International Journal of Clinical Trials
Vinay Kumar N et al. Int J Clin Trials. 2014 Aug;1(2):37-40
http://www.ijclinicaltrials.com
pISSN 2349-3240 | eISSN 2349-3259
DOI: 10.5455/2349-3259.ijct20140801

Research Article

A computerized tomographic study of height of ethmoidal skull base

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Received: 1 July 2014
Accepted: 20 July 2014

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ABSTRACT

Background: During Endoscopic Sinus Surgeries (ESS), the most important anatomical structures that need preoperative visualisation and evaluation are the lateral lamella and ethmoidal skull base as many reports of complications due to injury of these structures exist. Ethmoidal Skull Base (ESB) extends from the superior attachment of lateral lamella of cribriform plate to the junction of the lamina papyracea. The aim is to study and evaluate ESB using coronal sinus CT images.
Methods: Sixty coronal sinus CT scan images at the level of visualization of anterior ethmoidal artery canal were taken for studying the ESB on both sides. A horizontal line bisecting the orbit was taken as the base line reference for inferior extent. The height of the ESB was measured and classified into high, moderate and low ESB by taking 7 mm as upper limit and 4 mm as lower limit. Mean height of ESB in the study group was computed and its difference among gender and sides were noted and statistically analysed.
Results: ESB varied between 3.7 mm to 15.4 mm with mean height of 10.05 mm. Low ESB was found only in females and there was no statistically significant side asymmetry of ESB height.
Conclusions: Preoperative recognition of low ESB and alerting the surgeon of the potential for iatrogenic injury by measuring the height of ESB needs to become a standard practice in order to minimize the complications during ESS.

Keywords: Ethmoid skull base, Low ESB

INTRODUCTION

With the advent of Endoscopic Sinus Surgeries (ESS), dreaded complications like orbital or skull base penetration are being encountered commonly.[1] A definite anatomic knowledge and familiarity of constant landmarks and variations along with a preoperative CT evaluation guides rhinologists to securely traverse through paranasal sinus region with minimal risk to patients.[2] The thin lateral lamella of cribriform plate and low Ethmoid Skull Base (ESB) are potential anatomical variants that can lead to iatrogenic injuries in the form of direct penetration trauma to the Dura, serious intracranial and intra-cerebral complications during ESS.[3-9]

ESB is defined as the orbital plate of the frontal bone, which extends from the superior attachment of Lateral Lamella of Cribriform Plate (LCP) medially to the junction of the Lamina Papyracea (LP) laterally (Figure 1).[10] Previous studies have classified ESB as Keros I, II, III, based on the length of lateral lamella of cribriform plate or depth of olfactory fossa.[11,12] Another study quantified ESB into high (>7 mm), moderate (4 to 7 mm) and low ESB (1 to 4 mm) depending upon the height of the ESB measured from a reference plane.[13]

Even though many studies reporting occurrence of low ESB causing complications during ESS exist[3-9] only limited studies have evaluated low ESB till date.[13,14] So the present study aims to evaluate and classify ESB

preoperatively using coronal paranasal sinus CT scan images in Indian population and to deduce the relationship of ESB between side and gender.

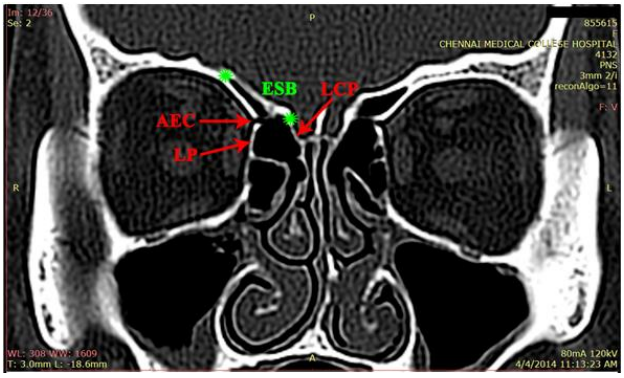

Figure 1: Showing ethmoidal skull base (ESB), anterior ethmoidal artery canal (AEC), lamina papyracea (LP), lateral lamella of cribriform plate (LCP).

METHODS

Sixty coronal paranasal air sinus CT scan images were collected from archives of department of radiodiagnosis. The CT scan images of 3mm thickness were taken using GE VCT multi slice scanner. All the images were analysed using RadiAnt DICOM viewer. CT scans of paranasal sinus done on subjects above the age of 16 years belonging to both genders were included in our study after excluding scan images of subjects with nasal or paranasal trauma, congenital abnormalities of the face, surgeries, tumours or conditions involving bone destruction.

For evaluating the height of ESB on both sides, the coronal slice taken at the level of visualization of Anterior Ethmoidal Artery Canal (AEC) was used (Figure 2). Inferior extent called Mid Orbital Line (MOL) was marked by a horizontal line bisecting orbit (Figure 3). ESB height (H) was measured from MOL to the mid aspect of the ethmoid roof in the medial-lateral plane between the LP and attachment of LCP (Figure 4).[13]

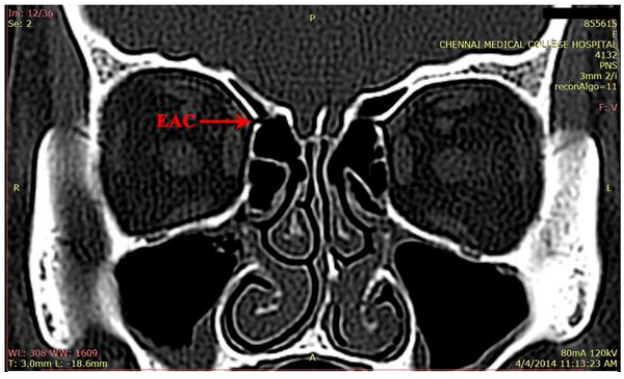

Figure 2: Coronal section at the level of anterior ethmoidal artery canal (AEC).

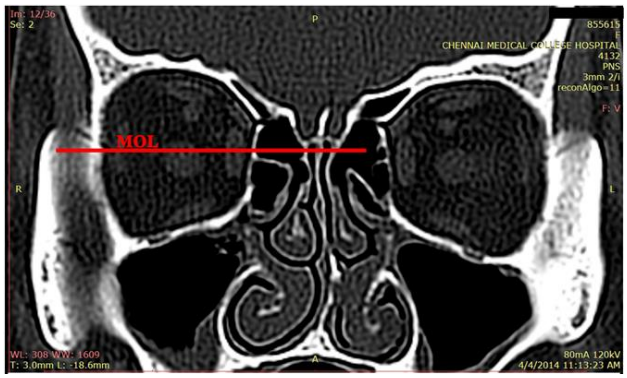

Figure 3: Coronal section showing mid orbital line (MOL).

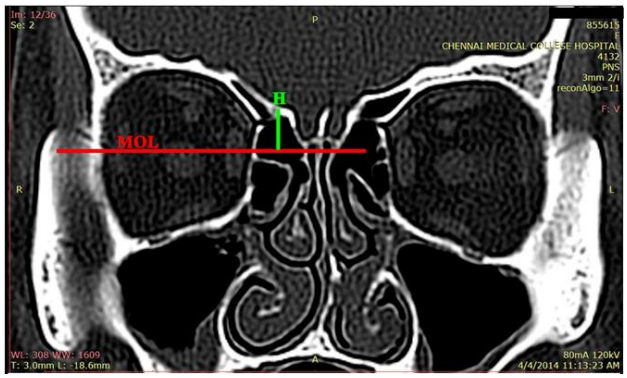

Figure 4: Coronal section showing mid orbital line (MOL) with height of ESB (H).

The data were classified into high, moderate and low ESB and were analysed statistically. The side asymmetry and relation of ESB height with gender and side were tested using two sample 't'test. The data were considered statistical significant at P <0.05.

The study was carried out after clearance from institutional ethical committee.

RESULTS

The observed coronal CT scan images were of 31 female and 29 male subjects with a mean age of 37 years. The height of ESB ranged from 3.7 mm to 15.4 mm inclusive of both sides in 60 CT images with a mean height of 10.05 mm. Of 120 sides measured, 87% belonged to high ESB, 11% to moderate ESB and 2% to low ESB.

On considering sides separately, the right side ESB ranged from 3.7 to 15.4 mm with a mean height of 9.7mm and the left side ESB ranged from 3.7 to 15.3 mm with a mean height of 10.4 mm. The percentages of high, moderate and low ESB individually on both sides were deduced (Figure 5). Even though the mean ESB showed difference between right and left sides, it is not statistically significant as P = 0.102 which is >0.05. Analysis of ESB height with respect to gender alone showed females and males having a mean height of 9.3

mm (range 3.7 mm to 13.8 mm) and 10.8 mm (range 6 mm to 15.4 mm) respectively and the classification showed 3% of females belonging to low ESB category (Figure 6).

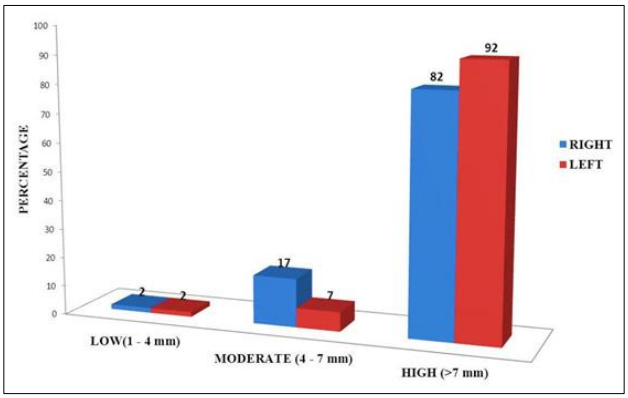

Figure 5: Classification and comparison of ESB height between sides.

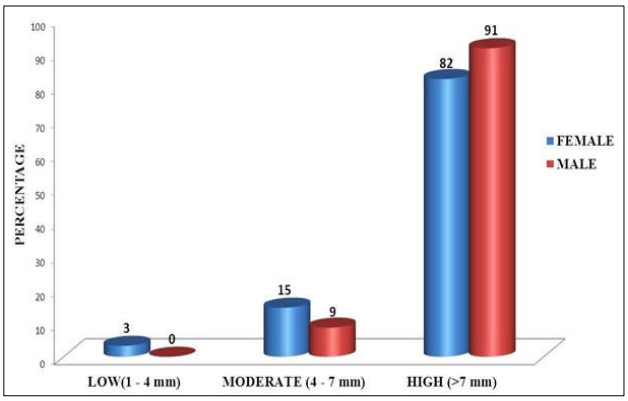

Figure 6: Classification and comparison of ESB height between genders.

The mean ESB height measured in males and females on right side were 10.3 and 9.1 mm while on left side 11.3 and 9.7 mm respectively. This difference in the means observed were statistically significant with P = 0.025 on right and P = 0.012 on left (P <0.05) (Figure 7).

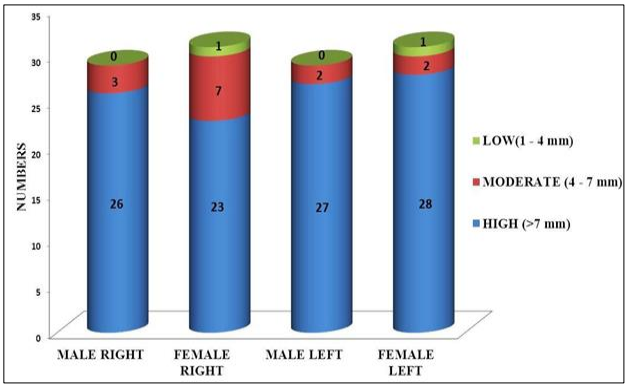

Figure 7: Comparison of ESB height between genders on right and left sides.

DISCUSSION

ESB is an important landmark for ESS which gets injured commonly. Extensive studies have been done on ESB height on various populations using Keros method (Table 1). Analysis of those previous studies, shows Keros II as the common type where olfactory fossa measures 4-7 mm deep. An olfactory fossa depth between 8-16 mm classified as Keros III was seen substantially more in Caucasians compared to other populations studied and this is considered as high risk type during ESS.

Table 1: Keros classification of ESB height in various population.

Population	Keros I (1-3mm)	Keros II (4-7mm)	Keros III (8-16mm)
Indian[9]	17.2%	77.2%	5.6%
Caucasian[11]	83%	15%	2%
German[12]	12%	70%	18%
Filipino[15]	81.6%	17.9%	0.5%
Brazilian[16]	26.3%	73.3%	0.5%
Caucasian[17]	34.4%	28.1%	37.5%
Caucasian[18]	23%	50%	27%
Thai[19]	11.9%	68.8%	19.3%
Korean[20]	53.8%	69.5%	-

An alternative methodology that measured ESB height at the level of visualization of anterior ethmoidal artery canal found high, moderate and low ESB in 70%, 25% and 5% respectively with a mean height of 8.5 mm.[13] The present study which measured ESB height following similar methodology showed high ESB in majority of subjects studied (87%), while moderate and low ESB were of less frequency (11% and 2%). The mean height of ESB observed in this study (10.05 mm) was found to be higher than previous study which explains for the infrequent reports of iatrogenic complications during ESS in Indian population.[13]

Different studies have reported asymmetry in height of ethmoidal roof with a finding of right roof lower than the left.[6,9,21] ESB height analysis for side asymmetry in the present study revealed a numerical difference which was found to be statistically insignificant. On comparing the ESB height between genders, low ESB was seen in 3% of females while it was absent in the males. In addition, range of ESB height in females was lower than males. Observing relation of ESB height between genders on right and left side separately showed a statistical difference between genders on both sides with female having a low mean ESB height.

The occurrence of low ESB in females when compared to males in the present study necessitates a preoperative radiological assessment and measurement of ESB height in Indian population, which will guide the rhinologist to perform ESS with minimal complications. No previous Indian studies have used the methodology of present

study for measuring and classifying ESB height. This study throws the potential for further study that can compare the risk associated with ESS by evaluating ethmoidal skull base using Keros and the present methodology.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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DOI: 10.5455/2349-3259.ijct20140801
Cite this article as: Vinay Kumar N, Gugapriya TS, Guru AT, Nalinakumari SD. A computerized tomographic study of height of ethmoidal skull base. Int J Clin Trials 2014;1:37-40.