Clinical implication of vascular and dimensional aspects of the cricothyroid space in the Turkish population

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ABSTRACT

Objectives: Cricothyroid space (CS) is one of the thinnest part in the framework of the larynx. The close relations of CS to the intralaryngeal subglottic area increase its anatomical importance. The aim of this study was to establish topographic distribution and the number of perforating vessels lying towards the intralaryngeal subglottic region and finding the calibrations of these vessels, thus revealing an index for the Turkish population.

Methods: In this study, 5 women and 45 men autopsy materials that had no pathology or previous surgery in the area were examined during the period February to November 2003. All specimens in this study were selected randomly from the criminal lab of the Republic of Turkey Ministry of Justice, Istanbul, Turkey. Microdissections were made by SMZ 10 Stereomicroscope. Superficial vascular structures of the membrane cricothyroidea at CS and their crossing places (foramens) to the intralaryngeal area, their numbers and localizations in relation to the midline (right/left and cranial/caudal) and their diameters were established.

Results: In the larynx dissections, which were made in 50 cases, a total of 180 vessels were seen. Seventy-eight vessels were situated on the middle line (cranial and caudal). Fifty-three vessels were at right side (cranial and caudal) and 49 vessels were at left side (cranial and caudal). In 20 specimens 2-4 vessels arrangement were passing through the foramen to the intralaryngeal subglottic area. Among these foramens, 20 of them consisted of 2 vessels (16 cranial, 4 caudal), 4 of 3 vessels (3 cranial, 1 caudal) and only one foramen was consist of 4 vessels (cranial).

Conclusion: The cricothyroid area is an anatomical compartment enclosed by a connective tissue membrane and connected to the adjacent laryngeal region by vessels. This region is important with regard to surgical procedures, spread of laryngeal cancer and traumatic lesions of the larynx. Therefore, the clinical and surgical importance of vascular anatomy and the dimension of the cricothyroid space should be given emphasis in our population.

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The cricothyroid space is a region between the inferior margin of the thyroid cartilage and the superior border of the cricoid arch. This place is covered by the cricothyroid membrane.[1-8] The strong medial portion, which is made from fibroelastic fibers has been termed the ligamentum cricothyroideum medianum.[1-3] To understand the anatomical structures of this space and its topography are of valuable importance with regard to surgical procedures, cricothyroidotomy and the spread of laryngeal cancers.[1,3,4-19] But extensive studies on determination of anatomical structures and limits of the cricothyroid space, numerical and metric characteristics of vascular structures, and

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Figure 1 - Photography of the cricothyroid space showing topographic regions. I-III: Middle line; II-IV: Horizontal (transverse) line. I–II-IV: Superior (cranial) half; II-III-IV: Inferior (caudal) half. a: cranial right; b: cranial left; c: caudal right; d: caudal left.

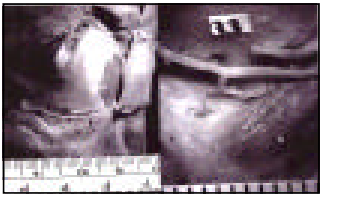

Figure 2 - Arch of the ramus (arteria) cricothyroideus (large arrows) in the cricothyroid space. The perforating vessels (small arrows). a, b: Musculus cricothyroideus.

Table 1 - Dimension of the cricothyroid space (cricothyroid membrane).

Authors	Year	Population	Vertical Diameter (mm)	Horizontal Diameter (mm)
Caparosa and Zabatsky[21]	1957	American population	5 - 12	-
Safar and Penninckx[4]	1967	American population	7 - 12	-
Greisz H et al[22]	1982	Swedish population	9	-
Kress and Balasubramaniam[6]	1982	American population	10	22
Feinberg and Peterson[2]	1987	American population	9	30
Reidenbach and Schmidt[12]	1995	German population	-	7.7 - 13
Dover K et al[15]	1996	American population	10.4	8.2
Bennett JDC et al[14]	1996	American population	8 - 19	9 - 19
Ortug G et al[present study]	2004	Turkish population	3 - 10	6 - 18

their topographic relations are few and inadequate. The classic anatomical textbooks, can give only basic knowledge about this region.[19, 20]

In the present study, carried out on the Turkish population, the dimensions of the cricothyroid space and its vascular structure have been investigated due to its clinical importance. The main goal of this present study was to establish the topographic distribution and numbers of perforating vessels lying towards the intralaryngeal subglottic region (their regional localizations) and finding the calibrations of these vessels, thus revealing an index for this population.

Methods. We examined autopsy materials from 5 females and 45 males who had no previous surgical procedures in the laryngeal area. Micro dissections were made by a SMZ 10 Stereomicroscope (Nikon, Japan). Forty six of these specimens were aged between 19-80 years. Three of the specimens were aged 18 years and the last was a 32-day-old baby. Vertical and horizontal measurements of the cricothyroid space were made. The vertical height of the membrane was the distance between the superior border of the cricoid cartilage and the inferior border of the thyroid cartilage in the midline. The horizontal diameter was the maximal width between the cricothyroid muscles. The number and diameter of the perforating vessels were determined. The entrance points (foramens) of perforating vessels (arteries and veins) to the intralaryngeal subglottic region were established according to the midline (right/left) and according to the horizontal line (cranial/caudal). The images and measurements were transferred onto the prepared pattern forms according to suggestions found in literature (**Figure 1**).

Results. The horizontal diameter of the cricothyroid space ranged from 6 - 18 mm, and the vertical diameter from 3 - 10 mm (**Table 1**). A highly dense vascular network was noticeable in some specimens (**Figures 2 - 6**). The vessels in the cricothyroid space were seen to belong to the

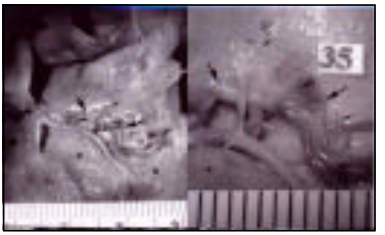

Figure 3 - The high dense network of the vessels in the cricothyroid space. Ramus (arteria) cricothyroideus (large arrows) and the perforating vessels with different calibrations (small arrows) are shown. a, b: Musculus cricothyroideus.

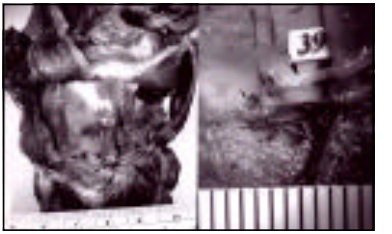

Figure 6 - The vessels lying in the cricothyroid space (large arrows) and branched perforating vessels with large calibration (small arrows). a: Musculus cricothyroideus.

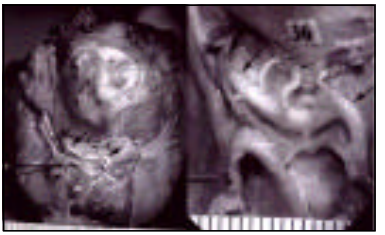

Figure 4 - The arch of the large calibration ramus (arteria) cricothyroideus (large arrows) and the symmetrical branched perforating vessels (small arrows). a: Musculus cricothyroideus.

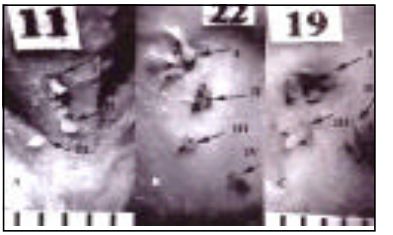

Figure 7 - Arrangement of the perforating vessels lying toward to the intralaryngeal subglottic region. A: A foramen with 3 vessels (I) and a foramen with 1 vessel (II, III), B: Four foramen with either 3 (I), 2 (II) or 1 (III, IV) vessels, C: Three foramen with either 4 (I), 3 (II) or 1 (III) vessels. Arrows indicate the vessels in the foramen.

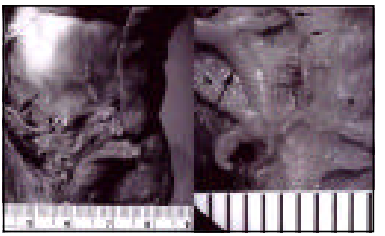

Figure 5 - The combination of the vessels in the cricothyroid space. Ramus (arteria) cricothyroideus (large arrows) and perforating vessels lying towards to the subglottic intralaryngeal region (small arrows).

Table 2 - Number and topographic localization of perforating vessels on the cricothyroid membrane.

Specimen (n=50)	Perforating vessels (N=180)			
	Located on right region	Located on the middle line	Located on left region	Total
Cranial	29	68	27	124
Caudal	24	10	22	56
Diameter rang (mm)	0.2-1.3	0.2-1.5	0.2-1.5	

superior thyroid arteries and the accompanying veins. There were rich anastomoses between the vessels of the 2 sides. We also observed in some cases, vessels with perforator of large calibration branching from the ramus cricothyroideus arch, symmetrically lying towards the intralaryngeal subglottic region (**Figure 4**). Some of these vessels were passing toward this region by 2, 3 or 4 coming together through the same foramen (**Figure 7**).

In the rhomboid-shaped cricothyroid spaces of 50 specimens, 180 perforating vessels were observed midline or on both sides (right and left) of ligamentum cricothyroideum medianum and lying towards the intralaryngeal subglottic area (**Table 2**). One hundred and twenty-four of them were situated in the superior (cranial) rhomboid half (69%), 56 of them in the inferior (caudal) half (31%). Perforating vessels were mostly in the midline (78 vessels, 43%), 68 (87%) of them in the superior (cranial) half of the midline, 10 (13%) of them in the inferior (caudal) half. The diameters of these vessels were measured as 0.2-1.5 mm. The number of vessels of superior and inferior halves and the right and left sides of the cricothyroid space were similar. Fifty-three vessels were situated on the right side (29%) (29 cranial, 24 caudal). Their diameters ranged between 0.2 - 1.3 mm, 49 perforating vessels (27%) (27 cranial, 22 caudal) were observed at the left side of the midline with a diameter 0.2-1.5 mm (**Table 2**).

Discussion. Many researchers have agreed that the dimensions of cricothyroid space and its vascular structure play an important role both in surgical procedures and in the spread of laryngeal cancer.[1,3,6,9,10,14,17,21,22] This may be partly due to the following: 1) high risk of tumor invasion due to their highly rich vascularization, 2) openings of the perforating vessels to the intralaryngeal subglottic region, 3) high incidence of voice changes and stenosis following cricothyroidotomy, 4) topography and 5) clinical implications of the cricothyroid space.[16]

The concavity between the inferior margin of the thyroid cartilage and the superior border of the cricoid arch has been termed the cricothyroid space.[5,14,16] Caparosa et al[21] described this area as rhomboid-shaped space, Sato et al[18] as a triangular space. The particular shape of the space acquired is influenced by the thyroid cartilage morphology and its inferior border structure. In our specimens, we usually observed a rhomboid-shaped space.

The thyroid and the cricoid cartilages are connected by the cricothyroid membrane and its thickened medial portion, which is the median cricothyroid ligament.[16,19] Different measurements were given of the dimensions of the cricothyroid space. Dover et al[15] reported vertical diameter as 10.4 mm and horizontal diameters as 8.2 mm. Bennet et al,[14] however, reported vertical diameter as 8 - 19 mm and horizontal diameters as 9 - 19 mm. While Kress and Balasubramaniam[6] found the vertical diameter to be 10 mm and the horizontal diameter to be 22 mm, Feinberg and Peterson[2] reported 9 mm as vertical diameter and 30 mm as horizontal diameter. At the same time, some researchers gave information on only one diameter, vertical or horizontal. Caparosa and Zabatsky[21] measured vertical diameter as 5 - 12 mm, Safar et al[4] 7 - 12 mm and Greisz et al[22] at 9 mm. Reidenbach[12] found the horizontal diameter to be 7.7 - 13 mm. As seen in **Table 1**, different authors have found the dimensions of the cricothyroid space to be very similar. An exception was the paper by Feinberg and Peterson[2] who noted a horizontal diameter of 30 mm. In our study, we measured vertical diameters of the cricothyroid space in adults as 3 - 10 mm, horizontal diameters as 6 - 18 mm.

From the point of view of both emergency surgical procedures and the spread of intralaryngeal cancers, knowledge of the anatomy of the cricothyroid space and its components is inadequate.[1,7,10,15-18] Also, in classic anatomical textbooks, material on this subject fails to illustrate it. Other studies showed that there is no extensive index study examining numbers of perforating vessels, their calibrations and their localizations according to the cricothyroid membrane in the cricothyroid space, which is one of the weakest regions of the laryngeal framework.[1] They maintain that perforating vessels communicating between extra and intralaryngeal subglottic regions are very important for the spread pathways of intralaryngeal cancers.[1,7,13,14,16,18] The intralaryngeal cancers may spread from the cricothyroid space to other parts of the larynx by lymphatic, vascular permeation or by perineural spread.[7,18,23] In surgical manner, supracricoid partial laryngectomy is recently an alternative to total laryngectomy to obtain satisfactory result in selected cases to improved quality of life.[24] Goumas et al[17] have given very little information on the structure of cricothyroid space and perforating vessels. According to them, 30.8% of perforating vessels are located on the midline or maximum of 1 mm distance to the

midline. In our study, it was seen that perforating vessels were dense (69%) on the midline and in the superior half of the cricothyroid space. Therefore, some researchers reported that inferior half of the cricothyroid space is convenient for the surgical procedures, due to the highly dense vascular network in the superior half of cricothyroid space.[10,14,16,19] Goumas et al[17] also found that vessels greater than 2 mm were located on the midline at 10.2%. Our observation regarding the low incidence of great diameter vessels in the Turkish population is important. According to Goumas et al[17] the incidence of vascular network with a small diameter in this area was 25%. The intralaryngeal cancers may spread from the cricothyroid space to other parts of the larynx by lymphatic, vascular permeation or by perineural spread.[7,18,23] This incidence was 12% in our study but dimensions of the vessel of our specimens were relatively greater than Goumas's[17] specimens. Some investigators mentioned that there was only ramus (arteria) cricothyroideus as main vessel in this area and this vessel had importance in surgical procedures.[4,10,11,14,16,19] Other notable observation was a couple of vessels entering together from the same opening to the intralaryngeal subglottic area. In 20 of 50 specimens 2 vessels, in 4 of them 3 vessels and in one of them 4 vessels were passing through the same opening. Twenty of a total of 25 foramens were located in the superior half of the membrana cricothyroidea and 5 of them were in the inferior half. We have not seen similar findings in any other studies.

In conclusion, in Turkish population the incidence of vessels with great diameter in the cricothyroid space was relatively low. On the other hand, dense vascular networks and a lot of perforating vessels lying towards the intralaryngeal subglottic area were observed on and around the ligamentum cricothyroideum medianum, which covered part of the cricothyroid space. Knowing this vascular topography of the cricothyroid space is essential for understanding the invasion of the framework of laryngeal cancers and for surgical procedures.

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