



Course and Length of the Human Thoracic Duct

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Abstract

The Thoracic duct is generally accepted as the major pathway of lymphocytes enroute to the circulating blood, accounting for approximately 70 per cent of all the lymphocytes in the peripheral blood. The variations in the length and position of the Thoracic duct is great clinical importance during surgeries related to the upper abdomen, posterior mediastinum and in cervical region, but still now a detailed study had not been done in Andhra Pradesh state, it was decided to undertake this present study. Isolation of the thoracic duct and tracing the course and length were done to know more about it than already documented and thereby hoping to add more information to guide the radiologists and operating surgeons. A total number of 45 cadavers were studied, of these 15 were female and 13 were male cadavers. The material consisted of adult cadavers between the ages of 42-81 from the dissection halls of department of anatomy of 3 different medical colleges in costal Andhra Pradesh. The observations of the course, length and vertebral levels are documented in this study. The present findings showed a great variability compare the previous studies. The findings noted in the present study regarding thoracic duct had contributed to a better understanding the length, and will prove definitely useful to clinicians in their respective fields.

Keywords: Course, length, thoracic duct, variations.

Introduction

The Thoracic duct conveys the greater part of the lymph and chyle into the blood. It is the common trunk of all the lymphatic vessels of the body, excepting those on the right side of the head, neck, and thorax, and right upper extremity, the right lung, right side of the heart, and the convex surface of the liver. In the adult it varies in length from 38 to 45 cm. and extends from the second lumbar vertebra to the root of the neck. It begins in the abdomen by a triangular dilatation, the cisterna chyli, which is situated on the front of the body of the second lumbar vertebra, to the right side of and behind the aorta, by the side of the right crus of the diaphragm. It enters the thorax through the aortic hiatus of the diaphragm, and ascends through the posterior mediastinal cavity between the aorta and azygos vein. Behind it in this region are the vertebral column, the right intercostal arteries, and the hemiazygos veins as they cross to open into the azygos vein; in front of it are the diaphragm, esophagus, and pericardium, the last being separated from it by a recess of the right pleural cavity. Opposite the fifth thoracic vertebra, it inclines toward the left side, enters the superior mediastinal cavity, and ascends behind the aortic arch and the thoracic part of the left subclavian artery and between the left side of the esophagus and the left pleura, to the upper orifice of the thorax. Passing into the neck it forms an arch which rises about 3 or 4 cm. above the clavicle and crosses anterior to the subclavian artery, the vertebral artery and vein, and the thyrocervical trunk or its branches. It also passes in front of the phrenic nerve and the medial border of the Scalenus anterior, but is separated from

these two structures by the prevertebral fascia. In front of it are the left common carotid artery, vagus nerve, and internal jugular vein; it ends by opening into the angle of junction of the left subclavian vein with the left internal jugular vein¹. Throughout its length it gives a beaded appearance due to the presence of valves. The lymph in the thoracic duct often has a milky appearance because of the fine droplets of the fat as a result of the intestinal lymph².

Any variations of thoracic duct are of utmost importance to a thoracic surgeon, because of its vulnerability of damage during any surgical procedures³. The trauma to the chest by blunt objects producing fracture, fracture and dislocation of vertebra, stab wounds in the vicinity of the vertebral column may lead to rupture of the thoracic duct. Chronic inflammatory conditions like tuberculosis of lung, fungal infections, sarcoidosis and other granulomatous diseases involving the posterior mediastinal lymph nodes may cause compression of the Thoracic duct as its sequelae. The neoplasms of the thoracic viscera may by direct spread compress the thoracic duct. As a complication of rupture of the major lymphatic duct conditions like chylothorax, chylous ascites, chyluria and chylous fistula are produced, which are often fatal⁴.

With the recent advances in radio imaging techniques like ultrasonography, computerized tomographic scanning, MRI, lymphangiography and lymphoscintigraphy and also catheterization of the thoracic duct are being successfully undertaken to demonstrate the course of the thoracic duct⁵.

Thorough knowledge of the relations of the structures in the posterior mediastinum will help us to have correct interpretation of the computerized tomographic scans and magnetic resonance imaging scans.

The thoracic duct is the largest lymph channel which could be traced. Since it is at danger in number of injuries and operations in the region of the posterior mediastinum detailed study of its course and length were made. The common pattern and variations are studied in a detailed manner to help the surgeons and thereby to prevent complications.

Material and Methods

A total number of 45 cadavers were studied, of these 15 were female and 13 were male cadavers. The material consisted of adult cadavers between the ages of 42-81 from the dissection halls of Departments of Anatomy of ASRAM, Eluru, A.P. and Department of Anatomy of PIMS, Ganavaram, A.P. and Department of Anatomy of KIMS, Amalapuram, and A.P. The study was carried in the dissection halls of the above colleges.

During routine dissection of thorax, abdomen and head and neck region part of the work was done in the particular region whenever the dissection was in progress. The observations were neatly taken by 8.1 Mega pixel of Nikon camera. The findings observed regarding thoracic duct was documented in a schematic manner as for the proforma enclosed.

Results and Discussion

Observations: In the present study thoracic duct showed duplication in its course and united later. The extent of duplication varied from the height of single vertebral body to that of four or five. In 11 cadavers duplication was related to the single vertebral body (figure 1), in 10 cadavers, related to two vertebral bodies (figure 2), in 24 cadavers related to three vertebral bodies (table 1).

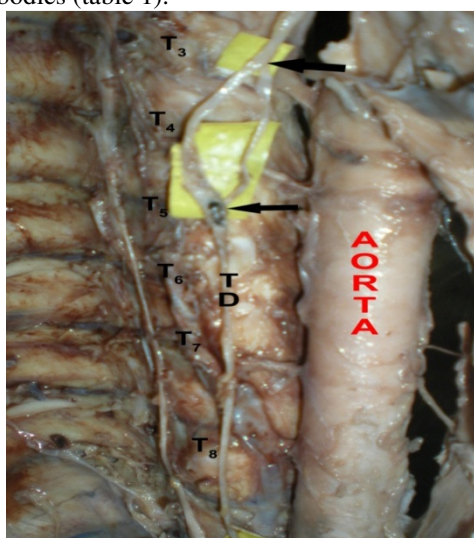


Figure-1
Extent of Duplication-Single Vertebral Level
(TD- Thoracic Duct)

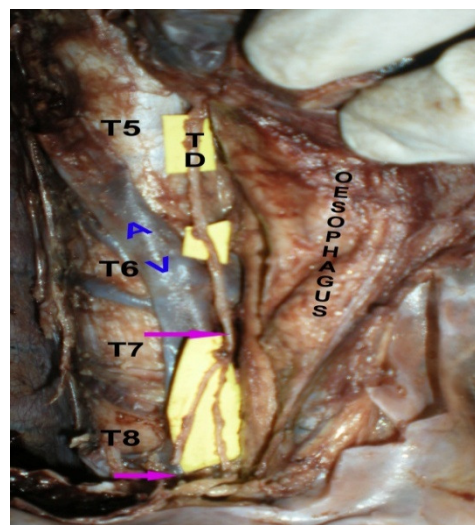


Figure- 2
Extent of Duplication-two Vertebral Level
(TD- Thoracic Duct, AV- Azygos Vein, T- Thoracic Vertebrae)

Table-1
Position of the Thoracic duct

| S. no | Extent of duplication in relation to height of vertebral body | No. of specimens |
|-------|---|------------------|
| 1 | Single vertebral body | 11 |
| 2 | Two vertebral bodies | 10 |
| 3 | Three vertebral bodies | 24 |

In one specimen from a male cadaver duplication persisted in its distal part giving rise to 2 thoracic ducts (figure 3). The data is shown in (table 2).

Table-2
Duplication of the thoracic duct in distal part

| S. No. | Specimen | No. of specimens dissected | No. specimens showing duplication | Percentage of incidence |
|--------|--------------|----------------------------|-----------------------------------|-------------------------|
| 1 | Adult male | 30 | 1 | 3.3% |
| 2 | Adult female | 15 | 0 | 0% |
| 3 | Total | 45 | 1 | 3.3% |

The obliquity present was measured in terms of the heights of the vertebral bodies. It was crossing from the 6th thoracic vertebra to the 4th thoracic vertebra in 18 cadavers (40%) (figure 4), from the 6th thoracic vertebra to the 3rd thoracic vertebra in 9 cadavers (20%) (figure 5), from 7th thoracic vertebra to 4th thoracic vertebra in 11 cadavers (24.4%) and from the 7th thoracic vertebra to the 3rd thoracic vertebra in 7 cadavers (15.5%) (figure 6, table 3).

Table-3
Crossing of the Thoracic duct – Vertebral levels

| S. No. | Crossing | | No. of cadavers | Percentage of incidence |
|--------|----------------|----------------|-----------------|-------------------------|
| | from | To | | |
| 1 | T ₆ | T ₄ | 18 | 40% |
| 2 | T ₆ | T ₃ | 9 | 20% |
| 3 | T ₇ | T ₄ | 11 | 24.4% |
| 4 | T ₇ | T ₃ | 7 | 15.5% |

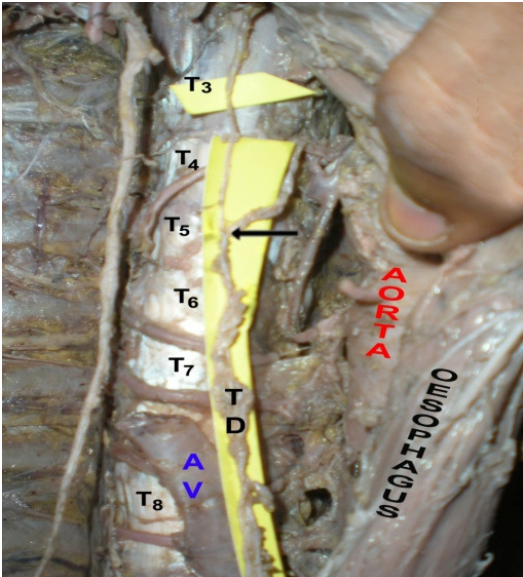


Figure-3
Two Thoracic Ducts
(TD- Thoracic DCT, AV-Azygos Vein, T-Thoracic Vertebrae)

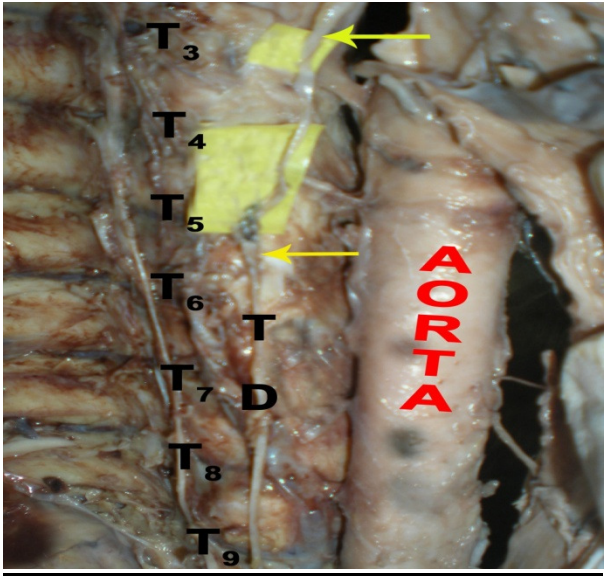


Figure-5
Crossing of the Thoracic Duct from T6 to T3 Vertebrae
TD- Thoracic Duct

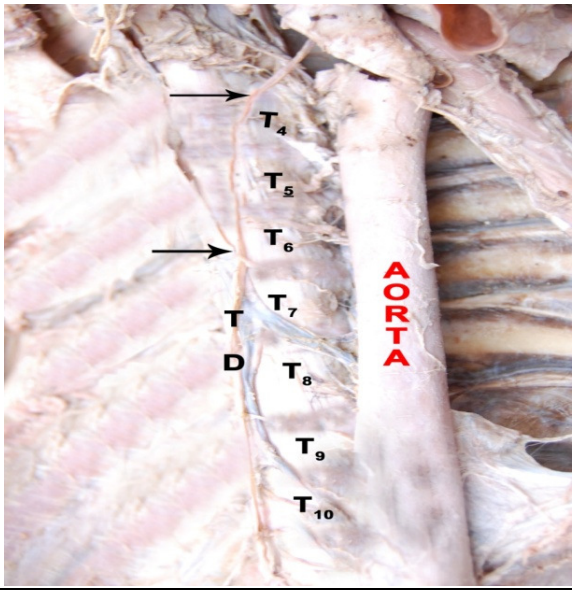


Figure- 4
Crossing of the Thoracic Duct from T6 to T4 Vertebrae
TD - Thoracic Duct, T- Thoracic Vertebrae

In the present work the length of the thoracic duct was ranging from 36 to 43 cms in the adult subjects (table 4). An attempt was made to find out the presence of any difference in length of the thoracic duct depending on the sex of the individual. In 18 out of 30 male cadavers dissected the length of the thoracic duct ranged between 35 to 40 cms, amounting to 60%. In rest of the 12 the length was ranging between 41 to 45 cms, amounting to 40%. Similarly in 12 out of 30 adult females dissected, the length was ranging between 35 to 40 cms, about 80%. In rest of the three females the length was ranging between 41 to 45 cms, amounting to 20%. The details were shown in the (table 5).

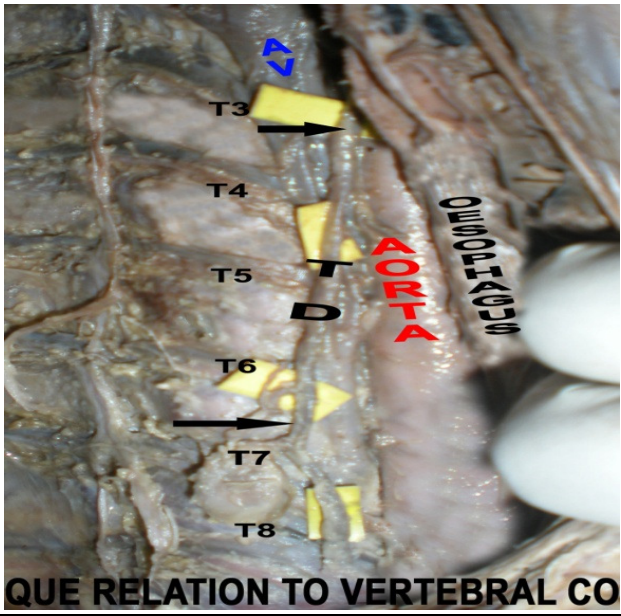


Figure- 6
Crossing of the Thoracic Duct from T7 to T3 Vertebrae
TD- Thoracic Duct, AV-Azygos Vein

Table-4
Length of the Thoracic duct

| S.No. | Specimen | Total no. of the specimens dissected | Length of the thoracic duct |
|-------|--------------|--------------------------------------|-----------------------------|
| 1 | Adult male | 30 | 38.5-43 cms |
| 2 | Adult female | 15 | 36-40cms |

In 1972, Jacobsson presented a very useful summary of the thoracic duct. An anatomical study was made on the thoracic duct in 100 autopsy cases. A thoracic duct was found in every case and always started below the diaphragm, passed through the posterior mediastinum in the thorax and opens in to the veins of neck. In 4% of the cases a branch left the thoracic part of the thoracic duct at aortic arch emptied into the veins in the right side of the neck⁶.

Table-5
Length of the thoracic duct in relation to the cadavers

| Specimen | Total no of specimens | Length of the thoracic duct in cms | Present in No. of cadavers | Percentage of incidence |
|---------------|-----------------------|------------------------------------|----------------------------|-------------------------|
| Adult males | 30 | 35-40 | 18 | 60% |
| Adult males | 30 | 41-45 | 12 | 40% |
| Adult females | 15 | 35-40 | 12 | 80% |
| Adult females | 15 | 41-45 | 3 | 20% |

In the present study duplication of the thoracic duct was observed below the crossing. The extent of duplication in relation to height of vertebral body was varying. In 24.4% extent of duplication related to the one vertebral body in 22.2% it was related to two vertebrae in 53.3% it was related to three vertebrae. No statistical data about the duplication below the crossing of the thoracic duct is available in literature except that of Hollenshead and Davis^{3,7} had observed the duplication of lower part of the thoracic duct in 27%. It was not coinciding with the present observation.

In one specimen from a male cadaver duplication persisted in its distal part giving rise to two thoracic ducts. The percentage of occurrence was 3.3%. The exact percentage of the occurrence of duplication of thoracic duct is not mentioned in many text books. This 3.3% of duplication of thoracic duct is much below the percentage quoted by Paul Van Pernis (1949), (38.7%) and it is closely related to the Jacobsson (1972) percentage (4%)^{6,8}.

The gradual mode of crossing was described by Du plessis (1975). No other statistical data about the crossing of thoracic duct available in literature except the work done by Kubik⁹ He stated that thoracic duct is taking oblique course in 17% and bowed course in 14% of 100 autopsies studied by him as (table 6). Oblique part was measured in terms of the heights of the vertebral bodies. It was crossing from the 6th vertebra to 4th thoracic vertebra in 18 specimens (40%), from 6th thoracic vertebra to 3rd thoracic vertebra in 9 specimens (20%), from 7th thoracic vertebra to 4th thoracic vertebra in 11 specimens (24.4%), and from the 7th thoracic vertebra to 3rd thoracic vertebra in 7 specimens (15.5%). (Details are shown in the table

3). It is evident from the above data that the crossing of the thoracic duct from right to left of the vertebral columns is oblique, instead being abrupt, having a short horizontal course.

Table- 6
Relation to the vertebral column

| S.No. | Relation to vertebral column | Percentage of occurrence |
|-------|------------------------------|--------------------------|
| 1 | Left side | 36% |
| 2 | Mid line | 20% |
| 3 | Oblique | 17% |
| 4 | Righ side | 6% |
| 5 | Bowed | 14% |
| 6. | Angulated | 7% |

Length of the Thoracic duct:- The Thoracic duct is a long lymphatic vessel extending from the upper abdomen to the root of neck. The length of the thoracic duct as described in standard text books is as follows (table 7) the above data of the length pertains to the adult's subjects only. In the present work the length of the thoracic duct is ranging between 36-43 cms in adult subjects. Shown in the (table 4).

An attempt was made to find out the presence of any difference in the length of thoracic duct depending on the sex of the individual. In 18 out of 30 adult males dissected the length of the thoracic duct ranged between 35-40 cms, amounting to 60%. In rest of the 12 the length was ranging between 41-45 cms, amounting to 40%. Similarly in the 12 out of 15 adult female cadavers dissected, the length was ranging between 35-40 cms, about 80%. In the rest of the 3 female cadavers the length was ranging between 41-45 cms, amounting to 20%. The details are shown in table 5.

However a difference of range of 1.5-3 cms, more in the case of males may be attributed to the difference of the stature. The variations observed in the length of the thoracic duct in the present study were within the limits mentioned in the various text books. The difference of the length as per the sex is not mentioned.

Conclusion

The thoracic duct is taken up for study in view of the multiplicity of its relations to the important neighboring viscera, its vulnerability to trauma from outside as well as due to surgery involving neighboring viscera. It is likely to be caught in the fibrous scar tissue due to chronic granulomatous infections. A thorough knowledge of its origin, course and relation to the neighboring structures is very essential to give an accurate and precise, interpretation of the latest radio imaging techniques. This study is very useful for the anatomists, radiologists, surgeons during their respective procedures.

Table-7
Length of the thoracic duct by various authors

| S.NO. | Text book | Ref. No. | Length of thoracic duct in cms |
|-------|---|----------|--------------------------------|
| 1 | Gray's Anatomy-by Henry Gray | 18 | 38-45 cms |
| 2 | Cunningh's text book of Anatomy by G.J.Romans | 54 | About 45 cms |
| 3 | Text of Anatomy of surgeons by Hollenshead | 21 | Not specified |
| 4 | Basic Anatomy nby Mfitchell and Patterson | 44 | 40-45 cms |
| 5 | Essentials os Human Anatomy by Woodburn's | 57 | 36-35 cms |
| 6 | A text book of Human Anatomy by Ranganathan | 52 | 45 cms |
| 7 | Essentials of Human Anatomy by Asim kumar Datta | 4 | 38-45 cms |
| 8 | Text book of Surgical Anatomy by Philip Thorax | 51 | 18 inches |
| 9 | Anatomy of the human body by Lockhard, Hmilton and Fyfe | 41 | About 18 inches |
| 10 | A synopsis of surgical Anatomy by D. J. Du. Plesis | 14 | 45 cms |
| 11 | Human Anatomy by S. N. Shana | 61 | 38-45 cms |
| 12 | In the present study | 45 | 36-43 cms |

References

- Ashim Kumar Datta, Essentials of Human Anatomy 3rd Edition, current book international (Kolkata, Bombay and Madras) 105, 165, (1994)
- Healy Jc. Abdomen and pelvis,; Gray's Anatomy, 39th Ed. Starndings, Edinburgh, Elsevier; 1021-1023 (2005)
- Henry Holinshed W., Anatomy for Surgeons, Reprinted in 1961(Volume-2) A Hoeber-Harper books: 193-194 and 608-610 (1961)
- Jdanov D.A., Anatomical du canal thoracique it dus princifanx colleterus lymphatigues des tromes chez.Lomme, Acta Anatomica, 37, 20-47 (1959)
- Kinnert P.K., Anatomical variations of the cervical part of the thoracic duct in man, Jour. of Anat., 115 (1973)
- Jacobsson S.I., Clinical Anatomy and Pathology of the thoracic duct, An investigation of 122 cases stocpholm; Almqvist and Wiksell (1972)
- Davis H.K., Statistical study of thoracic duct in man, American Journal of Anatomy, 17, 211-244 (1915)
- Paul A. Van Pernis, Variations of the thoracic duct, Annual of Surgery, 26, 806-809 (1949)
- Kubik St., The variations in position and form of the thoracic part of the thoracic duct, Its skeletal relations Rofo-fortschr-Geb, Rontgenstr-Nuklearmed, 122(1), 1-5 (1975)
- Du Plessis D.J., A synopsis of surgical Anatomy-11th Edition -K.M. Varghese Company, Bombay, 341-43 (1975)
- Basmajajian J.V. and Slonker C.E., Grants' method of Anatomy, 11th Edi. B.I. Waverly, New (1989)
- Gollub M.J. and Castellino and R.A., Cisterna chyli as a potential mimic of Retrocrucl lymphadenopathy on CT scan-Radiology: May, 199(2) 477-80 (1996)
- Keith L. Moore, Clinical oriented Anatomy, 3rd edition 1992- Williams and Wilkins-London, 25, 115, 237, 815-816 (2006)
- Parsons F.G. and Sargent P.W.G., Termination of thoracic duct, Lancet, I, 1173-1174 (1909)
- Shunada K. and Sato I., Morphological and Histological analysis of the thoracic duct at the jugulosubclavian junction in Japanese cadavers, Clinical Anatomy, 10, 163-172 (1997)
- Srinivas Mondam, Srikanth Babu V., Raviendra Kumar B. and Jalaja Prakash, A Comparative Study of Proprioceptive Exercises versus Conventional Training Program on Osteoarthritis of Knee, Res. J. Recent Sci., 1(12), 31-35 (2012)
- Dinkar A., Bhattacharyya S., Kumar D., Kumar A., Gupta P., Banerjee G. and Singh M., Pneumonia caused by Candida kefyri in a Pediatric patient with Acute Lymphoblastic Leukemia: Case Report, Int. Res. J. Medical Sci, 1(1), 18-19 (2013)
- Uma R. and Pravin B., Invitro Cytotoxic Activity of Marsilea Quadrifolia Linn of MCF-7 Cells of Human Breast Cancer, Int. Res. J. Medical Sci, 1(1), 10-13 (2013)
- Chakraborty Monali, An Insight into the Aetiology of Tropical Chronic Pancreatitis and Fibrocalculous Pancreatic Diabetes, Int. Res. J. Medical Sci., 1(2), 5-14 (2013)
- Naher H.S. and Ktab F.K., Bacterial Profile Associated with Appendicitis; Int. Res. J. Medical Sci., 1(2), 1-4 (2013)
- Kalaiselvan A., Gokulakrishnan K., Anand T., Akhilesh U. and Velavan S., Preventive Effect of Shorea Robusta Bark Extract against Diethylnitrosamine -Induced Hepatocellular Carcinoma in Rats, Int. Res. J. Medical Sci, 1(1), 2-9 (2013)