Original Article

Relationship between Height of Ethmoid Skull Base and Length of Lateral Lamella by Sectional Coronal Computed Tomography Scan before Endoscopic Sinus Surgery

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Abstract

Background: Damage to ethmoid skull base (ESB) and lateral lamella (LL) during endoscopic sinus surgery (ESS) causes penetration into the brain. This study is aimed to determine the relationship between the height of ESB and length of LL by sectional coronal computed tomography (CT) scans before ESS. **Materials and Methods:** In a cross-sectional study, 100 patients admitted to ENT clinic of Al-Zahra Hospital, filled the consents regarding the use of CT scan stereotype. Each stereotype was evaluated and using the software on two sides the height of ESB and the length of LL were measured, investigated and recorded. Next, the maximum and minimum height and length in the two sides was measured, and its mean calculated. Then, the relationship between the length of LL and the height of ESB was investigated. **Results:** There was a direct correlation, with the rate of 0.25 between the length of right LL and height of right ESB that was significant according to Pearson test (P = 0.013). Also, the rate of correlation between the left LL and height of left ESB was 0.15 that was not significant according to Pearson test (P = 0.15). **Conclusion:** Based on this study there was a direct correlation between height of the right ESB and the length of LL, but this correlation is very low, about 0.25 and even this correlation was lower in the case of left, about 0.15, which both of them are not significant. This may be due to other affecting factors, such as length, slope and angle of fovea ethmoidallis from the horizontal line.

Keywords: *Endoscopic sinus surgery, ethmoid skull base, lateral lamella*

Introduction

Paranasal sinuses (PNS) refer to air cells located around the nose which have several functions in the body including facial shaping, prevention from transmission of trauma and injury to vital organs such as brain and orbital contents and participation in clearing the air passing the nose. Sinuses may be involved by diseases such as polyps, benign and malignant neural, vascular, bony, and mucosal tumors. Endoscopic sinus surgery (ESS) is an efficient method for biopsy and to determine the cause of disease and also prevention and treatment of sinus disease.[1,2]

ESS is a medical skill which its correct operation requires great experience and science, and also situation of PNS located in the proximity of vital organs such as cranial nerves (optic nerve) and arteries of head and neck (internal carotid artery) calls for the importance of preoperative examination and evaluation.[3-6]

ESS, like any other surgeries, may lead to unwanted consequences, and sometimes they could be dangerous and even fatal. Some of these consequences include cerebrospinal fluid (CSF) leak, intracranial hemorrhage, damage to the frontal lobe, and even death.[1,2,4,6]

Nowadays, computed tomography (CT) scanning with thin slices is the best methods for assessing anatomic boundaries and individual changes.[1,7,6] The ideal way for CT scanning for measuring the ethmoid skull base (ESB) is in the form of coronal cuts with 1 mm cuts.[7,8] ESB needs particular attention since it has located in the base, and middle bed of skull base, and also is tenuous. This sinus is divided into small cells by the thin bone blade. It is necessary to assess the ethmoid cells and be aware of its sizes, because there are natural changes in its height in each person, ethmoid cells are sticking to orbital cavity in both sides, and lateral lamella (LL),

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which is the thinnest bone part in the skull base is located in medial part of each ethmoid cells.[2-5]

Damage to LL is not rare, with increasing its length the likelihood of damage will increase and this damage may cause entering to skull base and penetrating into brain parenchyma. The likelihood of damage to LL has a direct correlation with the length of the bone.[5,7,9]

ESB extends from LL junction in the medial to lamina papyracea in the lateral.

In two great studies done for repairing of iatrogenic CSF leak only 9–18% of juries were located in LL and 62–74% were located elsewhere in ethmoid sinuses.[10]

Damage to ESB also causes penetration into the brain which its likelihood has a reverse correlation with ESB height and this fault can occur meantime the ethmoid roof is mistaken with posterior ethmoid air cells and so causes entering to brain.[5,7,9]

Materials and Methods

This study is a descriptive and sectional study conducted in health centers of Al-Zahra in Isfahan in 2014. Studied samples were patients who went to ENT clinic during 2014.

The inclusion criteria in the study were lack of congenital diseases in the PNS, any history leading to fracture of skull base, lack of radiotherapy history, lack of ESS history, and patient consent to participate in the study.

The required sample size for the study was estimated 83 patients and ultimately 100 patients were studied.

$$n = \frac{(z_1 + z_2)\ (1 - r^2)^2}{r^2} + 3$$

z_1 = confidence level 95% means 1.96

z_2 = power of study 80% means 0.84

r = correlation confidence at least 0.3

The procedure was as follows:

After the proposal verification, 100 patients of ENT clinic, who had been qualified to be included in the study, were selected by the simplified sampling method. Then the aim of the study was explained for them, and their consent was obtained regarding the use of CT scan stereotype. After collecting the CT scan files, each stereotype was evaluated, and by using the software on the two sides the height of ESB and length LL were measured investigated and recorded. Next, maximum and minimum height in the two sides was measured and its mean was calculated. Then, the relationship between the length of LL and the height of ESB was examined.

"Keros" classification is the standard classification for assessing the length of LL. There are some methods for assessing the height of ESB, but none of them is the standard method like "Keros" classification.

In this study, we used a relatively easy to use and popular method for classifying and assessing the ESB.

The method is:

- First step is to identify the coronal CT image at the level of the anterior ethmoid artery canal. This image can be found by identifying the characteristic anterior ethmoid artery canal along the superior aspect of the lamina papyracea [Figure 1]
- Next, a line is drawn through the middle of the orbit, bisecting the orbital contents, to provide a reproducible landmark for the inferior extent of the measurement [Figure 2]
- Finally, the height of the ESB is measured from the bisecting orbital line to the mid aspect of the ethmoid roof in the medial-lateral plane [Figure 3]
- Finally, the obtained data analyzed by computer using the SPSS software (SPSS version 18.0, Chicago, IL, USA), *t*-test (for comparing the mean of one quantitative parameter between two groups), paired *t*-test (for comparing the mean of two quantitative parameters in one group), Pearson correlation test (for determining the correlation between two quantitative parameters) and linear regression (for considering the impact of several parameters on one quantitative parameter) [Figures 4 and 5].

Results

In this study, 100 patients were studied 58 men and 42 women. Minimum and maximum length of right LL was 0.5 and 5 and in left was 0.6 and 6.

Minimum and a maximum height of right ESB was 4.1 mm, and 17.3 mm and in left was 3.4 mm and 16.4 mm.

In Table 1, the length of right and left LL and the height of right and left ESB have been illustrated according to the gender of patients.

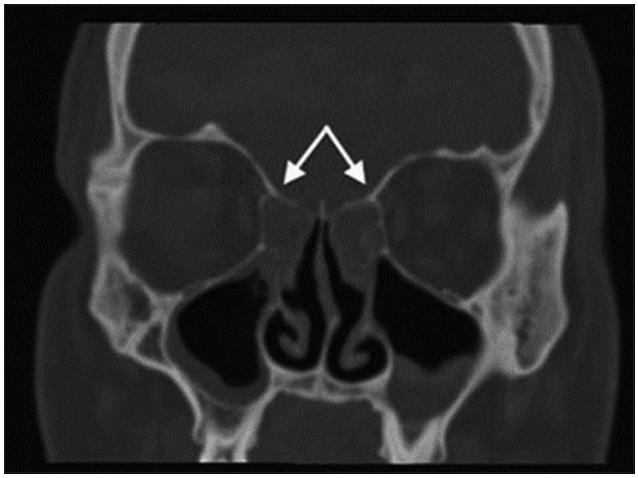

Figure 1: Superior aspect of the lamina papyracea

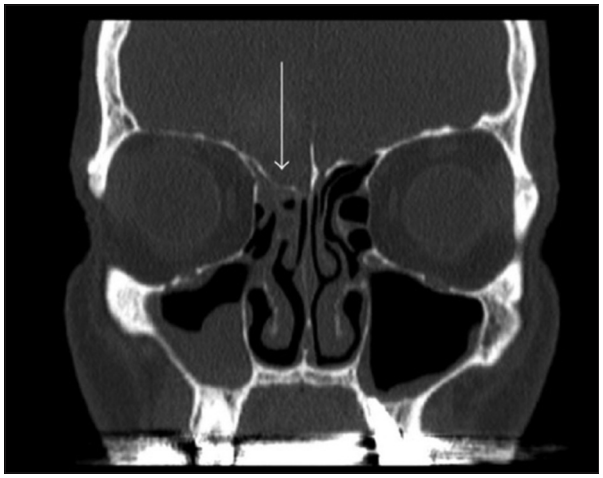

Figure 2: Reproducible landmark for the inferior extent

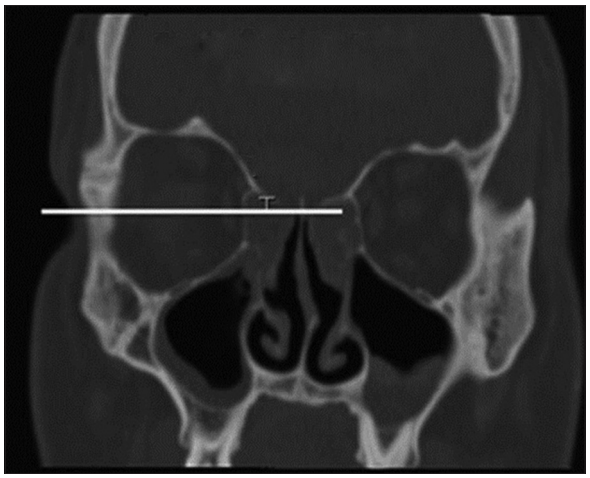

Figure 3: Ethmoid roof in the medial-lateral plane

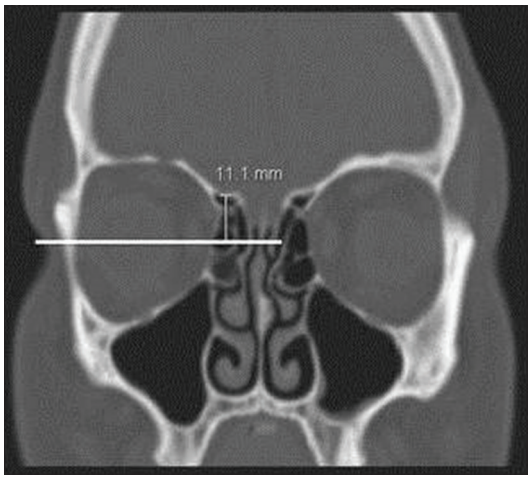

Figure 4: High ethmoid skull base

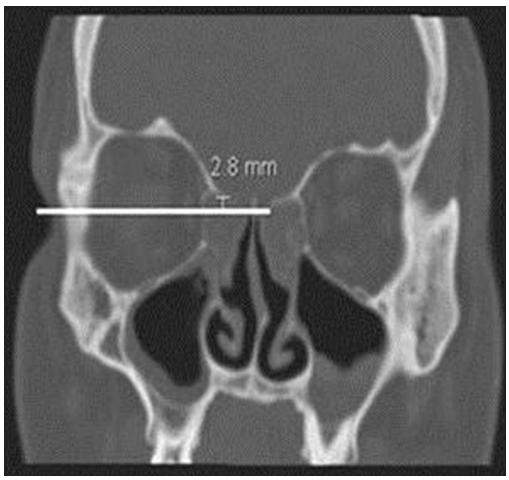

Figure 5: Low ethmoid skull base

Also, frequency of the length of LL and height of ESB in all patients is shown in Figure 6 and classified based on lower than 4 mm, between 4 and 7 mm and higher than 7 mm.

There was a correlation between right and left ESB height that is, statistically significant with rate 0.67 in Pearson test ($P < 0.001$). On the other hand, according to paired *t*-test, there was no significant difference between the mean of the length of right and left LL and between the height of right and left ESB ($P = 0.3$ and $P = 0.4$) respectively.

According to *t*-test, there was no significant difference between the mean of the length of LL and height of ESB in men and women ($P < 0.05$).

Based on obtained results, there was a direct correlation with degree of 0.25 between the length of right LL and height of right ESB which it was significant according to Pearson test ($P = 0.013$). Also, the degree of correlation between the left LL and height of left ESB was 0.15 which was not significant according to Pearson test ($P = 0.15$).

Table 1: Mean and SD of length of LL and height of ESB according to gender of patients

Index	Total	Male	Female	*P**
Right LL	2.59±1.02	2.48±1	2.74±1.03	0.22
Left LL	2.54±1.08	2.49±1.11	2.62±1.05	0.55
*P***	0.3			
Height of right ESB	9.01±2.81	8.91±2.98	9.16±2.58	0.67
Height of left ESB	8.76±3.08	8.9±3.45	8.58±2.49	0.61
*P***	0.4			

*Difference level between male and female based on independent sample *t*-test, **Difference between left and right based on paired *t*-test. SD: Standard deviation, LL: Lateral lamella, ESB: Ethmoid skull base

The degree of correlation between two aforesaid indices with separation of men and women was as follows:

- In men

  There was a direct and significant correlation, with a degree of 0.36 between the length of right LL and height of right ESB ($P = 0.006$). However, there wasn't significant correlation between the length of left LL and height of left ESB ($P = 0.11$). The degree of this correlation was 0.21

- In women

  There was a direct correlation, with a degree of 0.07 between the length of right LL and height of right ESB, which it wasn't significant statistically (P = 0.67). There was a weak correlation, with a degree of 0.1 between the length of left LL and height of left ESB, which was not significant statistically (P = 0.53).

In Table 2, correlation between length of LL and height of ESB totally and in either sex are mentioned.

It is noteworthy that linear regression analysis on the aforesaid data indicated that the height of right ESB can explain the length of right LL with degree of 0.25, which it is significant statistically (P = 0.013), while the height of left ESB can explain the length of LL with degree of 0.15, which is not significant statistically (P = 0.15). In Figures 7 and 8, the correlation

Table 2: Correlation between right and left ESB and length of LL in all patients with separation of sex

Sex	Right LL	Left LL	Right ESB	Left ESB
Male and female				
Right LL				
Correlation	1	0.84	0.25	0.26
P		0.000	0.013	0.009
Left LL				
Correlation	0.8	1	0.21	0.15
P	0.000		0.037	0.15
Right ESB				
Correlation	0.25	0.21	1	0.67
P	0.013	0.037		0.000
Left ESB				
Correlation	0.26	0.15	0.67	1
P	0.009	0.149	0.000	
Male				
Right LL				
Correlation	1	0.83	0.36	0.32
P		0.000	0.006	0.013
Left LL				
Correlation	0.83	1	0.27	0.21
P	0.000		0.040	0.108
Right ESB				
Correlation	0.36	0.27	1	0.68
P	0.006	0.040		0.000
Left ESB				
Correlation	0.32	0.21	0.68	1
P	0.013	0.108	0.000	
Female				
Right LL				
Correlation	1	0.85	0.07	0.17
P		0.000	0.665	0.27
Left LL				
Correlation	0.85	1	0.100	0.02
P	0.000		0.53	0.9
Right ESB				
Correlation	0.07	0.100	1	0.67
P	0.67	0.53		0.000
Left ESB				
Correlation	0.17	0.02	0.67	1
P	0.27	0.9	0.000	

LL: Lateral lamella, ESB: Ethmoid skull base

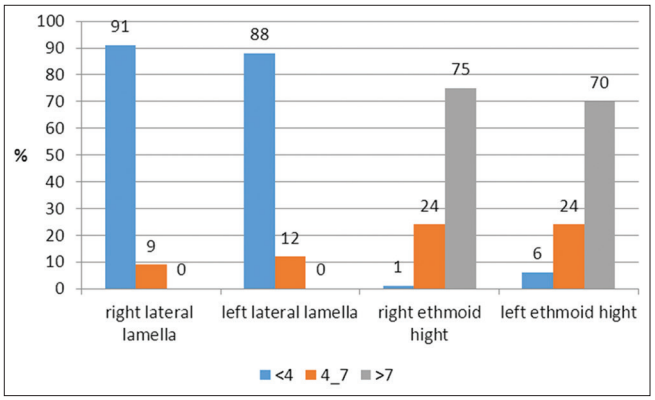

Figure 6: Frequency of length of lateral lamella and height of ethmoid skull base in patients studied

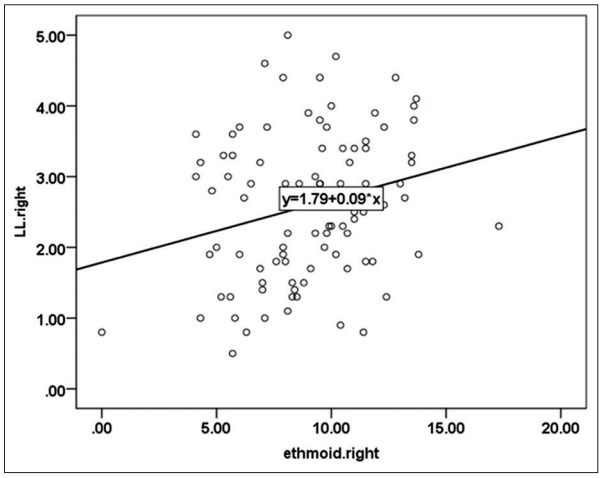

Figure 7: The correlation between the length of right lateral lamella and height of right ethmoid skull base

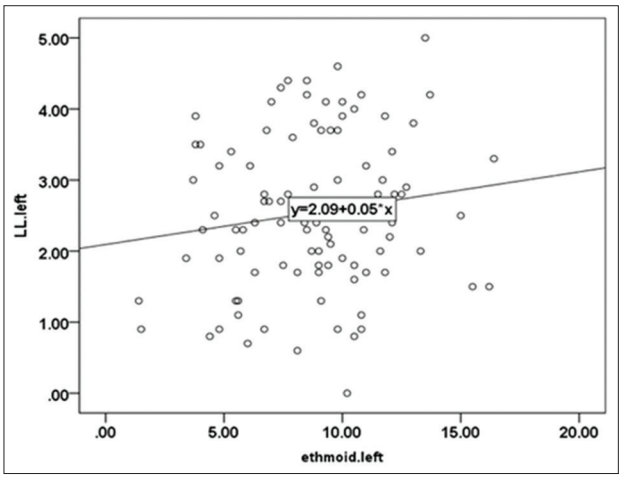

Figure 8: The correlation between the length of left lateral lamella and height of left ethmoid skull base

between the length of LL and height of ESB has been shown.

Discussion

LL is a part of the skull base that is, exposed to injury during endoscopy and therefore identifying predictive indicators to traumatic injury is necessary and essential. On the other hand, low ESB is a variant that can be detected by CT scan before the ESS and any omission to detect such a risky situation may cause serious and fatal events.

In confirming this issue, two investigators Stankiewicz and Chow in a study declared 4 patients suffered from skull base injury after ESS. All of them had ESB height lower than 4 mm, on that time 2 of them were suffering from complete neural deficit, 1 were suffering from massive intracranial hemorrhage and the other one died.[5,11]

Detecting these two dangerous situations prior to surgery will definitely aware the surgeon from possible fatal events and also determining the probable correlation between these two parameters and the possibility of coexistence of these parameters simultaneously is more helpful.

Conclusion

Based on this study, there was a correlation between height of the right ESB and the length of LL but the degree of explanation was very low and even this estimation was lower in the case of left. Although, with increase of the height of ESB, the length of LL increases too, this correlation is not complete.

Other involving factors should be studied to understand what factors are effective in the height of ESB, these factors may be the fovea ethmoidallis and its height, slope and its angle from horizontal line, but there is no study yet.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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