International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(1):2128-33. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.162

Original Research Article

STUDY OF OSTEOMEATAL UNIT VARIATIONS USING COMPUTED TOMOGRAPHY

Deepa G *[1], Shrikrishna B H [2].

[*1] Assistant Professor, Department of Anatomy, Navodaya Medical College, Raichur, Karnataka, India.

[2] Professor, Department of ENT, Navodaya Medical College, Raichur, Karnataka, India.

ABSTRACT

Background and objective: Several studies have shown that anatomical variations of the osteomeatal unit of nose predispose to sinusitis. Hence this study was aimed to know the various anatomical variations of the osteomeatal unit of the nose using computed tomography.

Materials and Methods: A prospective study was done on 200 computed tomography scans of patients visiting ENT OPD for evaluation of headache.

Results: The different anatomical variations observed in our study were concha bullosa, paradoxical middle turbinate, retroverted uncinate process, enlarged ethmoid bulla, haller cells, agger nasi cells, onodi cells and pneumatisation of vomer. The most frequent anatomical variation found was presence of concha bullosa (22%).

Conclusion: Variations are common in the osteomeatal unit of the nose. These variations may predispose to paranasal sinus diseases. Also, awareness of these variations helps the otorhinolaryngologist and/or radiologist to evaluate the CT scans of paranasal sinuses better. This will, in turn, help in endoscopic examination as well as in surgery.

KEY WORDS: Paranasal Sinuses, Anatomic Variation, Tomography, Concha Bullosa, Turbinates.

Address for Correspondence: Dr. Deepa G, Assistant Professor, Department of Anatomy, Navodaya Medical College, Raichur (Karnataka)-584103. India. Phone: 09916920666.
E-Mail: drdeepagadwal@gmail.com

Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.162

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 01 Mar 2016 Accepted: 15 Mar 2016
Peer Review: 01 Mar 2016 Published (O): 31 Mar 2016
Revised: None Published (P): 31 Mar 2016

INTRODUCTION

The osteomeatal unit is present in the lateral wall of the nose. It plays a very important role in the ventilation of the paranasal sinuses. Any anatomical variation in the osteomeatal region will hamper the normal ventilation of the paranasal sinuses and thereby leads to paranasal sinus disease. It is differently defined by several authors. In the present study, the concept developed by Stammberger & Kennedy was adopted, defining osteomeatal unit as a functional unit of the anterior ethmoid unit representing the final common pathway for drainage and ventilation of the frontal, maxillary and anterior ethmoid cells [1]. Any of these cells, clefts, ostia, recesses or cavities may be affected by the variation. Dua et al. reported that removal of disease in osteomeatal unit region is the basic principle of Functional Endoscopic Sinus Surgery (FESS) which is best appreciated on CT scan [2]. In the present study, the anatomical variations of the osteomeatal unit were assessed by means of CT scans in

patients of headache.

Objectives: To study the various anatomical variations of the osteomeatal unit of the nose using computed tomography.

MATERIALS AND METHODS

This study was carried out at the Department of Anatomy, Navodaya Medical College, Raichur. The sources of data for our study were randomly selected Computed Tomography (CT) films of patients who visited Otorhinolaryngology out-patient clinic of our medical college hospital for evaluation of headache. The study was done over a period of 1 year from 1st January 2015 to 31st December 2015. The study was carried out on 200 Computed Tomography (CT) films. All the CT films chosen randomly were of adult patients with age above 20 years. CT scans of patients with past history of sinus surgery or facial trauma were excluded from the study. All the scans were done using GE Pro-Speed Plus 4 Slice Multi-detector CT machine. The sections were taken with slice thickness of 5 mm. The scans thus were analysed for anatomical variations. The data collected was subjected for statistical analysis.

ETHICAL CONSIDERATIONS:

The study got clearance by the Institutional Ethical Committee before its commencement. Also, a written informed consent was taken from all the patients whose CT scans were involved in the study.

RESULTS

The presence of concha bullosa was the most common anatomical variation in the region of osteomeatal unit (Fig. 1). It was observed in 44 scans (22%). Concha bullosa was unilateral in 20 scans (10%) and bilateral in 24 scans (12%). Haller cells were observed in 10 scans (5%) (Fig. 2). They were unilateral in 8 scans (4%) and bilateral in 2 scans (1%). Pneumatization of vomer was observed in 6 scans (3%) (Fig. 3). Onodi cells were observed in 12 scans (6%). They were unilateral in 8 scans (4%) and bilateral in 4 scans (2%) (Fig. 4). Paradoxical middle turbinate was observed in 6 scans (3%). It was unilateral in 4 scans (2%) and bilateral in 2 scans (1%) (Fig. 5). Agger nasi cells were observed in 8 scans (4%) (Fig. 6). They were unilateral in 4 scans (2%) and bilateral in 4 scans (2%). Enlarged ethmoid bulla was observed in 10 scans (5%) (Fig. 7). It was unilateral in 6 scans (3%) and bilateral in 4 scans (2%). Retroverted uncinate process was found in 2 scans (1%) and it was bilateral in both the cases (Fig. 8).

Fig. 1: Coronal CT image showing right concha bullosa. (IT: Inferior turbinate, MT: Middle Turbinate)

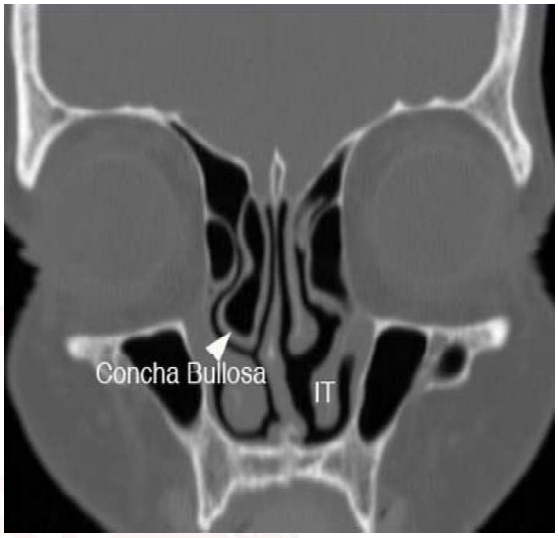


Fig. 2: Coronal CT image showing haller cell (infraorbital air cell) (MT-Middle Turbinate, MS-Maxillary Sinus)

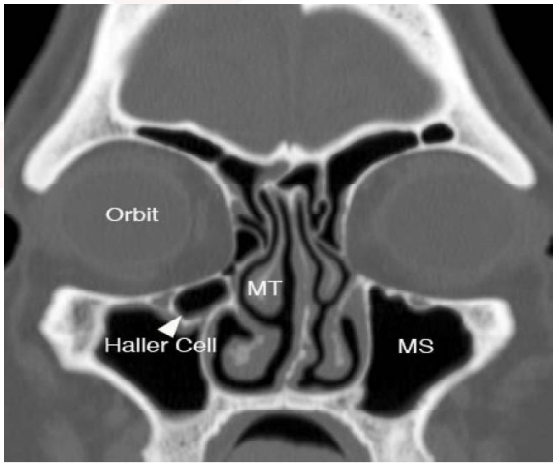


Fig. 3: Coronal CT image of paranasal sinus area showing pneumatization of vomer (v)

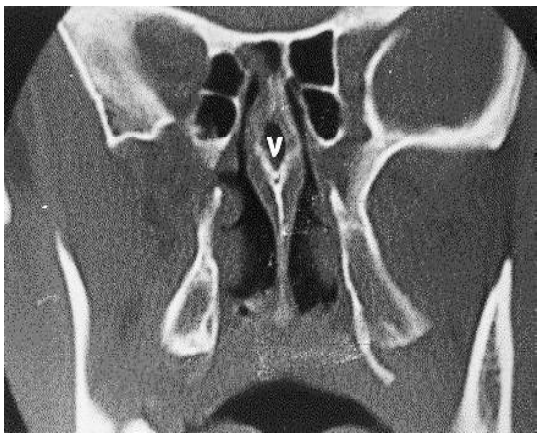


Fig. 4: Axial CT Image Showing Onodi Cells (Spheno ethmoidal Air Cells).

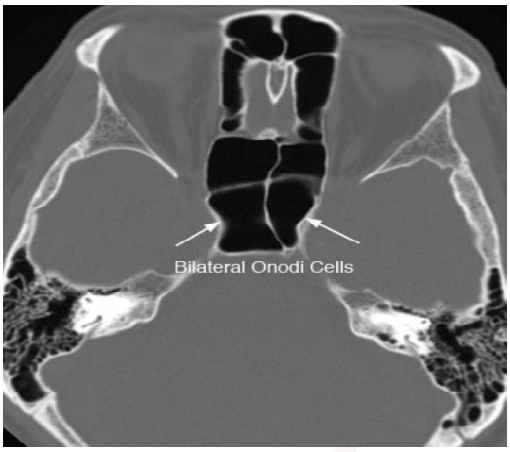


Fig. 5: Coronal CT Image Showing Paradoxical Turn of Right Middle Turbinate. (IT: Inferior Turbinate)

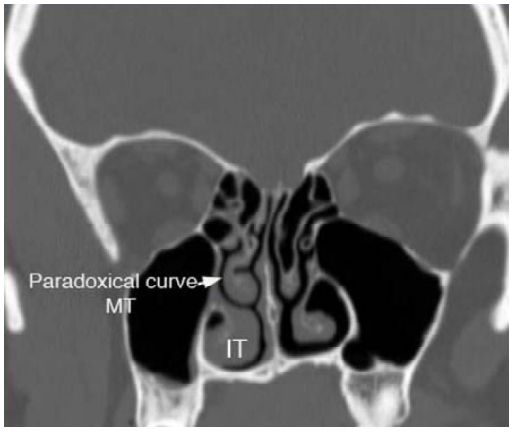


Fig. 6: Coronal CT Image Showing Agger Nasi Cell (MT- Middle Turbinate, IT- Inferior Turbinate, MS- Maxillary Sinus)

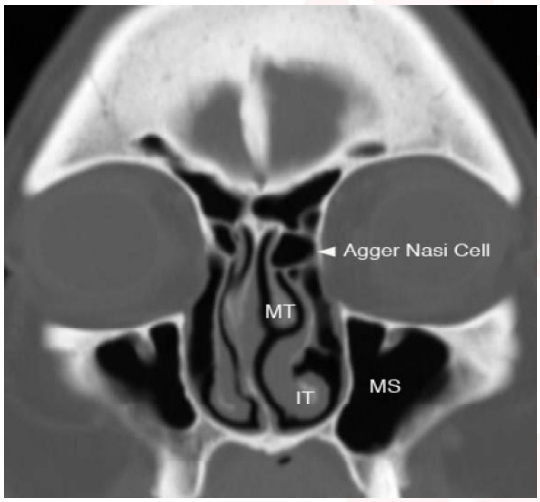


Fig. 7: Coronal CT Image Showing Bilateral Large Ethmoidal Bullae (EB). (U: Uncinate Process, MT: Middle Turbinate]

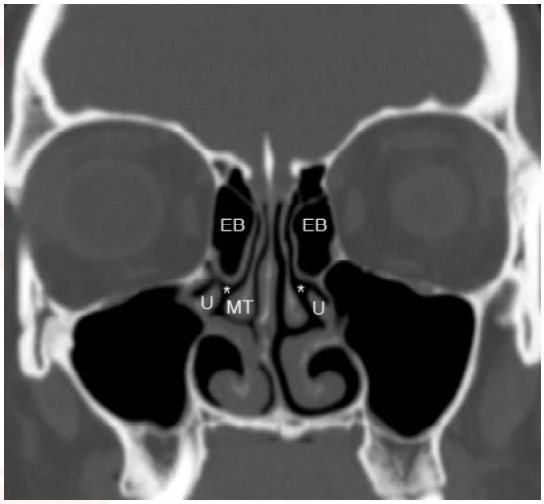
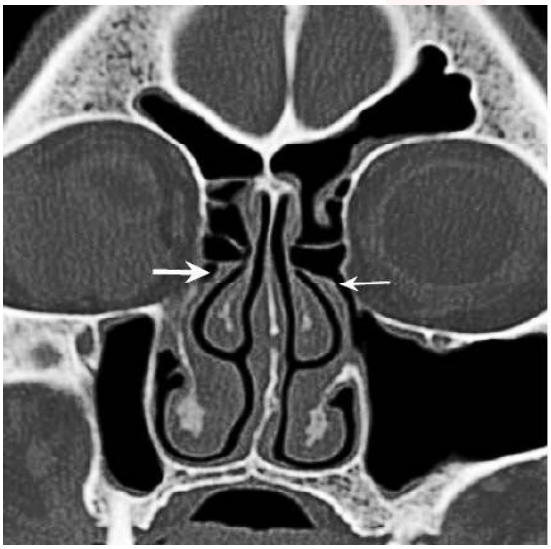


Fig. 8: Coronal CT Showing Bilateral Retroverted Uncinate Process (Arrows)



DISCUSSION

The osteomeatal unit is present in the lateral wall of the nose. It plays a very important role in the ventilation of the paranasal sinuses. Any anatomical variation in the osteomeatal region will hamper the normal ventilation of the paranasal sinuses and thereby leads to paranasal sinus disease. Scribano et al. have defined the osteomeatal unit as a unit including the maxillary sinus ostium, ethmoid infundibulum and middle meatus; in other words, as the final site of drainage from the frontal and maxillary sinuses and anterior ethmoidal cells [3]. Casiano has defined the osteomeatal unit as the ethmoid bulla, uncinate process and adjacent spaces and ostia draining the anterior sinuses (anterior ethmoid sinus, frontal and maxillary sinuses) [4]. Zinreich et al. have defined the osteomeatal unit as the group of bony structures and aerated channels into which the paranasal cavities drain, and have subdivided the unit into three parts.

The first most anterior portion of the unit includes structures surrounding the frontal recess; the

second one corresponds to the structures including the maxillary sinus and middle meatus; and the third and most posterior portion includes the structures surrounding the spheno-ethmoidal recess. The osteomeatal unit would be formed by the two first portions [5]. Mafee et al. and Mafee have described the osteomeatal unit similarly to the definition by Zinreich et al. [6,7]. Laine & Smoker have defined the osteomeatal unit as an aerated channel of the middle meatus representing the final common pathway for drainage of the maxillary and frontal sinuses and anterior ethmoid cells, delimited by the uncinate process, ethmoidal bulla and middle turbinate [8]. Shankar et al. have defined osteomeatal unit as a unit including the maxillary ostium, ethmoid infundibulum, hiatus semilunaris, middle meatus, frontal recess, ethmoid bulla and uncinate process [9].

In the present study, the concept developed by Stammberger & Kennedy was adopted, defining osteomeatal unit as a functional unit of the anterior ethmoid unit representing the final common pathway for drainage and ventilation of the frontal, maxillary and anterior ethmoid cells [1]. Any of these cells, clefts, ostia, recesses or cavities may be affected by a pathological process, thereby contributing to the symptoms and pathophysiology of sinusitis.

Concha bullosa is a pneumatised middle turbinate. The degree of pneumatisation varies from person to person and may involve only the bulbous portion (distal) or lamellar portion (proximal), or the called true variant where there is pneumatisation of both portions. Bolger et al., reported this pneumatisation in 53% of the sinus patients, as an extension of the anterior air cells (55%) or posterior (45%) ethmoidal air cells [10]. The highest incidence of 80% was found in the study of Goldman in patients with chronic sinusitis on resected middle concha materials [11]. In our study, the incidence was 22%. These discrepancies in the incidence may depend on the criteria of pneumatisation of different researchers and on the method of analysis.

Haller's cell is the pneumatisation of the anterior ethmoid cells into the roof of the maxillary sinus extending into the floor of the orbit. In our study, Haller cells were observed in 10 scans (5%). They were unilateral in 8 scans (4%) and bilateral in 2 scans (1%). Zinreich reported presence of Haller cell in 10% of cases [12]. However, using the same criteria, Bolger reported it in 45.1% of cases [10]. Lloyd reported it in 2% of cases [13]. Earwaker reported it in 20% of cases [14]. The possible reasons for this discrepancy could be difference in interpretation of Haller cell, sample study or in the technique of CT scanning. Also important is the fact that a narrow window setting often fails to delineate Haller cell [10].

Pneumatization of vomer was observed in 6 scans (3%) in the present study. Similar variant has also been described by Lang Jin his work [15].

Onodi cells were first described by the Hungarian laryngologist Adolf Onodi, in 1904 [16]. They are also known as spheno-ethmoidal cells. Onodi cells are in fact, ethmoid cells that have migrated to the anterior region of the sphenoid sinus, with antero-superior location, and intimately related to the optic nerve, causing optic neuropathy in case of certain conditions that affect such cells [17]. Onodi cell is the most posterior ethmoid air cell that extends laterally. This extension is near the carotid canal and close to the optic nerve, which emphasizes the clinical importance of considering this anatomic variation prior to any attempt for invasive intervention. The surgeon must pay close attention to the occasional Onodi cell in preoperative evaluation to avoid potential complications of endoscopic sinus surgery. Therefore it would seem logical to assume that rhinogenic optic neuritis and Onodi cell are related findings [18]. In our study, Onodi cells were observed in 12 scans (6%). They were unilateral in 8 scans (4%) and bilateral in 4 scans (2%). In other studies, this finding ranged from 7% to 12%: Jones, 7-9% [19]; Basic, 10% [20]; Perez et al., 11% [21]; and Arslan et al., 12% [22].

Normally, the convexity of the middle turbinate is directed towards the septum. Paradoxical middle turbinate occurs if the convexity of the middle turbinate is directed towards the medial wall of the maxillary sinus. According to Stammberger and Wolf, paradoxical curvature of the middle concha may cause obliteration or alteration in nasal air flow dynamics and thus

may lead to sinusitis [23]. In our study, paradoxical middle turbinate was observed in 6 scans (3%). It was unilateral in 4 scans (2%) and bilateral in 2 scans (1%). In other studies, this finding ranged from 12% to 26.1%: Calhoun, 12% [24]; Lloyd, 17% [13]; and Bolger, 26.1% [10].

Agger nasi cells are the most anterior ethmoid cells and extend anteriorly into the lacrimal bone. They are located in the anterior floor of the frontal sinus, on the drainage pathway of the frontal sinus, and therefore are possibly involved in recurrent or chronic frontal sinusitis. In our study, agger nasi cells were observed in 8 patients (4%). They were unilateral in 4 cases (2%) and bilateral in 4 cases (2%). Schaefer et al. reported an incidence of 10% while van Alyea had observed an incidence of 89% in their series of anatomic dissections for the study of agger nasi cells [25, 26].

The exact prevalence of enlarged ethmoidal bulla is not known[8]. An enlarged ethmoidal bulla may obstruct the infundibulum or the middle meatus. Its size is an important factor when associated with opacification of anterior ethmoidal cells at CT in patients diagnosed with sinusitis [27]. Late in its development, the ethmoidal sinus measures on average 36 x 18 x 14 mm (length, height and width) in measurements performed in MRI studies [28]. These measures were similar in cadaver skulls [29]. The ethmoidal bulla, however, has not been separately evaluated in these studies. In measurements at CT in adults, the average area of each ethmoidal cell is 0.73 ± 0.42 cm^2, the larger ones, situated in the posterior portion of ethmoid, measure 1.46 ± 0.64 cm^2 [30]. Again, the size of the ethmoidal bulla has not been described separately. Since the ethmoidal bulla is the largest anterior cell [28], it is implicit that its average area should not exceed 2.1 cm^2. In our study, enlarged ethmoid bulla was observed in 10 scans (5%). It was unilateral in 6 scans (3%) and bilateral in 4 scans (2%).

Normally the free edge of the uncinated bone is directed laterally. In a retroverted uncinated process, it is directed medially. In such a scenario, the uncinate process (rather than the middle turbinate) is the first bone to be encountered during sinus surgery. This can mislead the operating surgeon and lead to inadequate surgery [31]. Familiarity with anatomic variations such as the retroverted uncinate process should increase the safety and effectiveness of FESS [32]. In our study, retroverted uncinate process was found in a 2 scans (1%) and it was bilateral in both the cases. Earwaker, in a study of 800 cases, have described variants of the uncinate process in detail [14].

CONCLUSION

Anatomical variations are common in the osteomeatal unit of the nose. The most frequent anatomical variation found in our study was presence of concha bullosa (22%). The other anatomical variations included paradoxical middle turbinate, retroverted uncinate process, enlarged ethmoid bulla, haller cells, agger nasi cells, onodi cells and pneumatisation of vomer. Awareness of the possibility of such variations helps the otorhinolaryngologist and/or radiologist to evaluate the CT of paranasal sinuses better. This will, in turn, help in endoscopic examination as well as in sinus surgery.

ABBREVIATIONS

CT - Computed Tomography
FESS - Functional Endoscopic Sinus Surgery

Conflicts of Interests: None

REFERENCES

[1]. Stammberger HR, Kennedy DW. Paranasal sinuses: anatomic terminology and nomenclature. The Anatomic Terminology Group. Ann Otol Rhinol Laryngol Suppl. 1995;167:7-16.
[2]. Dua K, Chopra H, Khurana AS and Munjal M. CT scan variations in chronic sinusitis. Ind. J. Radiol. Imag. 2005;15(3):315-320.
[3]. Scribano E, Ascenti G, Loria G, et al. The role of the osteomeatal unit anatomic variations in inflammatory disease of the maxillary sinuses. Eur J Radiol. 1997;24:172-4.
[4]. Casiano RR. Correlation of clinical examination with computer tomography in paranasal sinus disease. Am J Rhinol. 1997;11:193-6.
[5]. Zinreich SJ, Albayram S, Benson M, et al. The osteomeatal unit and functional endoscopic surgery. In: Som PM, Curtin HD, editors. Head and neck imaging. 4th ed. St. Louis: Mosby; 2003:149-74.
[6]. Mafee MF, Chow JM, Meyers R. Functional endoscopic sinus surgery: anatomy, CT screening, indications, and complications. AJR Am J Roentgenol. 1993;160:735–44.

[7]. Mafee MF. Preoperative imaging anatomy of nasal ethmoid unit for functional endoscopic sinus surgery. Radiol Clin North Am. 1993;31:1-20.
[8]. Laine FJ, Smoker WR. The osteomeatal unit and endoscopic surgery: anatomy, variations and imaging findings in inflammatory diseases. AJR Am J Roentgenol. 1992;159:849–57.
[9]. Shankar L, Evans K, Hawke M, et al. An atlas of imaging of the paranasal sinuses. London: Martin Dunitz; 1994.
[10]. Bolger WE, Butzin CA, Parsons DS. Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. Laryngoscope 1991;101:56-64.
[11]. Goldman JL. The principles and practice of rhinology: a text on the diseases and surgery of the nose and paranasal sinuses. Wiley, New York, 1987.
[12]. Zinreich SJ, Kennedy DW, Rosenbaum AE. Paranasal sinuses: CT imaging requirements for endoscopic surgery. Radiology 1987;163:769-775.
[13]. Lloyd GAS. CT of the paranasal sinuses: study of a control series in relation to endoscopic sinus surgery. J Laryngol Otol 1990;104:477-81.
[14]. Earwaker J. Anatomic variants in Sino nasal CT. Radiographics. 1993;13:381-415.
[15]. Lang J. Clinical anatomy of the nose, nasal cavity and paranasal sinuses. Thieme Medical Publishers, Inc., New York, 1989.
[16]. Onodi A. Die Sehstoerungen und Erblidung nasalen Ursprunges, bedingt durch Erkrankungen der hinteren Nebenhoehlen. Z Augenheilkd.1904;12:23-46.
[17]. Klink T, Pahnke J, Hoppe F, et al. Acute visual loss by an Onodi cell. Br J Ophthalmol. 2000;84:801-2.
[18]. Talaiepour AR, Sazgar AA, Bagheri A. Anatomic Variations of the Paranasal Sinuses on CT scan Images. Journal of Dentistry, Tehran University of Medical Sciences. 2005; 2(4):142-146.
[19]. Jones NS, Strobl A, Holland I. CT findings in 100 patients with rhinosinusitis and 100 controls. Clin Otolaryngol, 1997;22:47-51.
[20]. Basic N, Basic V, Jukic T et al. Computed tomographic imaging to determine the frequency of anatomic variations in Pneumatization of the ethmoid bone. Eur Arch Otolaryngol, 1999;256:69-71.
[21]. Pérez-Piñas, Sabaté J, Carmona A, et al. Anatomical variations in the human paranasal sinus region studied by CT. J Anat. 2000;197:221–7.
[22]. Arslan H, Aydinlioglu A, Bozkurt M, et al. Anatomic variations of the paranasal sinuses: CT examination for endoscopic sinus surgery. Auris Nasus Larynx. 1999;26:39-48.
[23]. Stammberger H, Wolf G. Headaches and sinus disease: the endoscopic approach. Ann Otol Rhinol Laryngol, 1988; suppl 134:3-23.
[24]. Calhoun KH, Waggenspack GA, Simpson CB, Hokanson JA, Bailey BJ. CT evaluation of the paranasal sinuses in symptomatic and asymptomatic populations. Otolaryngol Head Neck Surg 1991;104:480-3.
[25]. Schaefer SD, Manning 5, Close LG. Endoscopic paranasal sinus surgery: indications and considerations. Laryngoscope 1989;99:1-5.
[26]. Van Alyea OE. Ethmoid labyrinth: anatomic study, with consideration of the clinical significance of its structural characteristics. Arch Otolaryngol Head Neck Surg, 1939; 29:881-901.
[27]. Liu X, Han D, Zhou B. Relationship between anatomic variations of nasal sinus and chronic sinusitis. Zhonghua Er Bi Yan Hou Ke Za Zhi 1998;33:149-152.
[28]. Dos Santos RM. Desenvolvimento dos seios paranasais: estudo por ressonância magnética do crânio. (Tese de Mestrado). São Paulo: Universidade Federal de São Paulo, 2002.
[29]. Wolf G, Anderhuber W, Kuhn F. Development of the paranasal sinuses in children: implications for paranasal sinus surgery. Ann Otol Rhinol Laryngol 1993;102:705-711.
[30]. Saheki T. The investigation of the structures in the ethmoidal air cells on CT. Nippon Jibiinkoka Gakkai Kaiho 1989;92:827-836.
[31]. Jyothi A C et al. Anatomical variations of the osteomeatal complex: tomographic findings in 100 patients**.** Journal of Evolution of Medical and Dental Sciences, 2013; 2(22):3966-3977.
[32]. Armando T. Isla Jr.,Josefino G. Hernandez. Retroverted Uncinate Process: An Anatomic Variation. Philippine Journal Of Otolaryngology-Head And Neck Surgery 2009;24(2):40.

How to cite this article:

Deepa G , Shrikrishna B H. STUDY OF OSTEOMEATAL UNIT VARIATIONS USING COMPUTED TOMOGRAPHY. Int J Anat Res 2016;4(1):2128-2133. **DOI:** 10.16965/ijar.2016.162