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EVALUATION OF NASOLACRIMAL CANAL FOR GENDER ASSESSMENT USING COMPUTED TOMOGRAPHY (CT) – A RETROSPECTIVE STUDY.

Oral Medicine

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ABSTRACT

Gender assessment in human is an indispensable component of biological evaluation in forensic science. Nasolacrimal canal is one of the prominent landmark of the craniofacial region. So, the aim of the study was to evaluate nasolacrimal canal for gender assessment using CT images. The anteroposterior, transverse diameters, sectional area of the bony nasolacrimal canal, the angle between the bony canal and the nasal floor and length of the nasolacrimal canal were evaluated bilaterally on 104 axial and sagittal CT scans images. Except for the length, all other four dimensions of the nasolacrimal canal were found to be highly statistical significantly greater in males. On comparison between right and left side, all the five dimensions of nasolacrimal canal, there was found to be no statistical significant difference. So it can be concluded that nasolacrimal canal is one of the reliable landmark for gender assessment.

KEYWORDS

Nasolacrimal canal, Computed tomography,

INTRODUCTION

Individuality is based on the establishment of a person's identity. Proper identification of the dead is required both for legal and humanitarian reasons. Traditional methods of identification have included visual recognition of the body, and personal property such as clothing, jewelry etc. These methods, however, are not very reliable in establishing the identity. The more appropriate approach is provided by the forensic experts as they help to analyze physical features present in the body, thus enabling a scientific means of identification. The word forensic, states Clark, is derived from the Latin *forensis,* which means 'before the forum'.[1]

Gender assessment is an indispensable component of biological assessment in forensic science.[2] The importance of gender determination is especially in mass disasters, events which result in multiple fatalities that may not be identifiable through conventional methods such as visual recognition or even fingerprints. Totally mutilated, putrefied human skeletal remains have been one of the most challenging tasks for forensic dentistry and anthropologists.[3]

So, population specific systematic compilation is the need of hour. There are certain skeletal remains which can guide forensic experts towards accurate identification like skull, pelvis. In humans, the bones of the face are considered as the landmarks of the individual distinctiveness since ages.[2] As such, they are more accessible, more familiar sociobiologically, and have been extensively studied.[3] But the inherent complexity of craniofacial bones flaunts diversity in a morphometric pattern which is the basis of individual testimony.[2]

It is not surprising that these parts have been used commonly for identification purposes as the teeth and the bones of the craniofacial skeleton are usually the best preserved parts of human remains.[3] Among various anatomical landmarks, nasolacrimal canal is one of the prominent landmarks of the craniofacial region.

Many patients have the antemortem medical records in the form of medical charts, radiographs, casts and/or photographs.Radiographs are the crucial aid in forensic science which can be well documented, preserved and reviewed. Computed tomography, one of the advanced modality is preferred due to its high resolution, better image quality and as it is readily available.[4] Nasolacrimal canal can be well evaluated routinely on computed tomography.

Literature showed nasolacrimal canal assessment in Japanese, Mongoloid population other than Indian population and single study on south Indian patients.

So, the present study was planned to evaluate nasolacrimal canal for gender assessment of Central Indian population.

SUBJECTS AND METHODS:

This retrospective, comparative, observational study was carried out in collaboration with the Department of Radiodiagnosis, after its approval from the Ethics Committee and Board of research study in the department of Oral Medicine and Radiology. 104 CT images of 52 males and 52 females of high resolution and best quality were randomly selected. Total sample size of 104 subjects (52 per gender type) would yield 95 % power to detect significant differences, with effect size of 0.65 and significance level at 0.05. The images retrieved were of patients above 15 years of age. CT images of patients with any evidence of pathology, trauma or any previous surgery in the same region were excluded from the study. Computed tomography machine used for scan was of 16 slice Toshiba with Vitrea software. The thickness of axial images was 0.05-10 mm.

Nasolacrimal canal dimensions like the anteroposterior diameter, transverse diameter and sectional area of the canal were measured on axial CT scans at the level of infraorbital margin. (Fig 1a)

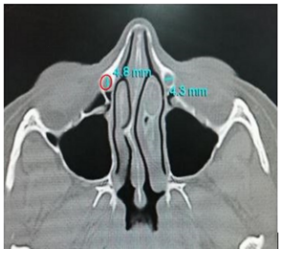

Fig 1a – Showing the anteroposterior diameter, transverse diameter and the sectional area of the nasolacrimal canal (Left nasolacrimal canal showing the anteroposterior diameter and the sectional area of the nasolacrimal canal. Right nasolacrimal canal showing the transverse diameter.)

While on the sagittal scan, the nasolacrimal length was evaluated as linear length from its distal end at the inferior meatus to its proximal end at the nasolacrimal sac-duct junction. (Fig 1b)

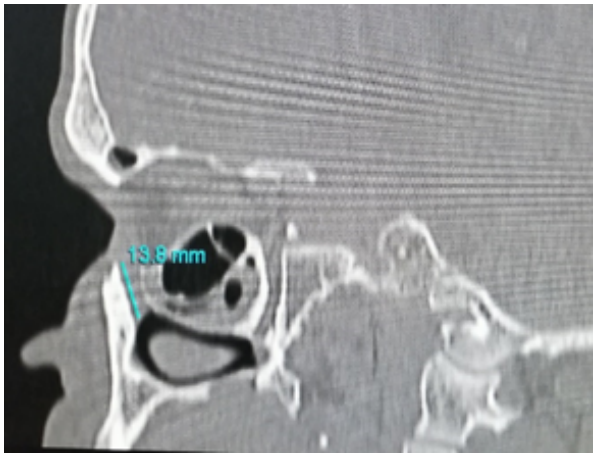

Fig 1b – Showing the length of the nasolacrimal canal.

The nasolacrimal canal angle was marked between the nasolacrimal canal and the line parallel to the nasal floor. (Fig 1c)

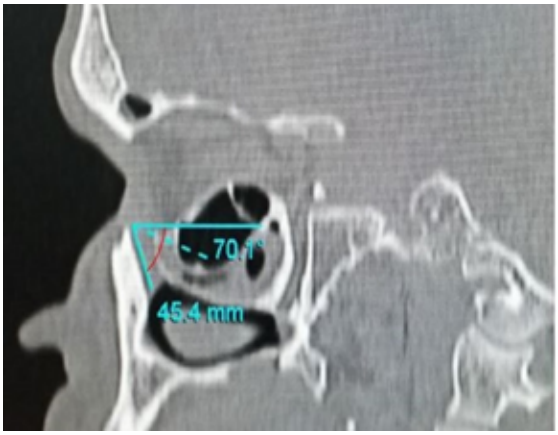

Fig 1c – Showing the angle.

These dimensions were noted bilaterally and in both gender and were analyzed statistically.

RESULTS:

Total 104 patients scans (52 males and 52 females) above 15 years of age group were evaluated. Stastical power analysis was established by G*Power, version 3.0.1 (Franz Faul universitat, Kiel,Germany). The analysis was done by unpaired 't' test. The mean age of the patients was 37.03 years.

In the present study, the mean anteroposterior diameter of the bony nasolacrimal canal in males was 6.02 mm (0.57) and in females was 4.85 mm (0.4). The transverse diameter in males was 5.64 mm (0.67) and in females was 4.79 mm (0.49). The sectional area of the bony nasolacrimal canal in males was 24.58 mm^2 (1. 3) and in females was 23.97 mm^2 (1.14). The angle between the bony canal and the nasal floor in males was 67.2^0 (5.27) and in females was 57.18^0 (3.67). The length of the canal in males was 12.97 mm (0.61) and in females was 14.32 mm (0.67).

Except for the length, all other four dimensions that is anteroposterior diameter, transverse diameter, angle and sectional area of the nasolacrimal canal were found to be highly statistical significantly greater ($p < 0.001$) in males. (Table 1)

Table 1: Comparison between males and females in relation to nasolacrimal canal dimensions in study population. (unpaired 't' test)

	Male Mean (SD)	Female Mean (SD)	Unpaired 't' test	p value, Significance
Anteroposterior	6.02 (0.57)	4.85 (0.4)	t = 16.9	p <0.001**
Transverse	5.64 (0.67)	4.79 (0.49)	t =10.22	p <0.001**
Area	24.58 (1.3)	23.97 (1.14)	t = 3.59	p <0.001**
Angle	67.2 (5.27)	57.18 (3.67)	t =15.89	p <0.001**
Length	12.97 (0.61)	14.32 (0.67)	t = -15.12	p <0.001**

$p > 0.05$ – not significant $*p < 0.05$ – significant $**p < 0.001$ – highly significant

On comparison between right and left side, all the five dimensions of nasolacrimal canal in study population, there was found to be no statistical significant ($p > 0.05$) difference. (Table 2)

Table 2: Comparison between right and left side in relation to nasolacrimal canal dimensions in study population. (Unpaired 't' test)

	RIGHT SIDE MEAN (SD)	LEFT SIDE MEAN (SD)	Unpaired 't' test	p value, Significance
Anteroposterior	5.44 (0.74)	5.44 (0.8)	t = -0.009	p = 0.993
Transverse	5.22 (0.73)	5.21 (0.72)	t = 0.114	p = 0.909
Area	24.26 (1.27)	24.29 (1.26)	t = -0.175	p = 0.861
Length	13.6 (0.92)	13.68 (0.95)	t = -0.598	p = 0.550
Angle	62.24 (6.98)	62.14 (6.57)	t = 0.104	p = 0.917

$p > 0.05$ – not significant $*p < 0.05$ – significant $**p < 0.001$ – highly significant

DISCUSSION

Nasolacrimal canal is one of the prominent landmarks of the craniofacial region. The nasolacrimal canal is 12 to 18 mm long. It is bordered medially by palatine bone and the inferior turbinate in the nose while laterally by maxillary bone. It extends intra nasally until it opens at the inferior meatus of the nose. Embroyologically, the nasolacrimal canal starts forming at around 5^{th} weeks of gestation. It starts as a linear thickening of ectoderm located in a groove between the nasal and maxillary prominences. This thickening eventually separates into a solid cord and sinks into the surrounding mesenchyme. Over time the cord canalizes forming the lacrimal sac and the beginning of the nasolacrimal canal.[4]

Nasolacrimal canal has been assessed mostly for ductal obstruction where females have suffered due to anatomically narrower canals may be due to the gender differences in the facial dimensions suggested by most researchers.[5] Nasolacrimal duct as difficult to ascertain clinically, was not studied much.[6]

Techniques for personal identification in mass disasters includes radiography, UV light, postmortem serology and DNA profiling. Radiographs when available constitute some of the most valuable pieces of evidence for identification. It can provide information in relation to age, gender, race and occupation, diagnosis of certain conditions and identification and cause of death. The present study is an attempt to evaluate nasolacrimal canal for gender assessment in Central India population using CT images.

The anatomical details of nasolacrimal duct can be examined on cadaveric, histologic and radiographic studies.[6] CT is one of the most widely available imaging modalities providing fast, high contrast resolution between bony structures and surrounding soft tissues. Patients with head and neck pathology often screened with CT provides valuable information about nasolacrimal canal.[7]

Nasolacrimal canal can be evaluated by its various dimensions. The present study has assessed its various dimensions like the anteroposterior diameter, transverse diameter, sectional area, angle and length of the canal which none of the previous studies have done.

Anteroposterior diameter of the bony nasolacrimal canal in healthy individuals has been evaluated by several studies like Ozlem O et al (2019)[4], Lee H et al (2012)[8] reported similar to the findings of the present study while the studies reported by Takashi Y et al (2013)[9], Shigeta K et al (2007)[10] done on Japanese cadavers and population respectively noted differences in the dimension.

Transverse diameter of the bony nasolacrimal canal in healthy individuals assessed by several studies as done by Ozlem O et al (2019)[4], Lee H et al (2012)[8], Shigeta K et al (2007)[10] showed findings in accordance with the present study whereas Takashi Y et al (2013)[9], Janssen A et al (2001)[11] noted dimension differences.

Several studies measured sectional area of the bony nasolacrimal canal measured in healthy individuals like studies reported by Lee H et al (2012)[8], Shigeta K et al (2007)[10] which coincides with the findings of the present study.

Length of the nasolacrimal canal measured on South Indian cadavers by Ravindranath Y et al (2012)[13] was similar to the present study.

Angle of the nasolacrimal canal in the present study is smaller than reported in the literature like study conducted by Ozlem O et al (2019)[4], and study on children reported by Ela A et al (2018)[12].

In the study conducted by Ozlem O et al (2019)[4], the anteroposterior diameter of the bony nasolacrimal canal was 6.56 ± 1.53 mm and the transverse diameter was 4.34 ± 1.03 mm. The sectional area of the canal was 7.39 ± 3.29 mm^2 and the angle between the bony canal and the nasal floor was 73.46 ± 6.77^0. Except for angle which was found to be statistically significant in females, no other measurements were found to be significant between gender. Takahashi Y et al (2013)[9] reported shorter transverse diameter in female than in male, on the contrary, no significant gender difference in anteroposterior diameter. Shigeta K et al (2007)[10] reported smaller sectional area, anteroposterior and transverse diameter of bony nasolacrimal canal in female patients than in males. Lee H et al (2012)[8] evaluated the diameters, angle and sectional area of bony nasolacrimal canal in normal patients and they reported no significant gender differences in diameter. McCormick and Sloan (2009)[14] investigated the gender and racial differences in nasolacrimal canal diameter among New Zealand, European population so they concluded that the narrower canals were observed in females and no statistical significant difference between right and left sides while a study by Ramey N et al (2013)[6] reported significantly greater nasolacrimal canal length and volume in men than those in women paralleling gender differences in overall stature. The study conducted by Ela A et al (2018)[12] on Turkish children regardless of the pathology reported no significant difference between gender in relation to sectional area, angle and length of the nasolacrimal canal.

Takashi Y et al (2012)[9] who performed the study on Japanese cadavers and Bulbul E et al (2016)[15] reported no statistical significant difference between right and left sides in relation to anteroposterior, transverse diameters and length of the nasolacrimal canal respectively. Groessl S et al (1997)[16] has reported length of the nasolacrimal canal as 21.9 mm with the mean anteroposterior width 5.6 mm. No difference in diameter between the right and left bony nasolacrimal canals was found. An Indian study on South Indian cadavers by Ravindranath Y et al (2012)[13] have reported no significant difference between the mean values of the right and left sides, no correlation between length and breadth of the duct.

Variations in the measurements in the reported studies to the present one may be due to patient orientation during CT examination and small sample size.

The present study definitely showed significant gender difference in nasolacrimal canal dimensions and hence can be considered as one of the prominent landmark for assessment of gender in Central Indian population.

CONCLUSION

Being an easily identifiable and prominent landmark in the craniofacial region, having low prevelance of pathologies and showed significant gender difference, nasolacrimal canal should be used for gender assessment.

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