

ANATOMICAL VARIANTS OF NERVE OF KUNTZ AND ITS CLINICAL AND SURGICAL IMPLICATIONS

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ABSTRACT

Background: The nerve of Kuntz is an inconstant intra thoracic ramus arises from the 2nd thoracic nerve and it carries the sympathetic fibres joined with either 1st thoracic or 1st intercostal nerve or stellate ganglion to contribute the sympathetic innervations to the upper limb. The intra thoracic nerve of Kuntz is one of the causes for surgical failures and recurrence of symptoms after sympathectomy. Knowledge of anatomy of the sympathetic innervation to the upper limb is of great importance for neurosurgeons during surgical sympathectomy procedures.

Materials and Methods: The study was conducted in 12 formalin fixed cadavers (24 sides) in the Department of Anatomy, Chettinad Hospital and Research Institute. After reflection of the anterior wall and eviscerated of the thorax, the intrathoracic organs were removed to expose the posterior mediastinum. The incidence of any connection between the 2nd to 1st thoracic or 1st intercostal nerve or stellate ganglion were noted and photographed. The variations observed were classified as per Zaidi and Ashraf (2010) classification of intra thoracic nerve of Kuntz.

Observations: In the present study, Out of 12 cadavers (24 sides) dissected, the nerve of Kuntz was present in 9 Specimens (37.6%). As per Zaidi and Ashraf (2010) classification, Type A was seen in 12.5%, Type B in 4.3%, Type C in 8.3% and of Type D in 12.5%

Conclusion: The data regarding the study on variations of intra thoracic nerve of Kuntz is helpful to the surgeons to successfully perform upper limb sympathectomy.

KEY WORDS: Intra thoracic nerve of Kuntz, Kuntz's Nerve, Thoracic Sympathetic Chain.

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INTRODUCTION

Palmar or axillary hyperhidrosis, craniofacial symptoms [1-5], facial blushing [6] and Raynaud's disease [7] constitute the acceptable

indications for the Endoscopic thoracic sympathectomy (ETS). The upper thoracic region is the most common targeted area for ETS to get relief from these symptoms. Recurrence of

symptoms after ETS is due to sympathetic regeneration or alternate sympathetic pathways. The most common alternate pathway is the Nerve of Kuntz [8-12].

Inconstant intra thoracic ramus connecting 1st and 2nd thoracic nerves was first described as nerve of Kuntz (INK) by Albert Kuntz in 1927. This nerve carries the sympathetic fibres to the brachial plexus without passing through the sympathetic trunk [9, 10]. Search of literatures revealed that the INK was seen in 60-80% of subjects anatomically [8-9, 11-12, 14,15]. But it was found only in 10-12% cases thoracoscopically [2,13,16].

Since the potential cause of failure of upper limb sympathectomy is the presence of INK [9-12, 17], therefore, it was proposed to determine the frequency of occurrence and variations of INK. The clinical and surgical importance of the frequency of occurrence and variations of INK observed has been discussed in the paper.

MATERIALS AND METHODS

The present study was conducted in the Department of Anatomy of Chettinad Hospital and Research Institute (CHRI), Chennai. Twelve formalin fixed cadavers of both the sexes were obtained from CHRI and Madras Medical College, Chennai. The anterior thoracic walls of each of the twelve cadavers were reflected. The heart and lungs were removed from the thoracic cavity and the posterior mediastinum was exposed. Then, the parietal pleura and the endothoracic tissue were carefully removed from the paravertebral gutter, extending from the first rib to costo - diaphragmatic recess. In this process, the sympathetic chain, thoracic spinal and intercostal nerves were exposed from the level of first thoracic vertebra to twelfth thoracic vertebra. Connections between spinal thoracic and intercostal nerves were looked for. Any connection between 2nd and 1st thoracic nerve or 1st intercostal nerve or stellate ganglion was noted and photographed. Nerve connecting 2nd thoracic nerve with 1st thoracic or 1st intercostal nerve or stellate ganglion was labelled as INK.

OBSERVATIONS:

Right and left paravertebral gutters of each of

the 12 formalin fixed cadavers were finely dissected. It was observed that 2nd thoracic nerve was communicating either with 1st thoracic nerve, 1st intercostal nerve or stellate ganglion in 9 cases i.e 37.6% (Table.1).

Table 1: Frequency of variations of INK observed in the present study.

Type of INK	Total no. of Specimens with unilateral INK, out of 12 cadavers dissected	Percentage %
A	3	12.5
B	1	4.3
C	2	8.3
D	3	12.5

The patterns of the variations of INK observed in the present study were as following:

In three cadavers, it was observed that the INK from 2nd thoracic nerve ascended upwards and joined 1st thoracic nerve i.e. in 12.5% of cases dissected. This type of pattern was seen unilaterally in each of these three cadavers (Fig.1).

Fig. 1: Showing INK connecting 2nd thoracic nerve (T₂) with 1st thoracic nerve (T₁). TG - thoracic ganglion, SG – Stellate ganglion.

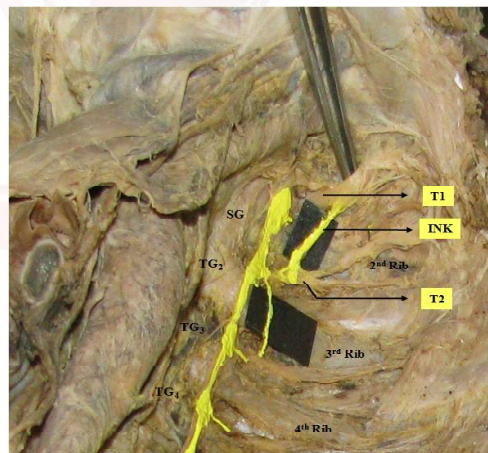
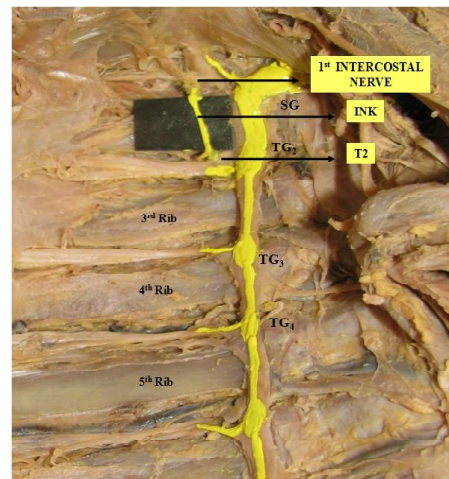


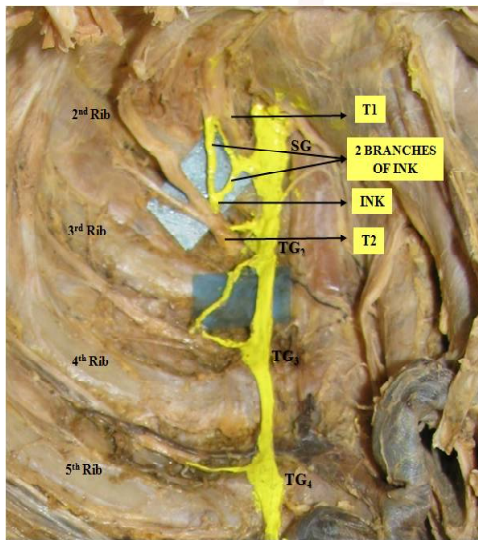
Fig. 2: Showing INK connecting 2nd thoracic nerve (T₂) nerve with 1st intercostal Nerve on the right side of cadaver.



In one cadaver, INK ascended upwards from the 2nd thoracic nerve and joined 1st intercostal nerve on the right side i.e. in 4.3% of the total number of cases dissected (Fig.2).

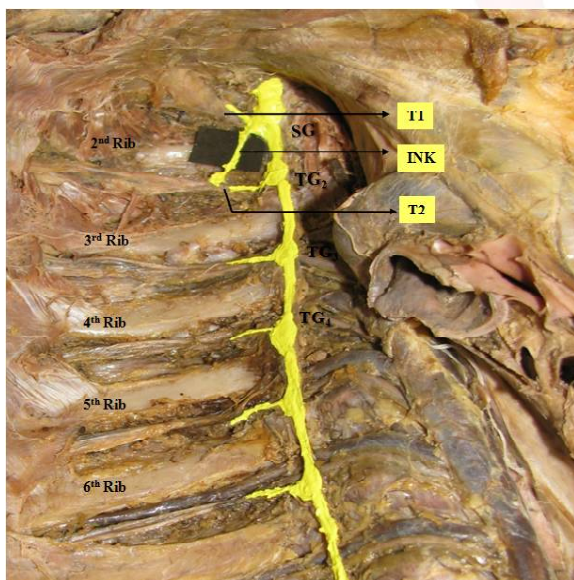
A branch from 2nd thoracic nerve i.e. INK, ascended upwards and divided into two branches. One branch joined the 1st thoracic nerve while the other branch joined the stellate ganglion. This type of variation was seen unilaterally in 2 cadavers out of a total of 12 cadavers dissected i.e.in 8.3% cases (Fig.3).

Fig. 3: Showing INK dividing into two branches. One branch joining the stellate Ganglion (SG) and the other joining first thoracic nerve (T₁).



The INK from 2nd thoracic nerve ascended upwards and crossed the neck of 2nd rib to join the stellate ganglion. This type of pattern was found to be present unilaterally in 3 cadavers, i.e. in 12.5% of cases (Fig.4).

Fig. 4: Showing INK connecting 2nd thoracic nerve (T₂) with Stellate Ganglion (SG).



DISCUSSION

Endoscopic thoracic sympathectomy has been the method of choice for the treatment of various autonomic disorders such as primary hyperhidrosis [1-5], facial blushing [6], and certain vascular disorders like Raynaud's disease [7] and reflex sympathetic dystrophy [18]. ETS is regarded as a safe and effective procedure. However, there are some instances of failure of the treatment due to incomplete thoracic sympathectomy. This is mainly caused by the INK directly connecting the sympathetic fibres from 2nd thoracic ganglion to the brachial plexus (Chung et al., 2002).

The INK was first described by Albert Kuntz in 1927, a neuro anatomist from the St. Louis University School of Medicine. He stated that the INK is an inconstant intra thoracic ramus connecting the 2nd thoracic nerve with 1st thoracic nerve. The 2nd thoracic nerve generally does not contribute to the brachial plexus. But when INK connects 2nd thoracic nerve to brachial plexus it carries sympathetic fibres from 2nd thoracic nerve to it. These fibres do not pass through sympathetic trunk (Ramsaroop et al., 2001).

When a ramus from 2nd thoracic nerve carrying sympathetic fibres joins the 1st thoracic nerve, then the brachial plexuses formed in such cases carry sympathetic fibres from T2 nerve. This kind of alternate neural pathway may not be observed during standard sympathectomy. Therefore, in order to avoid the recurrence of sympathetic activity after sympathectomy above or at the level of stellate ganglion, the surgeons should be aware of variations of INK (Reisfeld et al., 2002, Moodley et al., 2005, Singh et al., 2005, Zhang.B et al., 2009).

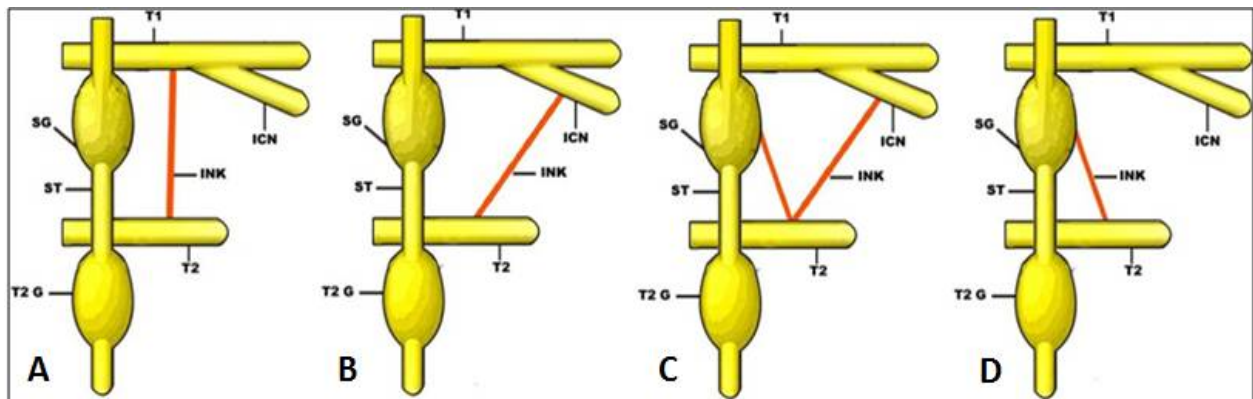
Chung et al 2002 proposed an anatomical classification of the variations of INK, which was later modified by Zaidi and Ashraf (2010). The variations of INK observed by them were categorized into four different types (Fig.5) as following:

- Nerve fibres connecting the 2nd thoracic nerve to 1st thoracic nerve were described as Type A.
- Nerve fibres connecting the 2nd thoracic nerve to 1st intercostal nerve were labelled as Type B.

c) Nerve fibres from 2nd thoracic nerve to stellate ganglion and 1st intercostal nerve were called Type C.

d) Nerve fibres from 2nd thoracic nerve to the stellate ganglion were known as Type D.

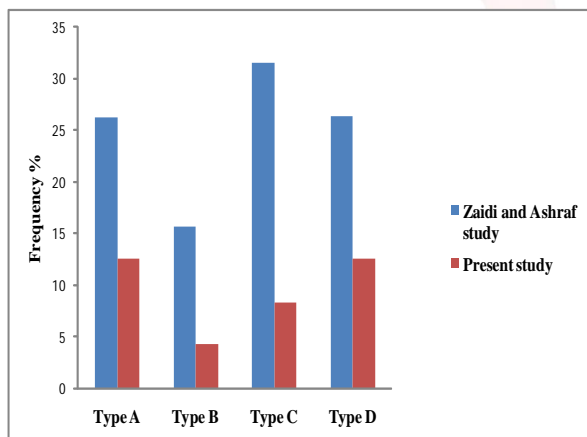
Fig. 5: Diagrammatic representation of anatomical classification of INK according to Zaidi and Ashraf (2010).



ICN –intercostal nerve, ST – sympathetic trunk, T1 – 1st thoracic nerve, SG – stellate ganglion, T2G – 2nd thoracic ganglion, T2 – 2nd thoracic nerve.

In the current study, the variations of INK observed were - type A- 12.5%, B - 4.3%, C - 8.3% and D - 12.5% (Fig.6), which was not in accordance with the study of Zaidi and Ashraf (2010). The variations observed by them were type A - 26.3%, B – 15.7%, C – 31.6% and D – 26.4%. All the four types of variation of INK were seen in the study, though the numbers of cases observed of individual type were different when compared to the study of Zaidi and Ashraf (2010). The difference between their study and the current study may be due to ethnic variation. The study groups of Zaidi and Ashraf (2010) were Saudi Arabians and the current study were South Indians.

Fig. 6: Comparison of the frequency of occurrence of INK with the study of Zaidi and Ashraf.



Search of literature revealed that the prevalence of INK was variably reported by different authors (Table-2). The prevalence of INK obtained by thoracoscopic surgeons was different from the

prevalence obtained from anatomists. The anatomic investigations report the presence of INK in up to 60 - 80% of cases [8-9, 11-12, 14, 15] , while the clinical studies describe the presence of INK in about 10 - 12% of cases [2, 13, 16].

Table 2: Comparison of variations of INK observed in the Present study with previous studies.

S. NO	Study of various Authors	No. of Specimen	Frequency of INK (%)
1	Ramsaroop et al (2001) [16]	50	92
2	Marhold F et al (2008) [14]	33	66.7
3	Zaidi and Ashraf (2010) [19]	25	66
4	Cho et al (2005) [11]	42	59.5
5	Chung et al (2002) [12]	39	57.7
6	Singh et al (2005) [9]	20	27.5
7	Present study	24	37.6

Ramsaroop et al., 2001 conducted a study on 50 fresh cadavers of South African origin. They observed that INK was present in 92% of the total number of cadavers dissected while Marhold F et al.,2008 found INK to be present in 66.7% of a total of 33 Austrian cadavers dissected by them. Zaidi & Ashraf, 2010 reported INK to be present in 66% of subjects when they conducted a study on 25 Arabic cadavers. Intra-thoracic nerve of Kuntz was found only in 37.6% cases in the present study. The difference between the

study of Ramsaroop et al., 2001 Marhold F et al., 2008; Zaidi & Ashraf, 2010 and the current study may be due to racial variation. The study group of Ramsaroop et al., 2001; Marhold F et al., 2008; Zaidi & Ashraf, 2010; consisted of South African, Austrian and Arabic cadavers respectively while the present study was conducted on South Indians (Table 2).

Intrathoracic nerve of Kuntz was seen in 59.5% cadavers out of a total of 42 cadavers dissected by Cho et al (2005) and in 57.7% cadavers out of a total of 39 cadavers dissected by Chung et al (2002). Out of 12 cadavers dissected, INK was found in 9 specimens i.e. in 37.6% of cases in the present study. Small sample size of the current study could be a possible explanation for the difference between their study and the present study (Table 2).

Singh et al., 2005 conducted a study on 20 South African cadavers and found that INK existed in 27.5% of cases only. In the present study, INK existed in 37.6% of cases. Pleural adhesions and increased fibrosis may in fact reduce the recognizability of INK was the possible explanation given by them for obtaining this low prevalence of INK (Table 2).

CONCLUSION

As the presence of INK is a potential cause for unsuccessful upper limb sympathectomy, therefore, we conclude that the data obtained by the present study would be helpful to the surgeons to successfully perform upper limb sympathectomy on South Indians.

ABBREVIATIONS:

INK - Intra thoracic Nerve of Kuntz
ETS - Endoscopic thoracic sympathectomy
T₁ - First thoracic Nerve
T₂ - Second thoracic Nerve
TG - Thoracic Ganglion
SG - Stellate Ganglion

Conflicts of Interests: None

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