

Original Article

ANATOMICAL INVESTIGATIONS OF THE CISTERNA CHYLI AND X-RAY AND CT-VISUALIZATION IN THE RETROCRURAL SPACE

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Summary

The aim of this study is to describe the histological characteristics of the abdominal part of the thoracic duct (TD) wall, the variable confluence pattern of lymphatic trunks and to determine the normal appearance of the cisterna chyli (CC). TD was studied and described in 18 adult cadavers dissected in our department. Samples from the abdominal part of the TD wall were taken and prepared using the standard paraffin method. The slides were stained and studied under a light microscope. An X-Ray lymphography and CT-scan investigation were conducted on four of the cadavers after an intraluminal administration of the contrast material Omnipaque. We found some anatomical variations in forming of the cisterna chyli. The results were categorized according to the official classifications. The most common tributary configuration was a single cisterna chyli formed where the intestinal trunk opens into the TD and the right lumbar trunk, left lumbar trunk, retroaortic nodes, and branches from the intercostal lymphatics join variably. The locations of the CC in relation to the vertebral column were observed. The histological analysis shows the specific features of the abdominal portion of the TD. Knowledge of the anatomy of the thoracic duct has practical implications in thoracic surgery, radiology and anatomical dissections.

Key words: thoracic duct, cisterna chyli, lymphatic drainage, smooth muscle cells, lymphangiography

Introduction

The lymphatic system is an integral part of the cardiovascular system. It consists of two main lymphatic trunks - thoracic duct and right lymphatic duct, numerous lymphatic vessels and organs of the lymphoid system. Lumbar trunks are formed by the lymphatic vessels of the lower limbs, pelvis and its organs. The lymph of the abdominal organs converges into one or several intestinal lymphatic trunks. Lumbar, intestinal trunks and the lower intercostal lymphatic vessels unite and form cisterna chyli, with which the biggest lymphatic trunk (thoracic duct) starts. Cisterna chyli is an elongated, at times dilated lymphatic sack 3-5 cm long. It is located to the right of the aorta, behind the right diaphragmatic crus along the anterior surface of L₁₋₂ or Th₁₂.

The basic research of the histological structure of the wall of cisterna chyli is connected with the thickness of the muscular layer, the orientation of the smooth muscle cells [1, 2], the type and ultrastructure of the valves and valve-like structures [3].

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With respect to the microscopic peculiarities of cisterna chyli, the main research refers to the peculiarities of its formation and localization in regard to the bodies of the vertebra. M. Loukas and C. Wartmann [4] have conducted an anatomical investigation of the cisterna chyli in the course of which they have described different patterns of lymphatic tributaries, and have also categorized its varying location with respect to the vertebral bodies. P. Pinto [5] and S. Tamsel [6] report an unusually large cisterna chyli into the retrocrural space. M. Gollub [7] reports how cisterna chyli can be wrongly interpreted as enlarged retrocrural lymph node.

Materials and Methods

Our research focused on 18 human cadavers after their formalin fixation during the dissection course in our department of Anatomy, Histology and Cytology, University of Medicine - Pleven. After careful dissection, segments from the three different parts of the thoracic duct were taken – the abdominal, middle third, and cervical part. Specimens were fixed in formol, embedded in paraffin and stained with haematoxylin, eosin and Azan for optical microscopy. With four of the cadavers, the tributaries of the cisterna chyli and their location in relation to the vertebral level were presented in a scheme. Those cadavers were additionally examined and registered by X-Ray lymphography and CT-scan investigation.

Results

The histological analysis showed that there were differences in the thickness of the wall of the cisterna

chyli compared to the thoracic and cervical parts of the thoracic duct. The structure of the wall follows the model of all vascular channels – a tunica intima, a tunica media and a tunica adventitia. Best featured is the middle layer – tunica media. It is composed of smooth muscle cells embedded in connective tissue, which determines their course. The muscular fibers follow into longitudinal, circular and oblique direction. As a rule, the elements of the tunica media decrease and the wall gets thinner and thinner in cranial direction. The wall in the cervical part of the thoracic duct has been proved to be the thinnest – it has only circularly situated muscular fibers. Along this part of the thoracic duct valves are common. (Fig. 1 a, b)

In the four cadavers subjected to thorough schematization and visualization by X-Ray and CT-scan was seen that there was variable confluence of intestinal trunk.

In one of the cases the right lumbar trunk joined the intestinal trunk on the border of L₁-L₂ (Fig. 2 a).

In the other three cases the thoracic duct joined the intestinal trunk proximal to the cisterna chyli at level L₁-Th₁₁ (Fig. 2 b, c, d).

With four of the cadavers cisterna chyli did not show the typical bulbous dilatation but a type of an inverted Y in the area of confluence of the lumbar trunks. With three of them, in the proximal parts of the thoracic duct at the level of Th₁₂ and about 2-3 cm cranially of cisterna chyli was found local duplication of the thoracic duct (bypass) which was 2-4 cm long.

Our CT and X-ray findings were consistent with the normal anatomy as described by P. Pinto and Al. Rozenberg [8] (Fig. 3).

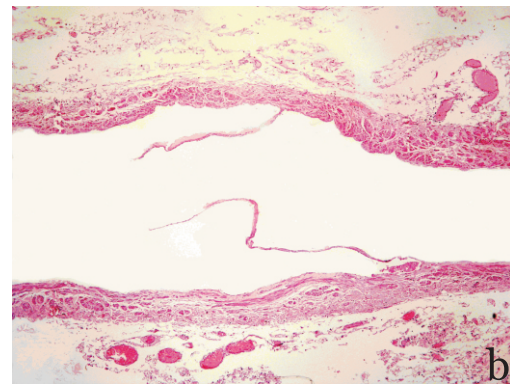
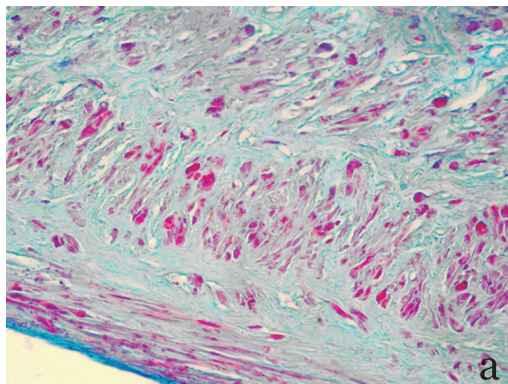


Fig.1. Optical micrographs of the abdominal (a) and cervical (b) parts of the thoracic duct, showing a notable diminution in the muscle layer in cranial direction. Note the bicuspid valve in cervical part.

Discussion

Our research presented cisterna chyli as a variable structure in regard to its form, location in the retrocrural space and different lymphatic tributaries forming the cisterna chyli. The knowledge about the most common variations of cisterna chyli and thoracic duct will prevent possible incidents during

intervention into abdomen, thorax and cervical region.

Our morphological observations correspond with the data in literature and show decrease of the thickness of the muscular layer in the wall of thoracic duct in proximal direction. Cisterna chyli and the lower two-thirds of the thoracic part of the thoracic duct are characterized by rich muscular layer and

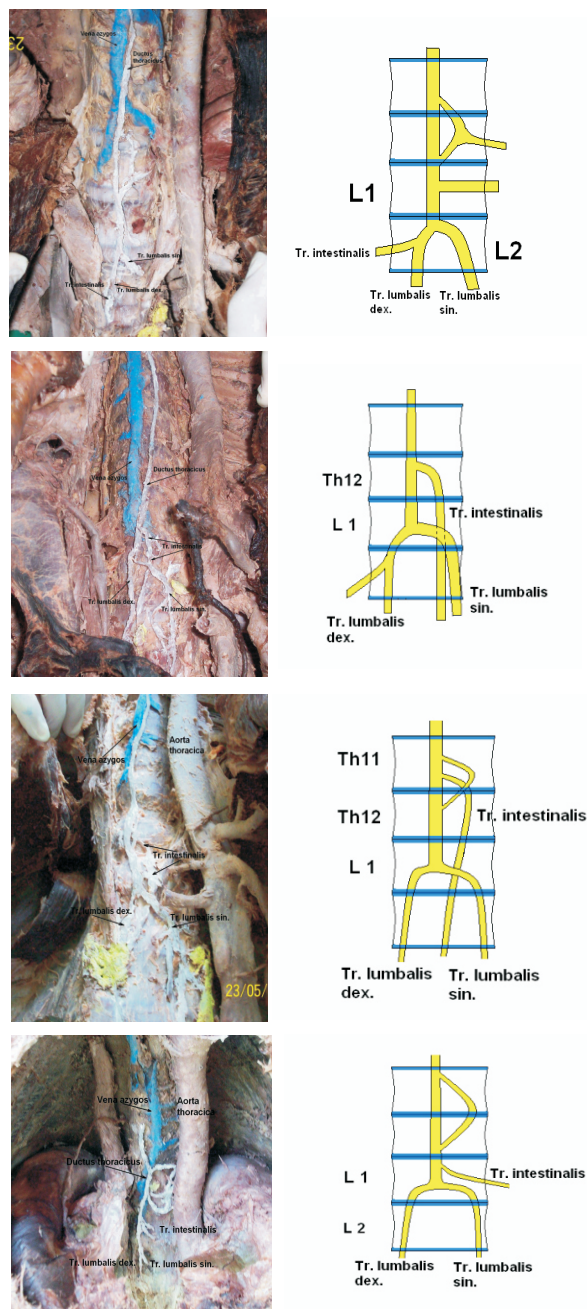


Fig 2. Photographs and schematic representation of the variable patterns of lymphatic tributaries of the cisterna chyli, a: cisterna chyli is formed by the junction of the right lumbar and intestinal trunk, b, c, d: cisterna chyli is formed where the intestinal trunk opened into the thoracic duct.

active peristaltic ability. The cervical part has a thinner muscular layer, here, the thoracic duct has flap-like structure and may also function as a valve to prevent the flow of blood from a vein. K. Shimada et al. [9] reported that a specific structure with ostial cusps regulated the continuous flow of chyli into the lacteal system.

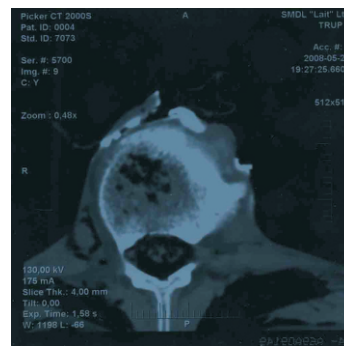


Fig 3. CT-scan in the retrocrural space showing cisterna chyli and main lymphatic tributaries

Our macroscopic findings also confirm the data in literature concerning the variability in regard to the ways of confluence of the main lymphatic tributaries forming the cisterna chyli. According to M. Loukas, who examined 120 human cadavers there are four types of variable patterns of lymphatic tributaries of the cisterna chyli:

I type- in 45% of the cases they describe the most common configuration is the one in which cisterna chyli is formed by the union of the left lumbar trunk and the intestinal trunk

II type in 30 % of the cases cisterna chyli is formed where the intestinal trunk opens into the thoracic duct while lumbar trunks, retroaortic nodes and branches from the intercostals lymphatics join variably

III type- in 20 % the cisterna chyli is formed by the junction of the right lumbar trunk and intestinal trunk.

In the remaining 5 % (IV type) variable confluence pattern of lymphatic trunks that cannot be classified, is observed. Our findings correspond to the II and III types of forming of the cisterna chyli.

In addition, M. Loukas, in order to analyze the variation of location of the cisterna chyli in respect to the vertebral column, classified the results into five types designated by letters A through E. The cisterna chyli was located at L₁-L₂ (type A), T₁₂-L₁ (type B), T₁₁-T₁₂ (type C), T₁₀-T₁₁ (type D), and T₉-T₁₀ (type E).

Conclusions

Regarding the conventional visual methods of diagnosis, the following conclusions can be drawn:

- the traditional X-ray lymphography is more informative as a method for examination of the lymphatic structure when searching the localization, way of formation of the cisterna chyli
- the CT-scan investigation is a preferred traditional method of examination where variations of the cisterna chyli and thoracic duct are looked for as well as when looking for correlation with neighboring anatomic structures, congenital pathologic dilatations and the exact measurement of their parameters.

The modern multisided and multicapturing CT scans allow reconstruction of the axial slices in

coronal and saggital dimensions which expand the range of morphological information.

References

1. Nakamura K, Yamamoto T. Morphology of smooth muscle cells in the rat thoracic duct. *Cell Tissue Res.* 1988;251:243-248.
2. Marinova D, Ivanov E. Morphology of the human thoracic duct. *Trakia Journal of sciences.* 2008; 6(2) Supp1:S122-5.
3. Bannykh S, Mironov AI. The morphology of valves and valve like structures in the canine and feline thoracic duct. *Anat Embryol.* 1995;192:265-74.
4. Loukas M, Wartmann CT, Louis RG Jr, Tubbs RS, Salter EG, Gupta AA, Curry B. Cisterna chyli: A detailed anatomic investigation. *Clin Anat.* 2007;20(6):683-8.
5. Pinto P, Sirlin C. Cisterna chyli at routine abdominal MR imaging: a normal anatomic structure in the retrocrural space. *RadioGraphics.* 2004;24:809-17.
6. Tamsel S, Ozbek S. Unusually large cisterna chyli: US and MRI findings. *Abdom Imaging.* 2006;31:719-21.
7. Gollub M, Castellino R. The cisterna chyli: A potential mimic of retrocrural lymphadenopathy on CT scans. *Radiology.* 1996;199:477-80.
8. Rosenberg A, Abrams H. Radiology of the thoracic duct. *Am J Roentgenol.* 1971;111(4):807-20.
9. Shimada K. Morphological and histological analysis of the thoracic duct at the jugulo-subclavian junction in Japanese cadavers. *Clinical anatomy.* 1997;10:163-172.