Libyan Journal of Medical Research

www.ljmr.ly/ eISSN:2413-6096

Original Article

Morphometric evaluation of bony nasolacrimal canal in Libyan adults in Benghazi using CT scan

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Received: 22/10/2024 | Accepted: 25/01/2025 | Published: 02/02/2025| DOI: https://doi.org/10.54361/LJMR.19.1.10

ABSTRACT:

Introduction: The nasolacrimal duct (NLD) consists of two segments: one surrounded by the maxillary bone and the other extending from the lacrimal sac to the bony nasolacrimal duct (BNLD) entry. Given its canal-like structure, the narrowest point of the NLD may play a crucial role in primary acquired nasolacrimal duct obstruction (PANDO). This study aimed to assess the anatomical characteristics of the NLD, specifically the proximal and distal bony diameters, as well as the length of the bony nasolacrimal canal, using computed tomography (CT). Additionally, the study sought to determine whether these parameters differ between males and females.

Method: A retrospective analysis was conducted on 413 individuals (145 females and 268 males) randomly selected from Benghazi Medical Center and Aljala Hospital. CT scans were used to measure the anatomical dimensions of the NLD. Data were analyzed using the Statistical Package for the Social Sciences (SPSS), employing t-tests and one-way ANOVA to compare the parameters across genders and age groups, respectively.

Result: The length of the bony nasolacrimal canal was significantly greater in males than in females. However, no significant differences were found between males and females in the proximal and distal diameters of the bony nasolacrimal canal. Age groups showed no significant correlations with the proximal and distal diameters, but a marginally significant correlation was found between age and the length of the bony nasolacrimal canal.

Conclusion : This study offers valuable insights into the anatomical features of the nasolacrimal duct system. It highlights that, while there are no significant differences in the proximal and distal diameters between males and females, the length of the bony nasolacrimal canal is significantly longer in males. These findings enhance our understanding of anatomical variations in the nasolacrimal duct and could inform clinical approaches to managing nasal obstruction in adults.

Key words: Morphometric, nasolacrimal, variations, interventions

How to cite this article: Almashity.Sh, Karwad .M, Araibi.O, Alfitorey.A, Algadi.Ab.Morphometric evaluation of bony nasolacrimal canal in Libyan adults in Benghazi using CT scan
Libya: 2025:19.1-68-76

INTRODCTION:

The palatine bone and the inferior turbinate or concha in the nose form the medial and lateral borders of the nasolacrimal canal, which opens at the inferior meatus of the nose.1 As shown in figure (1) NLD drains the tear fluid via the nasolacrimal canal which is about 12 to 18 mm long.[1]

The nasolacrimal canal begins to develop embryologically around the fifth week of pregnancy.[2] The ectoderm in a groove between the nasal and maxillary prominences begins to thicken linearly. Eventually, this thickening separated into a solid cord and sank into the nearby mesenchyme. The lacrimal sac and the nasolacrimal canal are created as a result of the cord canalizing over time. The inferior concha is where the nasolacrimal duct emerges after extending intranasally.[2]

The NLD is divided into two sections: the segment completely encircled by maxillary bone, and the portion extending from the lacrimal sac to the entrance of the bony nasolacrimal duct (BNLD).[3] as shown in figure 2. The NLD has a canal-shaped structure, and its narrowest point is thought to have a strong influence on the development of primary acquired nasolacrimal duct obstruction (PANDO).[3]

Obstruction of the lacrimal drainage system may be caused by acquired or congenital disorders, persistent membrane at the Hasner valve is a mucous membrane fold at the end of the NLD that prevents the air from blowing back from the nose into the lacrimal sac. The most common site of congenital defects is the Hasner valve, which is also the location where a complete blockage of the NLD may happen. A secondary process associated with a known causative factor or a main idiopathic condition could be responsible for the lacrimal drainage system's acquired blockage.[4] There are several causes of secondary acquired lacrimal duct blockage. The most common causes include facial trauma or surgery, neoplasms, sarcoidosis, or Wegener's granulomatosis (granulomatosis with polyangiitis).[5] Epiphora is a common presenting complaint in ophthalmology clinics and is caused in one-third of cases by NLD c

Furthermore, women over 40 are more likely to experience epiphora as a symptom of PANDO. Several factors are suspected to be predisposing factors, including nasal problems, sinusitis, topical timolol or chloramine exposure, and a history of conjunctival infections, even if the exact etiology of the disorder remains unknown.[7-8]

In the literature, nasolacrimal recanalization is a new endoscopic surgical treatment for treating NLD blockage that involves the retrograde removal of obstructing tissues through electrocauterization. This procedure, which has a high success rate, is an effective, safe, simple, and minimally invasive technique to treat NLD obstruction. The treatment of primary acquired NLD blockage needs knowledge of the NLD's whole physical structure as well as stereoscopic form differences between genders.[9]

Knowledge about the anatomical variations of this nasolacrimal duct system will be very useful in interventions for nasal obstruction in adults.

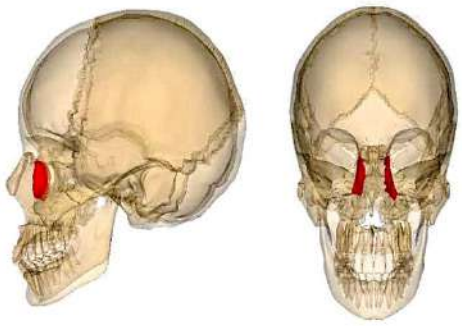
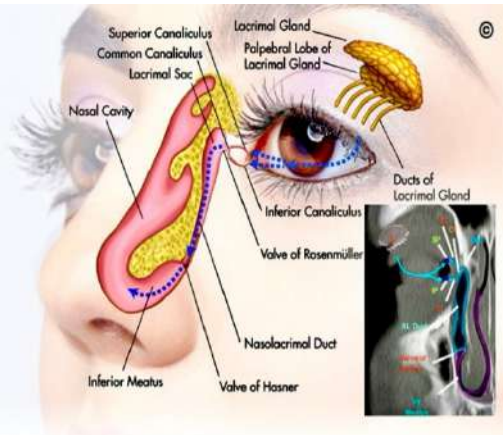


Figure 1. Anatomy of nasolacrimal duct (adopted from Kassel and Schatz).[10]



Figuer 2. Lacrimal bone (adopted from ČIHÁK and Radomír).[11]

Aim:

This study aims to assess the proximal and distal bony diameters, and length bony nasolacrimal canal using computed tomography (CT scan) to obtain detailed anatomical knowledge of the drainage system. It also aims to determine whether there are any differences in variations between males and females.

METHODS AND MATERIAS:

A retrospective study in 724 total number of the subjects randomly selected from Benghazi Medical Center and Aljala hospital, who had a CT scan of their nasolacrimal duct between February 2018 and October 2019, included 413 cases (268 male and 145 female) and 311 subjects were excluded, with ages ranging from 18 to 99. Exclusion criteria include the presence of pathological features or fractures in the entrance area, as well as imaging quality that was inadequate or inappropriate for CT scan, and individuals below 18 years were excluded.

Approval was provided by the Ethics Committee of the University of Libyan International Medical University.

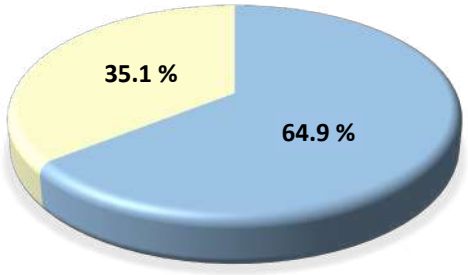
The software Radiant DICOM Viewer 2021 was used to visualize the medical images of CT scans in the sagittal, coronal, and axial planes. Statistical analysis of all the datasets was performed with SPSS, Version 26 (IBM, Armonk, New York) using t-tests and one-way ANOVA to compare the parameters between genders and age groups, respectively.

RESULT:

The current study includes 413 cases (64.9% male and 35.1% female), as shown in table 1 and chart 1. The ages ranged from 18 to 99, according to the distribution of age groups that reveal the majority of the cases at young ages between 18 and 27 years represent about 27% of the data, as a systematic decline of cases with an increase in age as demonstrated in table 2.

Table 1. Total number of cases

Gender	Counts	Percentage
Male	268	64.9 %
Female	145	35.1 %
Total	413	100 %



In order to explain the process used to calculate and analyze the measurements in the present, the *following computation has been performed:*

The vertical (V) and horizontal (H) canal diameters of the left and right canals were measured for a single case in order to determine the proximal and distal diameters. The mean was then computed to represent each case. After that, we could contrast each case with others based on factors including sex or age.

In order to determine the longest values, we first determined the mean of the left and right canals for each case independently. Then, using the measurements as a basis, we compared those mean values with those of the other cases.

Regarding length, we determined the mean of the left and right canals for each instance independently, comparing the results with those of the other cases based on measurements to determine which had the greatest values.

The male right canal proximal diameter is (6.57 mm, vertical 9.68 mm), while the left canal diameter is (7.52 mm, vertical 7.08 mm). The male right canal distal diameter is (8.41 mm, vertical 8.91 mm), while the left canal diameter is (7.83 mm, vertical 9.56 mm).

Female right canal proximal diameter (7.43 mm horizontal, 8.4 mm vertical), and left canal proximal diameter (6.01 mm horizontal, 8.38 mm vertical).

distal diameter of the left canal (7.87 mm, vertical 9.49 mm) and right canal (8.64 mm, vertical 9.98 mm) in females.

In men, the right canal measured roughly (1.40 cm) in length, whereas the left canal measured (1.50 cm). The females left canals measures approximately (1.43 cm) in length, whereas the right canal measures (1.63 cm).

Table 2. Distribution of age groups.

Age Groups	Frequency	Percentage
18-27	112	27.1 %
28-39	89	21.5 %
40-51	78	18. 9%
52-63	58	14.0 %
64-75	57	13.8 %
76-87	17	4.1 %
88-99	2	0.5 %
Total	413	100 %

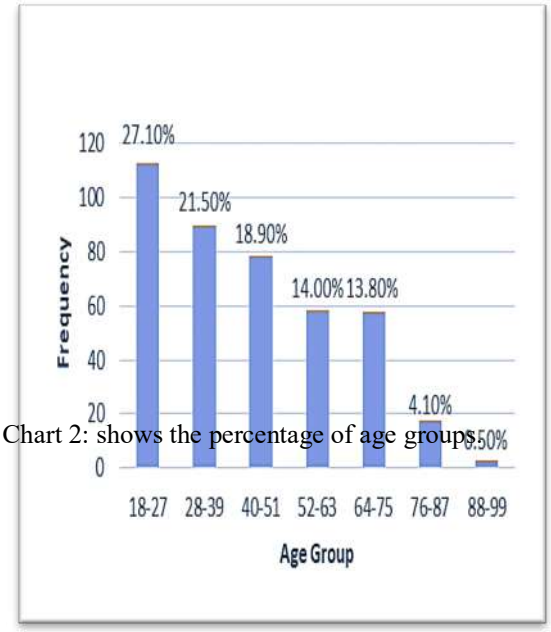


Chart 2: shows the percentage of age groups.

A T-test was used to compare the normal distribution parameters between the two groups, the descriptive statistics, mean values, and standard deviation, and the value of < 0.1 was considered significant statistically (P- value < 0.1

Table 3: Mean of anatomical proximal and distal diameters of the bony nasolacrimal canal by sex.

	Gender	Mean	Std-D	M-D	P-value
Proximal Diameter	Male	5.468	12.125	1.114	0.135
	Female	4.355	0.766		
Distal Diameter	Male	5.322	4.627	0.361	0.217
	Female	4.961	0.882		
Length	Male	8.744	2.103	1.397	0.000
	Female	7.365	1.799		

The proximal diameter of the bony nasolacrimal canal was 5.468 ± 12.125 mm (mean ± SD), and the distal diameter was 5.322 ± 4.627 mm in a male patient. In relation to the female patient, the proximal diameter was 4.355± 0.766 mm as well as the distal diameter was about 4.961± 0.882 mm. No statistically significant difference was found between genders, proximal diameter (p-value = 0.135) and distal diameter (p-value = 0. 217). In addition to this, the length of the bony nasolacrimal canal was significantly greater in male patients (8.744 ± 2.103; 7.365 ± 1.799) than in female patients, with highly statistically significant differences (p-value = 0.000).

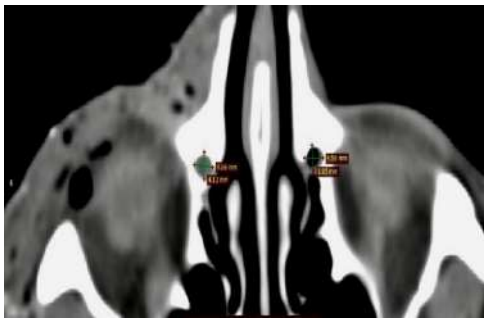
Table 4: Correlation between age and parameters

Age Groups	P-value
Proximal Diameter	0.813
Distal Diameter	0.740
Length	0.069

One-way ANOVA test was used for the comparison of parameters of the normal distribution to test the significant differences among the age groups, when the subjects were divided into seven groups no statistically significant difference was found in proximal and distal diameter (p-value =0.813; p =0.740). However, the length of the bony nasolacrimal canal was affected significantly in age groups (p-value =0.069).

DISCUSSION:

This study revealed that there are no statistically significant differences between males and females in the proximal diameter and distal diameter of the bony nasolacrimal canal. The age range of the cases varied from 18 to 99 years, with a majority of cases occurring in younger age groups (18–27 years). The distribution of age groups showed a systematic decrease in cases with increasing age. Also, in the proximal diameter and distal diameter of the bony nasolacrimal canal, there was no statistically significant difference between age groups in the proximal diameter and distal diameter.



Figuer3. Proximal diameter measurement (Horizontal and Vertical diameter)

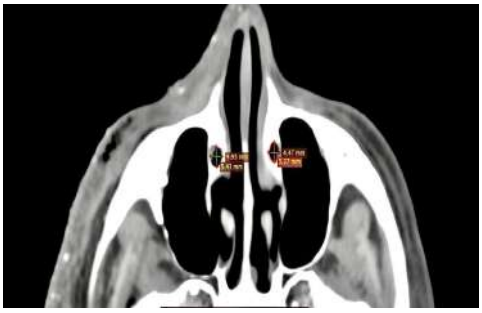


Figure 4**.** Distal diameter measurement (Horizontal and vertical diameter)

Consistent with this study, Ö. Okumuş (2020)[12] demonstrated that there was no statistically significant difference in the diameters of the bony nasolacrimal canal between males and females in all age groups. In addition, Hwa Leea et al. (2012)[13] reported that there is no statistically significant difference in parameters between males and females, which is consistent with this study.

It has been reported by Ela et al. (2019)[14] who investigated the NLD in children and adults that there are no differences in the morphometric value of NLD between age and gender. Furthermore, Czyz et al. (2016)[15] investigated the morphometry of NLD in adult participants according to respiration grade, found that no significant change in morphometric values of NLD between age and gender.

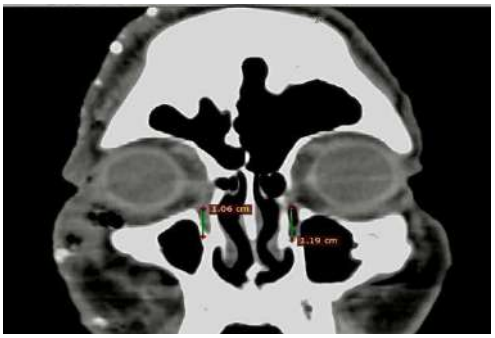
In contrast, Takahashi et al. (2014)16 observed a smaller transverse diameter in females than in males and conversely no discernible gender

eter. Also, Shigeta et al. (2007)17 reported reduced transverse, anteroposterior, and sectional diameters of the bone nasolacrimal canal in female patients compared to male patients as well as McCormick and Sloan (2009)[3] evaluated the racial and gender variations in nasolacrimal canal diameter and conclude that there were no racial differences and that females

had narrower canals. Moreover, Vatansever et al. (2021)[18] demonstrated statistically significant differences between genders for the anteroposterior diameter of the NLD in favor of men.

These findings provide valuable anatomical insights into the nasolacrimal duct system. The lack of significant differences in the proximal and distal diameters between genders suggests that these dimensions may not vary based on gender.

However, the length of the bony nasolacrimal canal was found to have a highly statistically significant difference among males and females (p-value = 0.000). Also, in the length of the bony



nasolacrimal canal, there was a statistically significant difference between age groups (p-value = 0.069). Difference in the length of the bony nasolacrimal canal between males and females indicates a potential anatomical variation that may have clinical implications. The anatomical differences observed in the length of the bony nasolacrimal canal between males and females may have implications for interventions targeting nasal obstruction in adults.

This is in agreement with the finding of Nicholas et al. (2014)[19] who found statistically significant differences in the length of the bony nasolacrimal canal among the genders.

Furthermore, Zhiheng et al. (2021)[20] discovered statistically significant differences in the length of the nasal cavity between genders when they compared the nasolacrimal duct anatomy between gender, age, and facial features and investigated correlations between bony parameters. Also,

Sonhyun et al. (2021)[9] investigated the length of bony nasolacrimal duct there was statistically significant between male and female, these studies are consistent with this study.

Although the precise etiology of nasolacrimal duct obstruction remains not completely understood, some studies have suggested that cigarette smoking, facial-sinonasal trauma, and a history of dacryocystitis are potentially contributing factors. [20] On the other hand, certain etiological factors, such as obstruction and stasis of the drainage system, result from inflammation that induces edema and congestion, and the lacrimal drainage system gradually fibrosis and atrophies as a result of this process. [21] Also, one of the identified etiological factors is the smaller dimension of the bony nasolacrimal canal. [21]

Any variation in nasolacrimal canal dimension may contribute to the obstruction by influencing tear flow. [12] In general, obstruction occurs in the area where the lacrimal drainage system physiologically narrows, such as the tract of the lacrimal duct or the junction of the lacrimal sac and duct. [13] Certain research findings indicate that variations in the dimension of the facial skull between genders and races may be responsible for the narrower nasal canal, as well as the differences in the incidence of obstruction of the nasal duct, which corresponds to this study. [12]

Understanding the etiological factor and variations of NLD can assist surgeons and ophthalmologist in treating patients more easily and effectively, especially according to our study, females are more susceptible to NLD obstruction because they have a shorter NLD than males. In addition, the study assessed the correlation between age and the parameters of the nasolacrimal duct system. The proximal and distal diameters did not show significant correlations with age. However, the length of the bony nasolacrimal canal demonstrated a marginally significant correlation with age groups. This suggests that the length of the canal may be influenced by age-related factors, although the significance of this finding requires further investigation.

The result of the current study helps to discussion on parametric diagnosis for nasolacrimal duct obstruction and epiphora, and help clinicians plan the management options and orient them to the invasive approaches for nasolacrimal duct pathology in adults. It will also help to advance radiology understanding, which may be utilized to create computerized models for creating newer surgical procedures and guidance techniques for nasolacrimal duct operations.

CONCLUSION:

This study provides detailed anatomical knowledge of the nasolacrimal duct system by assessing the proximal and distal bony diameters and the length of the bony nasolacrimal canal using CT. The findings suggest that there are no significant differences in the proximal and distal diameters between males and females, while the length of the bony nasolacrimal canal is significantly greater in males. These findings contribute to our understanding of the anatomical variations in the nasolacrimal duct system and may have implications for interventions targeting nasal obstruction in adults. Further research is needed to explore the functional significance of these anatomical differences and their clinical implications.

REFERENCES:

1. Sharma HR, Sharma AK, Sharma R. Modified External Dacryocystorhinostomy in Primary Acquired Nasolacrimal Duct Obstruction. J Clin Diagn Res. 2015 Oct;9(10):NC01-5.

2. Imre A, Imre SS, Pinar E, Ozkul Y, Songu M, Ece AA, Aladag I. Transection of Nasolacrimal Duct in Endoscopic Medial Maxillectomy: Implication on Epiphora. J Craniofac Surg. 2015 Oct;26(7):e616-9.

3. McCormick A, Sloan B. The diameter of the nasolacrimal canal measured by computed tomography: gender and racial differences. Clin Exp Ophthalmol. 2009 May;37(4):357-61.

4. Bartley GB. Acquired lacrimal drainage obstruction: an etiologic classification system, case reports, and a review of the literature. Part 3. Ophthalmic Plast Reconstr Surg. 1993;9(1):11-26. PMID: 8443110.
5. Hurwitz JJ. Diseases of the sac and duct. In: Hurwitz JJ, editor. The lacrimal system. Philadelphia: Lippincott-Raven; 1996. p. 117–22.
6. Linberg JV, McCormick SA. Primary acquired nasolacrimal duct obstruction. A clinicopathologic report and biopsy technique. Ophthalmology. 1986 Aug;93(8):1055-63.
7. Ohtomo K, Ueta T, Toyama T, Nagahara M. Predisposing factors for primary acquired nasolacrimal duct obstruction. Graefes Arch Clin Exp Ophthalmol. 2013 Jul;251(7):1835-9.
8. Seider N, Miller B, Beiran I. Topical glaucoma therapy as a risk factor for nasolacrimal duct obstruction. Am J Ophthalmol. 2008 Jan;145(1):120-123.
9- Lee S, Lee UY, Yang SW, Lee WJ, Kim DH, Youn KH, Kim YS. 3D morphological classification of the nasolacrimal duct: Anatomical study for planning treatment of tear drainage obstruction. Clin Anat. 2021 May;34(4):624-633.
10- Čihák R. Anatomy I. 2nd ed. Prague: Grada; 2001. 516 pp. ISBN 978-80-7169-970-5.
11- Kassel EE, Schatz CJ. Anatomy, imaging, and pathology of the lacrimal apparatus. In: Som PM, Curtin HD, eds. Head and neck imaging. 5th ed. St. Louis, MO: Elsevier-Mosby; 2011:757–853.
12- Okumuş Ö. Investigation of the morphometric features of bony nasolacrimal canal: a cone-beam computed tomography study. Folia Morphol (

13- Lee H, Ha S, Lee Y, Park M, Baek S. Anatomical and morphometric study of the bony nasolacrimal canal using computed tomography. Ophthalmologica. 2012;227(3):153-159.
14- Valencia MRP, Takahashi Y, Naito M, Nakano T, Ikeda H, Kakizaki H. Lacrimal drainage anatomy in the Japanese population. Ann Anat. 2019 May;223:90-99.
15- Czyz CN, Bacon TS, Stacey AW, Cahill EN, Costin BR, Karanfilov BI, Cahill KV. Nasolacrimal System Aeration on Computed Tomographic Imaging: Sex and Age Variation. Ophthalmic Plast Reconstr Surg. 2016 Jan-Feb;32(1):11-6.
16- Takahashi Y, Nakata K, Miyazaki H, Ichinose A, Kakizaki H. Comparison of bony nasolacrimal canal narrowing with or without primary acquired nasolacrimal duct obstruction in a Japanese population. Ophthalmic Plast Reconstr Surg. 2014 Sep-Oct;30(5):434-8.
17- Shigeta K, Takegoshi H, Kikuchi S. Sex and age differences in the bony nasolacrimal canal: an anatomical study. Arch Ophthalmol. 2007 Dec;125(12):1677-81.
18- Erçakmak B, Vatansever A, Demiryürek D, Gümeler E. Morphometric evaluation of nasolacrimal duct. Anatomy. 2021 Apr;15(1):64-8.
19- Maliborski A, Różycki R. Diagnostic imaging of the nasolacrimal drainage system. Part I. Radiological anatomy of lacrimal pathways. Physiology of tear secretion and tear outflow. Med Sci Monit. 2014 Apr 17;20:628-38.
20- Lin Z, Kamath N, Malik A. High-resolution computed tomography assessment of bony nasolacrimal parameters: variations due to age, sex, and facial features. Orbit. 2021 Oct;40(5):364-369.
21- Janssen AG, Mansour K, Bos JJ, Castelijns JA. Diameter of the bony lacrimal canal: normal values and values related to nasolacrimal duct obstruction: assessment with CT. AJNR Am J Neuroradiol. 2001 May;22(5):845-50.