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# Retropalatal and retroglossal spaces evaluation: a CT study

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## Abstract

**Background:** The retropalatal and retroglossal spaces are the main affected areas in obstructive sleep apnea (OSA) and they are the main targeted regions during OSA surgeries. But the dimensions of these spaces are sparsely referred to in literature.

**Aim:** To measure the retropalatal and retroglossal spaces dimensions in an easily measured way on the radiological evaluation to put basic measurements for such areas in normal subjects by multislice computed tomography (MSCT) in adults.

**Methods:** MSCT scans of asymptomatic adults were done for all included subjects to obtain delicate anatomical details of the recess using coronal, axial, and sagittal reformatted capability. Each retropalatal and retroglossal space was revised in the CT to find and measure their dimensions

**Results:** Within included 100 subjects, the mean transversal diameter (width) of the retropalatal space was 16.7±3 mm axially and the mean anteroposterior diameter (depth) was 6.9±1.4 mm. At the retroglossal area, the mean transversal diameter (width) was 17.7±3.8 mm axially and the mean anteroposterior diameter (depth) was 10.1±1.95 mm.

**Conclusion:** The current work describes the measurements of the retroglossal and retroplatal spaces. It is recommended to add the retroglossal and retropalatal space dimensions to the preoperative CT checklist, particularly in OSA.

**Keywords:** Retropalatal space, Retroglossal space, CT, Pharyngoplasty, Obstructive sleep apnea

## Introduction

The proper determination of the level of upper airway obstruction has a direct impact on the appropriate surgical choice and plan for obstructive sleep apnea (OSA). There are many available methods for upper airway topographical delineation including different types of radiology (CT, MRI, cephalometry) and endoscopy (awake nasoendoscopy with Müller's maneuver, and drug-induced sleep endoscopy (DISE)) [1, 2]. In addition, recent modern imaging modes of upper airway geometry have been utilized to judge treatment achievement [3].

DISE, MRI, and computed tomography (CT) can also be used to define the possible surgical sites in the upper airway in OSA patients. DISE is an alternative diagnostic tool for locating the obstruction site in patients that generates qualitative information regarding the level, degree, and direction of upper airway collapse. MRI is a non-ionizing radiation scanner providing high-resolution imaging, including upper airway soft tissue; however, it is slow, costly [4], and not always available and has some limitations.

The CT is a fast method of scanning, telling, and delineating the reasons and places of obstruction and is valid for numerically measuring the pharyngeal cross-sectional area. The relationship between CT data and sleep respiratory disorders registered by polysomnography (PSG) has not been completely explored [5] but to do

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so, it is needed to have baseline normal data about the dimensions in these areas.

The retropalatal and retroglossal spaces are the main affected areas in OSA and they are the main targeted regions during OSA surgeries. But these spaces are sparsely referred to in radiological literature without detailed data on them particularly their normal dimensions with a lack of studies describing the dimensions of these important anatomic locations. Therefore, we had conducted this work to measure the dimensions of these spaces in an easily measured way via radiological evaluation to put basic measurements for the retropalatal and retroglossal spaces in normal subjects.

## Methods

We conducted a retrospective analysis of multislice CT (MSCT) scans that were obtained for adult subjects. This study was conducted in otorhinolaryngology and radiodiagnosis departments, between January 2020 and January 2022. The institutional review board approved the research methodology. The study was conducted according to the Declaration of Helsinki on Biomedical Research Involving Human Subjects. Detailed informed consent was gained prior to inclusion in the study.

Subjects younger than 18 years, within the average range of BMI (body mass index); patients who underwent previous palatal or tongue base surgery; patients who had sleep disorders; and patients with pharyngeal neoplasm or trauma or craniofacial anomalies were excluded from the study.

All MSCT investigations were performed with a 64-slice CT (Light speeding amplitude VCT, GE Medical System, Milwaukee, WI, USA). The 64-slice MDCT protocol was conducted by a 0.625-mm width detector, a 1.5-mm section width, and a 0.5-mm interval reconstruction.

While the subject was supine, axial images were conducted with a parallel beam to the bony palate. The cuts start from the laryngeal inlet to the frontal sinuses, utilizing 130 KV and 150 mA/s with 1.5-s scan time. Broad window (window width approximately 1300 to 2000 and 80 to 300 window level). High-resolution algorithm was used for enhancement of the delicate details.

At a dedicated post-processing workstation (Advantage Windows Volume share 4.5, GE Medical System, Milwaukee, WI, USA), multiplanar reconstructions with delicate details in sagittal and coronal planes were got for all subjects. Films were analyzed in a regular standard manner to ascertain not missing any fine detail.

All retroplatal and retroglossal areas were reviewed in the axial cuts measuring the transverse dimensions at the retroplatal and the retroglossal areas. Then, the sagittal reformatted cuts were examined for measuring the anteroposterior dimension (depth) of same region. The measurements were taken at the least dimensions at both retroplatal and retroglossal spaces on the revised cults (Figs. 1 and 2).

Statistical analysis with the SPSS statistical software package (version 18; SPSS, Inc., Chicago, IL, USA) was done. $P< 0.05$ was reported to be significant.

## Results

One hundred adult subjects with 100 retroplatal spaces and 100 retroglassal spaces were included in the study. The age of the included subjects ranged between 20 and 46 years (mean= 36.96+13.4 years). They were 42 females (42%) and 58 males (58%) (Table 1).

In Table 2, at the retroplatal area, in all subjects, the mean transverse dimension (width) was 16.7±3 mm and the mean anteroposterior dimension (depth) was 6.9±1.4 mm. In males, the transverse dimension (width) was 16.5±2.97 mm and the anteroposterior dimension (depth) was 6.95±1.5 mm. In females, the transverse dimension was 16.9±2.97 mm and the anteroposterior was 6.7±1.57 mm, with no significant difference between males and females regarding both dimensions.

At the retroglossal area, in all subjects, the mean transverse dimension (width) was 17.7±3.8 mm and mean anteroposterior diameter (depth) was 10.1±1.95 mm. In males, the mean width was 17.23±3.6 mm and the mean depth was 10.5±1.8 mm. In females, the mean width was 18.4±4 mm and the depth was 9.6±2 mm, with no significant difference between males and females regarding both measurements.

In Table 3, age is only significantly associated with retropalatal space sagittally ($r = 0.045$, $p = 0.002$).

## Discussion

Fiberoptic examination with Muller's maneuver is particularly helpful in the evaluation of dynamic changes within the upper airway [1]. However, it is largely based on the physician's subjective evaluation and could lack precision. Cephalometry is capable to supply useful skeletal data before upper airway surgery. However, it gives a single 2-dimensional representation of a 3-dimensional organ, proved only one cut view, and is incapable to assess the important soft tissue structures as the uvulopalatal complex and tongue base represent the main cause and target for the OSA management. In addition, it provides no information about the lateral structures in the upper airway [6].

Polysomnography (PSG) as a diagnostic tool provides reliable data on the respiratory activity during sleep; however, it does not yield information on the relevant anatomical structures to the surgeons [7].

The CT scan is a non-invasive method giving an objective elaborate judgment of the whole upper airway and is valid

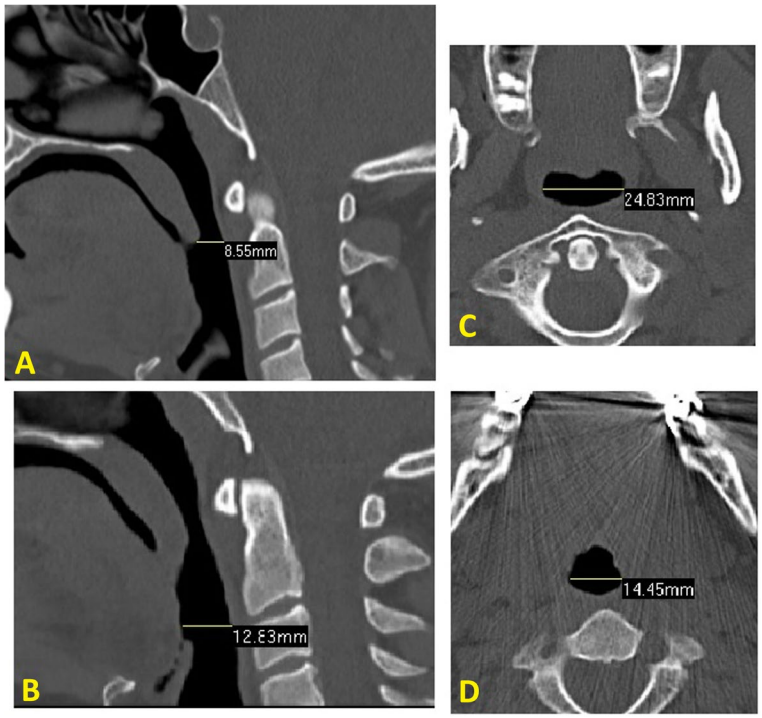


**Fig. 1** Sagital CT shows the measurement of the anteroposterior dimensions at the retroplatal (**A**) and the retroglossal (**B**) levels. Axial CT shows measurement of the transverse diameter at the retroplatal (**C**) and the retroglossal (**D**) levels

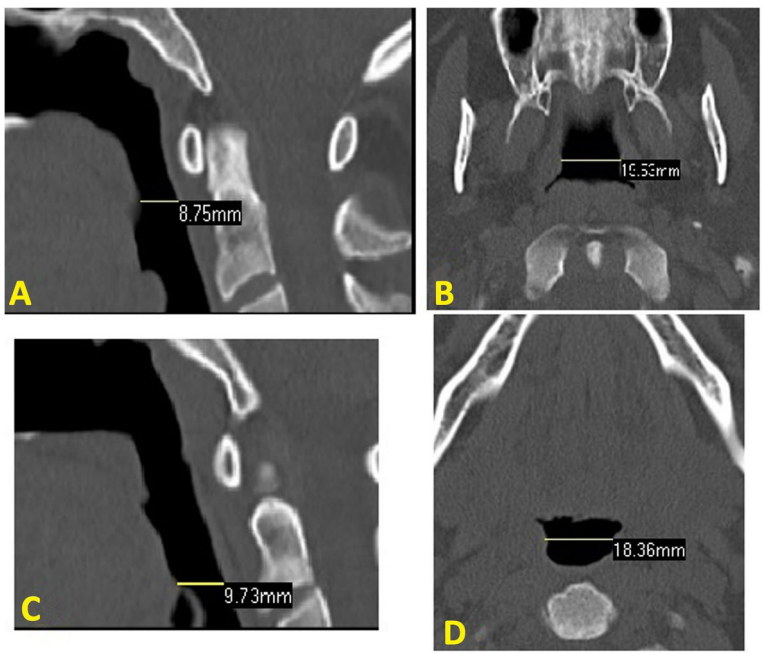


**Fig. 2** CT shows measurements of the anteroposterior dimensions at the retroplatal (**A**) and the retroglossal (**C**) levels on sagittal cuts and the transverse diameter at the retroplatal (**B**) and the retroglossal (**D**) levels on axial cuts

**Table 1** Age and gender of the subjects

| | Mean ± SD (range) |
|---|---|
| **Age (years)** | 36.96 ± 13.4 (20–46) |
| **Gender** | |
| Male | 29 (58%) |
| Female | 21 (42%) |

for quantitative pharyngeal cross-sectional area measurements. Modern CT technologies permit more rapid and reliable reconstruction of their scans [8] enhancing surgeons' and radiologists' understanding of narrowed regions in the upper airway. Studies in the literature have reported that the retroglossal and retroplatal spaces are closely related to sleep-disordered breathing manifestations [9].

Hence, in the current study, CT measurements of these regions were assessed. It is thought that the obtained anatomically measurements will be peculiarly important for OSA surgeons can utilize them during planning, performing, and following their surgical procedures for each patient and for objective pre- and postoperative assessment of the patients.

For example, the success rate of uvulopalatopharyngeal sleep apnea surgery is related to the location of obstruction, where patients who have retropalatal obstruction exhibit better results compared with those who have retroglossal obstruction [10]. Even though the retroplatal cause is the most common cause of OSA [11], missed retroplatal obstruction site represents the main cause of failure of the velopharyngeal procedure [12].

The CT can prove whether the airway constrictions occur at the retropalatal or the retroglossal region or both [13]. Furthermore, this procedure can be repeated in patients who have undergone unsuccessful pharyngeal surgery to determine the postoperative airway status and if further operation is required [7].

The association between CT data and sleep respiratory disorders is not fully explored in the literature. Therefore, we have conducted this work to describe the retropalatal and retroglossal space dimensions measured on radiological evaluation to put basic measurements for such areas in normal subjects in the way to build up the data in the diseases patients.

The registered retroplatal measurements, in the current study, could also help the surgeon for determining the length and width of the flap that need to be used during the new pharyngeal flap surgeries [14–16].

In our study, age is only significantly associated with retropalatal space on its anteroposterior dimensions reflecting the effect of age on the depth of that space and given one of the causes that sleep disorder breathing including snoring appears more with more age. At the retroplatal and retroglossal areas, there was no significant difference between males and females regarding transverse and anteroposterior dimensions.

Further studies on OSA patients are still needed to compare the presented normal data here with OSA patients.

## Conclusion

The current work describes the measurements of the retroglossal and retroplatal spaces. It is recommended to add the retroglossal and retropalatal space dimensions to the preoperative CT checklist, particularly in OSA patients and during their follow-up.

**Table 2** Transverse dimension (width) and anteroposterior dimension (depth) measurements by CT in males and females

| | | All subjects | Males ($n = 29$) | Females ($n = 21$) | *T* test | *P* value |
|---|---|---|---|---|---|---|
| **Retropalatal** | **Transverse dimension (width)** | 16.7 ± 3 | 16.5 ± 2.97 | 16.9 ± 2.97 | 0.474 | 0.637 (NS) |
| | **Anteroposterior dimension (depth)** | 6.9 ± 1.4 | 6.95 ± 1.5 | 6.7 ± 1.57 | 0.57 | 0.571 (NS) |
| **Retroglossal** | **Transverse dimension (width)** | 17.7 ± 3.8 | 17.23 ± 3.6 | 18.4 ± 4 | 1.083 | 0.284 (NS) |
| | **Anteroposterior dimension (depth)** | 10.1 ±1.95 | 10.5 ± 1.8 | 9.6 ± 2 | 1.666 | 0.102 (NS) |

*CT* Computed tomography, *NS* Non-significant

**Table 3** Spearman correlation (*r*) between age and CT parameters

| | Retropalatal | | | | Retroglossal | | | |
|---|---|---|---|---|---|---|---|---|
| | Transverse dimension (width) | | Anteroposterior dimension (depth) | | Transverse dimension (width) | | Anteroposterior dimension (depth) | |
| | *r* | *p* | *r* | *p* | *r* | *p* | *r* | *P* |
| **Age** | 0.145 | 0.314 (NS) | 0.045 | 0.002 (S) | 0.001 | 0.992 (NS) | 0.169 | 0.240 (NS) |

*CT* Computed tomography, *NS* Non-significant

**Abbreviations**
HRCT: High-resolution computed tomography; MPR: Multiplanar reconstruction; MSCT: Multislice computed tomography; SD: Standard deviation; OSA: Obstructive sleep apnea.

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**Authors' contributions**
MWE suggested and modified the idea, reviewed the literature, designed the study and concept, revised the results, did the statistical analysis, interpreted the data, tabulated the interpreted data, wrote and revised the article, and approved the final manuscript to be published; RME developed the research idea, reviewed the literature, prepared and did the measurements on the CT, contributed to the data interpretation, revised the manuscript, and gave final approval of the article; MAM developed the idea, assisted in the measurements on the CT, collected the data and tabulated the data, kept the patients' records, analyzed the data, revised the article, and contributed to the final approval of the article. All authors have read and approved the final manuscript.

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**Availability of data and materials**
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethics approval and consent to participate**
A written informed consent was obtained from the study participants, and Zagazig University IRB approved the study proposal (IRB 117-1-18).

**Consent for publication**
Not applicable (no images or videos related to participants).

**Competing interests**
The authors declare no competing interests.

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## Publisher's Note