International Journal of Anatomy and Research,
Int J Anat Res 2022, Vol 10(4):8469-75. ISSN 2321-4287
DOI: https://dx.doi.org/10.16965/ijar.2022.205

Original Research Article

A study on Morphometry and Related Surgical Importance of Naso Lacrimal Duct

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ABSTRACT

Introduction: The Nasolacrimal duct is the terminal part of the nasolacrimal apparatus or tear apparatus. The anatomy of lateral nasal wall is Important for planning the surgeries on lacrimal duct through intranasal approach.

Objective: The current study was designed to review the anatomy of nasolacrimal duct in relation to the lateral nasal wall.

Material and method: Thirty sagittal sections (14 right and 16 left side) of head and neck of formalin fixed adult cadavers of known sex, gender, ethnicity present in department of anatomy GMCH, Chandigarh were studied. The following parameters were made using a digital calliper and rounded off to the nearest millimetres. 1.Length of nasolacrimal duct (NLD Length) 2. Nearest distance from the nasolacrimal duct to maxillary sinus ostium (NLD - MSO) 3. Nearest distance from the NLD to the anterior nasal spine. (NLD- ANS)4. Nearest distance of the intranasal orifice of the NLD to the nasal floor (NLD- NF) 5. Nearest distance of the intranasal orifice of the NLD to the nasal roof. (NSD- NR) 6. Nearest distance of the intranasal orifice of the NLD to the anterior attachment of the Inferior concha. (NSD- AIT).

Observations: In our study the average length of the NLD was 19.8±1.57mm. The intranasal orifice of the NLD was observed to be located on an average of 24.5±2.6mm from the anterior nasal spine, ranging from 5.5-2. 9mm.The average distance from the nasal roof was found to be 32.2±1.67mm and 16.08±1.71mm from nasal floor. In addition, the average distance from the anterior attachment of inferior nasal concha was found to be 14.82±2.37mm. In our study the NLD was an average of 4.08±0.67mm anterior to MSO at the level of the anterior attachment of the MT. On Comparing right and left side The NLD Was found to be slightly longer 22.7 in comparison of 22.2 mm on left side. The distance of NLD From MSO was also found to be larger on left side. The distances of NLD-ANS, NLD NR, NLD -AIT and NLD- NF were also longer on left side.

Conclusion: We found that most of the parameters were closer to a study done by Ertugel while the NLD-NF distance was more in our specimen.

Running title: nasolacrimal duct: morphometry, surgical importance

KEY WORDS: Nasolacrimal duct, Maxillary sinus ostium, nasal floor, nasal roof, Anterior attachment of inferior concha.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Anatomy and Research** ISSN (E) 2321-4287 | ISSN (P) 2321-8967 **https://www.ijmhr.org/ijar.htm** **DOI-Prefix:** https://dx.doi.org/10.16965/ijar
DOI: 10.16965/ijar.2022.205	**Article Information**
	Received: 02 Jun 2022 Accepted: 20 Oct 2022 Peer Review: 05 Jun 2022 Published (O): 05 Dec 2022 Revised: 13 Sep 2022 Published (P): 05 Dec 2022

INTRODUCTION

The Nasolacrimal duct is the terminal part of the nasolacrimal apparatus or tear apparatus. It is the inferior continuation of lacrimal sac. It courses within the maxilla and lateral nasal wall so it has two parts, The intraosseous part and membranous part. The intraosseous or proximal part enters the lacrimal groove of maxilla and descends within nasolacrimal canal of maxilla. The lower part or distal part, which is called membranous part runs in the nasal mucosa. The membranous terminates below the inferior nasal meatus as a slit like opening [1].

Tears are normally drained into nose through the inferior ostium in to the inferior meatus of the nose. Any pathology causing obstruction of the NLD can lead to the excessive overflowing of the tears over the face, called as epiphora [2].

For most of the pathologies of the NLD surgery is usually the treatment of choice which can be attempted, externally or intranasally. The most favoured procedure for the surgical treatment of sinonasal pathologies is endoscopic technique because it favours direct revelation, evaluation and management of the intranasal pathologies, in comparison to external cystorhinostomy for the management of watering eye, which can leave patient with scar mark [3]. The understanding of anatomy of lateral nasal wall is Important for planning the surgeries on lacrimal duct through intranasal approach. For this the data from cadaveric studies can be very useful in designing approaches and procedures. These studies can help surgeons in enhancing their knowledge regarding lateral nasal wall [4].

However, complications like monocular vision, spatial disorientation and limits of the scope of the operative field can occur during endoscopic procedure. Here The Precise knowledge of intranasal anatomy chiefly that of lateral nasal wall will play an important role in preventing iatrogenic complications and can lead to a safe and successful intranasal endoscopic surgery [5].

Objective: The current study was designed to review the anatomy of nasolacrimal duct in relation to the lateral nasal wall. The morphometric measurements of relevant structures nearby, which help as guide during surgeries, were also taken. This data can be used as a guideline to assist the surgeon during surgical and radiological procedures.

MATERIALS AND METHODS

Thirty sagittal sections of head and neck of formalin fixed adult cadavers present in department of anatomy GMCH, Chandigarh were selected for the study. Out of thirty, sixteen sections were of left side and fourteen were of right side. Information about the sex and ethnicity of cadavers was not available. The sections with damaged lateral nasal wall were not included in the study. Nasal septum was removed, the orifice of Naso lacrimal duct (NLD) was identified and exposed.

To have a better view, some part of inferior nasal concha was removed. The anterior part of middle nasal concha was also dissected vertically up to its anterior attachment. Then the NLD was dissected and to observe the relationship with the maxillary sinus ostium (MSO), the uncinate process and anterior part of middle turbinate (MT) were resected, sparing a small part of MT for orientation

Dimensions of duct and other following parameters were made using a digital calliper and rounded off to the nearest millimetre. All the measurements were taken thrice and average was taken.

- Length of nasolacrimal duct (NLD Length)
- Nearest distance from the nasolacrimal duct to Maxillary Sinus Ostium. (NLD- MSO)
- Nearest distance from the NLD to the anterior nasal spine. (NLD -ANS)
- Nearest distance of the intranasal orifice of the NLD to the nasal floor (NLD- NF)
- Nearest distance of the intranasal orifice of the NLD to the nasal roof. (NSD -NR)
- Nearest distance of the intranasal orifice of the NLD to the anterior attachment of the Inferior concha. (NSD -AIT)

Table 1: Master Chart of the various parameters of Naso lacrimal duct (NLD).

Sr no	SIDE	NLD Length	NLD-MSO	NLD-ANS	NLD-NR	NLD-NF	NLD-AIT
1	RIGHT	22.2	4.3	29.4	33.9	17.09	12.5
2	LEFT	19.4	3.9	23.2	31.5	16.5	11.5
3	LEFT	22.7	4.7	22.3	32.9	16.4	12.4
4	LEFT	21	4.1	26.1	31.5	19.5	15.4
5	RIGHT	21.2	3.4	27.6	32.5	16.1	16.6
6	LEFT	20.2	5.5	24.8	28.8	18.5	17.5
7	RIGHT	22.2	4.3	26.6	32.7	19.1	14.7
8	LEFT	18.7	3.9	27.3	28.9	17.8	19.4
9	LEFT	21.2	4.2	23.8	30.8	17.4	19.6
10	LEFT	22.4	3.8	26.2	31.8	14.7	16.4
11	RIGHT	18.4	4.6	22.7	34.3	17.6	16.7
12	LEFT	17.8	3.2	21.5	32.4	17.2	12.4
13	LEFT	18.7	4.9	22.4	33.7	15.8	15.5
14	RIGHT	21.9	5.3	22	32.2	15.6	12.3
15	LEFT	18.5	4.2	24.4	30.1	16.4	11.7
16	LEFT	17.8	5.1	28	35.1	15.5	12.6
17	LEFT	18.5	4.8	30.6	32.6	15.2	11.5
18	RIGHT	17.5	4.2	28.2	34.2	18	12.1
19	RIGHT	19.4	3.81	23.8	33.9	16.2	12.7
20	RIGHT	18.2	4.38	22.4	33.4	13.8	16.8
21	RIGHT	18.9	3.8	23.6	32.8	15.4	16.6
22	RIGHT	20.4	3.2	21.6	31.4	12.5	13.4
23	LEFT	18.6	4.2	23.8	33.4	13.3	14.9
24	LEFT	17.9	4.3	22.5	30.1	16.7	15.1
25	RIGHT	20.4	2.9	21.8	31.66	15.4	17.2
26	LEFT	19.8	3.8	24.7	32.41	12.9	16.3
27	RIGHT	21.6	2.9	20.8	34.49	14.5	13.4
28	RIGHT	19.9	4.2	25.6	30.65	15.6	17.1
29	LEFT	21.2	3.9	27.3	29.99	17.01	17
30	RIGHT	19.8	2.9	21.9	34.43	14.9	13.4
S. D.		1.57	0.67	2.62	1.67	1.7	2.37
AVERA		19.88	4.08	24.56	32.28	16.08	14.8

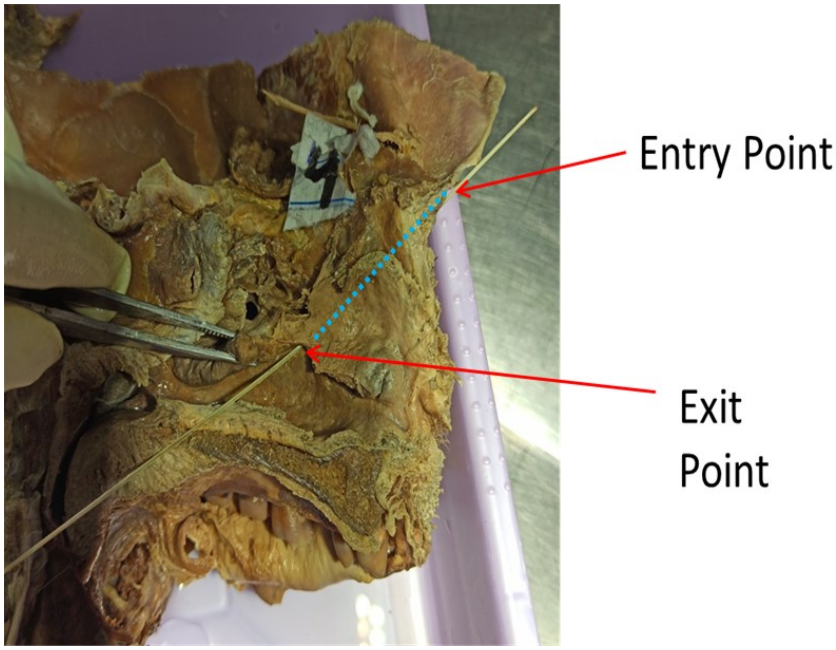

Fig. 1: Showing the probe in the nasolacrimal duct.

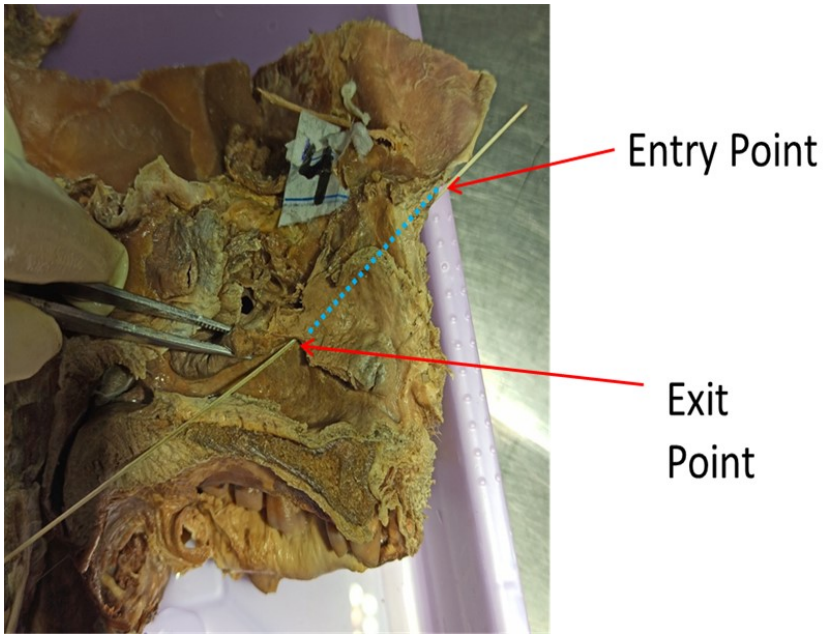

Fig. 2: Showing (A) probe in the nasolacrimal duct (B)measuring length of nasolacrimal duct with the help of caliper.

RESULTS

In our study the average length of the NLD irrespective of the side was 19.8±1.57mm (Table 1). The intranasal orifice of the NLD was observed to be located on an average of 24.5±2.6mm from the anterior nasal spine, ranging from 5.5-2. 9mm.The average distance from the nasal roof was found to be 32.2±1.67mm and 16.08±1.71mm from nasal floor. In addition, the average distance from the anterior attachment of inferior nasal concha was found to be 14.82±2.37mm.

Posteriorly the NLD has close relationship with the uncinate process and the maxillary sinus ostium. In our study the NLD was an average of 4.08±0.67mm anterior to MSO at the level of the anterior attachment of the MT.

Table 2: Comparison of range between measurements of the NLD from neighbouring structures on right and left side.

	Right [14]		Left [16]	
	Max	Min	Max	Min
NLD length(mm)	22.2	17.5	22.7	17.8
NLD-MSO (mm)	5.3	2.9	5.5	2.9
NLD-ANS (mm)	29.4	20.8	30.6	21.5
NLD-NR (mm)	34.9	30.6	35.1	28.8
NLD-NF (mm)	19.1	12.5	19.5	12.9
NLD-AIT (mm)	17.2	12.1	19.6	11.5

On Comparing right and left side The NLD was found to be slightly longer 22.7 in comparison of 22.2 mm on left side. The other distances of NLD From MSO was also found to be larger on left side. The distances of NLD-ANS, NLD NR, NLD -AIT and NLD- NF were also longer on left side. (Table 2)

DISCUSSION

The development of nasolacrimal duct in the nasolacrimal apparatus begins at five weeks of gestation. It starts as a linear thickening of ectoderm, present at the junction nasal and maxillary prominences. This Thickening later invades and forms a groove. The thickening in the groove gradually separates and forms a a solid cord. This cord further sinks into the surrounding mesenchyme. Gradually with the development this cord canalizes and forms proximally the lacrimal sac and distally the nasolacrimal duct[6]. This solid nasolacrimal duct extends intranasally to open in the inferior meatus under the inferior turbinate. Gradually the inside of the cord breaks down and forms a lumen so this forms a continuous canal from orbit to inferior meatus of lateral nasal wall. This process is generally complete by the time of birth. Tears are formed in the lacrimal gland. They are poured into conjunctival sacs. Most of the tear's fluid evaporates and the remaining fluid is drained into the nose through the NLD. In cases of incomplete canalization of lacrimal duct epiphora or excessive lacrimation occurs because of incomplete drainage of the tears. To expose the nasolacrimal apparatus for dacryocystorhinostomy (DSR) is done by surgeons both externally as well as through the nose. Endoscopic techniques is preferred by the surgeons nowadays in comparison to the external surgery [3,7,8].

Accurate anatomical knowledge of Naso lacrimal system and specifically Naso lacrimal duct Position and its relation with the surrounding structures on the lateral nasal wall is essential before proceeding for the internal endoscopic DSR for successful surgical results [9-15].

To localize the NLD on the lateral nasal wall, some important landmarks are used for localisation of NLD opening e.g., to estimate the position of the NLD at the beginning of endoscopic surgery, anterior nasal spine and anterior attachment of the inferior nasal concha can be used. The Usual distance as given in the foreign literature of intranasal orifice of NLD is approximately 24.5 mm away from the anterior nasal spine (ANS) and 14.8 mm from the attachment of the (AIT)inferior nasal concha. The NLD passage is normally superiorly and anteriorly from the orifice to the anterior attachment of middle nasal concha. The course of the NLD should be kept in mind during lateral osteotomies in rhinoplasty surgeries. In lateral osteotomy surgery, it begins from pyriform opening, just above to the anterior attachment of the inferior nasal turbinate. Care must be taken to prevent the NLD during procedures like rhinoplasty, which involve the lateral nasal wall; where NLD is constantly been at danger [16,17].

Iatrogenic Nasolacrimal system injury can lead to postsurgical epiphora, synechiae formation, which may require lacrimal diversion procedures later on. So, for identification of the operative limits, knowledge of the nasal anatomic variations is always good [16,17].

In the present study, average length of the NLD was 19.8mm. In Korean cadavers Kim et al found it to be 16.8 $\pm$ 2.4 mm [18].

In another study on Neolithic skulls length was found to be somewhat shorter among American coloured males than white males [19].

During cannulation of NLD from above or from inferior opening, length becomes vital in selecting the probe length so as to prevent surrounding visceral injury. The uncinate process and ostium of maxillary sinus are chief landmarks to determine the location of the NLD. The uncinate process is related just posterior to the NLD, which is only 4mm anterior to maxillary sinus ostium. These relationships play vital role during endoscopic sinus surgery. During maxillary sinus antrostomy, first of all, uncinate process is removed and then maxillary sinus ostium is enlarged anteriorly with the help of back-biting forceps. When these procedures are attempted, the NLD is at risk of injury due to its close relationship with the uncinate process and maxillary sinus ostium. Therefore, a good knowledge of surgical anatomical relationships plays a vital role to prevent unintended injury during endoscopic sinus surgery. The iatrogenic injury to NLD following endoscopic sinus surgery has been accounted to be 0.3-1.7% [20,21-25].

Table 3: Comparison of morphometric parameters of nasolacrimal duct by various authors with present study.

Mean/std dev	Kim et al [18]	Sahni SS et al [25]	Ertugral et al [26]	our study
NLD length (mm)	16.8±2.4	11.42±2.45	21±2.03	19.8±1.57
NLD-AIT (mm)	-	14.78±2.92	14.3±2.05	14.82±2.27
NLD-MSO (mm)			3.9±0.88	4.08±0.67
NLD-ANS (mm)			24.6±3.56	24.5±2.6
NLD-NF			13.7±3.15	16.08±1.71

To expose the bone covering of the NLD, the mucosa on the lateral nasal wall anterior to the uncinate process has to be removed during endoscopic DSR. we found that the average length of NLD is about 19.8mm, it depicts that at least 1.5 cm of mucosa has to be taken out to get the adequate exposure of entire NLD. On the other hand, this amount of mucosa removal may not be needed during endoscopic DSR.I n epiphora cases, there is sac dilation due to NLD obstruction. Consequently, the proximal portion of the obstruction or the sac directly must be opened into the nasal cavity on the lateral nasal wall. In most of the cases, the location of the NLS is above the anterior attachment of the MT [11].

For locating lower portion of NLD anterior attachment of MT in downward direction is a good guide enough to get exposure of obstructed area [12].

This is the area where the rhinotomy opening should be located. It is also imperative to keep in mind that that this area is just related anterior to the frontal recess region. This anatomical association should be noted during bone dissection in this region in order to prevent unintended injury to the frontal recess. Furthermore, the most anteriorly placed frontal ethmoidal cell, an Agger nasi cell, which lies anterior to the MT, can be encountered in this region [23-25].

The intranasal opening of the NLD can also be utilized to conclude the estimated position of NLD. We found that the former is positioned 24.5mm posterior to anterior nasal spine and can be found on the roof of the inferior nasal meatus. The NLD lies superiorly near the anterior attachment of the MT. Thus, the NLD must be searched for on the line between the orifice and anterior attachment of the MT. The average length of the MLD was about 19.88 mm.

his study provides some valuable data for surgical success during endoscopic DSR. However, these observations in the lateral wall of nasal cavity could be useful in familiarizing with such variations and guiding safe endoscopic procedures.

CONCLUSION

This study attempts to provide information regarding the position and location of the NLD in relation to the important landmarks in the lateral wall of the nasal cavity. These observations in the lateral wall of the nasal cavity are important during the endoscopic interventions. In our study, average length of the NLD was 19.8mm which is less then Turkish study but more then In Korean subjects NLD was found to be away from the floor and maxillary ostium in comparison to Turkish subjects.

ACKNOWLEDGEMENTS

The authors sincerely thank those who donated their bodies to science so that anatomical research could be performed. Results from such research can potentially increase mankind's overall knowledge that can then improve patient care. Therefore, these donors and their families deserve our highest gratitude."

Conflicts of Interest of each author/ contributor: No conflict of interest

Financial Assistance: No financial assistance was taken for this study.

Author Contributions

Diksha Sharma: Practical work
Anshu Sharma: conception and execution of the work
Kanchan Kapoor: Facilitator

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How to cite this article:

Diksha Sharma, Anshu Sharma, Kanchan Kapoor, A study on Morphometry and Related Surgical Importance of Naso Lacrimal Duct. Int J Anat Res 2022;10(4):8469-84775. **DOI:** 10.16965/ijar.2022.205