# **Keros Classification among Jordanian Population**

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# ABSTRACT

**Objectives:** To evaluate the prevalence of each KEROS subclass among Jordanian population, and to compare between subclass distribution in right and left side, and also between different genders.

**Methods:** Retrospectively evaluating computed tomography studies for paranasal sinuses of 100 different patients, the depth of lateral lamellae of cribriform plate was measured and this was plotted against the different subtypes of Keros classes considering gender variations.

**Results:** The favorable classes were found to be II, I and III in order, having percentages of 70.5%, 22% and 7.5% respectively. Minimal male to female variations were found as well as minimal right to left variations. Racial variations were noted when comparing our study results to other studies worldwide.

**Conclusion:** Significant racial variation is noted when considering Keros classification among population. Keros categorization of patients is emphasized when performing paranasal sinuses Computed Tomography.

Keywords: Keros, Lateral lamella of cribriform plate

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#### Introduction

The increased usage of endoscopy in sinus evaluation and surgery with the range of anatomical variation in anterior base of skull and the seriousness of possible complications of sinus surgeries made it very important for the surgeon to have an excellent knowledge of the exact anatomy of anterior skull base for each individual patient for pre- operative evaluation.

Reviewing our anatomy knowledge Ethmoid bone roof contains Crista Galli at central position and the thin fenestrated cribriform plate on either sides, in both sides, Cribriform plate is shallow and narrow both anteriorly and posteriorly, deep and wide in the midway (anterior to posterior) and is formed by the horizontal and the lateral lamellae (HLCP & LLCP), (Fig.) 1. These are the thinnest structures in skull base offering the least resistance to iatrogenic perforation during endoscopic sinus surgery (ESS), the longer the LLCP, the more the risk of major complications.

Prevention of complications in ESS relies on anatomic understanding and knowing the variations between different patients. It is now widely accepted that CT scan of paranasal sinuses with coronal reformat is a prerequisite to any ESS. One of the most important issues is to identify the LLCP.

Based on the length of LLCP patients are classified into three groups according to Keros

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classification: group I when it measures 1-3mm, group II 4-7 and group III measuring 8-16mm (Fig. 2)



**Fig. 1:** The anterior cranial fossa, note Crista Galli and the fenestrations of the cribriform plate



In this study we aim at evaluating the frequency of different types of Keros classification among Jordanian population

#### **Methods**

The study is a review of 100 coronal CT scans done for paranasal sinuses at KHMC over a period of one year between June, 2010 to June, 2011. The height of LLCP was measured on both sides by two radiologist in two separate settings giving a total of 200 measurements. Patient's presentation was with variable ENT complaints; including rhinosinusitis, sinonasal polyposis and nasal septal deviation.

Patient's age ranged from 6 years to 69 years with an average age of 38 years. Regarding patients gender, 60 were males and 40 were females.

All studies were done using GE light speed 16 slice machine using a standard protocol with slice thickness of 3mm and reconstruction at 1 and 0.3mm with coronal and sagittal reformat.

The way of measuring the highest of lateral lamella of cribriform plate is illustrated in the following drawing:



LEGEND: Height of lateral lamella

Exclusion criteria included any patient with history of facial trauma which might have affected the skull base, patients with history of previous sinus surgery, those with destructive pathology or malignancy affecting the skull base sinuses.

Patients were classified according to Keros classification, the data analyzed based on Keros type, gender and the measured side of the cribriform plate.

# Results

The mean height of the LLCP on the right side was 4.89mm, while on the left side it was 4.75mm.

44 measurements ranged between 1 and 3.99mm which is Keros type I (22%), 141 were type II (70.5%) and 15 were type III (7.5%).

Gender related Keros variations are shown in Table I.

Table I:Gender related Keros variations

Gender	Type I	Type II	Type III
Males	20%	70.8%	9.2 %
Females	25%	70%	5%

Right to left differences is shown in Table II.

Table II:Differences of right to left

Side	Туре І	Type II	Type III
Right	21 %	70 %	9 %
Left	23 %	71 %	6 %

In males 120 measurements weretaken, the mean on the right side was 5.11mm and on the left side was 4.8mm and results are listed in Table III.

 Table III: The mean measurements of right to left in males

Side	Type I	Type II	Type III
Right	16.7%	71.7%	11.7%
Left	23.3%	70%	6.7%

In females, 80 measurements were taken. The mean in right side was 4.55mm while on the Lt side it was 4.51mm. The results are listed in Table IV.

Table IV: The mean measurements of right to left in females

Side	Type I	Type II	Type III
Right	27.5%	67.5%	5%
Left	22.5%	72.5%	5%

In same patient the height of LLCP on both sides was the same in only 27% of cases while 73% of patients show difference between right and left side of cribriform plate.

# Discussion

Endoscopic sinus surgery is a surgical procedure in which the sinus cells are opened to improve ventilation of sinuses and mucociliary clearance.<sup>(8)</sup>

This procedure is widely accepted as treatment of many conditions involving paranasal sinuses, however; many complications might be encountered such as orbital hemorrhage, loss of vision, anosmia, injury to nasolacrimal duct, CSF leak, meningitis and brain abscess. A major risk in ESS is iatrogenic perforation of base of skull, and the most vulnerable area for this is the LLCP which is the thinnest structure in anterior skull base.

Keros classification was first introduced in 1962, and nowadays it is almost a must to do coronal CT scan for patients planned for surgery. Both radiologist and ENT surgeon should be aware of what they should look at, the report should include the extent of sinus disease, status of drainage pathways, anatomical variants, critical variants and soft tissues of head, neck and orbits.<sup>(6)</sup> Fig. 1 to 3 show the variations among different Keros classes.



Fig. 3: Keros I



Fig. 4:Keros II



Fig. 5: Keros III

According to our study we can see that the most common Keros classification among Jordanian population is type II (70.5%), and luckily Type III which carries the most risk of major complications account for only around 7.5%.

Our study also show that: in females the favorable type I is present in 25% of cases compared to 20% of males. In type II males and females have almost the same percentage which was around 70%, while in type III the percentage in males was 9.2% compared to only 5% in females.

The results show favorable distribution in the left side with only 6% type III, 23% type I and 70% type II compared to right side where the results were 9% type III, 70% type II and 21% type I.

Personal variation should also be emphasized, in 73% of the cases a difference of more than 1mm was noted between the heights of LLCP in both sides.

Similar studies were done among different populations and results are summarized in Table V.

**Table V:** Results among different population

Study done in	Type I	Type II	Type III
Turkey	8.1	59.6	44
Filipinos	81	17.9	0.5
Thailand	11.9	68.8	19.3
Pakistan	29.9	49.4	20.8
Egypt	42.5	56.8	0.6
Brazil	26.3	73.3	0.5

The shape and depth of LLCP are not exactly the same from the most anterior to most posterior parts; our measurements represent the deepest part of LLCP

#### Conclusion

The most common Keros classification among Jordanian population is type II followed by Type I then type III. Preferable classification is noted in females and on the left side.

In most patients the height of lateral lamella of cribriform palate is different between Right and left side. Moreover, significant variations are noted between different populations.

Our recommendation based on the results of our study are to emphasize on reporting Keros subtype in all paranasal sinuses CT scans, and to adopt a modified Keros classification in which the shape and slope of the lateral lamella of cribriform plate is precisely described relying on a 3D model.

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