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Incidence and Anatomy of Tubarial Salivary Gland in Local Indian Population

ABSTRACT

Background: Tubarial salivary glands were first discovered and reported in the year 2021 by Valstar et al and were named "tubarial salivary glands" depending upon their location. The presence of these glands is believed to play a major role in helping oncologists and otorhinolaryngologists in radiation therapy planning and surgical management, thus improving the quality of life of patients. The main objective is to study the incidence of tubarial salivary glands in the local Indian population and assess its anatomical characteristics using magnetic resonance imaging (MRI) scans.

Methods: Magnetic resonance images of 60 scans were examined from the database, and analysis was performed using the T2 weighted (T2W) sequences. The presence of the tubarial salivary glands, their position and number, and the size of the glands were examined on the MRI scans by an experienced radiologist.

Results: The glands were identified bilaterally in all 60 MRI scans. The average dimensions for the right and left glands were 39.4 mm × 15.3 mm × 6.5 mm and 38.9 mm × 15.4 mm × 6.6 mm, respectively. The age-wise distribution of the presence of glands showed a statistically significant increase in the size of the glands with increasing age groups ($P < .05$).

Conclusion: We observed a soft tissue structure in the anatomical site of the previously documented tubarial salivary glands on T2W MRI images. The structure's intensity was comparable to that of a typical parotid gland. The findings of our study offer crucial evidence in favor of the long-contested presence and identification of a novel salivary gland.

Keywords: Magnetic resonance imaging, salivary glands, tubarial glands

INTRODUCTION

The existence of 3 major salivary glands and thousands of smaller ones scattered throughout the submucosa of the aerodigestive tract in the human body has long been known.[1,2] However, Valstar et al[3] noticed a previously unnoticed pair of salivary glands showing ligand uptake similar to known major salivary glands. For this, they evaluated prostate-specific membrane antigen positron emission tomography/computed tomography (PET/CT) scans of 100 patients with prostate/paraurethral gland cancer.[3] Additionally, they dissected the nasopharynx of 2 human corpses and subjected the 3 × 3 × 3 cm tissue blocks to immunohistochemistry and hematoxylin and eosin (H&E) staining to substantiate the outcome, and the glands identified were named "tubarial salivary glands" depending upon their location.[3] Magnetic resonance imaging (MRI) analysis was also performed on a healthy volunteer, which revealed a subtle tissue structure with lower signal intensity on the T2 weighted sequence, compatible with glandular tissue, which was identified at the expected location of the tubarial gland on the medial side of the torus tubarius.[3]

Sainudeen et al[4] could not demonstrate the glands on T1-weighted (T1W) images, which they suggested could be due to their submucosal location and similar signal properties to the overlying mucosa, making them difficult to precisely locate in a healthy person using conventional imaging.[4]

Salivary gland toxicity is frequently observed after radiation therapy, leading to xerostomia and hypofunction of the salivary glands. Patients exposed to radiation often have

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dysgeusia, a burning sensation in the mouth, difficulty speaking, swallowing, sleeping, and mastication. When combined, these symptoms significantly impair the patients' quality of life (QOL).[5] Due to their location, tubarial glands may be irradiated during high-dose external beam radiation therapy (EBRT) as a treatment for head and neck cancer (HNC). Sparing of the tubarial salivary glands provides a potential opportunity for continued toxicity mitigation and improvements in patient QOL.[6,7]

Therefore, the purpose of this study is to confirm the presence of tubarial salivary glands in the local Indian population using T2W MRI, which can further help oncologists and otorhinolaryngologists in radiation therapy planning and surgical management to improve QOL of the patients.

MATERIAL AND METHODS

The presence of the glands in the nasopharynx was evaluated on MRI scans from retrospective data of 60 patients who fulfilled the inclusion criteria (from January 2021 to October 2022). Scans were acquired according to routine clinical protocols using a Siemens Healthineers MAGNETOM Vida 3 Tesla (Siemens, Erlangen, Germany) imager with the use of a 64-channel coil specially designed for head and neck imaging. Imaging parameters were FOV (mm): 140 × 140, T2 weighted: TR 5000 ms, TE 100 ms, and voxel size: 1.7 × 1.7 × 4 mm. The evaluation was done using the T2 weighted sequences with slice thickness of 4 mm with distance factor of 30. It is composed of the presence of the tubarial salivary glands, their position and number, along with the size of the glands.

As this study was retrospective in nature, waiver of consent was obtained from the department of radiodiagnosis and imaging. Ethics committee approval was obtained on February 5, 2021 by ethics committee of the Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune (reg number:.ECR/361/Inst/MH/2013), reference number: DYPDCH/EC/648/45/2021.

MAIN POINTS

This retrospective magnetic resonance imaging based study was performed using TW2 scans involving the nasopharynx to confirm the presence of tubarial salivary glands.

- The presence of the gland was consistent bilaterally on all the observed scans.
- The location was identified in the posterior nasopharynx, extending from the base of the skull to the Rosenmüller fossa region along the lateral wall of the nasopharynx, predominantly over the torus tubarius.
- The age-wise distribution of the glands showed a statistically significant difference between them.
- The dimensions of right and left glands showed an insignificant difference between them.
- The mean dimensions of the glands were as follows: right gland—superoinferior: 39.4 ± 5.2 mm; anteroposterior: 15.3 ± 3.8 mm; mesiodistal: 6.5 ± 1.9 mm; Left gland—superoinferior: 38.9 ± 5.2 mm; anteroposterior: 15.4 ± 3.9 mm; mesiodistal: 6.6 ± 1.7 mm.

RESULTS

We were able to identify bilateral soft tissue structures on T2W sequences having similar signal intensity as that of the normal parotid gland (isointense) and comparatively hyperintense to bone, muscle, and cartilage. The structure was identified in the posterior nasopharynx, extending from the base of the skull until the Rosenmüller fossa region along the lateral wall of nasopharynx, predominantly over the torus tubarius. (Figure 1A, B) This was the similar anatomical location of tubarial salivary glands described in previous studies. The presence of the glands was consistent in all the observed scans, with no variation in number or location. Out of the 60 MRI scans, the gender distribution was equal, with 30 males and 30 females (Table 1).

The age range of the collected scans was from 1 month to 89 years, with a mean age of 40.32 ± 27.85 years. The maximum number of scans were from the 21 years and above age group (65.02%). The average superoinferior dimension of the right and left glands was 39.4 mm ± 5.2 mm and 38.9 mm ± 5.2 mm, respectively. The average anteroposterior (AP) dimension of the right gland was 15.3 mm ± 3.8 mm, the average mediolateral (ML) dimension was 6.5 mm ± 1.9 mm and the average AP dimension of the left gland was 15.4 mm ± 3.9 mm, and the average ML dimension was 6.6 mm ± 1.7 mm. (Table 2, 3)

Difference between the right and left tubarial salivary glands was compared and only minimal differences in measurements were found which was statistically insignificant ($P \geq 0.05$) (Table 4).

On comparing the dimensions among the different age groups, we noticed that there was a significant difference between them. The smallest anteroposterior dimension (9.59 mm ± 4.66 mm) was noted in 0-5 years of age group, while highest dimensions (17.08 mm ± 2.63 mm) was noted in 16-20 years of age group. The smallest mediolateral dimension (3.64 mm ± 2.55 mm) was noted in 0-5 years of age group, while the highest dimension (7.53 mm ± 1.37 mm) was noted in age group of 21 years and above. The smallest superoinferior dimension (31.14 mm ± 11.93 mm) was noted in 0-5 years of age group, while highest dimension (40.66 mm ± 1.40 mm) was noted in 16-20 years of age group. Increase in size may be attributed to the development of glands with an increase in age (Table 5).

DISCUSSION

"An organ is defined as an anatomical area with a distinct shape and structure made up of more than one type of tissue that performs specific functions."[8] This description was used by Valstar et al[3] to describe a newly identified macroscopic glandular structure located in the posterior nasopharyngeal submucosa. A standard for the inclusion of a new organ was proposed based on this anatomical description, their functional importance, and the correlation between xerostomia and dysphagia in post-irradiated head and neck cancer patients.[3] Later, the term "tubarial salivary glands" or "tubarial glands" was coined to rhyme with the names of the other 3 pairs of major salivary glands, which are distinguished by their anatomical positions.[3]

In the present study, we investigated the presence of tubarial glands using T2W images retrieved from available MRI data. In

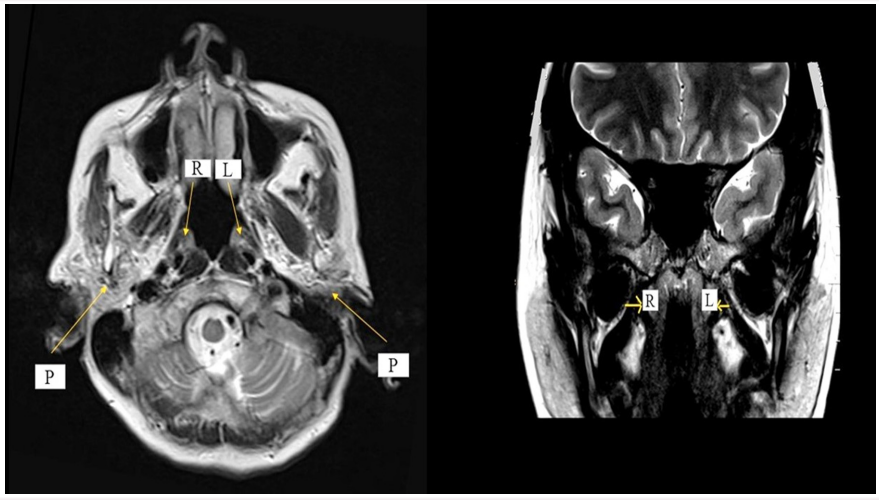

Figure 1. A) Tubarial glands: axial T2 weighted magnetic resonance image of the base of the skull region and the nasopharynx showing the tubarial glands R and L indicate the right and left tubarial glands. Note the signal characters of the parotid gland (P). B) Tubarial glands: coronal T2 weighted magnetic resonance image of the nasopharyngeal region showing the tubarial glands R and L indicate the right and left tubarial glands.

all 60 scans, we were able to identify a well-defined bilateral structure isointense to parotid gland in the region previously described as the anatomical location of the tubarial salivary gland.[3]

Vatsar et al[3] demonstrated the average cranio-caudal length of the tubarial salivary gland as 3.9 cm, which was similar to our results, with an average supero-inferior dimension of the right and left gland being 39.4 mm ± 5.2 mm and 38.9 mm ± 5.2 mm, respectively. However, anteroposterior and mediolateral dimensions were not calculated in their study, which was done in the present study. Interestingly, Sample et al[9] found the lengths for manually delineated tubarial glands to be 4.5 cm, which was approximately 5 mm larger than previously observed measurements. This variation was attributed to the choice of the threshold used for delineating the glands by the authors.

Sainudeen et al[4] observed that the glands were not visible in T1W images because of their submucosal location and similar signal properties to the overlying mucosa, which makes them difficult to precisely locate in a normal person in T1W images.However,

Table 1. Age Distribution of Scans

AGE GROUP	Frequency	Percentage
0-5 years	7	11.7
6-10 years	6	10.0
11-15 years	3	5.0
16-20 years	5	8.3
21 years and above	39	65.0
Total	60	100.0

Table 2. Dimensions of Right Tubarial Gland

Superoinferior (mm)		Anteroposterior (mm)		Mediolateral (mm)	
Mean	**39.4**	**Mean**	**15.3**	**Mean**	**6.5**
Standard deviation	5.2	Standard deviation	3.8	standard deviation	1.97
Standard error	0.67	Standard error	0.04	Standard error	0.02
Median	40.5	Median	15.3	Median	6.8
Minimum	10.8	Minimum	2.3	Minimum	1.3
Maximum	44.0	Maximum	22.6	Maximum	11

Table 3. Dimensions of Left Tubarial Gland

Superoinferior (mm)		Anteroposterior (mm)		Mediolateral (mm)	
Mean	**38.9**	**Mean**	**15.4**	**Mean**	**6.6**
Standard deviation	5.2	Standard deviation	3.9	Standard deviation	1.7
Standard error	0.06	Standard error	0.05	Standard error	0.02
Median	40.3	Median	15.2	Median	7.0
Minimum	12.4	Minimum	2.5	Minimum	1.5
Maximum	43.2	Maximum	24.0	Maximum	9.6

Table 4. Table Showing Comparison of Left and Right-Side Dimensions of Tubarial Glands

Dimension		Mean	Standard Deviation	*P*
Superoinferior	Right	39.47	5.12	.615
	Left	38.99	5.18	
Anteroposterior	Right	15.36	3.85	.955
	Left	15.40	3.94	
Mesiodistal	Right	6.59	1.99	.883
	Left	6.64	1.73	

Table 5. Comparison of Superoinferior Dimension of Right and Left Gland in Different Age Groups

Dimension	0-5 Years Mean (SD)	6-10 Years Mean (SD)	11- 15 Years Mean (SD)	16-20 Years Mean (SD)	21 Years and Above Mean (SD)	*P*
AP right (mm)	10.34 (5.20)	16.13 (2.20)	13.47 (2.97)	17.08 (2.63)	16.08 (3.32)	.002
AP left (mm)	9.59 (4.66)	17.25 (3.06)	13.97 (2.33)	16.62 (3.24)	16.12 (3.23)	.00
ML right (mm)	3.64(2.55)	5.68(1.38)	4.57 (1.25)	6.16 (1.16)	7.53 (1.37)	.00
ML left (mm)	3.86(2.50)	5.80(1.19)	5.17 (0.75)	6.48 (0.89)	7.41 (1.03)	.00
SI right (mm)	31.66 (13.11)	40.20 (2.12)	40.57 (0.40)	40.66 (1.53)	40.60 (1.40)	.00
SI left (mm)	31.14 (11.93)	38.17 (4.09)	40.20 (1.73)	40.00 (1.55)	39.30 (6.11)	.050

they could identify the glands on T2W images, but they did not calculate the dimensions of the glands.[4] Vatsar et al[3] also examined MRI images of a healthy volunteer, which revealed some tissue structure with reduced signal intensity on the T2 sequence, consistent with glandular tissue, located near the presumed site of the tubarial gland on the medial side of the torus tubarius. Small T2-intense spots were found within this tissue structure, which he hypothesized could represent the macroscopic duct openings seen in cadavers and 3D histology reconstructions. Taking this finding into consideration, the authors in the present study focused only on the T2-weighted images for locating the glands.

In the present study, differences between the right and left tubarial salivary glands were compared, and only minimal differences in measurements were found, which were statistically insignificant ($P \geq .05$). We could not find any previous studies during our literature search that have compared the right and left sides of the glands.

The scans were distributed based on their age, and their dimensions were compared. The variation was statistically significant ($P < .05$). There was a gradual increase in dimension with increase in age, except for the 6-10 year old age group which shows slightly higher dimensions than the 11-15 year old age group, which may be attributed to the development of the gland.

Although the number of scans observed in each age group was small and inequal, we cannot strongly confirm the association of increasing dimensions with age. Therefore, further research is necessary on this topic to know more about the development and age-related changes of the gland.

The smallest dimensions were noted in the age group of 0-5 years of age. Similar observation was noted by Sainudeen et al,[4] they noticed variation in the size of the glands in children, the glands being smaller in size and difficult to locate in the nasopharynx. They stated that this presumably could be due to the massive adenoid tissue and prominent nasopharyngeal wall, which has a similar signal intensity.

Strength of the study: To the best of our knowledge, this was the only retrospective MRI-based study performed amongst the Indian population to identify the tubarial glands. Data regarding only the average craniocaudal length of the gland are available in the literature; hence, we performed the three-dimensional assessment of the gland and calculated the superoinferior, mediolateral, and anteroposterior dimensions of the glands. We compared the variation in dimensions among different age groups and found a statistically significant difference between them ($P \leq .05$). Additionally, we analyzed the variation between the right and left glands, although the differences were not statistically significant.

Apart from the merits mentioned earlier, the studies also had certain limitation, such as the sample size, which was 60 and represented only a smaller population (n = 60). The comparison was made between different age groups with an unequal number of scans. Being a retrospective study, cadaveric or histological confirmation could not be done.

The function of the tubarial salivary glands is considered to lubricate the nasopharynx; hence, failure to protect them during radiotherapy for patients with head and neck cancers can exacerbate radiation-induced dysphagia and xerostomia. Sparing these glands in head and neck radiation therapy may help to improve the quality of life of the patients. Further studies are needed for evaluating the histological characteristics of the gland. The type and quantity of secretion should be studied in order to evaluate the functions of these glands. The location of these glands shows close approximation with the eustachian tube (ET), Future studies are needed to investigate the relationship between tubarial gland function and obstructive ET dysfunction pathophysiology.[10]

We identified a soft tissue structure with intensity similar to that of normal parotid gland on T2W images in the posterior nasopharynx stretching from posterior nasopharynx extending from the base of the skull till the Rosenmüller fossa region involving the lateral wall of nasopharynx, which was anatomical location of previously described tubarial salivary glands.

Significant differences amongst the age groups were noted, with the smallest dimensions in the age group of 0-5 years. The dimensions of right and left glands showed an insignificant difference between them. The exposition of the salivary gland has stirred scientific curiosity and opened the door for additional research using data from physiological studies in the focus area. The results of our investigation provide important supporting data for the long-debated existence and identification of a novel salivary gland.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Dr. D. Y. Patil Vidyapeeth, Pune University (Date: 5th February 2021, Number: DYPDCH/EC/648/45/2021).

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