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The importance of the cricoid cartilage as an anatomic land mark of cervical level

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Abstract

Background We aimed to evaluate the correlation of the changes radiologically in the vertebral level of the cricoid cartilage according to age and gender to reduce the application difficulties and complication rates in cervical region nerve blockades and surgeries.

Results The mean age of all patients included in the study was 56.06 ± 17.22 years. We observed that while the line drawn from the cricoid cartilage to the vertebral column level passed over the C6 transverse process in women, it was below the C6 transverse process in men. A significant difference was also observed between the vertebral corpus level according to gender ($p < 0.001$). We could not find a significant difference between the transverse process and corpus level according to age.

Conclusions We found a significant difference according to gender in the correlation of the cervical vertebra transverse process and corpus with the cricoid cartilage line which are two important levels frequently used in clinical practice to ensure successful and non-complicated blockage.

Keywords Cricoid, Computed tomography, Stellate ganglion

Background

Knowing the superficial landmarks on the neck and the corresponding cervical spinal levels is important for the physical examination, anterior cervical spinal surgeries, and the correct application of nerve blockades applied from the anterior cervical region (Ko et al. 2018; Siribum-rungwong et al. 2018; An et al. 2016).

Stellate ganglion blockade, which is one of the sympathetic blocks, is one of the most frequently applied cervical region blocks for head, neck pain, and upper

extremity vascular, neuropathic, and sympathetically mediated pain (Park et al. 2006). The stellate ganglion is located at the cervical 7 (C7)–thoracic 1 (Th1) vertebra level. Because of the course of the cervical artery anterior to the transverse process of the C7 vertebra, stellate ganglion blockade is often performed at the cervical 6 (C6) level. In addition to the application accompanied by ultrasonography and fluoroscopy, the blind technique can be used in practice in many clinics due to reasons such as device cost, education, and radiation exposure. The most commonly used classical blind technique is the determination of the localization of the C6 transverse process by the anterior paratracheal palpation method (Janik et al. 2008; Raj 1996). In the neutral supine position, the cricoid cartilage is the anatomical landmark used to determine the C6 vertebral level (Agur 1991).

In the procedures applied in anterior cervical spine surgeries such as cervical disc herniation surgery with an anterior approach, the cervical vertebral corpus level, where the cricoid cartilage passes, is used to determine the skin incision level in the anterior approach. This level

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is referred to as the C6 vertebral body (Hoppenfeld et al. 2003).

Current studies about cricoid cartilage levels in the literature have some limitations. Studies show that the cricoid cartilage level, which is frequently used to determine the level in surgical procedures or nerve blockades, is affected by factors such as neck movements and obesity, causing changes in the localization (Cha et al. 2002; Jung et al. 2011).

In this study, we aimed to evaluate the changes in the vertebral level of the cricoid cartilage with age and gender that were evaluated radiologically to reduce the application difficulties and complications.

Methods

This study was conducted by the principles of the Declaration of Helsinki, after approval from the hospital ethics committee. We retrospectively analyzed 170 patients whose cervical computerized tomography (CT) records were registered in the hospital patient record system between 01 January 2019 and 01 January 2021.

Inclusion criteria

Patients over 18 years of age were included in the study, whose cervical CT scans were taken while maintaining the neutral position of the head and neck and lying in the supine position with the lower and upper extremities extended horizontally on a flat surface so that there is no difference in height between the head and the trunk.

Exclusion criteria

The suitability of cervical CTs was evaluated by an experienced radiologist. Patients who were not suitable for evaluation due to incorrect patient positions or artifacts during the CT scan were excluded from the study. Patients who had cervical spine surgery and had cervical fractures or deformities were excluded from the study.

Determinations of the lines and groups

To determine the cervical vertebral level, where the cricoid cartilage is the landmark in cervical CT, a line was drawn parallel to the cricoid cartilage and perpendicular to the cervical column, and the levels at which it intersects with the cervical column were determined.

To evaluate the relationship with the vertebral transverse process, the distance of the line drawn from the cricoid cartilage to the endpoints of the transverse processes was measured and recorded. The recorded data were divided into 3 levels (above C6, C6, and below C6) to determine their relationship with the transverse process of the C6 vertebra, which is expected to coincide with the cricoid cartilage.

To evaluate the relationship with the vertebral body, the vertebral corpus level where the line drawn from the cricoid cartilage to the cervical column passes, was recorded. To determine the relationship with the vertebral body, the recorded data were divided into 4 levels as vertebral body upper 1/3, vertebral body middle 1/3, vertebral body lower 1/3, and intervertebral space.

To determine the correlation between age and the vertebral level where the line drawn from the cricoid cartilage passes, the patients were divided into the 1st group aged 64 years and older, and the 2nd group aged 65 and over. The ages, genders, and vertebral levels of the patients were recorded where the line drawn from the cricoid cartilage passed.

Statistical analyses

The sample size of the study was made using the G-Power package program (version 3.1.9.4, Universitat Düsseldorf, Germany). When the Type-I error rate was determined as $\alpha=0.05$, it was understood that a total of 126 people would be sufficient to detect a small to medium effect size (Cohen's $w=0.2$) with 80% statistical power.

Statistical analysis of the study was performed using the SPSS 26.0 (IBM, Arizona, USA) program. In the study, continuous variables were expressed as mean \pm standard deviation as descriptive statistics, and categorical variables were expressed as frequency and related percentage values. The chi-square test was used for intergroup comparisons of categorical variables. Statistical significance was accepted as $p < 0.05$.

Results

A total of 286 patients' radiological images were evaluated. After exclusion criteria were applied and 116 radiological images were decided as not suitable by the radiologist, remained 170 patients were included in the study (Fig. 1). Demographic data of the study population is summarized in Table 1.

When the patients were grouped according to their age, there were 110 (64.7%) patients aged 64 and below, while a total of 60 (35.3%) patients aged 65 and over. Of the patients in group 1, 66 (60%) were male and 44 (40%) were female. Of the patients in group 2, 36 (60%) were male and 24 (40%) were female. There was no statistical difference between the two groups in terms of gender ($p=0.347$).

When the relationship between the line was drawn from the cricoid cartilage to the vertebral column and the transverse process of the C6, it was found that this line passed under the C6 transverse process in 95 (55.9%) patients. In this patient group, the mean distance to the C6 transverse process was 4.33 ± 3.45 mm, and the mean

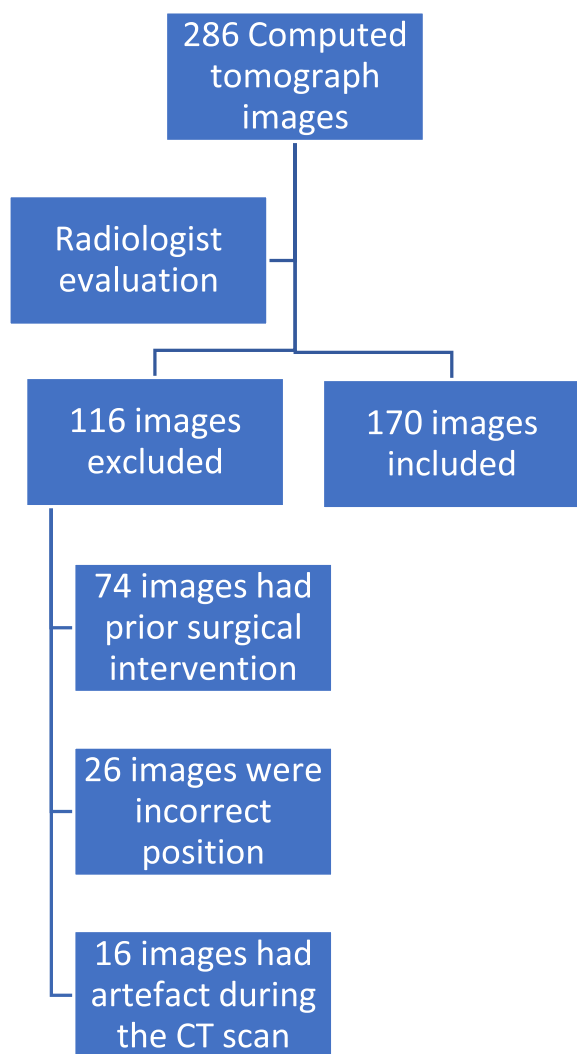


Fig. 1 Flowchart of the study

Table 1 Levels of the transverse process of the cervical vertebra, where the line drawn from the cricoid cartilage passes

	All patients	Female	Male
Number of patients	170	68 (40%)	102 (60%)
Mean age	56.06 ± 17.22	57.65 ± 16.91	55.01 ± 17.42

Table 2 Cervical transverse process level where the line drawn from the cricoid cartilage passes and its distribution by gender

Cervical vertebral level	n (%)	Distance between cricoid line and transverse protrusions (mm)	Distance between transverse protrusions (mm)
C5–C6	58 (34.1%)	5.27 ± 3.5	10.70 ± 2.05
C6	17 (10%)		
C6–C7	95 (55.9%)	4.33 ± 3.45	10.04 ± 2.21

distance between the C6 and C7 transverse processes was 10.04 ± 2.21 mm.

In the subgroup analysis for the below C6 group, it was found that 62 (65.2%) of 95 patients included in this group passed between the C6 and C7 transverse processes, and 33 (34.7%) patients passed through a level at or below the C7 transverse process.

In the subgroup analysis for the above C6 group, it was determined that 52 (89.6%) of 58 patients included in this group passed the cricoid cartilage level between the cervical 5 (C5)–C6 transverse processes. The distances from the cricoid line to the C6 transverse process and the distance between the two transverse processes at these levels are summarized in Table 2.

When the relationship between gender and the vertebral transverse process where the line drawn from the cricoid cartilage to the vertebral column passes, it was found that this level passed over the C6 transverse process in women and below the C6 transverse process in men, and there was a significant difference between the two groups ($p < 0.001$) (Table 3).

It was observed that 36 (52.9%) of 68 female patients passed through the upper C6 group of this line and the mean distance to the C6 transverse process was 5.70 ± 3.24 mm. The distance between the two transverse processes at this level was 10.09 ± 1.66 mm. In the subgroup analysis, it was determined that 34 (50%) of the female patients passed between the C5 and C6 transverse processes.

It was observed that this line passed below the C6 subgroup in 69 of 102 male patients (67.6%), and the mean distance to the C6 transverse process was 4.50 ± 3.68 mm. At this level, the mean distance between two transverse processes in male patients was 10.19 ± 2.18 mm. In the subgroup analysis for the C6 below group, it was found that 43 (42.7%) of the male patients passed between the C6 and C7 transverse processes, and 26 (25.4%) patients passed through the C7 transverse process and below.

We could not find statistical significance in terms of age between the vertebral level difference and the line drawn from the cricoid cartilage to the cervical vertebra transverse process ($p = 0.584$) and between the vertebral

Table 3 Cervical transverse process level where the line drawn from the cricoid cartilage passes and its distribution by gender

Cervical vertebral level	Female			Male		
	n (%)	Distance between cricoid line and transverse protrusion (mm)	Distance between transverse protrusions (mm)	n (%)	Distance between cricoid line and transverse protrusion (mm)	Distance between transverse protrusions (mm)
C6 upper	36 (52.9%)	5.70 ± 3.24	10.09 ± 1.66	22 (21.6%)	4.37 ± 3.30	11.42 ± 2.33
C6	6 (8.8%)			11 (10.8%)		
C6 below	26 (38.2%)	3.83 ± 2.71	9.58 ± 2.25	69 (67.6%)	4.50 ± 3.68	10.19 ± 2.18

body level difference and the line drawn from the cricoid cartilage to the cervical vertebral column ($p=0.899$).

When all the patients included in the study were examined, the vertebral corpus level where the line is drawn from the cricoid cartilage to the vertebral column passed through the C6 vertebral corpus level in 70 (41.1%) patients, and in 30 (42.8%) of these patients, the vertebral body level was the most common in the upper part of the C6 vertebral corpus level. It was observed that it passed through 1/3 of it.

In the tests performed to determine the relationship between gender and the vertebral corpus level where the line drawn from the cricoid cartilage to the vertebral column passes, it was observed that there was a significant difference between gender ($p<0.001$).

It was determined that the cricoid cartilage level in women most frequently passed at the level of C5–C6 intervertebral disc except for the C6 vertebral body, and in men, it most frequently passed at the level of C6–C7 intervertebral disc, except for the C6 vertebral body.

Discussion

In our study, it was found that the cricoid cartilage level, which is used as a landmark for the application of stellate ganglion blockade, often passes under the C6 transverse process. This means that when we take the cricoid cartilage cue point for blocking application, the application site is more likely to be between the transverse processes of the C6 and C7 vertebrae.

Stellate ganglion blockade can be applied at the level of the transverse process of the C6 and C7 vertebrae. However, due to the localization of the vertebral artery in front of the transverse process of the C7 vertebra, application from the C6 level is often preferred (Raj 1996; Agur 1991). Accurate level determination is one of the most important steps in procedural practice to increase the effectiveness of stellate ganglion blockade and prevent complications that may occur. In addition to various imaging methods, the location of the transverse process of the C6 vertebra can be estimated by using the cricoid cartilage as a landmark (Janik et al. 2008).

In a study, it was determined that the mean level of cricoid cartilage passes inferior from the lowest point of the C6 transverse process at 23.3 mm in men and 5.2 mm in women in the neutral position. In the same study, it was also found that the transverse process of the C6 and C7 vertebrae was located more caudally than the cricoid cartilage level during stellate ganglion blockade performed in the neutral supine position. When the localization according to gender is evaluated in this study, similar to our study, while the distance from the cricoid cartilage to the C6 transverse process in men was found to be significantly different from that of women, no such difference was reported for the distance between the cricoid cartilage and the C7 transverse process. In line with these findings, it was concluded that the injection point for stellate ganglion blockade would be different between men and women for the C6 transverse process, but not for the C7 transverse process. It has been reported that the reason for this difference according to gender may be the anatomical difference between the gender in the thyroid cartilage or the muscle connections between the thyroid cartilage and the cricoid cartilage (Park et al. 2011).

In our study, when we evaluated the cricoid cartilage level in terms of gender, it was found that the level of the cricoid cartilage in women often passed from a level above the transverse process of the C6 vertebra and below the level of the transverse process of the C6 vertebra in men. In line with these findings, when determining the C6 level before the blockade, it should be considered that the localization may be more cranial in female patients and more caudal in males. Especially during the classical blind technique for the stellate blockade, the target point should be determined more cranially in women and more caudally in men from the cricoid cartilage to prevent complications and succeed in an effective blockade.

In a study by Janik et al. using CT imaging of 70 patients to measure the distance between the cricoid cartilage, anterior and posterior tubercle, and vertebra, they demonstrated great variability in the size and position of landmarks used for needle insertion during stellate ganglion block. The difficulty in finding the exact localization

of the C6 level because of this variability helps explain the significant block failure rate. Therefore, it is unreliable for the application of the stellate ganglion block to consider the injection point as the landmark found by palpating only the transverse process of C6 in the supine position (Janik et al. 2008).

Ultrasound-guided stellate ganglion block has been discussed in some articles as a possible method of reducing the failure rate (Kapral et al. 1995). Ultrasound-guided stellate ganglion block shows benefits not only in reducing the failure rate but also in reducing the dose of local anesthetic (Jung et al. 2011). However, the traditional technique remains popular as it does not require the preparation of ultrasound equipment (Park et al. 2011).

In our study, when all patients were examined, the vertebral corpus level where the line is drawn from the cricoid cartilage to the vertebral column passed was found to be the upper 1/3 of the C6 vertebral body. When the correlation with gender was evaluated, it was found that it passed through the C5–C6 intervertebral disc level in women and C6–C7 intervertebral disc in men, except for the C6 vertebral body.

Neck marker points and corresponding vertebral levels are important for cervical vertebra surgeries. When using the anterior approach for cervical surgeries, it is necessary to determine the correct incision point to allow the approach to the target vertebra. It has been defined that the cricoid cartilage, which is one of these landmarks defined in the anatomy and spinal surgery books, corresponds to the C6 vertebra level (Ko et al. 2018; Siribumrungwong et al. 2018; An et al. 2016; Ellis 1964). In our study, the relationship between the cricoid cartilage and the C6 vertebral body was found to parallel with the level stated in the literature. In addition, it should be taken into account that this level may pass cranially in women and caudally in men, and often coincide with the level of the intervertebral disc. According to our study results, we advise planning the surgical interventions which are required an anterior cervical approach should be performed more cranially from the cricoid cartilage in women and more caudally in men.

In our study, no age-related correlation difference was found between the vertebral transverse process and corpus levels, where the C6 cricoid cartilage passes. We think that this may be because the cervical region is less affected by the loss of vertebral height that may develop due to age.

The limitation of our study is the lack of patient height data, which we think is one of the factors that may affect the vertebral level, especially depending on gender. In addition, since our evaluation was made with CT imaging, only the levels of the patients in the neutral supine position could be detected. It could not be evaluated

whether there is a change in the level of the cervical hyperextension position that can be given to the patient during the procedure.

Conclusions

In our study, we determined that there may be a significant difference with gender in the correlation of the vertebral transverse process and corpus, which are two important levels frequently used in clinical practice, with the cricoid cartilage. In line with the data obtained in our study, it should be kept in mind that the cricoid level in women may pass through more cranial vertebral levels than expected in women and more caudal vertebral levels in men to ensure successful blockage and correct incision localization.

Abbreviations

C5	Cervical 5 vertebra
C6	Cervical 6 vertebra
C7	Cervical 7 vertebra
Th1	Thoracic 1 vertebra
CT	Computerized tomography

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Authors' contributions

B.O.H. and Z.T.T. designed the manuscript, performed statistical analyses, write the manuscript, and revised literature, G.D.S. collect the radiological imaging data from the hospital system and revised the literature, O.E. measured and calculate the lines from the radiological imagines and record the data. All authors read and approved the final version of the manuscript.

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Availability of data and materials

The data that support the findings of this study are available from the corresponding author, (B.O.H.), upon a reasonable request.

Declarations

Ethics approval and consent to participate

After receiving approval from İzmir Bozyaka Training and Research Hospital, with Research Ethics Committee reference number 4, date of 28/01/2014, and obtaining written informed consent, we conducted the data.

Consent for publication

Not applicable

Competing interests

The authors declared that they have no competing interests.

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