Morphometric Analysis of the Nasolacrimal Canal: A Study on South Indian Maxillae

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ABSTRACT: Various anatomical and radiological studies have been conducted across the world to study the morphometry of nasolacrimal canal, considering its clinical importance in acquired nasal obstruction. However there is paucity of literature from India concerning the morphometry of the canal in the dry adult maxillae. The aim of the present study was to estimate quantitative parameters of the nasolacrimal canal of adult dry South Indian Maxillae. The measured parameters of the Nasolacrimal canals in the present study were found to be variable from other reported studies. The right nasolacrimal canal was found to be longer than the left canal and the width of the middle 1/3rd was narrower than the upper and lower 1/3rd. In 55.18% of the maxillae the canal was directed downwards and backwards and in 37.93% was found to be cylindrical in shape.

INTRODUCTION

Nasolacrimal Canal (NLC) is an interosseous canal extending from the medial wall of the orbit to the inferior meatus of the nose. Osseous canal is formed by the lacrimal crest, maxilla and inferior nasal concha. In life the canal lodges the lower excretory part of lacrimary system, the nasolacrimal duct (NLD) (Nema and Nema, 2002).

Obstruction of the NLD with epiphora constitutes about 3% of all the ophthalmic conditions (Linberg and McCormick, ’96; Kei-ichi-Sigeta, 2007).

Acquired obstruction of the canal is classified into two types; primary and secondary obstruction. The primary acquired nasolacrimal duct obstruction (PANDO) develops commonly in the lacrimal sac or the duct. Among the listed etiological factors, smaller diameter of the bony NLC is considered as one of the contributing factors for development of NLD obstruction (Linberg and McCormick, ’96; Kei-ichi-Sigeta, 2007; Casper et al., ’93; Bartley, ’93).

The previous studies have reported variable differences in the canal diameters for gender, age, side and the race (Kei-ichi-Sigeta, 2007; Bartley, ’93; Jannsen et al., 2001). The methods used to determine the NLD obstruction include clinical examination by

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fluorescein dye, lacrimal probing, irrigation, conventional radiography-CT scans. Currently lacrimal endoscopies—a new non-invasive method—are extensively used to assess the lacrimal system and its mucus membrane. As it allows the surgeon to differentiate between inflammatory, partial, and complete stenosis. Thus allowing the surgeon to choose the appropriate surgical therapy for patients.

It is necessary for the surgeon to have a thorough knowledge of the NLC. Thus an attempt had been made to measure the bony canal of the maxillae directly on dry macerated NLC of adult South Indian Maxillae.

The present study was aimed to estimate the length, width, shape, and direction of the osseous NLC, which is an essential prerequisite before the planning of invasive procedure of the NLD, so as to minimise functional interference with physiological action of the lacrimal apparatus.

MATERIAL AND METHODS

Cross sectional observational study was carried out on twenty nine (29) human macerated adult maxillae (right:15; left:14) of unknown sex, definite age, of South Indian origin from the collection of department of Anatomy, St John’s Medical College, Bangalore, India. All samples were inspected to ensure that the NLC was intact, free from anomalies and pathological destructions before measurement. The parameters were measured with digital callipers (Mitutuyo) by three observers separately and the mean of the three were analysed for statistical analysis.

The measured parameters include:

1. Length of NLC: measured from lacrimal notch to inferior endpoint of lacrimal margin (Fig. 1).
2. Width of upper, middle and lower 1/3rd of NLC (Fig. 2).
3. Direction of NLC (Fig. 3a & 3b).
4. Shape of NLC (Fig. 4): to determine the shape of the canal, silicone gel was injected into the nasolacrimal canal, it was allowed to dry, once dried gel was carefully removed and the shape of the canal was determined.

RESULTS

1. Length of NLC: (Table 1): On right side; the average length of NLC was 15.07mm with a range of 11.28 to 18.28mm and on the left side; the average length was 13.78mm with a range from 10.64 to 15.87. No significant difference was observed between the mean length on right side (15.07±2.02) and on left side (13.78±1.75).

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<td>Length of nasolacrimal canal</td>
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<td>n 29</td>
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<td>Mean ± SD</td>
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<td>Length (mm)</td>
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<td>(11.28 – 18.28)</td>
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<td>Unpaired t-test</td>
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2. Width of upper, middle and lower 1/3rd of NLC: (Table 2): The width at upper and lower 1/3rd was observed to be more than the middle 1/3rd for both right and left canals, indicating a narrower NLC in the middle 1/3rd. The width was observed to be more at upper and lower 1/3rd on left side than the right side whereas the width at middle 1/3rd on right side and left side was more or less similar. Unpaired t-test showed no statistical significance between the width of right and left sides.

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<td>Width of nasolacrimal canal</td>
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<td>n 29</td>
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<td>Mean ± SD</td>
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<td>Width</td>
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<td>6.32 ± 0.71</td>
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<td>Unpaired t-test</td>
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Pearson’s correlation was applied to study the association of length with the width on right and left side. Significant correlation was observed only for the right length with the right width at upper and middle 1/3rd (r=0.6; p<0.05)

3. Direction of NLC: Direction of NLC was found to be downwards and backwards in 44.82% (13) and downwards in 55.18% (16) maxillae irrespective of the side.
4. Shape of the NLC: Five different shapes were reported. Cylindrical 37.93% (11), funnel 27.58 (8), crescentric 6.89% (2), boat 6.89% (2) and hour glass 20.68% (6).

DISCUSSION

90-95% of the obstruction of the NLD has been successfully operated with newer surgical procedures. The reported surgical failure is mainly incorrect.
identification of the lacrimal apparatus, thus failure to make an adequate osteotomy and fibrosis of the bony osteotomy (Mannor and Millman, ’92).

Recent ophthalmic surgical interventions are made by non invasive procedures with the help of endoscopy. However other surgical procedures such as laser therapy, balloon dilatation, and stent implantation are all done with instrumentation or invasive procedures.

Either of these procedures requires a thorough anatomical knowledge of the lacrimal passages to prevent damage of the soft tissues and dislocation of the stent. The diameter of the balloon or stent selected should correspond to the diameter of the nasolacrimal duct. Thus it becomes an essential prerequisite for the operating surgeon to choose the optimal stent that may be implanted without irritating the lacrimal system (Groell et al., ’97).

Anatomical, CT scan studies have been performed on the measurement of the length and breadth of NLC by previous authors (Groell et al., ’97, Jeysingh et al., ’90; Ipek et al., 2007). On comparison with a similar study on dry maxillae by Ipek et al. (2007), the measured means showed a difference in length and width of the canal. The length was comparatively smaller and width was found to be widest at the middle 1/3 rd which is very much different from the present study.

Earlier studies have assessed the normal diameter of the bony canal on skulls or cadaver heads or radiographs.

The transverse diameter is approximately 4.6mm according to Duke-Elder, 4.8 mm by epoxy resin cast (Steinkogler, ’86), on macerated adult skulls. Wide variability has been reported for antero-posterior diameter of the canal from 6.8 mm to 3.5 mm by Janssen et al. (2001). The osseous length of the NLD varies from 6 to 21mm with breadth 2 to 7mm (Casper et al., ’93). The reported normal length of NLC is 17mm on the right and 18 mm on the left side.

CT scan studies by Groessl et al. (’97) has reported length of nasolacrimal canal as 21.9 mm with
mean anteroposterior width 5.6mm. An Indian study of 200 adult skulls from Uttar Pradesh population by Jeysingh et al. (’90) have reported that the anteroposterior diameter (6.8mm) of the superior aperture of the canal was more than the transverse diameter (4.6 to 4.8mm) on both sides of the NLC however the transverse diameter was reported to be more on right side, and the anteroposterior diameter was more on the left side.

A cadaveric study of the fifty NLD by Kumar et al. (2009) have reported that the length of 16mm and 16.42mm and breadth of 5.66 mm and 5mm for right and left side respectively. However no significant difference was found between the mean values of the sides, no correlation between length and breadth of the NLD.

On comparison with the available literature the mean length of canal is smaller (15.07 ± 2.02 on right and 13.78±1.75 on left) in the present study as compared to the other studies. The diversity of difference in measures could be the result of age, sex, race, methodology of estimation.

Considering the variability in the shape of the canal that is from cylindrical, funnel, hourglass, crescentric, and boat shaped the diameter cannot be same at all levels. Depending on the shape the canal diameter varies. So the diameter measured at the ends (infraorbital margin or meatal opening) cannot be considered as standard measures. Narrowest diameter is generally found at the half way through the canal (Kumar et al., 2009).

Tomographic measurement of NLC at three different levels (upper, middle and lower) of 36 men and 35 women, reported that the lower and middle canal dimensions were found to be smaller in women than men (Kumar et al., 2009).

However, in the present study middle 3rd diameter was found to be smaller than the upper and lower 3rd diameters bilaterally. NLD obstruction is commonly reported in female patients presenting with epiphora. The increased incidence is thought to be due to the smaller diameter of the lower nasolacrimal fossa and middle canal. The anteroposterior diameter was found to be larger in both sexes may be coinciding with the osteoporotic changes. Other etiological factors which have been put forth include low oestrogen levels leading to dryness of the mucous membrane, generalized deep epithelialization of mucous membrane during menstrual cycle. Thus the narrow passages when present would mechanically get obstructed with epithelial debris. Considering the above measures the diameter of the narrower canal doesn’t change following dacrocystoplasty, thus suggesting a negative effect on long term patency of the NLD system.

CONCLUSION

Data collected on NLC is an important prerequisite prior to any surgical procedure of the lacrimal passage. We hope awareness of quantitative measures of the canal can optimize the surgical outcome and minimises risk of damage. To the best of our knowledge this is the only bony study from South India done on NLC of the maxillae. The authors intend to continue the study by increasing the sample size and correlate the quantitative parameters with sex, age and the pathological involvement maxillae.

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