Black Sea Journal of Health Science
Open Access Journal
e-ISSN: 2619-9041

BSPublishers

Research Article
Volume 2 - Issue 1: 5-8 / January 2019

ASSESSMENT OF LACRIMAL GLAND VOLUME WITH COMPUTED TOMOGRAPHY IN A TURKISH POPULATION

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Received: *December 03, 2018;* ***Accepted:*** *December 20, 2018;* ***Published:*** *January 01, 2019*

Abstract

Computed tomography (CT) is a commonly utilized method for evaluating head and neck pathologies. The lacrimal glands are usually visible in routine head and neck CT scans. Lacrimal gland (LG) pathologies usually manifests with changes in gland size; therefore, it is essential to have a knowledge of normal LG volumes. The LG size may vary by age, gender and race. This study may be helpful in determining normal values of lacrimal gland volume in a select Turkish population. The aim of this study was to evaluate the volumes of the lacrimal glands by CT in a select Turkish population. One hundred and twenty consecutive paranasal CT scans were retrospectively evaluated. LG volumes were measured in axial paranasal CT images. The LG volume was calculated with OsiriX software by outlining the gland in all consecutive axial images. The statistical analyses of the data were performed using SPSS 20.0 (SPSS Inc., Chicago 2, USA) software. Two hundred and forty orbits of 120 subjects were included in the study. The mean LG volume was 52.94 ± 10.07 mm^3 for the right orbita and 54.48 ± 9.59 mm^3 for the left orbita. There was no significant gender sex-specific difference. There was no significant difference between gender-based LG volumes on both sides. ($p = 0.616$, $p = 0.884$, respectively). Our study may serve as a guide to determine the average values of the LG volumes in a select Turkish population and to identify orbital disorders involving the LGs.

Keywords: Lacrimal gland, Orbita, Paranasal computed tomography

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Cite as: Gungor G, Urfalioglu S. 2019. Assessment of Lacrimal gland volume with computed tomography in a Turkish population. BSJ Health Sci, 2(1): 5-8.

1. Introduction

Lacrimal glands (LG), are a pair of almond-shaped eccrine glands located at upper-outer parts of the orbita, adjacent to lateral and superior rectus muscles (Lorber, 2007; Gao et al., 2013). LGs are located inside the lacrimal fossa in the frontal bone. Their appearance may be confused with the preaponeurotic fat. LGs are divided into orbital and palpebral lobes by the lateral horn of the aponeurosis of

the levator palpebral muscle. However, their division are incomplete due to the posterior wall of the interlobar parenchyma (Gao et al., 2013; Conrady et al., 2016). Each gland is about 20 mm long and 12 mm wide, and the orbital and palpebral lobes are 5 mm and 3 mm thick, respectively (Whitnall, 1979; Obata, 2006).

In embryological life, the main LG develops from a conjunctival crest (Conrady et al., 2016). LG is an exocrine gland similar to mammary and salivary glands (Obata, 2006).

LGs contain both epithelial and lymphoid tissues and are affected by a broad range of neoplastic, infective, infiltrative, inflammatory, and structural conditions (Hughes and Miszkiel, 2006). As swelling and enlargement of one or both LGs occurs in most of these conditions, assessing the integrity of LG is an important task in most imaging studies8. It has been shown that aging impairs LGs' functions and results in an increased incidence of dry eye (Moss et al., 2004). Additionally, LGs are particularly targetted by autoimmune and granulomatous disorders. Alterations in LG size may aid in the diagnosis of these atypical and difficult-to-recognize pathological conditions (Jung et al., 2007; Rabinowitz et al., 2013).

Imaging studies have an important role for differentiating LG disorders from other orbital disorders as well as their diagnosis and follow-up. Furthermore, advanced imaging techniques aid in monitoring treatment response (Balchunas et al., 1983; Kawai et al., 2005). Assessing LG size with computed tomography (CT) scan, an easy-to-access and widely available technique for imaging the head and neck, may provide an opportunity for early diagnosis and treatment of those pathological conditions (Voyatzis et al. 2009).

This study was designed to assess the relationship between age group, sex, and laterality and normal LG volume using CT examination in a select Turkish population, and to compare our results with previous reports. OsiriX software (for volume calculation) was used to formulize LG volume assessment.

2. Material and Method

This retrospective study was conducted at the Kahramanmaraş Sütçü İmam University Department of Radiology. Study approval was obtained from the Institutional Review Board (25.07.18/132) and written informed consent was obtained from each subject. All of patients admitted to the ear-nose-throat (ENT) and plastic and reconstructive surgery departments because of septum deviation and were referred to the radiology department for tomographic evaluation. One hundred and twenty of 190 paranasal sinus CTs performed at Sütçü İmam University Medical Faculty Hospital, Department of Radiology were selected for analysis. The study included CT examinations of persons aged 18 years or older who were free of any orbital disorder in CT examination or any recorded history of such a disorder. Each subject's both LGs were separately visualized and assessed from the paranasal sinus CT images. Patients with a history of trauma, and infiltrative or inflammatory lesions were excluded even when their lesions were unilateral.

The images were obtained with a 64-detector scanner (Aquilion, ONE, Toshiba Medical Systems, Otawara, Japan) using a standard paranasal sinus CT protocol. CT images were acquired on axial plane, at a 1-mm section thickness, and with the values of 25 cm FOV (field of view), 130 kVp tube voltage, and 150 mAs. The coronal reformatted images were constructed perpendicularly to the axial images, using a DICOM image viewer. Image measurements were done on workstation (Apple Inc., Cupertino, California, US, OsiriX V.4.9 imaging software Pixmeo, Switzerland). Both axial and coronal images were assessed with a soft tissue window (Tamboli et al., 2011). An image from among the axial images where the lacrimal gland appeared the largest was selected to measure the dimensions of the gland (Figure 1).

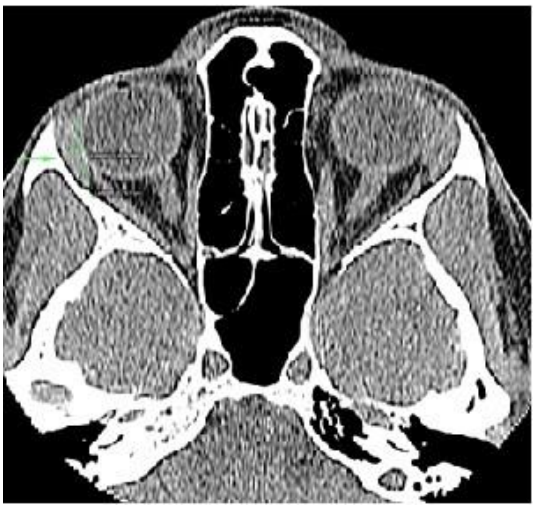

Figure 1. Axial CT image shows the lacrimal gland in the superolateral aspect of the right orbita

In order to formulize the reference values of LG volume, the OsiriX software (for volume calculation) was used. The borders of the gland were drawn with the free hand technique using the pen tool (Figure 2).

Figure 2. On an axial CT image the borders of the right lacrimal gland was drawn with a pencil and the mean volume was calculated by a software

Then, the volume of the selected area was calculated by the software. Interobserver variability was tested by a radiologist and an ophthalmologist measuring the glands independently from the same image series. After interobserver agreement was ensured by assessing twenty random CT scans, a radiologist performed the remaining measurements.

2.1. Statistical Analysis

A power analysis revealed a study power of 0.83. The statistical analyses were performed using SPSS 20.0 (SPSS Inc., Chicago 2, USA) software. Descriptive statistics were given as number (*n*), percentage (%), and mean ± standard deviation (SD). Normality of the data distribution was tested using Kolmogorov-Smirnov and Shapiro-Wilk tests. The Independent Samples t-test and One-way ANOVA test were used for the comparisons of categorical and numerical data. Leneve test was used to assess homogeneity of variances. A value of $p > 0.05$ was accepted as statistically significant. Spearman correlation analysis was used for correlation analyses of numerical data. If p was< 0.05, the r value was checked.

3. Results

A total of 240 lacrimal glands of 120 patients were assessed. An analysis of the demographic features revealed that 46.7% (*n*=56) of the study participants were female and 53.3% (*n*=64) were male; and the female patients had a mean age of 33.30 ± 14.37 (18-70) years while males had a mean age of 34.93 ± 13.11 (18-64) years (p = 0.516).

An analysis of LG volumes showed that the mean volume was 52.94 mm^3 ± 10.07 on the right side and 54.48 mm^3 ± 9.59 on the left side. There was no significant difference between gender-based LG volumes on both sides according to Independent-Samples *t* test. (p = 0.616, p = 0.884, respectively). Mean age and gender-based lacrimal gland volumes were presented on Table 1.

An analysis of the correlation between patient age and gland volumes on both sides revealed no significant correlation between the right lacrimal gland volume and age (p = 0.100) although there was a very weak inverse correlation with the left-sided lacrimal gland volume and age (p = 0.04, r= -0.19).

Table 1. Mean age and sex-based distribution of lacrimal gland volumes of the study population

	Sex			
	Female (*n*=56)	Male (*n*=64)	Total (*n*=120)	
	Mean ± SD	Mean ± SD	Mean ± SD	P value
Age (y)	33.30 ± 14.37	34.93 ± 13.11	34.18 ± 13.69	0.516
Right area (mm^3)	53.43 ± 11.09	52.50 ± 9.15	52.94 ± 10.07	0.616
Left area (mm^3)	54.61 ± 10.51	54.36 ± 8.80	54.48 ± 9.59	0.884

Table 2. Age group-based distribution of lacrimal gland volumes of the study population

	LG Volumes	
	Right	Left
Age Range (n)	Mean ± SD	Mean ± SD
18-28 (n=53)	54.50 ± 11.21	55.89 ± 10.59
29-39 (n=26)	53.35 ± 10.30	53.96 ± 9.53
40-50 (n=23)	51.24 ± 8.00	53.78 ± 8.61
51-61 (n=12)	49.05 ± 6.58	52.09 ± 5.68
≥62 (n=6)	51.74 ± 11.88	51.77 ± 11.34
P value	0.432	0.640

When the patients were categorized into homogenous age groups (18-28, 29-39, 40-50, 51-61, and 62≥ years), no significant difference was found between right-sided and left-sided lacrimal gland volumes in any of the age groups according to One-way ANOVA test (p= 0.432, p= 0.640, respectively) (Table 2).

4. Discussion

In this study, we evaluated normal LG volume using CT examination in a select Turkish population and to compare our results with previous reports. Our results were consistent with the literature. There was no significant difference between gender-based LG volumes on both sides.

Determination of lacrimal gland volume is usually dependent on user experience. Several studies have used lacrimal glands excised from cadavers to determine the actual dimensions of the gland. However, they had a limited clinical utility due to the small sample size and low measurement accuracy due to the destructive effects of dissection (Lorber and Vidic, 2009).

Avetisov et al. (2006) used ultrasonography to quantity lacrimal gland volume in a population of 40 healthy Russian individuals; where they reported a mean volume of 0.66 to 1.00 cm3. Bingham et al. (2013) examined a Caucasian population free of lacrimal disorders using orbita CT. Among 260 orbita examinations, the mean lacrimal gland volume was found0.680 cm3 in men and 0.662 cm3 in women. In another study where, lacrimal gland size and volume were studied the mean LG volume was measured 61.7 mm^3 in the right side and 59.7 mm^3 in

the left side. The authors reported that the volumes were similar on both genders (Bulbul et al., 2016). Our study demonstrated a mean volume of 52.94 mm^3 ± 10.07 in the right side and 54.48 mm^3 ± 9.59 in the left. In accordance with the literature, we showed no significant gender-based difference between the right- and left-sided LG volumes (p = 0,616, p = 0,884, respectively).

Yazici et al. (2015) examined the Schirmer score and LG volume changes in the obstruction-free contralateral eye in patients with unilateral primary acquired nasolacrimal duct obstruction (PANDO). They measured a mean LG volume of 0.479 cm3 in the side of PANDO; 0.479 cm^3 in the non-PANDO side, and 0.580 cm3 in the control group, with the former two being significantly smaller than the latter.

Another study that determined normal LG volume by different age groups and races in 998 lacrimal glands revealed a mean LG volume of 0.710 cm3 in Middle Easterners, 0.760 cm3 in Indians, 0.840 cm3 in Asians, and 0.790 cm3 in Africans. Thirty-six patients having an orbita or paranasal CT examination in addition to an MRI examination within the last three months were selected from among the same patient group and their LG volumes were quantified using the same method. LG dimensions on MRI were not found significantly different from those quantified by CT (Bukhari et al., 2014).

4.1. Study Limitations

Although previous studies have reported that there was no significant difference between CT and MRI for calculation of lacrimal gland volume, tissue densities around the lacrimal gland may cause difficulties in assessing gland borders in CT (Balchunas et al., 1983). Our study's other limitations include the inability to prefer an imaging modality due to the retrospective nature of the study and a relatively small sample size.

5. Conclusions

In conclusion, lacrimal gland volumes have a range that proves useful when making differentiation between normal and abnormal LGs with CT. Information about healthy lacrimal glands may aid in early diagnosis of gland pathologies in routine radiological procedures. This study may also provide assistance and guidance for determining the normal range of LG volume in a select Turkish population. A future multicenter study with a larger sample size may extend the study to involve various ethnic origins and geographic locations.

Conflict of interest

The authors declare that there is no conflict of interest.

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