# Abstract

**Objective:** Preoperative identification of anatomical variations in the nasal cavity helps to prevent or minimize the surgical complications of Endoscopic sinus surgery. CT scans are used to evaluate the anatomy of nasal cavity. Keros classification is a commonly used method to evaluate the depth of Olfactory fossa. Assessment of the variations of the uncinate process and it's superior attachment are very important for successful endoscopic surgery. Incidence of ethmoidal air cells, Choncha bullosa and ethmoid bulla cells are also important variations. Furthermore, Location of the anterior ethmoidal artery should be assessed due to it's great importance of minimizing orbital complications.

**Methods:** High Resolution Computerized Tomography scans of paranasal sinuses were analyzed at the CT scan console using standard criteria to evaluate the anatomy. Two hundred and fourty four CT Scans were evaluated in this study. The depth of olfactory fossa was measured using keros classification. (Keros 1 : 1-3mm, Keros 2 : 4-7mm, Keros 3 : 8-16mm) Anterior ethmoidal foramen and notch were used to localize the anterior ethmoidal arteries. Upper end of the uncinate process can bend and attach to the middle turbinate, lamina papyracea, or straight to the skull base. This attachment and uncinate process variations were evaluated. Position of the nasal septum was assessed. Agger nasi cells, Haller cell, Onodi cell, frontal recess cells, ethmoid bulla and middle turbinate were evaluated radiologically. Data was analyzed using the 25 th version of SPSS.

**Results:** 244 CT scans belong to 139 male patients and 105 female patients were analyzed. The highest proportion of participants (n=62, 25.4%) belonged to the 63-71 years age category and mean age of participants was 56.
The mean depth of the left sided olfactory fossa in males was 5.124mm compared to the 4.965mm in females. This minor difference between males and females is not statistically significant ($p > 0.05$). The mean depth of right olfactory fossa among male study population was 5.091 with a 1.4216 standard deviation. Mean depth of right olfactory fossa and standard deviation for the female population were 4.821 and 1.1969 respectively. Using the independent sample t-test, the p value is 0.022 This difference of right olfactory fossa depth between male and female study groups was statistically significant. According to the left olfactory fossa depth 22.1% of the study population were of Keros type 1 and 73.4% of cases were of Keros type 2. Remaining 4.5% of the study group belonged to the Keros type 3. Based on the right olfactory fossa depth 21.3% of the participants belonged to the Keros type 1 while 75.8% of the study population belonged to Keros type 2. Only 2.9% of participants associated with Keros type 3.

Keros type was further analyzed based on gender. On the basis of the Chi-square test, these differences in Keros types between female and male study populations were not statistically significant($p>0.05$).

Majority of the study population (n=212, 86.9%) had a normal uncinate process. 15 participants had a bifid uncinate process with 2 superior attachments. 16 study participants showed a curved uncinate process. Only 1 participant had an atelectatic uncinate process. Highest proportion of the study population(44.7%) showed upper attachment of their uncinate processes into the middle turbinate. The lamina papyracea was the second most common attachment of the uncinate process ( 35.2% in the left side and 30.3% in the right side). Left side uncinate process was found attached to the skull base in 15.2% of the study population, while 21.3% of the study participants had skull base attachment of their right uncinate process. One end of the bifid uncinate was found attached to the lamina papyracea, while the other end attached to either middle turbinate or skull base.

Majority of the study population (n=139, 57%) had nasal septum in the midline. Rest of the study population (43%) showed deviated nasal septum to either right side or left side in almost similar proportion.

Left middle turbinate was anatomically normal in 53.3% of the study group while remaining 46.7% showed choncha bullosa. The right middle turbinate of 56.6% of the study group was anatomically normal while 43.4% of the population had choncha bullosa on right side. This difference is not statistically significant.

202 participants (82.8%) had well developed agger nasi cells. 13.1% of the study population (n=32) found to have haller cells during radiological evaluation. Only 2.9% of the participants(n=7) had onodi cells. Nearly two thirds of the study population (67.6% ) had single or multiple frontal recess cells. 93.9% of the study population had ethmoid bulla cells, which are considered as important landmarks during endoscopic sinus surgery.

Anterior ethmoidal artery was identifiable in 98.4 % of the study cases in both sides using reliable anterior ethmoidal notch and anterior ethmoidal foramen. 87.3% of the study CT scans showed normal left anterior ethmoidal artery location. Left anterior ethmoidal artery was found to run inferiorly in 11% of the study CT scans. Right anterior ethmoidal artery was found in the normal location in 87.7% of the study population while 10.6% of the group showed inferiorly running right anterior ethmoidal artery.

All these anatomical variations were further analyzed based on the gender. On the basis of the Chi-square test, these differences between female and male study groups were not statistically significant. ($p > 0.05$)

**Conclusions:** Endoscopic sinus surgery is the standard surgical technique for chronic sinus disease, fungal sinusitis, nasal polyposis, mucocele, DCR, CSF leak repair and sino nasal tumors. Careful evaluation of important structures before the surgery is highly recommended for successful surgery and to avoid the surgical complications.

Keros type 2 was the most prevalent olfactory fossa type among this local study population. 73.4% of the study population belonged to the Keros type 2 according to left olfactory fossa depth, while this figure was 75.8% on the right. Even though the frequency of dangerous Keros type 3 olfactory fossa was low (only 4.5% of the study population had Keros type 3 on left side and only 2.9% of the group had Keros type 3 on right side), it was more common among male population and on the left side, and hence more vulnerable to surgical complications during FESS. Mean depth of left olfactory fossa was 5.055mm while the mean depth of right olfactory fossa was 4.975mm.

Middle turbinate was the commonest site of uncinate process attachment that accounted for 44.7% of the study population on both sides. Lamina papyracea was the second most common attachment of the uncinate process. Majority of the study population (n=212, 86.9%) had a normal uncinate process. Small portion of the population showed bifid, curved and atelectatic uncinate.

49.6% of the male study population and 66.6% of the female study group had their nasal septum in the midline. 28.8% of males showed deviated nasal septum to left side while 21.6% of males showed septal deviation to the right. This concludes that almost half of the males have deviated nasal septum and more frequently to the left side.

This study found that 53.3% of the local study group had a normal middle turbinate on the left side while 46.7% of the study group had choncha bullosa. On the right side 56.6% of the study population had normal middle turbinate while 43.4% of the study population showed choncha bullosa. Furthermore, 49.5% of the females had choncha bullosa. Prevalence of choncha bullosa among males was less than females.

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This study concludes that anterior ethmoidal artery is identifiable in 98.4% of the study population bilaterally. 87.3% of the study CT scans showed normal left anterior ethmoidal artery location.

Left anterior ethmoidal artery was found to be located in an unusual(Inferior) position in 11% of the study CT scans. When analyzing the right side 87.7% of the study CT scans showed normal anterior ethmoidal artery location. Right anterior ethmoidal artery was found to be located in an inferior position in 10.65% of study cases.
This study shows the anatomical variations in the nasal cavity among the local population. While some figures are almost similar to the worldwide and regional statistics, other parameters show significant variations from the worldwide statistics. Several parameters show differences between males and females. Moreover, this study concludes the anatomical variations between two sides of the same individual.
These differences clearly conclude the importance of preoperative assessment of anatomical variations in the nasal cavity before Endoscopic sinus surgery, in the view of successful surgery and minimizing surgical complications. High resolution CT scan of the nose and para nasal sinuses should be used as a map for assessing the anatomy.

**Key words:** Sri Lanka, DGH Nuwara Eliya, Keros classification, Olfactory fossa depth, Anterior ethmoidal artery, uncinate process, nasal septum, middle turbinate, Agger nasi cells, Haller cells, Onodi cells, ethmoid bulla cells, frontal recess cells, CT scan