Short communication

Topographic characteristics of the lymph nodes of the anterior mediastinum by postnatal ontogenesis stages in humans

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ABSTRACT

Introduction and Aim: In the diagnosis of diseases of the thoracic cavity, it's important to assess the state of the mediastinal lymph nodes (LNs). In this study, we evaluated the detailed topographic characteristics of the anterior mediastinal LNs by postnatal ontogenesis stages in humans.

Materials and methods: Topographic characteristics of the anterior mediastinal LNs were studied on 134 cadavers of different ages; causes of death were not associated with any diseases and/or damage to the thoracic cavity and/or lymphoproliferative disorders.

Results: Anterior mediastinal LNs are a constant group of LNs. Out of all anterior mediastinal LNs the more frequently found groups are preaortic and prevascular LNs, rarer ones are LNs of the horizontal chain. LNs of the horizontal chain located on the brachiocephalic trunk were found more frequently in children compared to teens and adults.

Conclusion: In the group of preaortic LNs constant LNs are those adjoined to the ligamentum arteriosum and ascending aortic arch; in a group of prevascular LNs adjoined to vena cava superior; in the group LNs of the horizontal chain located on the left brachiocephalic vein.

Keywords: Lymph nodes, prevascular lymph nodes, preaortic lymph nodes, mediastinum, topography.

INTRODUCTION

Currently, the diagnostic and surgical methods examining the lymph nodes (LNs) of the thoracic cavity are successfully developed, and the range of surgical interventions is significantly expanded (1, 2). In the diagnosis of diseases of the thoracic cavity, it's important to assess the state of the LNs of the mediastinum. The borderline position of mediastinal LNs creates anatomical prerequisites for early metastasis of the tumor process (3).

There is a high interest to understand the topography of LNs located on the anterior surface of the superior vena cava and its inflows, as well as the aortic arch and its branches; the interest is due to the special characteristics of development and topography of these LNs in the mediastinum, which secure lymph outflow to right and left venous angles.

The anterior mediastinal LNs are only connected with LNs located on ligamentum arteriosum and with LNs at the angles of fusion of brachiocephalic. Anatomy of the anterior mediastinal LNs has only been studied on fetuses, corpses of newborns and children of early ages (4, 5, 6), as well as adult corpses without clear distinction into age groups (5, 7). Considering the above, we have conducted a more detailed study describing the detailed topographic characteristics of the anterior mediastinal LNs by postnatal ontogenesis stages in humans.

MATERIALS AND METHODS

Topographic characteristics of the anterior mediastinal LNs were studied on 134 cadavers of different ages; causes of death were not associated with any diseases and/or damage to the thoracic cavity and/or lymphoproliferative disorders. LNs were identified by the introduction of a syringe through the needle into the thickness of the periosteum and capsules of the joints of the blue mass of Gerota; macromicroscopic preparation of engorged LNs under the MBS-2 microscope; histological slides were stained with hematoxylin and eosin; clarification of total preparations in salicylic acid methyl ester; morphometry of LNs, as well as loops of lymphatic capillaries using a micrometer eyepiece. The distribution density of the LN was calculated using a millimeter grid.

RESULTS

Prevascular LNs are situated on the anterior surface of the superior vena cava and right brachiocephalic vein, as well as at the angle of fusion of brachiocephalic veins. Respective of the abovementioned anatomic structures prevascular LNs have various topographic locations (Table 1). Type of prevascular LN locations situated only at the angle of fusion of brachiocephalic veins are found in newborns, childhood, and teenage groups (from 11.1-22.2% of all cases), while LNs situated only on the anterior surface of the superior vena cava or on the right brachiocephalic vein are found in adolescent, adults, senior and elderly age groups (from 15.4-21.4%, and 7.4-13.8% of all cases). A combination of locations of LNs both at the angle of fusion of brachiocephalic veins and on the right brachiocephalic vein is found in newborns and children in 33.3-37.5% of cases, while adolescents and adults have it in 5.3-7.1% of cases. Combination of the location of prevascular LNs on both the anterior surface of the superior vena cava and right brachiocephalic vein is found in newborn, children, and teens in 25.0-33.3% of cases, but become rare in older age groups (adolescent to elderly) – 10.5-23.1% of all cases. Combination of the location of prevascular LNs situated on the anterior surface of the vena cava superior, right brachiocephalic vein, and at the angle of fusion of brachiocephalic veins is found in 18.2-22.2% of cases in 2nd childhood and teenage groups, and become rare in older age groups (13.3-16.7% of cases).

Table 1: Variants of location (%) of pre-vascular lymph nodes in people of different ages

Age periods	N	Only			Simultaneously				Total		
		On the superior vena cava	At the confluence of the brachiocephalic veins	On the right brachiocephalic vein	On the superior vena cava In the corner of the brachiocephalic veins	At the confluence of the brachiocephalic veins On the right brachiocephalic vein	On the superior vena cava and right brachiocephalic vein	On the superior vena cava At the confluence of the brachiocephalic veins On the right rachiocephalic vein	On the superior vena cava	At the confluence of the brachiocephalic veins	On the right brachiocephalic vein
Newborns	8	-	12.5	-	25.0	37.5	25.0	-	50.0	75.0	62.5
Infant	8	-	12.5	-	25.0	37.5	25.0	-	50.0	75.0	62.5
Early childhood	8	-	12.5	-	25.0	37.5	25.0	-	50.0	75.0	62.5
First childhood	9	-	11.1	-	22.2	33.3	33.3	-	55.5	66.6	66.6
Second childhood	11	-	18.2	-	18.2	18.2	27.3	18.2	63.7	72.8	63.7
Teen	9	-	22.2	-	22.2	-	33.3	22.2	77.7	66.6	55.5
Adolescence	13	15.4	-	7.7	30.8	7.7	23.1	15.4	84.7	53.9	53.9
Adults of 1st age group	18	16.7	-	11.1	33.3	5.5	16.7	16.7	83.4	55.5	50.0
Adults of 2nd age group	19	21.1	-	10.5	36.8	5.3	10.5	15.8	84.2	57.9	42.1
Senior	15	20.0	-	13.3	33.3	6.7	13.3	13.3	80.0	53.3	46.6
Elderly	14	21.4	-	7.1	35.7	7.1	14.3	14.3	85.7	57.1	42.8

Overall, the frequency of prevascular LNs located on the anterior surface of the superior vena cava is found to be 50.0-63.7% in newborn and childhood age groups, up to 77.7%-85.7% in teen, adolescent, and adult age groups. On the contrary, the frequency of prevascular LNs located at the angle of fusion of brachiocephalic veins is lower - 75.0%-66.6% in newborn, children, and teenage groups, and 53.3%-57.8% in adolescents and adults. Similarly, there is a lower frequency of prevascular LNs on the right

brachiocephalic vein: 62.5-66.6% in newborns and children, and 42.8-55.5% in teens, adolescents, and adults.

Preaortic LNs are a continuous chain of nodes located on the anterior and lateral surface of the ligamentum arteriosum, on anterio-lateral and lateral surfaces of ascending aortic arch, on the anterior surface of the left carotid artery, and subclavian artery, as well as lie in between these arteries. Preaortic LNs located on the ascending aortic arch are adjoined to the left vagus and phrenic nerves, while preaortic LNs located on the anterior surface of the left carotid and subclavian artery are adjoined to the posterior surface of the left brachiocephalic vein.

Our study found three variants of the topographic location of preaortic LNs respective to the abovementioned anatomic structures (Table 2). A variant of the location of preaortic LNs on the ligamentum arteriosum, ascending aortic arch, left carotid artery, and in space between the left carotid and subclavian artery is found in newborns and children in a nearly similar number of cases – 42.8% and 46.2%. In teenage and adolescent groups, as well as adult and age groups up to the elderly this variant was found in 50.0-51.7% of cases. A variant of the location of preaortic LNs on the ligamentum arteriosum, ascending aortic arch, in space between the left carotid and subclavian artery, and left subclavian artery was found in 42.8% of cases in newborns, 33.3-30.0% in childhood and teenage groups. In the adolescent, adult, senior and elderly groups this variant was rarer – 26.6%-28.6% of cases. A variant of the location of preaortic LNs on the ligamentum arteriosum, ascending aortic arch, left carotid artery, and left subclavian artery was similar between different age groups in 20.0-28.6% of cases.

Our study estimated that location of preaortic LNs on the ligamentum arteriosum and ascending aortic arch is found in 100% of cases in all stages of postnatal ontogenesis, while a variant of the location of preaortic LNs on the left carotid artery and in space between the left carotid and subclavian artery is found in 60.0%-85.7% of cases, and a variant of the location of preaortic LNs on the left subclavian artery is found in 42.8%-71.4% of cases.

Table 2: Variants of location (%) of preaortic lymph nodes in people of different ages

Age periods	N	Simultaneously			Total				
		On the arterial ligament, ascending aortic arch, left common carotid artery between the left common carotid and left subclavian arteries	**On the arterial ligament, ascending aortic arch between the left common carotid and left subclavian arteries and the left subclavian artery**	**On the arterial ligament, ascending aortic arch, left common carotid artery and left subclavian artery**	**Arterial ligament**	**Ascen-ding aortic arch**	**Left common carotid artery**	**Between the left common carotid and left subclavian arteries**	**Left subclavian artery**
Newborns	7	42.8	42.8	28.6	100	100	71.4	85.6	71.4
Infant	9	44.4	33.3	22.2	100	100	66.6	77.7	55.5
Early childhood	9	44.4	33.3	22.2	100	100	66.6	77.7	55.5
First childhood	10	40.0	40.0	20.0	100	100	60.0	80.0	60.0
Second childhood	13	46.2	30.8	23.1	100	100	69.2	76.9	53.8
Teen	10	50.0	30,0	20.0	100	100	70.0	80.0	50.0
Adolescence	14	50,0	28.6	21.4	100	100	71.4	78.6	50.0
Adults of 1st age group	18	50.0	27.7	22.2	100	100	72.7	77.7	50.0
Adults of 2nd age group	19	52.6	26.3	21.1	100	100	73.7	78.9	47.4
Senior	15	53.3	26.6	20.0	100	100	73.3	80.0	46.6
Elderly	14	57.1	28.6	14.3	100	100	71.4	85.7	42.8

Table 3: Variants of location (%) of the lymph nodes of the horizontal chain in people of different ages

Age periods	N	Only		Simultaneously			Total		
		Left brachio-cephalic vein	Between the brachio-cephalic trunk and the left common carotid artery	Brachio-cephalic trunk	Left brachio-cephalic vein and on the brachio-cephalic trunk	Left brachio-cephalic veins between the brachio-cephalic trunk and the left common carotid artery	Left brachio-cephalic vein	Between the brachio-cephalic trunk and the left common carotid artery	Brachio-cephalic trunk
Newborns	4	25.0	25.2	-	50.0	-	750	25.0	50.0
Infant	5	20.0	20.0	-	40.0	20.0	80.0	40.0	40.0
Early childhood	5	20.0	20.0	-	40.0	20.0	80.0	40.0	40.0
First childhood	5	20.0	20.0	-	40.2	20.0	80.0	40.0	40.0
Second childhood	7	14.3	14.3	-	42.8	28.6	85.7	42.8	42.8
Teen	7	14.3	14.3	-	28.6	42.8	85.7	57.1	28.6
Adolescence	10	20.0	200	10.0	10.0	40.0	70.0	60.0	20.0
Adults of 1st age group	14	14.3	21.4	7.1	14.3	42.8	71.4	64.3	21.4
Adults of 2nd age group	15	20.0	20.0	13.3	6.7	40.0	66.6	60.0	20.0
Senior	11	18.2	27.3	9.1	9.1	36.4	63.7	63.7	18.2
Elderly	11	18.2	27.3	9.1	9.1	36.4	63.7	63.7	18.2

LNs of the horizontal chain are located on the anterior, upper, and inferior surface of the left brachiocephalic vein: on the anterior-upper surface of the brachiocephalic trunk and in the space between the brachiocephalic trunk and left carotid artery (Table 3). A variant of the location of LNs of the horizontal chain adjoined to the left brachiocephalic vein only is found in newborns, children, and teenage groups in a similar number of cases (14.3-25.0%), and in adults (14.3-20.0%).

A variant of the location of LNs of the horizontal chain in the space between the brachiocephalic trunk and left carotid artery was found to be rarer in newborn, children, and teenage groups (14.3-25.0%) compared to adults (20.0-27.7% of cases).

A variant of the location of LNs of the horizontal chain adjoined to the brachiocephalic trunk was found only in adults in very rare cases (7.1-13.3%). Combined location of LNs of the horizontal chain simultaneously on the left brachiocephalic vein and on the brachiocephalic trunk was found in newborn and children age groups in 40.0-50.0% of cases, while it was rare in teens and adults – 28.0 to 9.1 of cases. On the contrary, a variant of the combined location of LNs of the horizontal chain simultaneously on the left brachiocephalic vein and in the space between the brachiocephalic trunk and left carotid artery was found to be rarer in childhood age groups (20.0-28.8% of cases) compared to teen, adolescent and adult age groups (36.4-42.8% of cases).

Overall, our study estimated that LNs of the horizontal chain located on the left brachiocephalic vein are found in newborn, children, and teenage groups most frequently (80.0-85.7% of cases) compared to adolescents and adults (63.7-71.4% of cases).

LNs of the horizontal chain located in the space between the brachiocephalic trunk and left carotid artery was found to be rarer in newborns and children (25.0-42.8% of cases) compared to teens, adolescents, and adults (57.1 -64.3% of cases). LNs of the horizontal chain located on the brachiocephalic trunk were found more frequently in children (40.0-42.8% of cases) compared to teens and adults (18.2-28.6% of cases).

DISCUSSION

Anterior mediastinal LNs consist of LNs situated on the anterior surface of vessels at the basis cordis. They are furthermore classified into three groups: prevascular, and preaortic LNs of the horizontal chain (4, 5, 8).

Among the numerous anterior mediastinal LNs, the LNs of its anterior part occupy a borderline position and are primarily involved in the pathological process with specific and non-specific lesions of the thoracic cavity (2,3). We found that the lymphatic anterior mediastinum (pre-venous, preaortocarotid LNs, and

lymphatic horizontal chains) occupy a different position in relation to the anatomical formations of the mediastinum, which apparently causes the ambiguity of their definition in the existing literature, especially clinical (9). A detailed anatomical study of the topography of the anterior mediastinal LNs makes it possible to clarify the topography of these nodes and changes in their position during the postnatal period of human development.

CONCLUSION

Anterior mediastinal LNs are a constant group of LNs. Out of all anterior mediastinal LNs the more frequently found groups are preaortic and prevascular LNs, rarer ones are LNs of the horizontal chain. In the group of preaortic LNs constant LNs are those adjoined to the ligamentum arteriosum and ascending aortic arch; in a group of prevascular LNs adjoined to vena cava superior; in the LN groups of the horizontal chain located on the left brachiocephalic vein.

CONFLICT OF INTEREST

Authors have no conflict of interest to declare.

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