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Research Article

EVALUATION OF ANATOMICAL VARIATIONS OF HEAD AND NECK REGION AND ITS SIGNIFICANCE WITH THE AID OF CONE BEAM COMPUTED TOMOGRAPHY– A RETROSPECTIVE STUDY

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A B S T R A C T

Background: Cone Beam Computed Tomography can indubitably visualize three dimensional images of anatomical structures with high resolution and lower radiation dose.Multi-planar imaging with cone beam computed tomography is very easy to re-create and also to increase the diagnostic efficiency.The current study aims atevaluation of anatomical variations of head and neck region and its significance with the aid of cone beam computed tomography. **Materials and Methods:** A Retrospective study carried out using 100 Cone Beam Computed Tomography images of Full skull taken from the achieves with the age ranging from 18-60 years were analysed to assess the anatomical variations of head and neck region. **Results:** Total of 697 anatomical variations were observed in 100 patients. Most common anatomical variations were noted as Nasal septum deviation(98%), Naso palatine canal variations(96%),Agger nasi cells(93%),sphenoid septa (43%), Kuhn cells (41%),Conchae bullosa(39%), convex condyle(35%),Sphenoid pneumatisation (32%), Maxillary sinus septa(29%), etc findings were noted respectively. **Conclusion**: CBCT images constitute a valuable tool for diagnosis in the head and neck region and thus, the dentists should make an appropriate use of the advanced diagnostics imaging to interpret the image and must report with their clinical significance.

INTRODUCTION

Anatomy of oral and maxillofacial region served as a fundamental approach for varying concepts in its entities and sub entities and evolved with multiple assertions in the study and description of its structural variability (Grizzi *et al*. 2005).This growing complexities propelled the need for a deep insight into the existing variations that are important yet normal and hence, provide a significant scope for assessment during clinical and or surgical proceedings. The study of anatomy employs multiple modalities constituting surface/macrostructure anatomy, surgical and ultra structural anatomy, and radiographic imaging (Ganguly P.K, 2010). Medical imaging and its applications in dentistry and other allied disciplines, has viewed many advancements of which, three dimensional imaging in particular has gained a paramount importance in the art of diagnosis (Karatas *et al*.2014).Tomography has made its revolutionary introduction into the era of diagnostic imaging (sikka *et al*.2012). Cone beam computed tomography with its eccentricity in volumetric analysis of the structures, and dimensional accuracy due to the production of sub millimetre resolution comparable to that of the medical computed tomography, serves as a reliable source for the assessment of various anatomical structures in the head and neck region (Ogeng'o *et al* in 2013). The study of anatomical variations pertaining to the head and neck region should include the regions of nasal septum, par nasal sinuses, foramina, condoles, cervical vertebrae, teeth and their relationship with the vital structures, and calcifications. The current study employed CBCT assessment of head and neck region with an objective to determine its reliability in visualizing the anatomical variations.

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MATERIALS AND METHODS

A retrospective observational study was conducted for duration of two months (August- October, 2018) in the Department Of Oral Medicine And Radiology of a private dental college in Chennai. Sample size was calculated to be 100 CBCT images, acquired from the archives that were generated using PLANMECA PROMAX 3D MID PROFACE CBCT machine and assessed with Romex is software. The images were grouped according to the age of the individuals into three groups (Group I: 18-30 yrs, Group II: 31-50yrs, Group III: 51-60 yrs). The obtained images were of the patients who were subjected to full skull CBCT for various other clinical purposes such as Implant assessment,

orthodontic analysis, endodontic assessment etc. Images depicting artifacts, pathologies and trauma in the regions of interest were excluded from the study analysis.

Multi-planar, and reconstructed panoramic and 3 dimensional visualization of the full skull images was carried out to assess the anatomical variations. The observed variations were grouped based on their region of occurrence into – Nasal variations, paranasal sinus variations, variations in the foramens, condylar variations, variations in the cervical vertebrae patterns, teeth and their proximity to the vital structures, and calcifications.

Evaluation of nasal variations consisted of the assessment of the nasal septum for deviation and its patterns such as deviation to right, deviation to left, straight nasal septum, Reverse sigmoid pattern, sigmoid pattern, conchae bullosa for the presence of pneumatisation in the middle conchae, and presence of Paradoxical middle conchae and secondary conchae.

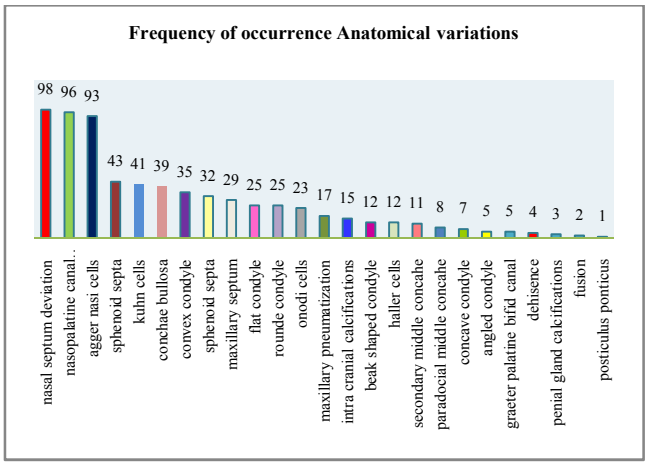
Sinus evaluation consisted of, evaluation of maxillary sinus for septae, pneumatisation and maxillary posterior teeth vicinity with floor of the sinus, and sphenoid sinus for its septae and pneumatisation. Variation in the paranasal sinuses were assessed for the presence of Kuhn cells, agger nasi cells, odoni cells, haller cells.

Cervical Vertebra variations included presence of ponticulus posticus, fusion of c3-c4 and dehiscence. Variations in the courses of greater palatine nerve canal, nasopalatine nerve canal and mandibular nerve canal were assessed for different morphologies. Morphological variations in the condylar head were analysed in coronal and sagittal sections. All the full skull images were also evaluated for the presence of calcifications which included calcifications in the region of pineal gland, styloid processes and other intra cranial calcifications.

RESULTS

Statistical analysis was carried out with SPSS version 16 software (Ibv.corp.chicago., USA).

Qualitative data analysis was carried out using chi square test. Sample of 100 CBCT full skull images were scanned for evaluation purpose of anatomical variations. The anatomical Variations are grouped as mentioned above and the results were tabulated (graph 1).



Graph 1

The nasal variations were considered as category1.Nasal septum deviation patterns were further denoted as(fig 1a1, fig 1a2, fig 1a3, fig 1.a4, fig 1.a5) of which 1a nasal Septum deviation towards left were observed 13% in males,12%in females, 1b Nasal septum deviation towards right were observed in 5%in males,10%inFemales, 1c straight nasal septum were observed in 21%in males, 17%in females, 1d reverse sigmoid pattern were observed 2% in males,4%in females,1e sigmoid pattern were observed in 8% in males,6%in females. Presences of conchae bullosa were observed 22%in males and 17% in females. Presences of paradoxical middle conchae were observed 4%in male and 4%in females. Presence of secondary middle Conchae were observed in 5% in males and 6% in females. There were no statistical significant differences in nasal variations were noted among the gender and categories of age.

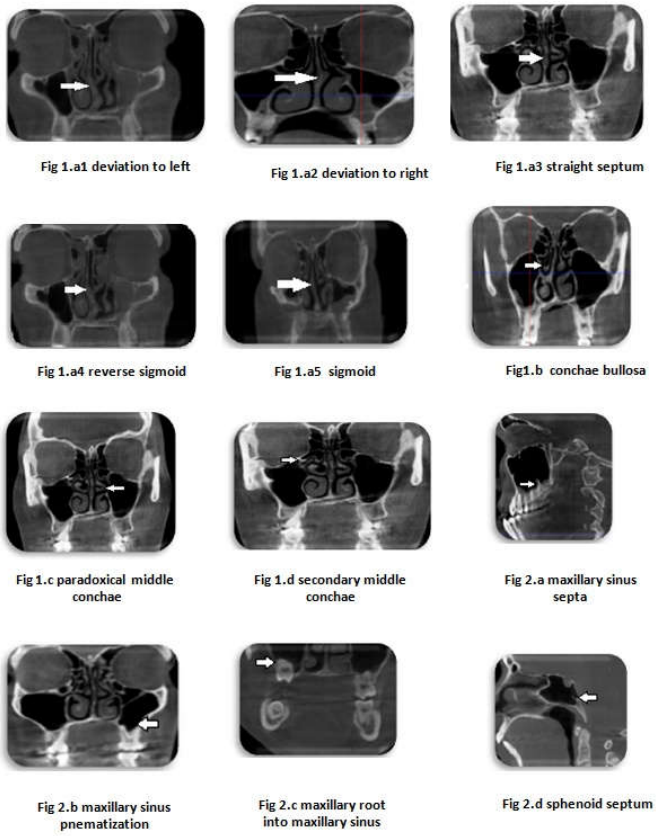


Fig 1.a1 deviation to left

Fig 1.a2 deviation to right

Fig 1.a3 straight septum

Fig 1.a4 reverse sigmoid

Fig 1.a5 sigmoid

Fig1.b conchae bullosa

Fig 1.c paradoxical middle conchae

Fig 1.d secondary middle conchae

Fig 2.a maxillary sinus septa

Fig 2.b maxillary sinus pnematization

Fig 2.c maxillary root into maxillary sinus

Fig 2.d sphenoid septum

Sinus variations were considered as category 2.Presence of maxillary septum were observed in12%in males and 17%in females and showed statistical significant difference among the categories of age $P<0.05$ with more prevalent in Group III 14%,Group II-10%,Group I-5%.Presence of maxillary pneumatization were observed in 7%in males and 10% in females. Presences of teeth vicinity with vital structures were observed 4%in males and 7%in females. Presences of sphenoid septa were observed in 26%in males and 17%in females. Presence of sphenoid pneumatisation observed 18 % in males and 14%in females. There was no statistical significance in vicinity with vital structures were noted among the different categories of ages.

Para nasal air sinus cells were considered as category 3 where in the presence of cells were noted .Presence of 3a (fig3.a) Kuhn cells were observed 20%in males and 21%in females. Presence of 3b (fig3.b) agger nasi cells were observed 50%in males and 43%in females. Presence of 3c (fig3.c) onodi cells

were observed 22%in males and 1%in females. Presence of 3d (fig 3.d) haller cells were observed in 8%in males and 4%in females. There were no statistical significant differences in occurrence of paranasal sinus cells among the various age groups.

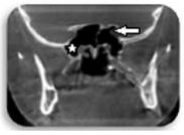


Fig 2.d sphenoid septum pneumatization

Fig 3.a Kuhn cells

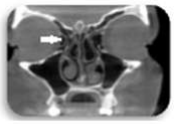


Fig 3.b Agger cells

Fig 3.c Onodi cells

Fig 3.d Haller cells

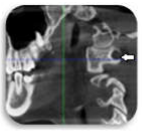


Fig 4.aPonticulus posticus

Fig 4.b fusion c2-c3

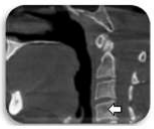


Fig 4.c dehisence

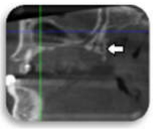


Fig 5.a bifid greater palatine foramen

Fig 5.b1 cylindrical NPC

Fig 5.b2 Funnel NPC

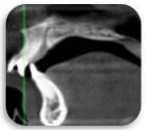


Fig 5.b3 spindle NPC

Cervical vertebra variations are considered as category 4where in the presence of posticulus ponticus were observed in 1%in males and 0%in females (fig4.a). Fusions of c2-c3 were observed in 1% in males and 1%in females (fig 4.b). Presences of dehiscence in the vertebral canal were observed 2%in males and 2% females (fig 4.c). There were no statistical significant differences in occurrence of vertebral variations among the various age groups.

Variations in the canals where grouped as category 5.Presence of bifid greater palatine foramen were observed in 3%in males,2%in females (fig 5.a). Presence of Nasopalatine canal variations where further denoted as (fig5.b1,fig5.b2, fig5.b3,fig5.b4). Presence of cylindrical canal variations were observed 29%in males and 29%in females. Funnel shaped canal variations were observed 9% in males and 12%in females.Presence of spindle canal were observed 5%in males and 6%in females.Presence of hourglass canal variations were observed 3%in males and 3%in females.Presence of mandibular nerve looping were observed 9%in males and 14%in females.There were no statistical significant differences in occurrence of variation in the canals among the various age groups.

Variations of the condylar head were considered as category 6. Variations were observed in both coronal and sagital view. Presence of angled condyle(fig6.a1) were observed in2%in males and 3%in females.Presence of concave condyle(fig6.a2) were observed in 2%in males and 5%in females.Presence of Flat condyle(fig 6.a3) were observed in10%in males and 15%in femlaes.Presence of convex conyle(fig6.a4) were observed in 19%in males and 16%in females.Presence of round conyle (fig6.a5) were observed in 16%in males and 9%in females. In sagittal view, Presence of round condyle (fig 6.b1)were observed in 22%in males and 15%in females. Presence of beak condyle(fig 6.b2) were observed in 8%in male and 4%in females.Presence of Flat conyle (fig6.b3)were observed in6%males and 25 %in females.

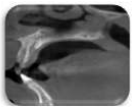


Fig 5.b4 hour glass shape NPC

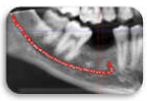


Fig 5.C Mandibular nerve looping

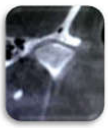


Fig 6.a1 angled condyle

Fig 6.a2 concave condyle

Fig 6.a3 Flat condyle

Fig 6.a4 convex condyle

Fig 6.a5 round condyle

Fig 6.b1 round condyle in sagittal section

Fig 6.b2 beak condyle in sagittal section

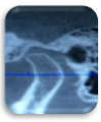


Fig 6.b3 flat condyle in sagittal section

Fig 7.a Penial gland calcifications

Fig 7.b1 calcified outline of styloid process

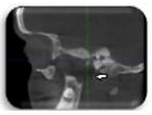


Fig 7.b2 Partially calcified outline of styloid process

Fig 7.b3Nodular outline of styloid process

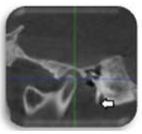


Fig 7.b4 fully calcified calcifications

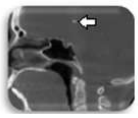


Fig 7.c Intracranial calcifications

Calcifications were considered as category 7in which penial gland calcifications (fig7.a)were observed 1%in males and 2%in females.Presence of styloid calcifications were further denoted by (7.b1,7.b2,7.b3,7.b4). Calcified outline (fig7.b1)were observed in 1%in males and 2%in females.Partially calcified(fig 7.b2)were observed in 5%males and 1%female.Nodular calcification(fig 7.b3) were observed in 1%in males and 2%in females.Fully calcified outline(fig 7.b4) were observed in 3%in males.Presence of intra cranial calcifications fig 7.c were observed 10%in males and 5%in females.

DISCUSSION

The use of radiological technique became widespread during 21st century and also serves as a reliable source for assessment of various anatomical structures. Nasal septum deviation may cause mild nasal obstruction, nasal discharge, facial pain, epitasis and disturbance of smell. Various patterns of nasal septum deviation were observed in the study of which straight septum were more common among both the genders 31%,followed by right deviation 15%,left deviation 25%, sigmoid 14%, reverse sigmoid 6% respectively which was in accordance with the study done David MP *et al*, 2010 using digital radiograph in 2010 and with the study done by Taniguchi *et al in 2003*.The middle conchae bullosa is the Pneumatization of osseous plate extension into ethmoid, leading to bulging which is sufficient to cause nasal obstruction. In the present study conchae bullosa were observed in 40% of the individuals in middle conchae which was in accordance with the study done by Hatipogulu *et al* in 2005 stating prevalence of conchae bullosa may varies from 4.6-53.6%.Few studies reported prevalence of conchae bullosa were statistically significant in correlation with maxillary sinus pathologies. Paradoxical middle conchae refer to a convex

curvature on the lateral, rather than medial side of the turbinate. Prevalence of paradoxical middle conchae according to Jothi A in 2013 ,Khojastepour *et al* in 2015, Patel AK *et al* 2015,Fadda G L *et al* 2012,were observed in 4% to 27% of the population which were in relation with our study showing prevalence of 8%. Secondary middle conchae originate between lateral nasal wall and middle meatus, and it is an accessory turbinate observed between superior and middle turbinate. It could be falsely evaluated as osteoma or polyp in endoscopic examination. Its morbidity has been reported to vary from 1.5% to 2.5% (Khanobthamchai, K in 1991). In present study prevalence were 10% which shows lower morbidity reports.

Anatomical variations with in maxillary sinus have been reported to increase the risk of schneiderian membrane perforation and to avoid complications during sinus lifting a meticulous study of the sinus is necessary (Luz.j *et al* ,2018)and Velasquez- Plata *et al* in 2002 using computer tomography found 72 septa in 312 population which denoted a minimal occurrence which were in concordance with our study showing a prevalence of about 29% with the population of 100 CBCT images. Maxillary sinus pneumatization can pose a surgical hazard in terms of oro-antral communication following extraction and endodontics surgery of antral related teeth. Results shows pneumatization of maxillary sinus is 14%in the study done by Reham *et al* in 2014which were in accordance with our study showing 17% pneumatization. Various extension of sphenoid sinus brings it in close relationship with anatomical structures such as Internal carotid artery and optic nerve. In the present study pneumatization of the sphenoid were observed to be 32% respectively which were in accordance with the study done by Azadesh Rahmati *et al* 2016 showing 38% pneumatization.

Paranasal sinus variation include Agger nasi cells, Haller cells, Kuhn cells, Onodi cells. Haller cells is the pneumatization of anterior ethmoidal cells extending into the floor of the orbit. Prevalence of Haller cells is remarkably variable, ranging 3 % to 78%FaddaG L *et al* 2012,Arun K *et al* 2015, which is in accordance with the present study showing prevalence of 28.6% .Agger nasi cells anterior ethmoid cells to the frontal process of the maxilla. Extensive pneumatisation of agger nasi cells may narrow the drainage pathway of the frontal sinus and so result in chronic sinusitis.Reported prevalence of agger nasi cells ranges from 15 to 92%.According to Scribano *et al* reported that agger nasi cells were seen in nearly all patients which were in accordance with the present study also showing agger nasi cells found nearly in all patients(93%). In the current study prevalence of kuhn cells(54.8.%), onodi cells(25.5%) were in accordance with the study done by Fada *et al* in 2012 and Turna*et al* in 2016 stating Khun cells was the second most common (78%), and the least was Onodi cells(8-13%) .

Occurrence of ponticulus posticus has a vital role in cervical pain and headache. According to Kim *et al* in 2007 study 700 CBCT scans showed Posticulus Ponticus in higher number of subjects (26%) and the difference might be due to subjects in the study of kim et have cervical problems. In present study it was noted to be 1% in the specific group III (50-60yrs) category. Variations in the cervical vertebrae such as fusion of c3-c4 predict the association with the head posture. In present study fusion of c3-c4 were observed to be 1% which was in accordance with suhas *et al* in 2014 stated fusion of c3-c4 were seen (1%) and has no statistical significance among the categories of ages. Farman *et al* in 1979 found dehiscence of c3in 3.6% of cases and our study was in accordance showing (4%) of dehiscence respectively with no statistical significance among the categories of age.

Various variations of the nasopalatine canal were observed respectively with the most common prevalence of cylindrical shaped canal (50.0%)followed by spindle canal (35.5%),hourglass canal(7.8%),funnel shaped canal(6%) respectively which was in contrast with the study done by Ibraham *et al* in 2017, Mardinger *et al* in 2008,Tozum etal in 2012 showed cylindrical and funnel shaped canal to be the most common(36.8%).According to carala *et al* in 2013 showed the relation of greater palatine canal to each erupted maxillary third molar and was found to be in 92%population with single canal and 7% with bifid canals. Our study was in accordance showing 5% of bifid canal. Importance must be during any harvesting palatal mucosal surgery should be done cautiously around the third molar.Anterior loop is an important structure in the interforaminal area of mandible thus placement of implant needs a proper diagnosis. According to Mitra *et al* prevalence of mandibular nerve looping were observed to be 32.8% in Iranian population and in present study it was noted to be 26% respectively.These wide ranges of the incidence may be related to inter-individual's anatomical variability associated with race.

Condylar variations were observed according to study conducted by Yale *et al*in 1996 showed convex morphology in coronal plane and round condyle in sagittal plane were found to be the most commonest among the population. our study was also in accordance with yale *et al* stating condylar morphology in coronal view convex(37%) followed by Round(30%),Flat (17%),5%(concave),4%(angled). In sagittal sections round condyle (42%) was more commonly observed followed by Flat condyle (37%), beak condyle 12%).

Calcifications are a relatively common finding in the various structures of the head and neck region. These calcifications may occur as a result of either physiological (age-related) or pathologic mineralization (Bargan.s 2016).Ossification of styloid calcifications were observed to 15% in the population of all incidental findings. Reviewing different studies showed that approximately 4-10% of the general population has calcification of the styloid as, partial or complete, continuous or segmental. No follow-up or intervention is required unless the patient presents with symptoms associated with Eagle's syndrome. Physiologic calcifications are pineal gland, habenula, choroid plexus, basal ganglia, falx, tentorium, petroclinoid ligaments, and sagittal sinus. Physiologic calcification is asymptomatic and are detected incidentally on advanced imaging. They are almost never clinically significant and often do not lead to any clinical concern. In our present study intracranial calcifications were observed (18%), mostly in the pineal gland (3%), followed by intracranial atherosclerosis (15%).According to Pette *et al* in 2012 penial gland calcifications were observed in 19.1% and intracranial calcifications were observed to be 26.1% respectively. This study unlike the other study includes the anatomical variations and also the calcifications of head and neck region. This study highlights the importance of reviewing CBCT volumes in their entirety in order for clinically significant findings requiring

referral or monitoring to be diagnosed and managed appropriately. Care must be coordinated with medical radiologists and physicians in a timely fashion.

CONCLUSION

Anatomical variations are very important to be known, considered, and well identified especially when planning fine surgeries. Theseare discovered during the normal course of interpretation of a study and hence it is particularly important to know and recognize these variations that can misinterpret the radiographic diagnosis. Thus, CBCT enables us to evaluate the anatomical structure clearly and help the radiologist to derive at a proper diagnosis.

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