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MORPHOMETRY OF PAROTID AND SUBMANDIBULAR GLANDS ONCOMPUTED TOMOGRAPHY IN ADULTS AT BPKIHS

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ABSTRACT

Background: The knowledge regarding the normal dimensions and different morphological patterns of these salivary glands is very much important in day to day clinical practice. Specifications about the sizes of normal salivary glands are not widely available. It is important to have a standardized morphometric data in order to differentiate between normal and pathological salivary glands. Computed Tomography (CT) is an important radiographic technique to detect several salivary gland and has replaced other radiography techniques as the first-line imaging test mostly due to its improved sensitivity for detecting calcifications, intraglandular masses, and adjacent inflammatory standing. **Objectives:** To measure length, width, thickness and volume of parotid and submandibular glands. To correlate the linear dimensions and volume of parotid and submandibular glands with age, gender, laterality and BMI. **Material and Methods:** The study was cross sectional study carried out in the Department of Radiodiagnosis & Imaging, B. P. Koirala Institute of Health Sciences, over a period of one year. Patients 18 years and above referred to the Department of Radiodiagnosis and Imaging for computed tomography of head, neck and PNS were included in our study. Patients with known diseases of parotid and submandibular gland, patients with parotid and submandibular gland lesions detected during computed tomography and patients who underwent surgery of parotid or submandibular glands or that of neck, patients with history of radiotherapy in head/neck region and systemic diseases affecting salivary glands, adjacent lesions causing compression/ displacement/deformation of gland and patients in whom any of the measurements is not possible due to inadequate visualization of gland were excluded from the study. **Result:** A total of 54 participants were enrolled in the study. Participants ranged from 19 to 78 years and maximum number of cases belonged to 40-59 years age group [23 (42.6%)]. Mean thickness and volume of submandibular gland was significantly greater in left side. Mean length, width, thickness and volume of submandibular gland in males were 3.42±0.33 cm, 2.28±0.22 cm, 2.56±0.21 cm, 8.08±0.53 cc respectively. Mean length, width, thickness and volume of submandibular gland in females were 2.96±0.16 cm, 2.12±0.23 cm, 2.40±0.21 cm, 7.55±0.36 cc respectively. The length, width and volume of submandibular showed weak negative correlation with age (r=-0.16, -0.11, -0.32 and -0.05 respectively). However, none of these correlation were statistically significant (p>0.05). The thickness of submandibular gland showed weak negative correlation with age (r= -0.32) which was statistically significant. Length, thickness and volume of submandibular gland showed weak positive correlation with BMI (r=0.32, 0.22 and 0.23 respectively) which were statistically significant. Width of submandibular gland showed weak positive correlation with BMI (r=0.119) which was not statistically significant. Overall mean length, width, thickness and volume of parotid gland were 3.19±0.34 cm, 2.20±0.24 cm, 2.48±0.22 cm, 7.81±0.52 cc respectively. The length and width of parotid gland showed weak negative correlation with age (r= -0.22, -0.20 respectively). The volume of parotid gland showed weak positive correlation (r= 0.39) with age. The thickness of parotid gland showed weak negative correlation (r=-0.07) with age, however it was not statistically significant. Length and volume of parotid gland showed weak positive correlation with BMI (r= 0.28, 0.23 respectively). The width and thickness of parotid gland showed weak positive correlation with BMI (r= 0.12, 0.14 respectively), however the correlations were not statistically significant. **Conclusion:** The mean length, width, thickness and volume of submandibular gland were 3.19±0.34 cm, 2.20±0.24 cm, 2.48±0.22 cm, 7.81±0.52 cc respectively. The mean length, width, thickness and volume of parotid gland were 5.03±0.32 cm, 2.99±0.33 cm, 3.35±0.35 cm, 23.16±1.36 cc respectively. The mean thickness and volume of left submandibular gland were significantly larger than those in right submandibular gland. Mean length, width, thickness and volume of submandibular gland were significantly greater in male compared to female. The thickness of submandibular gland showed weak negative correlation with age. Length, thickness and volume of submandibular gland showed weak positive correlation with BMI. The mean length of right parotid gland was significantly larger than that in left parotid gland. The mean volume of left parotid gland was significantly larger than that in right parotid gland. Mean length, width and volume of parotid gland were significantly greater in male compared to female. The length and width of parotid gland showed weak negative correlation with age. The volume of parotid gland showed weak positive correlation with age. Length and volume of parotid gland showed weak positive correlation with BMI. **KEYWORDS:** BMI, CT, PG, PNS, SMG.

INTRODUCTION

The paired parotid, submandibular, and sublingual glands are referred to as the major salivary glands; each is anatomically, histologically, and functionally unique. Major salivary glands together are responsible for 90% of the total saliva. Minor salivary glands in turn, comprise ~600–1000 glands distributed throughout the oral cavity.[1] The parotid glands are the largest of the three major salivary glands which are paired, weighing approximately 28 gms each.[2] The average length is 5.8 cm in the cranio- caudal dimension and 3.4 cm in the ventro-dorsal dimension. The anatomic plan createdby the facial nerve divides the parotid gland into superficial and deep lobes. Glandulartissue located lateral to the plane is considered to be the part of superficial lobe and medial to the plane is considered to be the part of deep lobe.[3] The submandibular gland is the second largest salivary gland, weighing approximately about 15 grams and contribute some 60–67% saliva secretion. The average length of the normal human submandibular salivary gland is approximately 27mm, while the average width is approximately 14.3mm. It is located deep to the angle of the mandible and straddles both the submandibular and sublingual spaces. The parotid gland (PG) and submandibular gland (SMG) are major salivary glands that are affected by various diseases including neoplasm, infection, and inflammation. These diseases cause hyperplastic or hypertrophic changes in the salivary glands. Estimation of the size andvolume of these glands provide one element of diagnostic information. Salivary glands grow from birth to early adulthood in an approximately logarithmic growth pattern. An understanding of how these structures change helps in differentiation of normal and pathological states. However, information about the age and sex related change in the normal size of healthy salivary is lacking.[4] In various pathological conditions they may manifest clinically as a lateral swelling on the face or diffuse enlargement of the gland accompanied by certain symptoms like obstruction or inflammation. When thereis bilateral enlargement, it is difficult to compare with the other gland. Thus information about the gland size is important for the clinician.[5] Diagnosis of these conditions may be challenging. Radiographic examination is essential in diagnosing such conditions, and plays a pivotal role in planning further management (2). Plain radiography, sialography, sialendoscopy, computed tomography (CT), conebeam CT (CBCT), ultrasonography (US), magnetic resonance imaging (MRI), and nuclear scintigraphy/positron emission tomography (PET) are the various diagnostic techniques used for the detection of salivary gland pathologies.[4] Limited information is obtained by evaluation of the salivary glands by conventional methods. Ultrasonography (USG) is initial imaging modality for assessment of salivary glands with high spatial and temporal resolution. It can also be used for image guided biopsies. However ultrasonography has limitations in evaluating structures behind bone, that is behind the mandible and the deep parts of the parotid gland which are accessible by computed tomography. Computed Tomography (CT) is radiographic technique which helps to detect several salivary gland abnormalities such as sialolith within the salivary gland or duct, bony erosion caused by malignant lesions, and inflammatory diseases such as abscess, major salivary duct dilatation etc. Unenhanced CT has replaced radiography as the first-line imaging test mostly due to its improved sensitivity for detecting calcifications, intraglandular masses, and adjacent inflammatory standing.[6] Computer tomography (CT) scan can successfully identify the PG and show changes that occur with development. CT scan has been used to quantify the volume of the salivary glands and is an easy, reliable, and reproducible method of determining volume by three-dimensional (3D) reconstruction, which calculates the volume by multiplication of the area obtained from manually traced regions of interest on axial slices by the interval thickness. A previous study reported that CT may be used to quantitatively and qualitatively assess structures of the head and neck, and that the technique is useful in the assessment of structural and functional changes of these structures with aging. Such information can be used as a normative baseline to assess subjects in the clinical setting who undergo CT imaging for age-related change.[4] The purpose of this study was to calculate the dimensions of normal PG and SMG and to evaluate their relationship with respect to age, sex, laterality and BMI using 3D imaging. In the ever expanding arena ofknowledge and information, it is vital for any clinician to remain in touch with latest innovations in the field of one's expertise and apply the same for the benefit of patient care and be ready and willing to accept new trends, find time to learn and practice the technological and diagnostic or treatment advances in the related field.[7]

MATERIALS AND METHODS

The study was carried out on cross sectional basis in the Department of Radio diagnosis & Imaging, B. P. Koirala Institute of Health Sciences, over a period of one year and thestudy was reviewed and approved by the institutional ethical review board. All the patients 0f 18 years and above undergoing computed tomography of head, PNS and neck were included in the study. After obtaining informed consent, relevant clinical history, age & sex and other relevant details were recorded as per structured pro forma. Patients with known diseases of parotid andsubmandibular gland, patients with parotid and submandibular gland lesions detected during computed tomography, patients who underwent surgery of parotid or submandibular glands or that of neck, patients with history of radiotherapy in head/neck region and systemic diseases affecting salivary glands, adjacent lesions causing compression/displacement/deformation of gland and the patients in whom any of the measurements is not possible due to inadequate visualization of gland were excluded from the study. Purposive sampling was adopted for collection of study sample. Sample size was calculated by using two sample mean formula with a significance level of .05 and a power of .80. Applying two

sample mean formula, the sample size was calculated as follows: According to the study done by Hwang et al. the mean thickness of parotid glands in male and female was 35.4±3.9 mm and 32.4±3.7 mm respectively.

n =(2σ2)(z1−α/2+z1−β)^2= sample size for each male and female group

Δ2

WhereΔ = |μ1 − μ2|

n =(2)(3.92)(1.96 + 0.84)^2

|35.4 − 32.4|2

n≈ 27 for each male and female group

(Hence minimum of 54 cases was taken for the study).

The data collected was tabulated in Microsoft Excel and analysis was carried out using Statistical Package for Social Sciences (SPSS) version 11.5. Continuous variables were described in terms of mean ± standard deviation (SD). Categorical variables were described in the form of, frequency and proportion. Intergroup differences were analysed by using student's t-test. Pearson's correlation coefficients were used to calculate correlation between various variables. P-value of <0.05 was considered to bestatistically significant.

Computed tomography was done in the scanner available in the department with the institution protocol for the type of study. Measurements were taken from axial images and coronal reformats from CT head, neck and PNS with the help of electronic calipers available in console. Employing the CT software, the software calculated the cross- sectional area for each slice. This area was multiplied by the slice thickness (i.e. 5mm) to calculate the volume for each section of parotid and submandibular glands. Individual volumes were added together to give the total parotid and submandibular glands volume. The width (a) and thickness (b) of the each of the gland was the largest horizontal and anteroposterior diameters in the axial plane of the greatest transverse dimension, respectively. The length (c) of each of the gland was the maximum distance between the superior and inferior portions in the coronal plane.

RESULTS

A total of 54 patients meeting the selection criteria were included in the study. The age of patients in this study ranged from 19 to 78 years (mean age of 46.54 ± standard deviation of 17.10 years). Maximum number of cases belonged to 40-59 years age group [23 (42.6%)] followed by 18-39 years age group [19 (35.2%)] as shown in table 1.

Table 1: Distribution of patients according to age.

Age (years)	Frequency (N=54)	Percentage (%)
18-39	19	35.2
40-59	23	42.6
>60	12	22.2
Total		100%

Out of 54 patients, 27(50 %) were male with a mean age ± SD of 44.44 ±18.51 years and 27 (50 %) were female with a mean age ± SD of 47.86 ±15.85 years.

Table 2: Distribution of subjects according to gender (n=54).

Gender	N	%
Male	27	50.00
Female	27	50.00
Total		100%

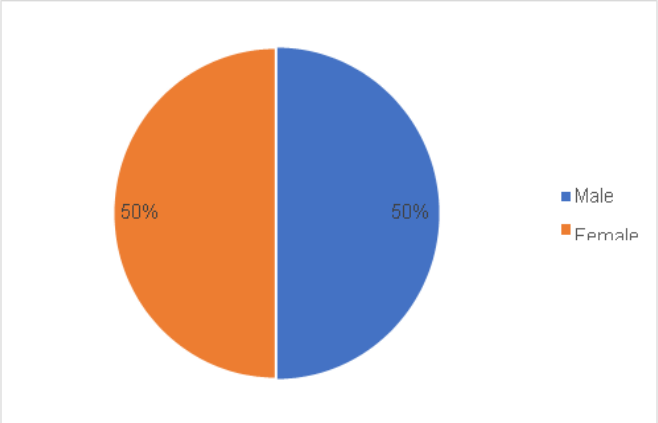

Figure 1: Distribution of subjects according to gender.

Table 3: Size of submandibular gland (N= 54x2=108).

Parameters	Mean ± SD	Minimum	Maximum
Length (cm)	3.19 ± 0.34	2.53	4.14
Width (cm)	2.20 ± 0.24	1.83	2.98
Thickness (cm)	2.48 ± 0.22	2.02	2.98
Volume (cc)	7.81 ± 0.52	6.91	9.19

The mean of submandibular gland length, width, thickness and volume were 3.19 ± 0.34 cm, 2.20 ± 0.24cm, 2.48 ± 0.22cm, 7.81 ± 0.52 cm respectively as shown in the table 3.

Table 4: Size of Submandibular gland comparing Right and Left side.

Parameters		Mean ± Standard deviation	Range (Minimum-Maximum)	P-value*
Length (cm)	Right (n=54)	3.18±0.34	2.53 – 4.03	0.212
	Left (n=54)	3.20±0.35	2.63 – 4.14	
Width (cm)	Right (n=54)	2.20±0.25	1.88 – 2.98	0.398
	Left (n=54)	2.19±0.22	1.83 – 2.72	
Thickness (cm)	Right (n=54)	2.43±0.24	2.02 – 2.98	<0.001
	Left (n=54)	2.52±0.19	2.04 – 2.83	
Volume (cc)	Right (n=54)	7.741±0.50	6.912 – 8.887	<0.001
	Left (n=54)	7.886±0.54	7.006 – 9.195	

(*)- Paired Samples T test

The mean thickness of the left submandibular gland 2.52±0.19 cm was greater than right submandibular gland 2.43±0.24 cm and the difference was statistically significant.

Similarly, the mean volume of the left submandibular gland 7.886±0.54 cc was greater than the volume of right submandibular gland 7.741±0.50 cc and the difference was statistically significant.

No statistical significant difference observed for length and width in right and left submandibular glands.

Table 5: Size of Submandibular gland in Male and Female.

Parameters		Mean ± Standard deviation	Range (Minimum-Maximum)	P-value*
Length (cm)	Male (n=54)	3.42±0.33	2.89 – 4.14	<0.001
	Female (n=54)	2.96±0.16	2.53– 3.24	
Width (cm)	Male (n=54)	2.28±0.22	2.03 – 2.98	<0.001
	Female (n=54)	2.12±0.23	1.83 – 2.85	
Thickness (cm)	Male (n=54)	2.56±0.21	2.12 – 2.92	<0.001
	Female (n=54)	2.40±0.21	2.02 – 2.98	
Volume (cc)	Male (n=54)	8.08±0.53	7.13 – 9.20	<0.001
	Female (n=54)	7.55±0.36	6.91– 8.30	

(*) P-value – Independent Samples T test

Mean length, width, thickness and volume of submandibular gland in male were greater than those in Females and The differences were statistically significant.

Table 6: Correlation of size submandibular gland with age (n=54x2=108).

	Pearson's correlation coefficient (r)	P-value	Remarks
Length	-0.16	0.80	Not significant
Width	-0.11	0.25	Not significant
Thickness	-0.32	0.001	Significant
Volume	-0.05	0.57	Not significant

The length, width and volume of submandibular gland showed weak negative correlation with age. However these were not statistically significant. The thickness of submandibular gland showed weak negative correlation with age which was statistically significant.

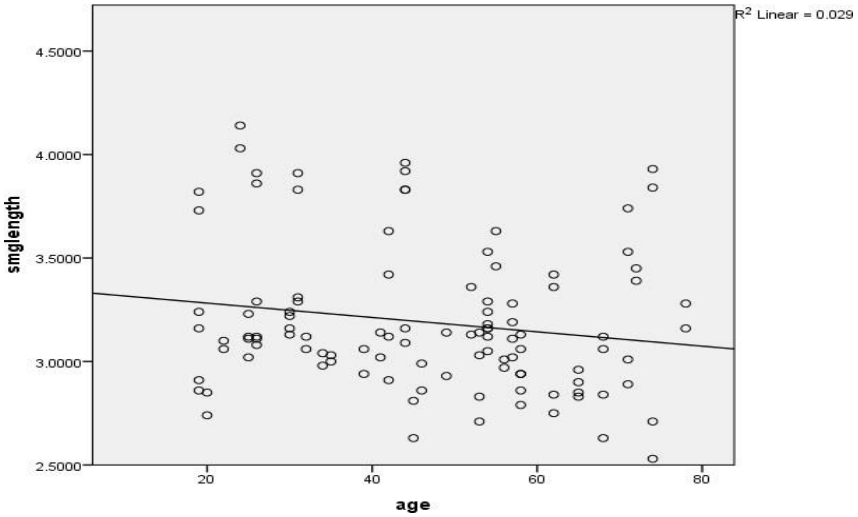

Figure 2: Scatter plot showing weak negative correlation of length ofsubmandibular gland with age.

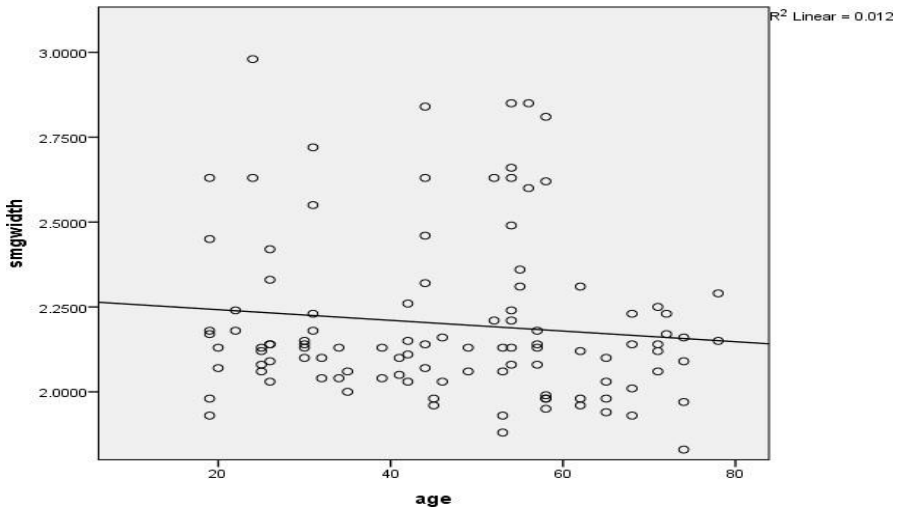

Figure 3: Scatter plot showing weak negative correlation of width ofsubmandibular gland with age.

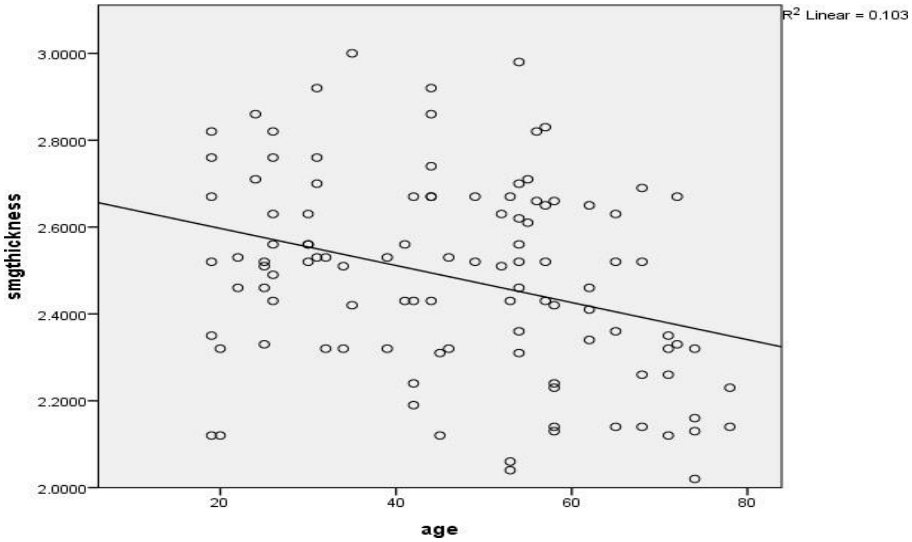

Figure 4: Scatter plot showing weak negative correlation of thickness ofsubmandibular gland with age.

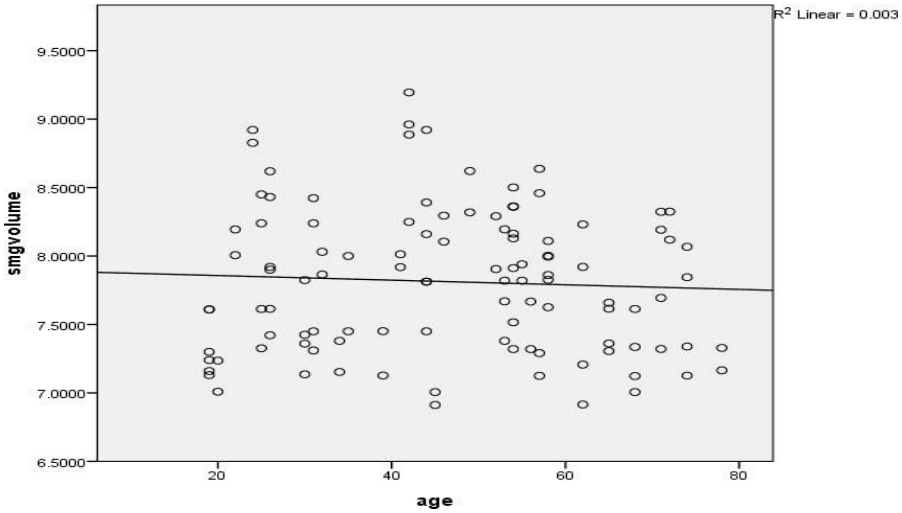

Figure 5: Scatter plot showing weak negative correlation of volume ofsubmandibular gland with age.

Table 7: Distribution of subjects according to BMI (Body Mass Index) (n=54).

BMI	Male	Female	Total
Underweight (BMI < 18.5)	07	09	16
Healthy (BMI = 18.5 to 24.9)	07	07	14
Overweight (BMI = 25 to 29.9)	09	06	15
Obese (BMI > 30)	04	05	09

Out of total study participants 07 male and 09 females were underweight, whereas 07 male and 07 females were having normal BMI. Total 04 males and 05 females were found obese.

Table 8: Correlation of size submandibular gland with BMI (n=54x2=108).

	Pearson's correlation coefficient (r)	P-value	Remarks
Length	0.32	0.001	Significant
Width	0.119	0.22	Not significant
Thickness	0.22	0.01	Significant
Volume	0.23	0.01	Significant

Length, thickness and volume of submandibular gland showed weak positive correlation with BMI, which was statistically significant. Width of submandibular gland showed weak positive correlation with BMI, however it was not statisticallysignificant.

Table 8: Size of parotid gland (N= 54x2=108).

Parameters	Mean ± SD	Minimum	Maximum
Length (cm)	5.03 ± 0.32	4.45	5.94
Width (cm)	2.99 ± 0.33	1.75	3.63
Thickness (cm)	3.35 ± 0.35	2.18	4.37
Volume (cc)	23.16 ± 1.36	19.86	25.85

The mean of parotid gland length, width, thickness and volume were 5.03 ± 0.32 cm, 2.99 ± 0.33 cm,3.35 ± 0.35 cm, 23.16 ± 1.36 cc respectively as shown in the table16.

Table 9: Size of parotid gland comparing right and left side.

Parameters		Mean ± Standarddeviation	Range (Minimum-Maximum)	P-value*
Length (cm)	Right (n=54)	5.06±0.32	4.61 – 5.94	<0.001
	Left (n=54)	4.99±0.32	4.45 – 5.94	
Width (cm)	Right (n=54)	2.99±0.32	1.93 – 3.63	0.241
	Left (n=54)	2.98±0.34	1.75 – 3.63	
Thickness (cm)	Right (n=54)	3.36±0.37	2.18 – 4.37	0.355
	Left (n=54)	3.34±0.32	2.25 – 4.19	

Volume (cc)	Right (n=54)	23.07±1.34	20.08 – 25.12	<0.001
	Left (n=54)	23.26±1.39	19.86 – 25.85	

(*)- Paired Samples T test

The mean length of right parotid gland 5.06±0.32 cm was greater than the length of left parotid gland 4.99±0.32 cm, and the difference was statistically significant.

Similarly, the mean volume left parotid gland 23.26±1.39 cc was greater than right parotid gland 23.07±1.34 cc and the difference was statistically significant.

No statistically significant difference was observed for width and thickness for rightand left parotid glands.

Table 10: Size of parotid gland in Male and Female.

Parameters		Mean ± Standard deviation	Range (Minimum-Maximum)	P-value*
Length (cm)	Male (n=54)	5.22±0.34	4.72 – 5.94	<0.001
	Female (n=54)	4.84±0.16	4.45– 5.24	
Width (cm)	Male (n=54)	3.16±0.24	2.36 – 3.63	<0.001
	Female (n=54)	2.83±0.33	1.75– 3.23	
Thickness (cm)	Male (n=54)	3.40±0.36	2.18 – 4.01	0.180
	Female (n=54)	3.31±0.33	2.86 – 4.37	
Volume (cc)	Male (n=54)	23.93±0.92	22.02 – 25.85	<0.001
	Female (n=54)	22.41±1.32	19.86– 24.22	

(*) P-value – Independent Samples T test

Mean length, width and volume of parotid gland in male were greater than those in females and the differences were statistically significant. Mean thickness of parotid gland was larger in males than females, however the difference was not statisticallysignificant.

Table 11: Correlation of size parotid gland with age (n=54x2=108).

	Pearson's correlation coefficient (r)	P-value	Remarks
Length	-0.22	0.02	Significant
Width	-0.20	0.03	Significant
Thickness	-0.07	0.43	Not significant
Volume	0.39	< 0.001	Significant

The length and width of parotid gland showed weak negative correlation with age which was statistically significant. The thickness of parotid gland showed weak negative correlation with age, however it was not statistically significant. The volume of parotid gland showed weak positive correlation with age which was statistically significant.

Scatter diagram

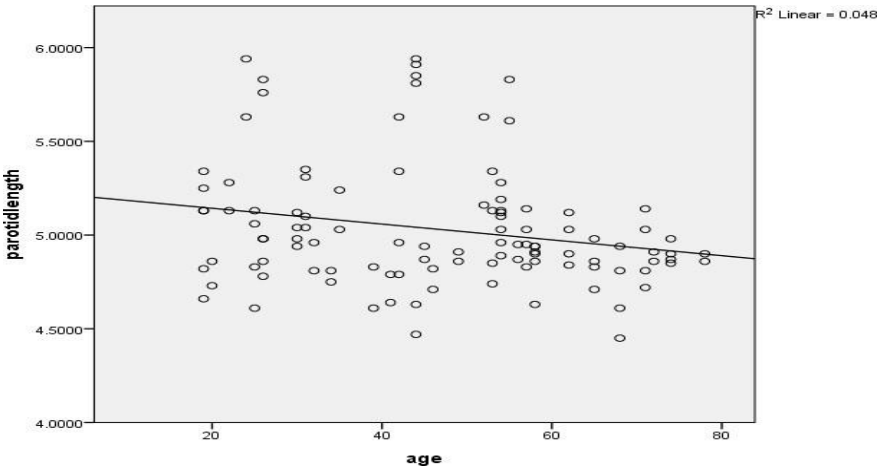

Figure 6: Scatter plot showing weak negative correlation of length of parotid glandwith age.

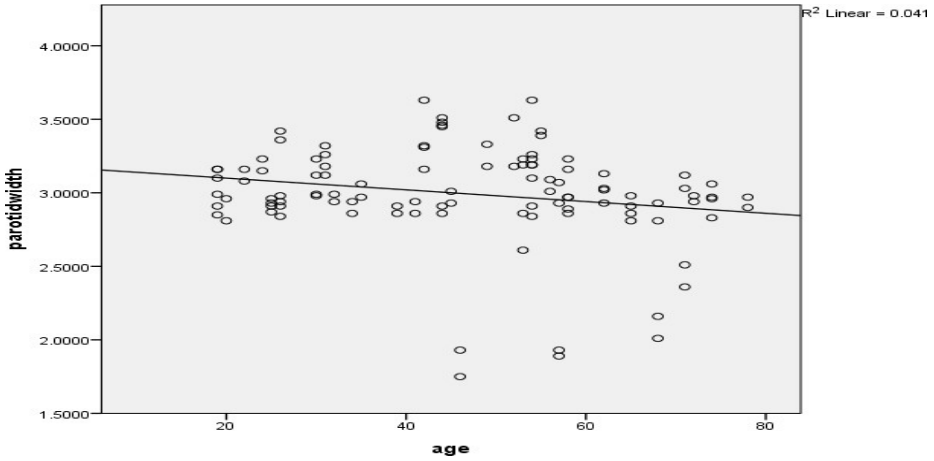

Figure 7: Scatter plot showing weak negative correlation of width of parotid glandwith age.

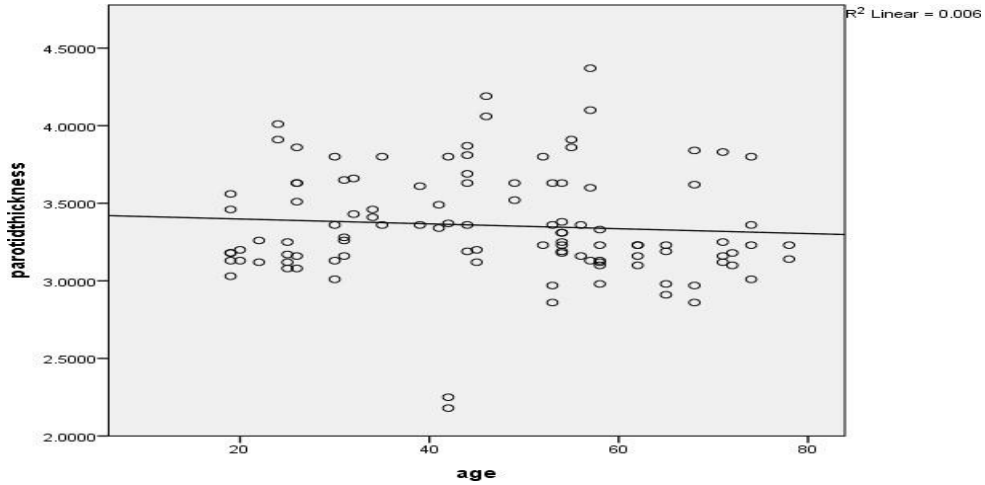

Figure 8: Scatter plot showing weak negative correlation of thickness of parotidgland with age.

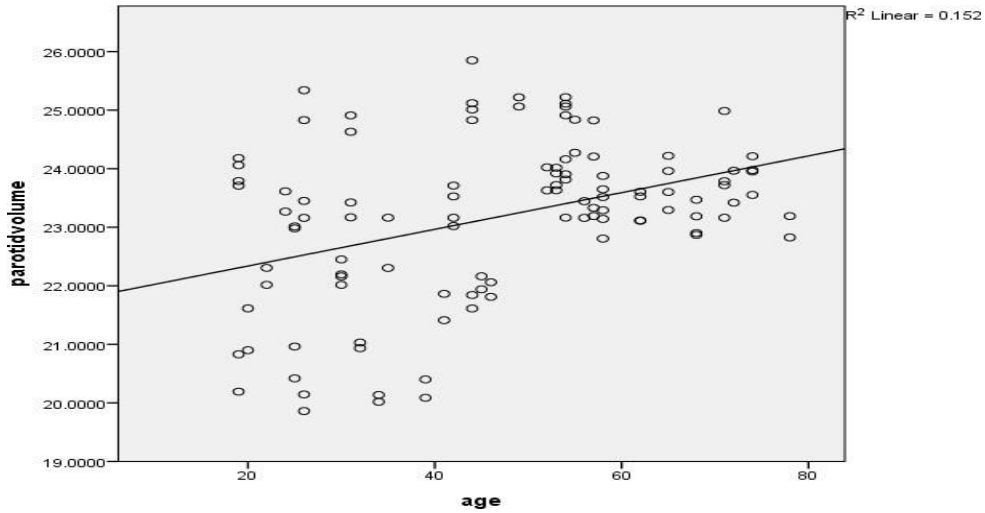

Figure 9: Scatter plot showing weak positive correlation of volume of parotid gland with age.

Table 12: Correlation of size parotid gland with BMI (n=54x2=108).

	Pearson's correlation coefficient (r)	P-value	Remarks
Length	0.28	0.003	Significant
Width	0.12	0.19	Non significant
Thickness	0.14	0.12	Not significant
Volume	0.23	0.01	Significant

The length and volume of parotid gland showed weak positive correlation with BMI which was statistically significant. The width and thickness of parotid gland showed weak positive correlation with BMI, however it was not statistically significant.

DISCUSSION

This study was conducted to determine the dimensions of parotid and submandibular glands.

The age of patients in this study ranged from 19 to 78 years (mean age of 46.54 ± standard deviation of 17.10 years).Maximum number of cases belonged to 40-59 years age group [23 (42.6%) followed by 18-39 years age group [19 (35.2%)]. In the study carried out by Min-Suk Heo et alout of 42 study cases, majority were from 30 to 40 years age group (8). In our study, the mean length, width, thickness and volume of submandibular glands were 3.19±0.34 cm, 2.20±0.24 cm, 2.48±0.22 cm and 7.81±0.52 cc respectively. This was similar to the study by Onkar et al where the mean length, width, thickness and volume of submandibular glands were 3.26±0.34cm, 1.74±0.27 cm, 2.23±0.37 cm and 7.06±2.5 cc respectively (5). In our study, mean length, width, thickness and volume of right submandibular glands were 3.18 ± 0.34 cm, 2.20 ± 0.25 cm, 2.43 ±0.24 cm and 7.74±0.50 cc respectively. Mean length, width, thickness and volume of left submandibular glands were 3.20 ± 0.35 cm, 2.20 ± 0.25 cm, 2.19±0.22cm, 2.52±0.19 cm and 7.88 ±0.54 cc respectively. Mean thickness and volume of submandibular gland was significantly greater in left compared to right side. However in the study by Yonetsu et al the mean volume of submandibular glands on left and right side did not differ significantly (9). In our study, mean length, width, thickness and volume of submandibular gland in males were 3.42±0.33 cm, 2.28±0.22 cm, 2.56±0.21 cm, 8.08±0.53 cc respectively. Mean length, width, thickness and volume of submandibular gland in females were 2.96±0.16 cm, 2.12±0.23 cm, 2.40±0.21 cm, 7.55±0.36 cc respectively. Mean length, width, thickness and volume of submandibular gland were significantly greater in male compared to female. Similar observations of males having larger dimensions of submandibular gland were made by Fang et al where mean length, width and thickness of submandibular gland in males were 3.53+0.54, 1.75+0.28 and 2.79+0.13 cm and those in females were 3.21+0.86, 1.55+0.31 and 1.70+0.14 cm respectively (10). Similarly in the study by Yonetsu et al the mean length, width, thickness and volume of submandibular gland in males were 2.95±0.40 cm, 1.84±0.35 cm, 2.66±0.33 cm and 8.96±2.40 cc respectively which were significantly larger compared to females where the mean length, width, thickness and volume were2.70±0.41 cm, 1.70±0.38 cm, 2.43±0.33 cm and 6.31±2.33 cc respectively (9). The length, width and volume of submandibular showed weak negative correlation with age (r=-0.16, -0.11, -0.32 and -0.05 respectively) However, none of these correlation were statistically significant. The thickness of submandibular gland showed weak negative correlation with age (r= -0.32) which was statistically significant.

Length, thickness and volume of submandibular gland showed weak positive correlation with BMI (r=0.32, 0.22 and 0.23 respectively) which were statistically significant. Width of submandibular gland in our study showed weak positive correlation with BMI (r=0.119) which was not statistically significant. There is paucity of literature specifically correlating dimensions of submandibular gland with BMI. In the study by Fang et al, there was no statistically significant differences in measured parameters (length, width and thickness) of submandibular gland between two groups (BMI ≥23 and BMI<23) [10]. In our study, the mean length, width, thickness and volume of parotid glands were 5.03+0.32 cm, 2.99+0.33 cm, 3.35+0.35 cm and 23.16+1.36 cc respectively. This was similar to the observations in the study done by Fang et al where mean length, width and thickness of parotid gland were 4.36+1.0 cm, 1.69+0.40 cm and 3.61+0.12 cm respectively (10). In our study, mean length, width, thickness and volume of right parotid glands were 5.06+0.32 cm, 2.99 + 0.32cm, 3.36 ±0.37 cm and 23.07+1.34 cc respectively. Mean length, width, thickness and volume of left parotid glands were 4.99 + 0.32 cm, 2.98+0.34 cm, 3.34±0.32 cm and 23.26+1.39 cc respectively. The mean length of right parotid gland was greater than the length of left parotid gland and the difference was statistically significant. Similarly, the mean volume left parotid gland was greater than right parotid gland and the difference was statistically significant. No statistically significant difference was observed for width and thickness for right and left parotid glands. In the study by Medbery et al, mean volume of right parotid gland was 28.15 cc which was significantly larger that of left parotid gland which was 26.91 cc (11). In this study, mean length, width, thickness and volume of parotid gland in males were 5.22±0.34 cm, 3.16±0.24 cm, 3.40±0.36 cm, 23.93±0.92 cc respectively. Mean length, width, thickness and volume of parotid gland in females were 4.84±0.16 cm, 2.83±0.33 cm, 3.31±0.33 cm, 22.41±1.32cc respectively. All of the measures parameters were significantly larger in males than in females except for mean thickness. This observation was in accordance to the study by Fang et al where mean length, width and thickness of parotid gland in males were 4.60±1.10 cm, 1.74±0.39 cm and3.89±1.02 cm respectively which were significantly larger than in females where the mean length, width and thickness of parotid gland were 4.00±0.98 cm, 1.67±0.39 cm and 3.21±1.64 cm (10). In the present study, the length and width of parotid gland showed weak negative correlation with age (r= -0.22, -0.20 respectively). The volume of parotid gland showed weak positive correlation (r= 0.39) with age. The thickness of parotid gland showed weak negative correlation (r=-0.07) with age, however it was not statistically significant. However, in the study by Fang et al, there was nostatistically significant correlation of age with measured parameters of parotid gland (10). Length and volume of parotid gland showed weak

positive correlation with BMI (r= 0.28, 0.23 respectively). The width and thickness of parotid gland showed weak positive correlation with BMI (r= 0.12, 0.14 respectively), however the correlations were not statistically significant. Although thorough search of literature did not provide the studies focusing specifically on correlation of BMI with length, width, thickness or volume of parotid gland, in a study by Heo et al there was a positive correlation between the BMI and maximum cross section area (MCSA) of the parotid gland (r= 0.64) [8]. Upon thoroughly reviewing various studies concentrated on morphometric study of submandibular and parotid glands, it was noticed that there were very fewsimilar studies and even fewer based on computed tomography. Hence the results of our study could have substantial impact in this regards. In our study, equal number of male and female patients were included. However, this was not true for age categories and BMI. Hence further studies with equal number in these subgroups are warranted to better study the variation according to body size and age. Similarly other factors like effect of smoking and hyperlipidemia which mayaffect sizes of salivary glands could also be studied. Moreover newer CT/MRI scanners with various 3D reconstruction algorithms have better abilities to measure the dimensions especially volume of the salivary glands, which could be employed in future studies.

CONCLUSION

The mean length, width, thickness and volume of submandibular gland were 3.19±0.34 cm, 2.20±0.24 cm, 2.48±0.22 cm, 7.81±0.52 cc respectively. The mean length, width, thickness and volume of parotid gland were 5.03±0.32 cm, 2.99±0.33 cm, 3.35±0.35 cm, 23.16±1.36 cc respectively.

The mean thickness and volume of left submandibular gland were significantly larger than those in right submandibular gland. Mean length, width, thickness and volume of submandibular gland were significantly greater in male compared to female. The thickness of submandibular gland showed weak negative correlation with age. Length, thickness and volume of submandibular gland showed weak positive correlation with BMI.

The mean length of right parotid gland was significantly larger than that in left parotid gland. The mean volume of left parotid gland was significantly larger than that in right parotid gland. Mean length, width and volume of parotid gland were significantly greater in male compared to female. The length and width of parotid gland showed weak negative correlation with age. The volume of parotidgland showed weak positive correlation with age. Length and volume of parotid gland showed weak positive correlation with BMI.

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