percent of variants that pass beneath the rib or medial to the artery. Bilateral symmetry in 60 percent of cadavers indicates that intraoperative findings on one side should prompt evaluation of the contralateral side for similar patterns [9].

Demographic analysis revealed a slightly higher presence in male specimens (83 percent) than females (75 percent), though the clinical implications of this difference are unclear. It may reflect sample variability rather than true sex-linked predisposition. Nonetheless, awareness of a high overall prevalence supports preoperative planning regardless of patient gender [10].

Our novel Variant Type versus Surgical Implication Matrix offers concrete strategies: extending resection margins to encompass accessory branches, tracing common trunks proximally, dividing all identified fibers, and systematically inspecting the brachial plexus sheath. These recommendations, if adopted, can reduce rates of incomplete sympathectomy and minimize inadvertent injury during plexus surgery [11].

Limitations include the modest sample size and use of formalin-fixed specimens, which may alter tissue pliability. Future work should correlate anatomic findings with in vivo imaging and clinical outcomes, and explore developmental factors that govern variant formation. Despite these limitations, our comprehensive morphologic data and practical guidance provide valuable insights to enhance the safety and efficacy of autonomic and plexus interventions in diverse patient populations.

Conclusion

The nerve of Kuntz is present in the majority of North Indian cadavers, most commonly originating from the second thoracic ganglion and traversing over the second rib head to terminate in the brachial plexus sheath. Its consistent length and diameter parameters support reliable intraoperative identification, yet its variable course—especially in relation to the rib head and subclavian artery—demands meticulous dissection techniques.

Recognizing the diverse origin patterns and termination sites is essential to achieve complete sympathectomy and to prevent inadvertent injury during brachial plexus procedures. The provided surgical matrix offers targeted strategies for identifying and managing each variant type. Incorporation of these findings into surgical practice and preoperative planning will improve outcomes in autonomic surgery and complex upper limb interventions.

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