ANATOMICAL VARIATIONS OF HUMAN PARANASAL SINUSES: COMPUTED TOMOGRAPHIC ANALYSIS.

By

Elhawary, A ; Elmogy, S*; Eltahry, H and Ismail, E.

From

Departments of Anatomy and Radiology,*

Faculty of Medicine, Mansoura University

ABSTRACT

The present investigation presents the anatomical variations of the human paranasal sinuses using computed tomography scanning (CT scan). Paranasal sinus CT scans obtained from 300 subjects (120 male and 180 female) were analyzed. Their ages ranged from 15 to 55 years with a mean age (28.4±8.79).

The maxillary sinus revealed a number of anatomical variations in 30% of cases. They appeared in the form of septated sinus in 16%, sinus hypoplasia in 10 %, and the presence of a tooth in the sinus in 4% of the cases. Examination of the frontal sinus revealed extensive pneumatization of the sinus in 38%, hypoplasia in 26 % and aplasia in 4 % of the cases. CT examination of the sphenoidal sinus revealed sinus hypoplasia in 4%, extensive pneumatization of the sinus in 6 % and unseptated sphenoidal sinus in 10% of cases. Impression of the optic nerve on the wall of sphenoidal sinus was found in 60% of the cases. The internal carotid artery bulged within the lumen of the sphenoidal sinus in 50% of the cases. Anatomical variations of the ethmoid sinus detected by CT included Agger nasi cell (72%), sphenoethmoidal (Onodi) cell (70%), pneumatized middle turbinate (concha bullosa) (56%), enlarged ethmoid bulla (34%), infraorbital ethmoidal (Haller's) cell (30%), and paradoxically curved middle turbinate (20%).The uncinate process showed hypoplasia in 24%, elongation in 10%, pneumatization (uncinate

bulla) in 8%, lateral deviation in 38% and medial deviation in 28% of cases.

It was concluded that various anatomical variations of paranasal sinuses detected by CT could be of great importance in understanding the pathophysiology of sinus diseases and in avoidance of iatrogenic complications during endoscopic sinus surgery.

INTRODUCTION

Anatomy and variations of the paranasal sinuses have gained interest with the advent of endoscopic sinus surgery (ESS) and computed tomography (CT) imaging. Precise knowledge of anatomical variations of the paranasal sinuses is critical for surgeons performing ESS and for radiologists involved in the preoperative investigations to improve the success of the diagnostic and therapeutic management of sinus diseases. (Mackay and Lund,1997; Kantarci et al., 2004; Sukalaya and Busakorn, 2005).

CT has dramatically improved the imaging of the paranasal sinuses as compared to the standard sinus radiographs. Although magnetic resonance imaging (MRI) offers a definite advantage in the differentiation of soft tissue pathology in sinus diseases, CT remains the method of choice because it produces better definition of bony landmarks (Meyers and Valvassori, 1998). Anatomic variations of the paranasal sinuses are thought to be predisposing factors for the development of sinus diseases as they may impair drainage and ventillation of such sinuses (Lloyd ,1990; Bolger et al., 1991; Calhoun et al., 1991; Joe et al., 2000). Moreover, these anatomic variations may produce difficulties during ESS (Zinreich et al., 1987; Stammberger and Hawke, 1993). CT can provide the anatomic "road map" for the endoscopic sinus surgery.

In the light of the high degree of variability in sinus anatomy, preoperative awareness of a patient unique sinus anatomy may help in preventing iatrogenic injury to the surrounding vital structures during ESS (Lebowitz et al., 2001). Therefore, the present investigation was carried out to throw light on the anatomical variations of the paranasal sinuses utilizing CT imaging.

SUBJECTS AND METHODS

Consecutive CT scans of the paranasal sinuses obtained from 300 (120 males and 180 females) subjects after exclusion of those with previous alteration of the paranasal sinus anatomy due to facial trauma, paranasal sinus carcinoma, or previous sinonasal surgery . Their age ranged from 15 to 55 years with a mean age 28.4 ±8.79 They were referred from ENT, Ophthalmology, Neurology and Neurosurgery Departments for different reasons and were undergoing evaluation at the Department of Radiology, Mansoura University Hospital from 2003 to 2005. Coronal and axial CT scans were done for each subject. The coronal CT scans were taken from the glabella to the posterior clinoid processes and the axial scans were taken from the hard palate to above the frontal sinus (Figs. 1 & 2). This approach assured complete coverage of all the paranasal sinuses. All subjects were scanned on Toshiba Asteion unit with 5 mm sequential scan and window width = 1500 HU without the use of intravenous contrast (Zinreich et al., 1987). CT images were analyzed for the incidence of anatomical variations of the paranasal sinuses including excessive pneumatization, hypoplasia, septation and variations of bony walls of each sinus.

RESULTS

1- Anatomical variations of the maxillary air sinus (Table 1) :

Normally, the floor of the maxillary sinus appeared formed by the alveolar process of the maxilla and the apices of the teeth were separated from the floor by a bone of varying thickness (Fig. 3). Septated maxillary sinus was present in 48 cases (16%) (Figs. 4 & 5) and maxillary sinus hypoplasia was detected in 30 cases (10%) (Fig. 6). A tooth was detected in the maxillary sinus in 12 cases (4%) (Figs.7 & 8).

II. Anatomical variations of the frontal air sinus (Table 2) :

Extensive pneumatization of the superciliary portion of the frontal bone with an apparent increase in the volume of the frontal sinus was detected in 114 cases (38%) (Figs. 9 &10). Frontal hypoplasia was present in 78 cases (26 %) (Fig. 11) and aplasia of the frontal sinus was detected in 12 cases (4 %) (Fig. 12).

III. Anatomical variations of the sphenoidal air sinus (Table 3) :

The sphenoidal air sinus is normally septated (Fig.13). Absence of such septation was detected in 30 cases (10%) (Fig. 14). Extensive pneumatization of sphenoidal sinus with an apparent increase in its volume was detected in 18 cases (6 %) (Fig.15) and hypoplasia of the sinus was present in 12 cases (4%) (Fig.16).

Normally, as the internal carotid artery leaves the petrous bone it enters the cavernous sinus and usually passes in a groove on the lateral aspect of the basisphenoid separated from the sphenoidal sinus by a thick bony wall (Fig.17). When the sphenoidal sinus is extensively pneumaptized, the internal carotid artery appeared bulging within the lumen of the sinus, being covered only by a thin bony shell. This variation was observed in 150 cases (50%) (Figs. 18 & 19). When the basisphenoid is highly pneumatized, the optic nerve appeared producing an impression in the superior wall of the sphenoidal sinus. This impression was found in 180 cases (60 %) (Fig.20).

III. Anatomical variations of the sphenoidal air sinus (Table 3) :

The sphenoidal air sinus is normally septated (Fig.13). Absence of such septation was detected in 30 cases (10%) (Fig. 14). Extensive pneumatization of sphenoidal sinus with an apparent increase in its volume was detected in 18 cases (6 %) (Fig.15) and hypoplasia of the sinus was present in 12 cases (4%) (Fig.16).

Normally, as the internal carotid artery leaves the petrous bone it enters the cavernous sinus and usually passes in a groove on the lateral aspect of the basisphenoid separated from the sphenoidal sinus by a thick bony wall (Fig.17). When the sphenoidal sinus is extensively pneumatized, the internal carotid artery appeared bulging within the lumen of the sinus, being covered only by a thin bony shell. This variation was observed in 150 cases (50%) (Figs. 18 & 19).When the basisphenoid is highly pneumatized, the optic nerve appeared producing an impression in the superior wall of the sphenoidal sinus. This impression was found in 180 cases (60 %) (Fig.20).

IV. Anatomical variations of the ethmoidal air sinuses (Table 4) :

Normally, the Agger nasi is a non-pneumatized crest present anterior and superior to the middle turbinate (Fig.21). Agger nasi cell is a pneumatized Agger nasi. In coronal CT, this cell was seen below the level of the frontal sinus and anterior to the attachment of the middle turbinate in 216 cases (72%) (Figs.22 & 23). Haller's cell (infraorbital ethmoidal cell) is an ethmoidal air cell appeared along the medial part of orbital floor. Haller's cell was detected in 90 cases (30%) (Figs.24 & 25). Onodi (sphenoethmoidal) cell is the most posterior ethmoid cell when it becomes extensively pneumatized and extends laterally and to some degree superiorly to the sphenoidal sinus. Onodi cell was detected in 210 cases (70 %) (Fig. 26). In normal subjects, the uncinate process (UP) appeared as a thin sickle shaped bony leaflet and its concave free margin was parallel to the anterior surface of the ehmoid bulla. Hypoplasia of UP was detected in 72 cases (24%) (Fig.27). Elongation and apparent fusion of the UP tip to the floor of the ethmoid sinus was found in 30 cases (10%) (Fig.28). Pneumatized UP (uncinate bulla) was detected in 24 cases (8%) (Fig.29). Laterally deviated UP was present in 114 cases (38%) (Fig.30), while medial deviation was detected in 84 cases (28 %) (Fig.31).

In normal subjects, ethmoid bulla was related laterally to the orbital plate of ethmoid. It extended to the roof of ethmoid and posteriorly to the basal lamella of the middle concha. Enlarged ethmoid bulla was detected in 102 cases (34 %) (Fig. 32). Normally, crista galli appeared not pneumatized (Fig.33); its pneumatization was detected in 18 cases (6%) (Figs.34 & 35). Pneumatized middle turbinate (concha bullosa) was encountered in 168 cases (56%) (Figs. 24 & 31). Paradoxically curved middle turbinate with concave medial wall was present in 60 cases (20 %) (Fig.36).

Table 1: Anatomical variations of the maxillary air sinus.

Variations	No. of cases	Percentage %
Septated sinus	48	16
Hypoplasia	30	10
A tooth in the sinus	12	4

Table 2 : Anatomical variations of the frontal air sinus.

Variations	No. of cases	Percentage %
Extensive pneumatization	114	38
Frontal hypoplasia	78	26
Frontal aplasia	12	4

Table 3 : Anatomical variations of the sphenoidal air sinus.		
Variations	No. of cases	Percentage %
Unseptated sinus	30	10
Extensive pneumatization	18	6
Hypoplasia	12	4
Bulging of the internal carotid artery into the sinus	150	50
Impression of the wall of the sinus by the optic nerve	180	60

Table 4: Anatomical variations of the ethmoid air sinuses.		
Variations	No. of cases	Percentage %
Agger nasi cell	216	72
Haller's cell	90	30
Onodi cell	210	70
Hypoplasia of UP	72	24
Elongation of UP	30	10
Pneumatized UP	24	8
Lateral deviation of UP	114	38
Medial deviation of UP	84	28
Enlarged ethmoid bulla	102	34
Pneumatized crista galli	18	6
Pneumatized middle turbinate	168	56
Paradoxically curved middle turbinate	60	20

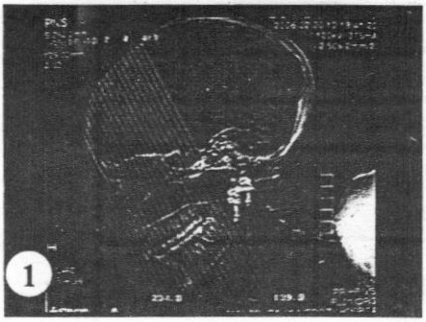

Fig. (1) : A photograph showing the scannogram for coronal CT images

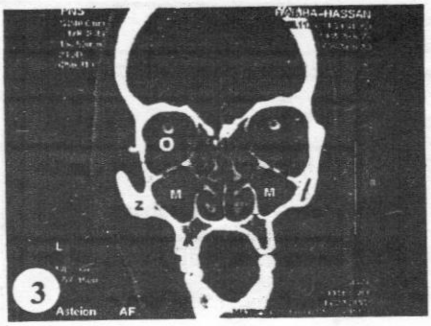

Fig. (3) : A photograph of coronal CT of paranasal sinuses showing normal maxillary sinus (M).Note the orbit (O), the zygomatic bone (Z) and the alveolar process of maxilla (A).

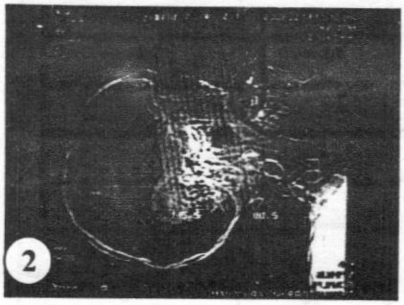

Fig. (2) : A photograph showing the scannogram for axial CT images.

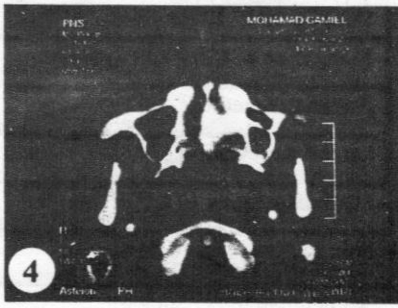

Fig. (4) : A photograph of axial CT of paranasal sinuses showing septation of left maxillary sinus (arrow).

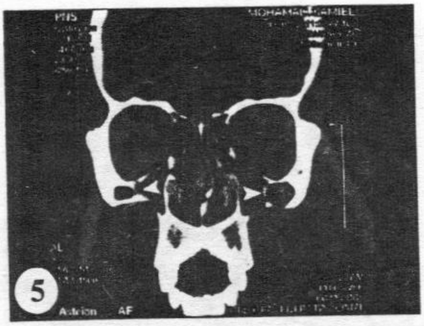

Fig. (5) : A photograph of coronal CT of paranasal sinuses showing septation of both maxillary sinuses (arrow heads). Note the concha bullosa (C).

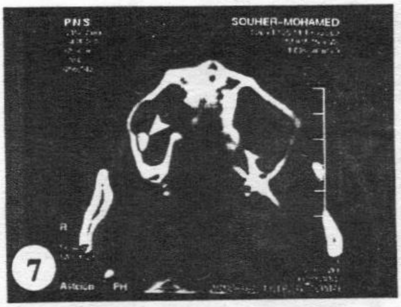

Fig. (7) : A photograph of axial CT of paranasal sinuses showing a tooth in the right maxillary sinus (arrow head).

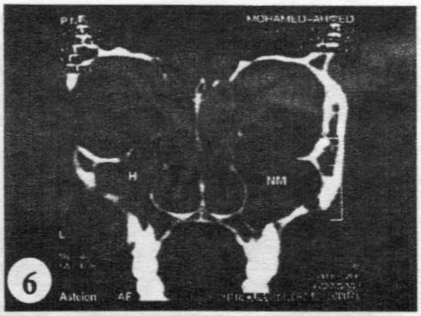

Fig. (6) : A photograph of coronal CT of paranasal sinuses showing left maxillary hypoplasia (H). Note the normal right maxillary sinus (NM).

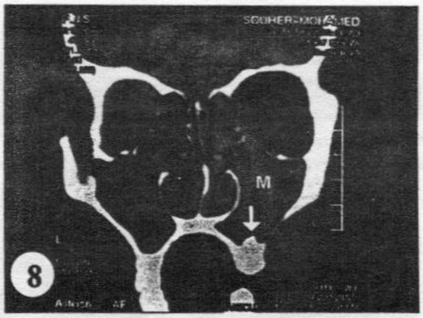

Fig. (8) : A photograph of coronal CT of paranasal sinuses showing a tooth (arrow) in the right maxillary sinus (M).

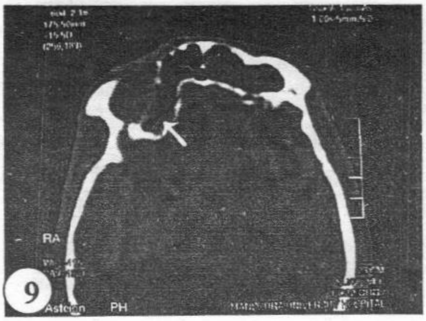

Fig. (9) : A photograph of axial CT of paranasal sinuses showing extensive pneumatization of the frontal sinus. Note the extension into the roof of the orbit (arrow).

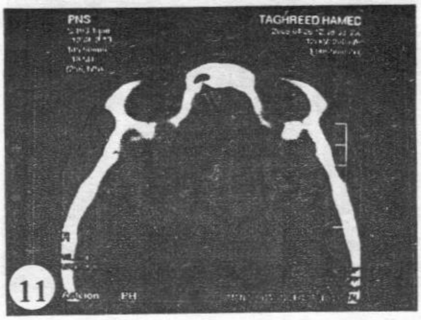

Fig. (11) : A photograph of axial CT of paranasal sinuses showing right frontal sinus hypoplasia (black arrow) and aplasia of the left frontal sinus.

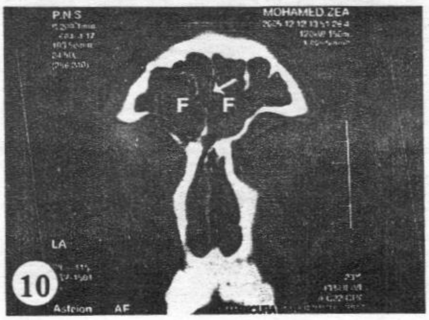

Fig. (10) : A photograph of coronal CT of paranasal sinuses showing extensive pneumatization of the frontal sinus (F). Note that the sinus is divided by septa (arrow).

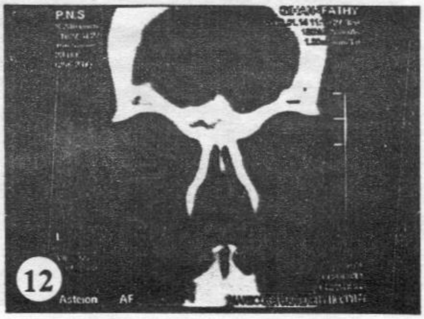

Fig. (12) : A photograph of coronal CT of paranasal sinuses showing frontal sinus aplasia.

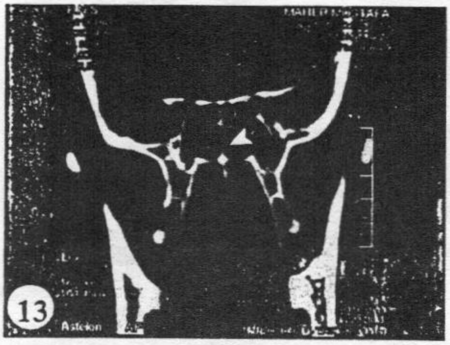

Fig. (13) : A photograph of coronal CT of paranasal sinuses showing septation of the sphenoidal sinus (arrow head).IFGGGRDGHGWER FDFF

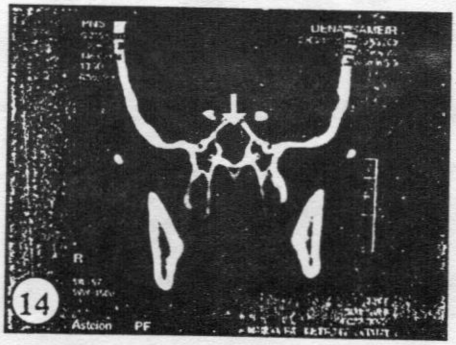

Fig. (14) : A photograph of coronal CT of paranasal sinuses showing unseptated sphenoidal air sinus (arrow)

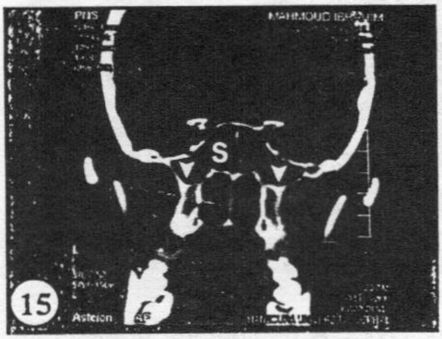

Fig. (15) : A photograph coronal CT of paranasal sinuses showing extensive pneumatization of the sphenoidal sinus (S) and pneumatization of the pterygoid process (arrow heads).

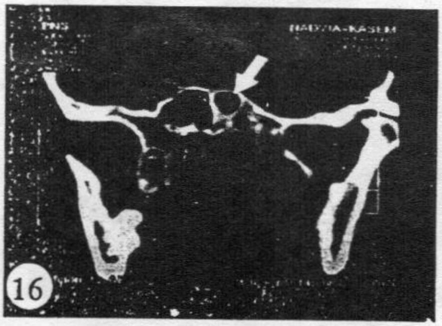

Fig. (16) : A photograph of coronal CT of paranasal sinuses showing sphenoidal sinus hypoplasia (arrows).

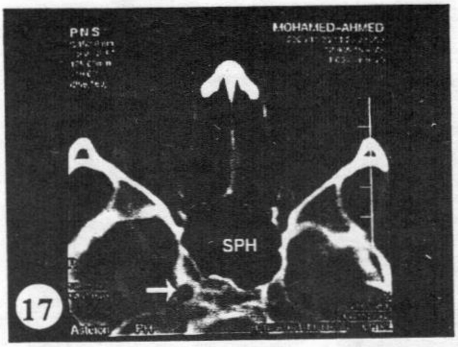

Fig. (17) : A photograph of axial CT of paranasal sinuses showing that the right internal carotid artery (white arrow) is separated from the sphenoidal sinus (SPH) by a thick bony segment, while the left one (black arrow head) is separated from SPH by a thin bony segment.

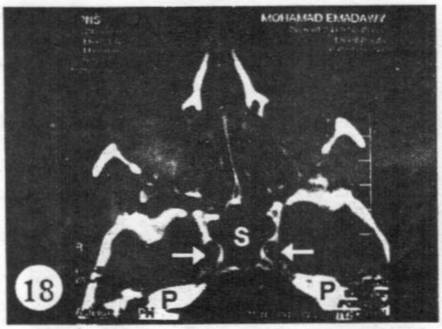

Fig. (18) : A photograph of axial CT of paranasal sinuses showing bulging of the internal carotid arteries (arrows) into the sphenoidal sinus (S).

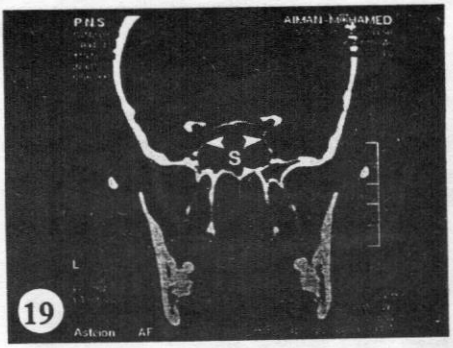

Fig. (19) : A photograph of coronal CT of paranasal sinuses showing bulging of the internal carotid arteries (arrow heads) into the sphenoidal sinus (S).

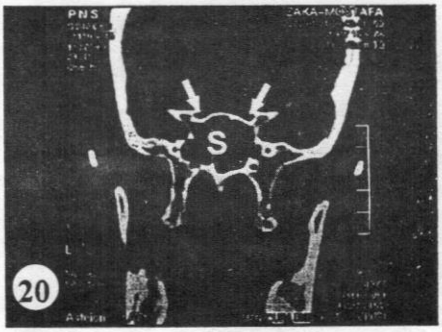

Fig. (20) : A photograph of coronal CT of paranasal sinuses showing bulging of the optic nerve (arrows) into the sphenoidal sinus (S).

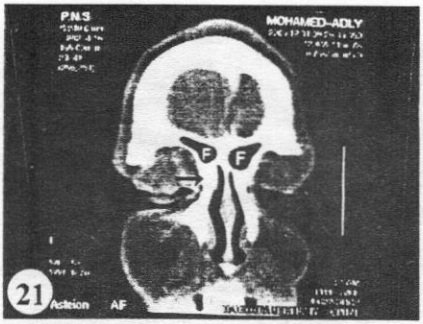

Fig. (21) : A photograph of coronal CT of paranasal sinuses showing unpneumatized agger nasi cells (black arrow) . (F) represents the frontal sinus.

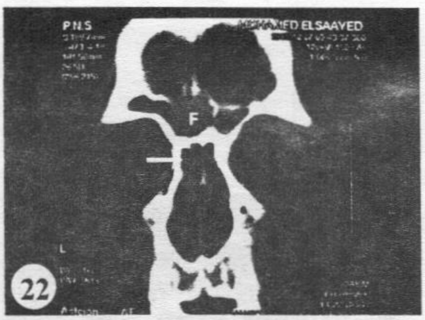

Fig. (22) : A photograph of coronal CT of paranasal sinuses showing unilateral agger nasi cell (white arrow). (F) represents the frontal sinus.

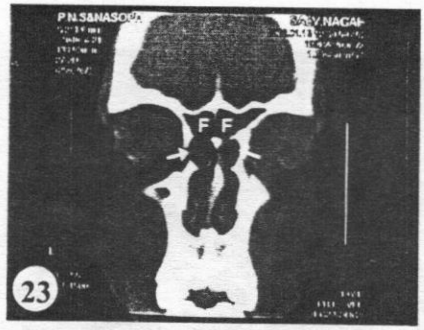

Fig. (23) : A photograph of coronal CT of paranasal sinuses showing bilateral enlarged agger nasi cell (arrows). (F) represents the frontal sinus.

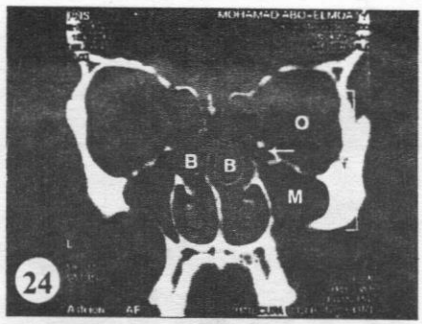

Fig. (24) : A photograph of coronal CT of paranasal sinuses showing unilateral Haller's cell (arrow) situated in the medial part of the roof of the right maxillary sinus (M) below the orbit (O). Note the presence of pneumatized middle turbinates (B).

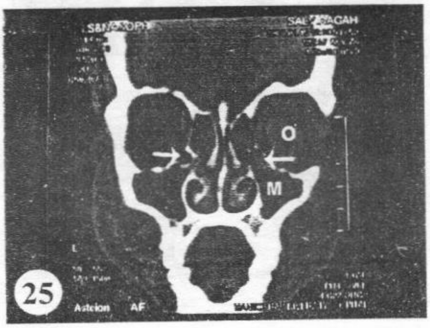

Fig. (25) : photograph of coronal CT of paranasal sinuses showing bilateral Haller's cells (arrows). Note the orbit (O) and maxillary sinus (M).

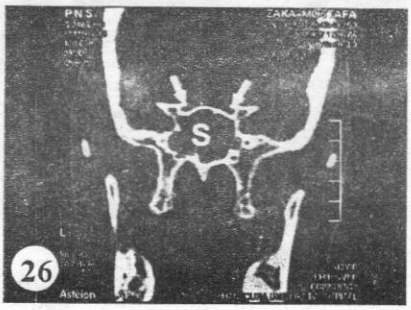

Fig. (26): A photograph of coronal CT of paranasal sinuses showing Onodi cell (arrow). Note the sphenoidal sinus (S).

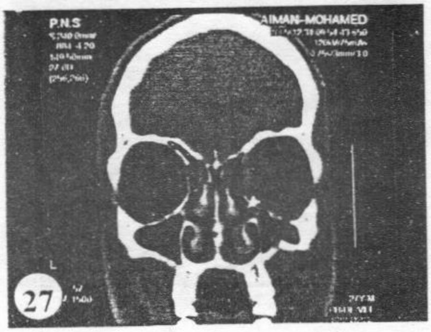

Fig. (27) : A photograph of coronal CT of paranasal sinuses showing hypoplastic uncinate process (arrow head).

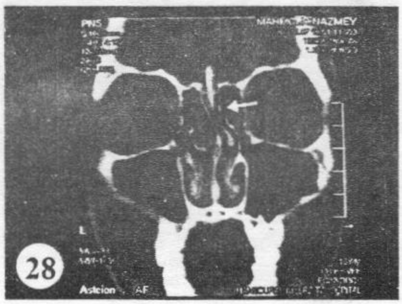

Fig. (28) : A photograph of coronal CT of paranasal sinuses showing elongation of the uncinate process (arrow)

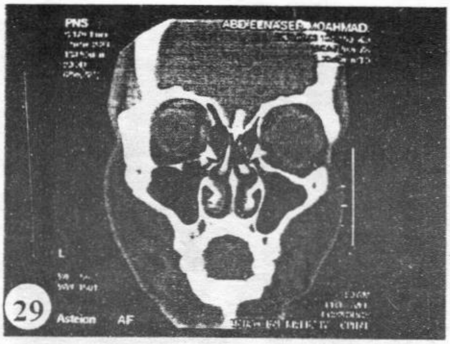

Fig. (29) : A photograph of coronal CT of paranasal sinuses showing bilateral uncinate bulla (arrow heads).

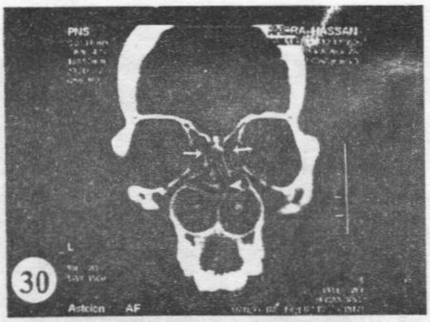

Fig. (30) : A photograph of coronal CT of paranasal sinuses showing lateral deviation of the uncinate process (arrow).Note the deviated nasal septum (arrow head).

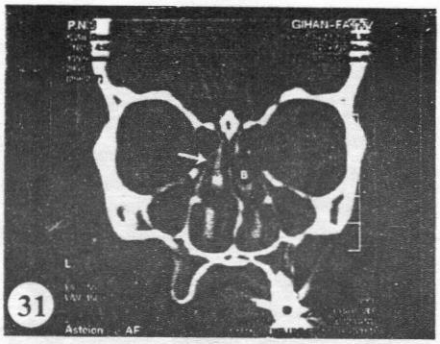

Fig. (31) : A photograph of coronal CT of paranasal sinuses showing that the uncinate process is medially deviated (arrow) and attached to the left middle turbinate (M). Note pneumatized right middle turbinate(B).

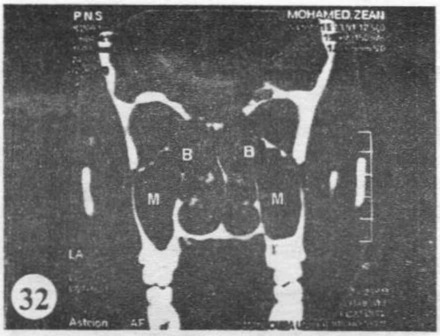

Fig. (32) : A photograph of coronal CT of paranasal sinuses showing well-pneumatized ethmoidal bulla (B). Note the maxillary sinus (M).

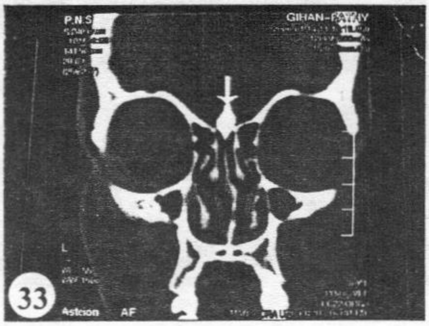

Fig. (33) : A photograph of coronal CT of paranasal sinuses showing unpneumatized crista galli (arrow).

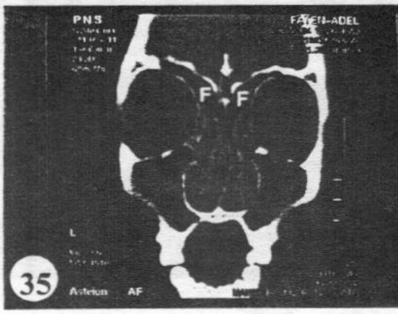

Fig. (35) : A photograph of coronal CT of paranasal sinuses showing pneumatized crista galli (arrow). Note the frontal sinus (F).

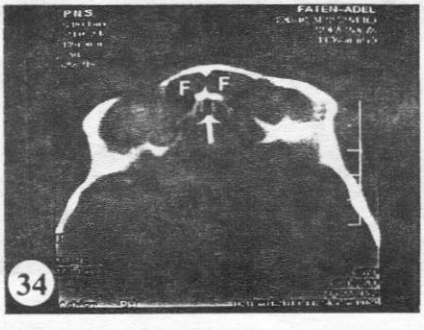

Fig. (34) : A photograph of axial CT of paranasal sinuses showing pneumatized crista galli (arrow). Note the frontal sinus (F).

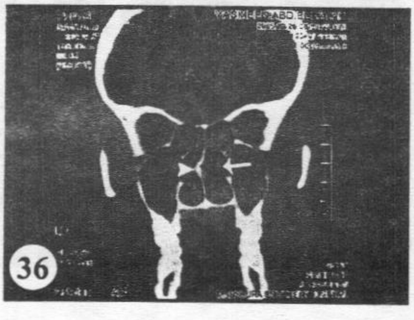

Fig. (36) : A photograph of coronal CT of paranasal sinuses showing paradoxically curved middle turbinate (arrow).Note the deviated nasal septum (arrow head).

DISCUSSION

The revolutionary changes in the management of sinus diseases in recent years require the clinician and radiologist to have precise and detailed knowledge of the paranasal sinuses anatomy and their anatomical variations; many of which are detectable only by the use of CT (Tonai and Baba, 1996). It is commonly accepted that CT is more useful than the conventional radiology and MRI in delineating anatomical variations of paranasal sinuses because it produces better definition of the bony landmarks (Meyers and Valvassori, 1998). These anatomical variations have been implicated in the etiology of sinusitis and they may also produce difficulties during endoscopic sinus surgery (Lebowitz et al., 2001 ; Tan and Chong, 2001).

In the present study, different forms of anatomical variations of the paranasl sinuses were detected. Maxillary sinus hypoplasia was detected in 10% of cases. This incidence is almost similar to that reported by Bolger et al. (1991), but is much lower than that reported by Milczuk et al. (1993) and Basak et al.(1998) (17.5% and 20%, respectively). Other investigators (April et al., 1993; Meyers and Valvassori, 1998; Krzeski et al., 2001 and Sirikci et al., 2003) reported lower incidences of maxillary sinus hypoplasia (6.5%, 4%, 2.23% and 4%, respectively). Maxillary sinus hypoplasia should be considered in the differential diagnosis of patients showing an apparently opaque maxillary sinus with plain sinus radiographs to avoid in-appropriate treatment (Tonai and Baba, 1996). In the current investigation, the maxillary sinus was divided by septa into unequal cavities in 16% of the cases. This incidence coincides with that reported by Krennmair et al (1997), but is higher than that reported by Krzeski et al. (2001) and Sirikci et al. (2003) (5.73% and 10%, respectively). Marked projection of a tooth in the floor of the maxillary sinus was detected in 4% of the cases of the present series. This condition may be associated with developmental disturbance, pathological process or iatrogenic activities (Delbalso, 1990).

In this investigation, frontal sinus aplasia was detected in the 4% of the cases . This incidence is lower than that claimed by Landsberg and Friedman (2001) (4.9%) and higher than that reported by Sanchez et al. (2000) (2.4%) and Aydinlioglu et al. (2004) (3.8%). Frontal sinus hypoplasia was detected in 26% of the cases, an incidence which is much higher than those of Amedee (1993) , Sanchez et al. (2000) and Krzeski et al. (2001) (5.9%, 3.9% and 7.01%, respectively).

In the present study, extensive pneumatization of the sphenoidal air sinus is observed in 6% of the cases, an incidence lower than that recorded by Kosling et al. (1993) (20%). Septation of the sphenoidal sinus was the rule in 90% of the present cases. This incidence is much higher than those reported by Krzeski et al. (2001) and Nitinavakarn et al. (2005) (29.94% and 47.7%, respectively) but lower than that reported by Sanchez et al. (2000) (94.4%). Protrusion of the optic nerve into the superolateral part of the sphenoidal sinus was observed in 60% of the present cases. Sethi et al. (1995) reported slight protrusion of the optic nerve into the superolateral part of the sphenoidal sinus in all of their cases, 3% of which were prominent. Such protrusion of the optic nerve into the sphenoidal sinus may lead to damage of the optic nerve during intranasal sinus surgery (Dessi et al.1994). The internal carotid artery may bulge within the lumen of the sphenoidal sinus, being covered only by a thin bony shell. This variation was observed in 50 % of the cases of the present study, an incidence which is lower than that reported by Sethi et al. (1995) (93%).

In the present investigation, examination of the ethmoidal air sinus revealed large number of anatomical variations. Agger nasi cell was detected in 72% of the cases. The reported prevalence of Agger nasi cell varied widely among investigators. In anatomic dissections, Agger nasi cell was reported in 10% of the specimens dissected by Messerklinger (1967). Using coronal CT imaging, the incidences of Agger nasi cell reported by Bolger et al. (1991); Lloyd et al. (1991); Kosling et al. (1993) ; Tonai and Baba (1996); Kayalioglu et al. (2000) and Liu et al. (2002) were 98.5%, 3%, 23.6%, 88.9%, 4.88% and 0.70%, respectively. Differences in reported prevalence of Agger nasi cell could be attributed to the method of analysis employed. The location of Agger nasi is of clinical importance. Its intimate relation to the lacrimal bone and the frontal sinus could be an important factor in infection of lacrimal system and in frontal sinusitis (Mackay and Lund, 1997). Haller's cell was found in 30 % of the cases of the present series. The reported incidences of Haller's cell using CT scanning by Bolger et al. (1991), Tonai and Baba (1996), Stackpole and Edelstein (1997), Sanchez et al. (2000) and Liu et al., (2002) were 45.1%, 33.3%, 34.1%, 3.2% and 1.0%, respectively. Sanchez et al. (2000) attributed the discrepancy in incidences of the prevalence of Haller's cell to variations in interpretation of Haller's cell, sample study or technique of CT scanning. Haller's cell has been impiicated as a possible etiological factor in maxillary sinusitis as it can produce narrowing of the maxillary infundibulum (Zinreich et al., 1987 ; Stammberger and Wolf, 1988). Onodi cell was identified in 70% of the present cases, an incidence which is higher than that reported in previous studies. Habal et al. (1976) using transorbital dissection detected Onodi cell in 25% of the cases. Kainz and Stammberger (1992) using endoscopic dissection reported 42% of the cases with Onodi cell. According to Kosling et al. (1993); Dessi et al. (1994); Sethi et al. (1995) and Sanchez et al. (2000), the reported incidences of Onodi cell using CT scanning were 1.3%, 8%, 3% and 8.3%, respectively. On the other hand, Meyers and Valvassori (1998) detected no Onodi cell in their series.

Uncinate process (UP) was observed in all the present cases. Lang (1989) reported absence of UP in 1% of cases. Elongation of UP was found in 10% of the cases of the present series, a percentage which is lower than that reported by Liu et al. (2002) (19.36%) but higher than that reported by Chao (2005) (1%). Pneumatization of UP (uncinate bulla) was detected in 8% of cases of the present series, an incidence lower than that reported by Gumusburun, et al. (1996) (12%) and Sirikci et al. (2003) (10%) but higher than that detected by Krzeski et al. (2001) and Chao (2005) (0.96, and 1%, respectively).The incidence of laterally deviated UP detected in the present study (38 % of cases) is higher than that recorded by Danese et al. (1997) (31%). Milczuk et al. (1993) reported that laterally curved UP may narrow the hiatus semilunaris. Medial deviation of UP was detected in 37% of the cases in the present study; an incidence which is lower than that observed by Liu et al. (2002) (45.27%), but higher than that reported by Zinreich (1993) ; Joe et al. (2000) and Krzeski et al. (2001) (3% ,15% and 8.3%, respectively).

In the present study, the bulla ethmoidalis was well pneumatized in 34% of the cases, an incidence which is higher than that estimated by Scribano et al. (1997) (3.5%) and Krzeski et al. (2001) (26.75%). Crista galli was pneumatized in 6% of the present cases compared to 5.4% reported by Bolger et al. (1991) and 14% reported by Krzeski et al. (2001). Pneumatized middle concha (concha bullosa) was detected in 56% of cases of the present series. The reported incidences of concha bullosa varied widely among investigators; Basic et al. (1998), Joe et al. (2000), Pبrez-Piژas et al. (2000), Sanchez et al. (2000), Krzeski et al. (2001), Pospisilova et al. (2001), Sirikci et al. (2003) and Hatipoglu et al. (2005) reported concha bullosa in 42.5%, 15%, 73%, 8.3%, 30.25%, 51.7%, 50% and 70.58% of their cases, respectively. Criteria for pneumatization differ among investigators thus influencing the reported prevalence rates. In the present investigation, any degree of pneumatzation detected by CT was considered significant. Pneumatization may also be influenced by the sensitivity of the method of analysis. Inherent differences may exist between standard radiographic analysis, CT imaging and microscopic dissection techniques (Eltahry 2000). Krzeski et al. (2001) stated that an abnormally large middle turbinate may obstruct the ostiomeatal complex causing secondary infection of the ethmoid, frontal and maxillary sinuses. Obstruction of drainage of the concha bullosa itself can lead to mucocele formation.

Paradoxically curved middle turbinate was observed in 20% of the present cases. Bolger et al. (1991); Earwaker (1993); Tonai and Baba (1996) and Basic et al. (1998) reported higher incidences (26.1%, 25%, 29.8%, and 24.2%, respectively). Lower incidences were reported by Calhoun et al. (1991), Lloyd et al. (1991), Kosling et al. (1993), Krzeski et al. (2001) and Sirikci et al. (2003) (12%, 15%, 13.3%, 6.05% and 10 %, respectively).Variations in the reported prevalence of the paradoxically curved middle turbinate might be due to the fact that some investigators were concerned only with the paradoxical curve affecting the middle meatus. Paradoxically curved middle turbinate may block the entrance to the middle meatus, however, it has not been reported to be related to sinus disease (Sukalaya and Busakorn, 2005).

In conclusion, the discrepancy in the prevalence of the anatomical variations of the paranasal sinuses detected in the present study and those reported by others may be explained by differences in study population, criteria for the variations or sensitivity of the utilized techniques. The variations reported in the present investigation may be considered as a sample for the Egyptian population and should be taken into consideration when treating or performing operations of paranasal sinuses in the Egyptians.

REFERENCES

Amedee, R. (1993) : Sinus anatomy and function. In head and neck surgery-otolaryngology. Bailey B. (ED). Philadelphia: J.B. Lippincott Co., P. 342-349.

April, M.M.; Zinreich, S.J.; Paroody, F.M. and Nacleiro, R.M. (1993) : Coronal CT scans abnormalities in children with chronic sinusitis. Laryngoscope, 103:985-90.

Aydinlioglu, A.; Kavakli, A. and Er-

dem, S. (2004) : Absence of frontal sinus in Turkish individuals. Eur. Radiol., 14 (2):281- 5.

Basak, S.; Kahraman, C. Z.; Metin, K.K. and Kurt, T. (1998) : Anatomical differences of paranasal sinuses in children with chronic sinusitis. Turkish Archives of Otolaryngology, 36 (3-4):116-121.

Basic, N.; Basic, V.; Jelic, M.; Nikolic, V.; Jukic,T. and Hat, J. (1998) : Pneumatization of the middle nasal turbinate: A CT study. Lijec Vjesn, 120(7-8):200-1.

Bolger, W.E.; Butzin, C.A. and Parsons, D.S. (1991) : Paranasal sinus bony anatomic variation and mucosal abnormalities: CT analysis for endoscopic sinus surgery. Laryngoscope, 101:56-64.

Calhoun, K.H.; Waggenspack, G.A. and Simpson, C.B. (1991) : CT evaluation of the paranasal sinuses in symptomatic and asymptomatic populations. Otolaryngology Head Neck Surg., 104: 480-3.

Chao, T.K. (2005) : Uncommon anatomic variations in patients with chronic paranasal sinusitis. Otolaryngol. Head and Neck surgery, Feb; 132(2):221-5.

Danese, M. ; Duvoisin, B.; Agrifoglia, A.; Cherpillod, J. and Krayenbuhl, M. (1997) : Influence of naso-sinusal anatomic variants on recurrent, persistent or chronic sinusitis. X-ray computed tomographic evaluation in 112 patients. J. Radiology, Sep; 78(9):651-7.

Delbalso, A.M. (1990) : Maxillofacial imaging. Saunders, Philadelphia, PA. P: 521-563.

Dessi, P.; Moulin, G.; Castro, F.; Chagnaud, C. and Cannoni, M. (1994) : Protrusion of the optic nerve into the ethmoid and sphenoid sinuses prospective study of 150 CT studies. Neuroradiology, Oct; 36 (7):515-6.

Earwaker, J. (1993) : Anatomic variants in sinonasal CT. Radio-Graphics, 13: 381-415.

Eltahry, H.M. (2000) : Anatomical variations of the ethmoid bone : Computerised tomographic and endoscopic analysis. Egypt J.Anat. Vol. 23 (1) 119-143.

Gumusburun, E.; Aykut, M.; Muderris, S. and Adiguzel, E. (1996) : The uncinate bulla. Okajimas Folia Anat. Jpn. Aug., 73(2-3):101-3.

Habal, M.B.; Maniscalco, J.E.; Lineaweaver, W.C. and Rhoton, A.L. (1976) : Microsurgical anatomy of the optic canal: Anatomical relations and exposure of the optic nerve. Surg Forum., 27 : 542-4.

Hatipoglu, G.H.; Cetin, A.M. and Yuksel, E. (2005) : Concha bullosa: their relation with sinusitis, ostiomeatal and frontal recess disease. Diagn. Intervent. Radiol., 11:145-149.

Joe, J.K., Ho, S.Y. and Yanagrisawa, E. (2000) : Documentation of variations in sinonasal anatomy by intraoperative nasal endoscopy. Laryngoscope, 110(2Pt.1): 229-35.

Kainz, J. and Stammberger, H. (1992) : Danger areas of the posterior rhinobasis. Acta Otolaryngol., 112:852-861.

Kantarci, M.; Karasen, R.M.; Alper, F.; Onbas, O.; Okur, A. and Karaman, A. (2004) : Remarkable anatomic variations in paranasal sinus region and their clinical importance. Eur. J. Radiol., Jun; 50(3):296-302.

Kayalioglu, G.; Oyar, O. and Govsa, F. (2000) : Nasal cavity and paranasal sinus bony variations: A computed tomographic study. Rhinology, 38(3):108-13.

Kosling, S.; Wagner, F.; Schulz, H.G. and Heywang-Kobrunner, S. (1993) : Osseous variations in the coronary CT of the paranasal sinuses. Rofo Fortschr Geb Rontgenstr Neuen Bildgeb Verfahr, Dec.,159(6):506-10.

Krennmair, G.; Ulm, C. and Lungmayr, H. (1997) : Maxillary sinus septa: Incidence, morphology and clinical implication. J. Craniomaxillofac. Surg., 25(5):261-265.

Krzeski, A.; Tomaszewska, E.; Jakubczyk, I. and Galewicz-Zieli-ska, A. (2001) : Anatomic variation of the lateral nasal wall in the computed tomography scans of patients with chronic sinusitis. American Journal of Rhinology, November-December, vol.15 (6): 371-357.

Landsberg, R., and Friedman, M. (2001) : A computer-assisted anatomical study of the nasofrontal region. Laryngoscope, 111(12) : 2125-30.

Lang, J. (1989) : Clinical anatomy of the nose, nasal cavity and paranasal sinuses. In: Stell PM Translator, Thieme Medical Publisher, New York. P 56-81.

Lebowitz, R.; Alyssa T.; Joseph, B. and Holliday A.R. (2001) : Asymmetry of the Ethmoid Roof: Analysis Using Computed Tomography. Laryngoscope, 111: P. 2122-2130.

Liu, X.; Zhang, G. and Xu, G. (2002) : Anatomic variations of the ostiomeatal complex and their correlation with chronic sinusitis: CT evaluation. Proc. Natl. Acad. Sci. U. S. A., Jun 11; 99(12):8454-6.

Lloyd, G.A.S. (1990) : CT of the paranasal sinuses: Study of a control series in relation to endoscopic sinus surgery. J. Laryngol. Oto., 104: 477-81.

Lloyd, G.A.S.; Lund, V.J. and Scadding, G.K. (1991) : CT of the paranasal sinuses and functional endoscopic surgery: a critical analysis of 100 symptomatic patients. J. Laryngol. Otol., 105: 181-5.

Mackay, L.S. and Lund, V.J. (1997) : Surgical management of sinusitis: Anatomical variants. In Scott-Brown otolaryngology (6th edition), Butterwoth-Heinman, pp.4122-4124.

Messerklinger,W. (1967) : On the drainage of the normal frontal sinus of man. Acta Otolaryngol, 63: 167-178.

Meyers, R.M. and Valvassori, G. (1998) : Interpretation of anatomic variations of computed tomography scans of the sinuses: A Surgeon's Perspective. Laryngoscope, 108: P 422-425.

Milczuk, H.A.; Dalley, R.W.; Wessbacher, F.W. and Richardson M.A. (1993) : Nasal and paranasal sinus anomalies in children with chronic sinusitis. Laryngoscope, 103 : 147-52.

Nitinavakarn, B.; Thanaviratananich, S. and Sangsilp, N. (2005) : Anatomical variations of the lateral nasal wall and paranasal sinuses: A CT study for endoscopic sinus surgery (ESS) in Thai patients. J. Med. Assoc. Thai., 88 (6):763-768.

Perez-Pinas, S.J.; Carmona, A.; Catalina-Herrera, C.J. and Jimenez-Castellanos, J. (2000) : Anatomical variations in the human paranasal sinus region studied by CT. J. Anat., Aug; 197 (PT2):221-7.

Pospisilova, B.; Prochazkova, O.; Kracik, M.; Stoganov, R.;

Slizova, D. and Krs, O. (2001) : Finding of massive pneumatization of the middle nasal turbinate in a collection of skulls from the 13th-18th centuries. Acta Medic. A., suppl.44 (2):43-8.

Sanchez, F.J.M.; Anta Escuredo, J.A.; Sanchez, D.R.A. and Santaolalla, M.F. (2000) : Morphometric study of the paranasal sinuses in normal and pathological conditions. Acta Otolaryngol., 120:273-278.

Scribano, E.; Ascenti, G.; Loria, G.; Cascio, F. and Gaeta (1997) : The role of the ostiomeatal unit anatomic variations in inflammatory disease of the maxillary sinuses. Eur. J. Radiol., May; 24(3):172-4.

Sethi, S. D.; Stanley, R.E. and Pillay, K.P. (1995) : Endoscopic anatomy of the sphenoid and sella turcica. The Journal of Laryngology and Otology, October, (109) pp.951-955.

Sirikci, A.; Bayazit, Y.A.; Bayram, M. and Kanlikama, M. (2003) : Ethmomaxillary sinus: a particular anatomic variation of the paranasal sinuses. Eur. Radiol., 14 (2):281-5.

Stackpole, S.A. and Edelstein, D.R. (1997) : The anatomic relevance of the Haller's cell in sinusitis. Ann. J. Rhinol., 11(3):219-23.

Stammberger, H. and Hawke, M. (1993) : Essentials of endoscopic sinus surgery. Edit, Robert Hurley, Mosby, Philadelphia.P.70-94.

Stammberger, H. and Wolf, G. (1988) : Headaches and sinus disease: The endoscopic approach. Ann. Otol. Rhinol. Laryngol., (suppl.), 134: 3-23.

Sukalaya L. and Busakorn V. (2005) : Prevalence of anatomic variation demonstrated on screening sinus computed tomography and clinical correlation. J Med Assoc Thai Vol. 88 Suppl.4 : 110-114.

Tan, H.M. and Chong, F.H.V. (2001) : CT of the paranasal sinuses: Normal anatomy, variants and pathology. CME Radiology, 2 (3):120-125.

Tonai, A. and Baba, S. (1996) : Anatomical variations of the bone in sinonasal CT. Acta Otolaryngol. (Stockh), Suppl. 525:9-13.

Zinreich, S.J. (1993) : Imaging of inflammatory sinus disease. Otolaryngol. Clin. North Am., 26:535-547.

Zinreich, S.J.; Kennedy, D.W. and Rosenbaum, A.E. (1987): Paranasal sinuses: CT imaging requirements for endoscopic surgery. Radiology, 163: 769-75.

التباين التشريحي فى الجيوب الأنفية للإنسان : تَحليل بالأشعة المقطعية

كان هدف هذا البحث هو دراسة الاختلافات التشريحية في الجيوب الأنفية بواسطة الأشعة المقطعية حيث ان الالمام بهذه الإختلافات له بالغ الأثر في تشخيص وعلاج أمراض الجيوب الأنفية وبخاصة أثناء استخدام المناظير الجراحية. ولقد تم فحص الأشعة المقطعية للجيوب الأنفية لعدد ٣٠٠ مريض من الجنسين تراوحت أعمارهم بين ١٥ و ٥٥ عاما.

أظهرت الأشعة المقطعية للجيب الفقمى وجود إختلافات تشريحية عديدة منها قصور فى نموه مع قلة حجمه فى ١٠% من الحالات ، حواجز فاصله بداخله فى ٢٦% كما وُجدَ بروزا للأسنان في داخله في٤% من الحالات. وعند فحص الجيب الجبهى لوحظ به تضخم هوائى فى ٣٨% من الحالات، كما لوحظ أيضاً انعدام التكوين للجيب الجبهى في ٤% من الحالات وقصور فى النمو مع قلة الحجم في٢٦% من الحالات. وعند فحص الجيب الوتدى (الأسفينى) ظهر قصور فى نموة فى ٤% من الحالات وظهر به تضخم هوائى فى ٦% من الحالات، وقد لوحظ عدم وجود فواصل بداخل الجيب الوتدى فى ١٠% من الحالات ، كما كان لكل من العصب البصرى والشريان السباتى الداخلى أثرهما الواضح على جدار الجيب الوتدى فى ٦٠% و ٥٠% من الحالات على التوالى. وبدراسة الجيب المصفوى لوحظت التباينات التشريحية التالية : تضخم هوائي بالأكمة الأنفية (بنسبة ٧٢%) ، الخلية المصفوية تحت الحجاجيه (خلية هيلر) (بنسبة٣٠%) ، الخلية المصفويةالأسفينيه (خلية اونودى) (بنسبة ٧٠%) ، تضخم الفقاعة المصفوية (بنسبة ٣٤%), تضخم هوائي بصدفه الأنف الوسطى (بنسبة ٥٦%) و تقوس معكوس لصدفه الأنف الوسطى (بنسبة ٢%). أما بالنسبة للبروز المعقوف فقد لوحظ قصور فى نموه فى ٢٤% من الحالات , استطالة فى ١٠% , انحراف وحشى فى ٣٨% , انحراف أنسى فى ٢٨ % و تضخم هوائى (فقاعة معقوفة) فى ٨ % من الحالات.

ولقد أستنتج من هذا البحث أن التباينات التشريحية المختلفة للجيوب الأنفية يمكن تحديدها بالأشعة المقطعية كما أن أكتشاف تلك التباينات التشريحية تساعد على فهم أمراض الجيوب الأنفية وكذلك تساعد على تفادى المضاعفات التى يمكن أن تحدث أثناء اجراء جراحات الجيوب الأنفية بالمناظير.