IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 6 Ser. 16 (June. 2019), PP 36-42
www.iosrjournals.org

Cephalometric Assessment of Bony Choanal Aperture Width (Bcaw) Using Computed Tomographic (Ct) Scan from Usmanu Danfodiyo University, Sokoto, Nigeria.

*Ammani, T.[1], Zagga, A.D.[1], Yunusa, G.H.[2], Umar, M.B.T.[3], Musa,M.A.[1], Usman, J.D.[1], Bello, A.[1], Bello, S.S.[1], Bello, R.[1], Abubakar, U[4]
Departments of [1]Anatomy, [2]Radiology,[3]RadiographyCollege of Health Sciences, UsmanuDanfodiyo University, Sokoto, Nigeria.
Departments of [3]Anatomy, , College of Health Sciences, University of Jos, Jos, Nigeria.
**Corresponding author: Ammani, T*

Abstract
Cephalometry is a branch of anthropometry that describes measurements of head and face in cadaveric, living or radiological specimen. Assessment of Anterior Bony Width of the nasal cavity using Computed Tomographic (CT) has been documented to be used for determination of sexual dimorphism.
Aim: *To assess the cephalometry of the anterior bony width (ABW) of the nasal cavity using computed tomographic (CT) scans from UsmanuDanfodiyo University, Sokoto, Nigeria.*
Methods: *Measurements of the Anterior Bony Width (ABW) were taken from the pyriform aperture of the nasal cavity using CT of the nasal cavity. A total of one hundred and thirty CT scans were obtained (46 females and 84 males). Study subjects were divided into 7 groups namely: A (birth to 10years), B (11 to 20years), C (21 to 30years), D (31 to 40years), E (41 to 50years), F (51 to 60years) and G (61 to 70years). Data was sorted out manually, tabulated and then entered into computer using Microsoft Excel. Data was analyzed using SPSS version 20 statistical package with discriminant functional analysis. Three-dimensional reconstructed images of the nasal cavities were made usingCT data as Digital Imaging and Communications in Medicine (DICOM) files,*
Results: *The mean and standard deviation values for the various groups were determined using SPSS. In females, we observed the lowest mean value for anterior bony width of pyriform aperture were in group A (22.69±3.774) and the highest mean value in group C (28.92±1.246). However, in males, we had the lowest mean value in group B (24.95±1.622) and the highest in group F (28.87±1.751).*
Conclusion: *We conclude by saying that the highest mean value in both males and females were found in age groups F and C respectively, while the lowest values were seen in age groups B and A for males and females respectively. There was no statistical significant difference observed between sexes.*
Key-words: *Cephalometric, Anterior Bony Width (ABW), Nasal Cavity, Computed Tomographic(CT),Sokoto.*

Date of Submission: 12-06-2019 Date of acceptance: 28-06-2019

I. Introduction

Cephalometry is a branch of anthropometry that describes measurement of head and face in cadaveric, living or radiological specimen. Cephalometry use landmarks on the skull to take specific measurements, which are used to calculate indices. Europe's anatomists dissected and analyzed the skeletons of animals and humans from every corner of the world in their attempts to substantiate the notion that nature shades continuously from one form to another(Umar *etal*., 2006).The transitional forms bridging the gap between animals and humans areof special interest.Sexual and racial differences in cranium have also been widely studied (Umar *etal*., 2006).

Cephalometric techniques have been used by numerous researchers to produce standard values for skeletal, dental, and soft tissue structures for different ethnic groups (Broadbent, 1931; Brodie, 1938) as well as in forensic medicine (Krishan, 2007). It has also been shown that skeletal and dental development changes throughout adulthood [5] and that stature and sex can be determined using lateral cephalometric (Patil and Kumar, 2005).

It is well established that a single standard of facial esthetics is not appropriate for application to diverse racial and ethnic groups(Wuerpe, 1936 and Moyers 1988). Therefore, researches on craniofacial study of different ethnic groups are ongoing with the intention to establish ethnic specific anthropometric data for populations with different ethnic background (Krishan, 2007).

Rossini *et al.,* 2011, observed that usual cephalometric analysis presents the same restrictions of the radiograph on which it is performed: the two dimensional character and geometric alteration of the anatomical structures being imaged. The 2-D Cephalometric radiography allows bi-dimensional assessment of craniofacial morphology and growth, but ignores the mediolateral axis. Frontal cephalometric radiographs are useful for facial asymmetry evaluation but neglect the postero-anterior dimension (Rossini *et al.,* 2011).

These problems may be overcome by means of computed tomography (CT) imaging techniques that produce three-dimensional images of cranial bone, jaws and the surrounding tissues, allowing focusing the anatomic structures more accurately than 2D conventional radiography. Different techniques has been developed in order to obtain three dimensional landmarks and to generate 3-D cephalograms, after combining and integrating the data of both 2-D cephalograms (lateral and postero-anterior) (Rossini *et al.,* 2011).

Specification of the anatomic site of the nasal airway obstruction using CT of the nasal cavity, the nasopharynx, and orbits can be obtained using contiguous 3-mm thick slices in a plane parallel to the hard palate. Measurements should be performed at the level of the maximum transverse diameter of the pyriform aperture, the posterior choanae, and the posterior inferior os vomer. The pyriform aperture is considered stenotic when either the maximum transverse diameter of each aperture is 3 mm (Royal *et al*., 1999) or when the pyriform aperture width is <8 mm (Belden *et al*., 1999). Choanal atresia can be diagnosed if the posterior choanal orifice measures <0.34 cm unilaterally, in combination with a thickened inferior posterior os vomer measuring >0.55 cm (Chinwuba *et al*., 1986).

Contencin*et al.,* 1999, conducted a study at Hôpital Saint-Vincent-de-Paul, a pediatric university hospital in Paris, France andconfirm that the width of the nasal fossae increases with age. However, the posterior and especially the anterior widths increase more rapidly than the width of the middle nasal fossae. This may be owing to the role of the mucosa covering the inferior turbinate that enlarges in the first few months of life. This may also be owing to the technique of measurement.

Likus*et al.,* 2014, from Department of Human Anatomy, School of Medicine in Katowice, Medical University of Silesia, Poland reported that (a) analyzing the correlation of parameters measured with the age of the child, a linear increase of the osseous parameters has been found, related to age, up to three years of age on caucasoid. Only the biggest width of the vomer failed to increase under three years of age in the study group; (b) for all the measured linear dimensions of bone and mucosa, no differences have been noted between the sexes, with the exception of the length of septum, which was bigger in case of girls in the age range of 0–3 months ; (c) analyzing the differences between the mean values of measured distances, for various age groups, the authors found that there were no statistically significant differences in analyzed morphometric parameters between adjacent age groups.

II. Materials and Methods

This research work was a two-year retrospective and cross sectional study on 130 CT images.It was conducted in the Department of Radiology, UsmanuDanfodiyo University Teaching Hospital Sokoto, Nigeria, using CT images. All available head Computed Tomography (CT) scans of subjects, from January 2016 to December 2017 were retrieved from the Records Unit of the Radiology Department, UsmanuDanfodiyo University Teaching Hospital (UDUTH) Sokoto.

Only head CT films interpreted by experienced radiologist were included in the study .Scans with regular development of the brain, without any craniofacial abnormality.

Subjects born preterm, with alterations within the bones of skull, with genetic disorders (e.g., Down's syndrome), mental retardation, congenital defects and/or complexes of congenital defects craniosynostosis, hydrocephalus cleft palate, cleft lip, cleft face were excluded. There were no patients found with any of these abnormalities. Patients with a history of nasal surgery or significant facial trauma, maxillofacial trauma.. patients were also excluded. Two patients were found with nasal masses and three were found with Naso-gastric tubes.

Study subjects were divided into 7 groups namely: A (birth to 10years),B (11 to 20years), C (21 to 30years), D (31 to 40), E (41 to 50), F (51 to 60) and G (61 to 70).

Ethical clearance was obtained from the Ethical committee of UsmanuDanfodiyo University Teaching Hospital Sokoto, Nigeria (Reference number: UDUTH/HREC/2016/No.498).

2.1 Equipments Used in Taking the Head CT Scans in the Study

NEUSOFT C 3000 Spiral CT machine. Dual Slide Helical CT, (2005) model. Head CT Scans were obtained from the local data base of the CT machine and backed up in compact disc from the CT library. Images were viewed on the computer monitor. Good positioning to ensure symmetry or asymmetry of the nasal cavity was observed. Measurements were made with Neusoft Dual Slide Helical CT machine, (2005) model, with software that provides a meter rule, with which measurements were made.

2.2 Technique of Reading Images (Mohammed and Eman, 2011)

A Hi-Speed CT with high resolution bone algorithm, 15 cm field of view, 200mA, 120 kV, scanning time of 1 second and slice thickness of 5mm was used to obtain the axial images from the occlusal margin of the nasal cavity. The axial images were reformatted to axial and sagittal views by experienced radiologist. Using the CT data as Digital Imaging and Communications in Medicine (DICOM) files, three-dimensional reconstructed images of the nasal cavities were made using the V-works(version 3.0) program.

2.3 Nasal Region Dimensions.

The following 3 dimensions (widths) of the anterior part of the nasal cavity were measured to evaluate the nasal fossae as shown in Table 1 and Figures 11 to 13. All measurements were taken according to Likus*et al.,* 2014.

Nasal Region	Abbreviation	Measurement
Anterior nasal cavity	Anterior Bony Width (ABW)	Distance between the two ridges extrudingfrom the maxilla to pyriform aperture.
	Right anterior bony width (RABW)	Distance from the right maxillaryridge to the septal mucosa
	Left anterior bony width (LABW)	Distance from the left maxillary ridge to the septal mucosa

2.4 Statistical Methods

Data was sorted out manually, tabulated and then entered into computer using Microsoft Excel. Data was analyzed using SPSS version 20 statistical package with discriminant functional analysis. Statistical tests were employed for data analysis. The mean (±SD) bony width, mucosal width, minimal soft tissue thickness, choanal aperture diameter were determined. Comparison of mean values in relation to sex and age distribution of the subjects were done using student's T test. The level of significance for all statistical tests was set at $p < 0.05$.

III. Results.

One Hundred and Thirty CT scans (46 female and 84 male) were subjected to analysis. The subjects were divided into seven age groups at the interval of 10years: Group A=0-10years, Group B=11-20years, Group C=21-30years, Group D=31-40years, Group E=41-50years and Group F=51-60years and Group G=61-70years. Three measurements were taken from posterior nasal aperture (choana): Bony Choanal Aperture Width (BCAW), Right Posterior Bony Width (RPBW) and Left Posterior Bony Width (LPBW).

3.1: Means, Standard Deviation and *p-values* of BCAW

The lowest dimension in BCAW was observed in group A: 22.28±4.451 and 20.79±3.668 for males and females respectively whereas the highest was measured in group D males: 28.14±3.592. Details of the measurements for this variable are shown in Table 8 and Figure 17.

Table 8: Showing the Details of Means, Standard Deviation, and *p-values* of BCAW.

PATIENT'S GROUPS	SEX	BCAW	
		Mean±SD	p-value
A	M	22.28±4.451	0.466**
(0-10)Years	F	20.79±3.668	
B	M	25.77±3.420	0.121**
(11-20)Years	F	23.51±3.500	
C	M	26.43±3.027	0.567**
(21-30)Years	F	27.28±2.157	
D	M	28.14±3.592	0.344**
(31-40)Years	F	26.66±2.754	
E	M	27.89±4.603	0.182**
(41-50)Years	F	25.28±3.421	
F	M	24.13±2.247	0.928**
(51-60)Years	F	23.96±3.892	
G	M	26.21±2.577	0.755**
(61-70)Years	F	25.45±4.951	

** No statistically significant difference between sexes (*p-value* set at < 0.05).

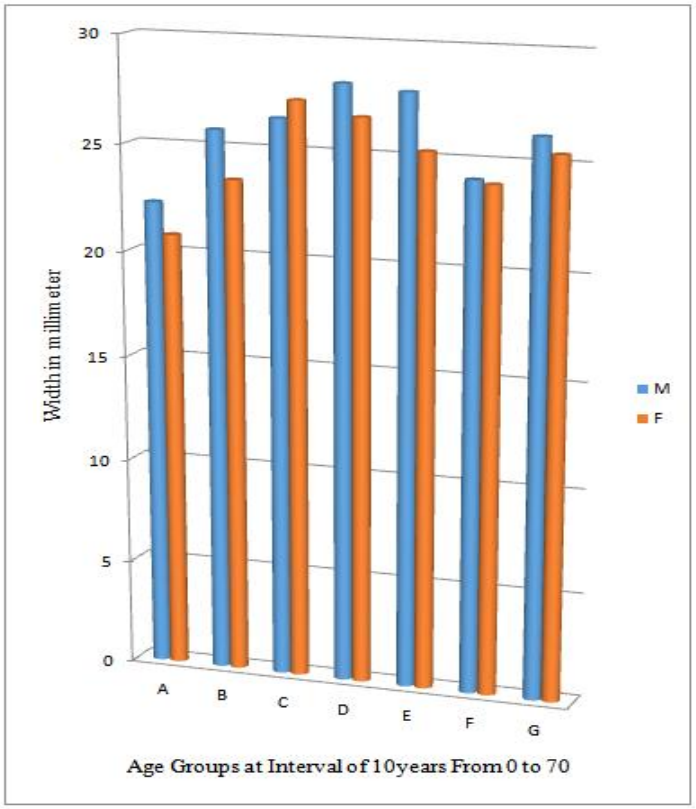


Figure 20: A3-D Cylindrical Column Chart Comparing Mean Differences in BCAW Between Males and Females in Different Age Groups. BCAW = Bony Choanal Aperture Width.

3.2: Means, Standard Deviation and *p-values* of RPBW

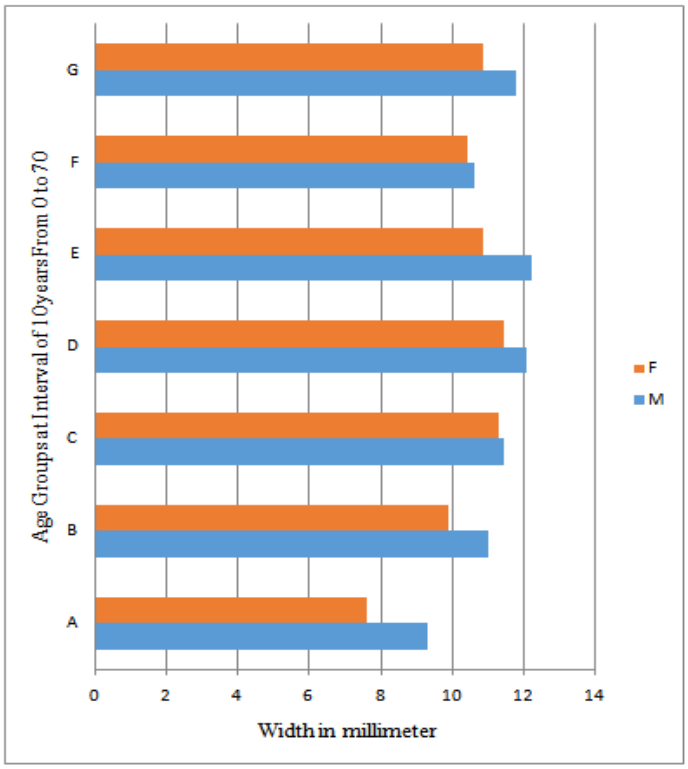
RPBW was also observed to have the highest mean value in group D males: 12.11±2.180, the lowest mean value was measured in group A females: 7.60±2.656. The range for this variable is 4.51±0.476. For more details refer to Table 9 and Figure 18.

Table 9: Showing the Details of Means, Standard Deviation, and *p-values* of RPBW.

		RPBW	
PATIENT'S GROUPS	**SEX**	Mean±SD	p-value
A	M	9.32±2.850	0.220**
(0-10)Years	F	7.60±2.656	
B	M	11.01±2.096	0.206**
(11-20)Years	F	9.91±2.021	
C	M	11.48±1.885	0.879**
(21-30)Years	F	11.34±1.472	
D	M	12.11±2.180	0.510**
(31-40)Years	F	11.46±2.048	
E	M	12.26±2.241	0.182**
(41-50)Years	F	10.89±2.136	
F	M	10.61±1.316	0.853**
(51-60)Years	F	10.44±1.646	
G	M	11.80±1.568	0.481**
(61-70)Years	F	10.89±2.364	

** Not statistically significant difference between sexes (*p-value* set at < 0.05).

Figure 21: A 2-D Bar Chart Comparing Mean Differences in RPBW Between Males and Females in Different Age Groups. RPBW = Right Posterior Bony Width



3.3: Means, Standard Deviation and *p-values* of LPBW

Like RPBW, the lowest mean value, 8.11±2.148, for LPBW was also observed female of group A, while the highest was measured in group E males 12.66±2.216.

Table 10: Means, Standard Deviation, and *p-values* of LPBW

PATIENT'S GROUPS	SEX	LPBW	
		Mean±SD	p-value
A	M	8.94±2.691	0.498**
(0-10)Years	F	8.11±2.148	
B	M	11.14±2.162	0.172**
(11-20)Years	F	9.97±1.722	
C	M	11.63±1.276	0.791**
(21-30)Years	F	11.80±1.217	
D	M	11.83±2.174	0.951**
(31-40)Years	F	11.77±1.871	
E	M	12.66±2.216	0.067**
(41-50)Years	F	10.77±2.088	
F	M	10.19±1.618	0.603**
(51-60)Years	F	10.74±1.740	
G	M	11.19±1.423	0.904**
(61-70)Years	F	11.33±2.386	

** Not statistically significant difference between sexes (*p-value* set at < 0.05).

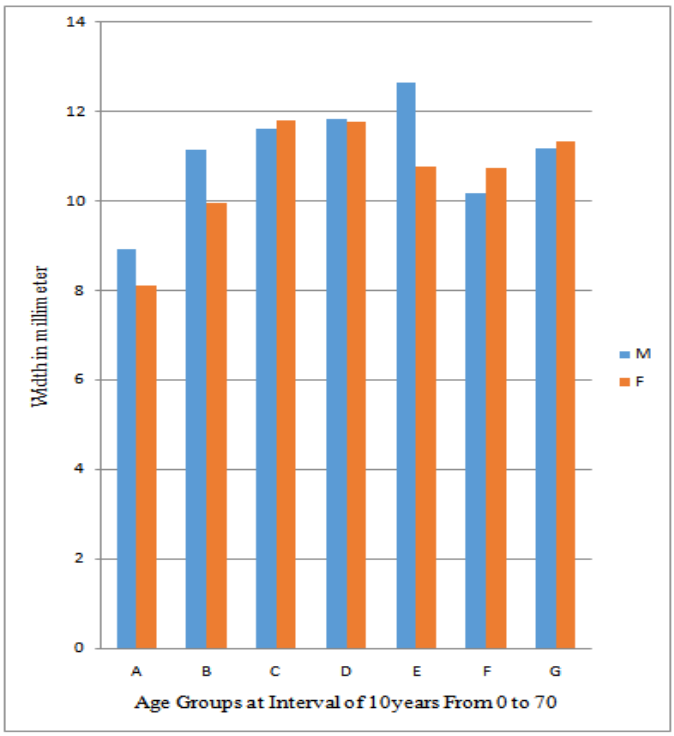


Figure 22: A 2-D Column ChartComparing Mean Differences in LPBW Between Males and Females in Different Age Groups. RPBW = Left Posterior Bony Width

IV. Discussion

Computer tomography (CT) is currently the golden standard in diagnostics of nasal cavity diseases; thus, it can be used successfully as a tool for assessing anatomical structures (Sk´ora*et al*., 2008). Over the past decade, computer-aided surgical (CAS) systems, which provide precise 3-dimensional (3D) localization during various neurosurgical and otorhinolaryngological procedures, have been introduced. Typically, these computer systems assign a 3D coordinate system to preoperative computed tomographic (CT) scan data, and the software packages comprise specific software for surgical planning. Although not optimized for regular analysis of CT images, such systems can be applied for this purpose (Sk´ora*et al*., 2008).

The dimensions of the nasal cavity are dependent on personal differences; nevertheless, changes in size more often are due to pathological causes (Likus*et al* 2014). Before conducting surgical treatment of nasal

cavity stenoses, it is essential to perform evaluation employing imaging techniques, as well as to take morphometric measurements, in order to establish the degree of deviation from norm. Despite the substantial clinical importance of morphometric parameters of nasal cavity in children, the number of morphometric studies is still inadequate, studies which would assess the variability of nasal cavity dimensions with age, in newborns and small children, without difficulties with breathing through the nose (Likus*et al.,* 2014).

The mean values of posterior nares (BCAW) or choanae width obtained in our research are close to the results obtained by Groblewski*et al.,* 2005, especially in the first and second decades (groups A and B). They obtained 21.24mm and 22.72mm for males and females in their first decade respectively; 24.12mm and 25.43mm in males and females respectively in their second decade of life. In group A we obtained 22.28±4.451and 20.79±3.668 for males and females respectively with no statistical significance (*p-value*=0.466).Choanal width was noticed to decline in groups F and G. This might be attributed to osteolytic changes at advanced ages. In case of RPBW, there was no statistical significance between males and females in all the age groups. As with other variables, the mean value of RPBW was also noticed to be lowest in group A (9.32±2.850 and 7.60±2.656 for males and females respectively). These values are lower than the findings of Groblewski*et al.,* 2005, for similar variable in the first decade of life (10.31mm and 11.24mm for males and females respectively) our findings are much higher than those obtained by Likus*et al.,* 2014, (2.75 ± 1.40 and 3.65 ± 1.24 for males and females respectively). Difference in the age of their study subjects and their grouping system may account for this significant difference. All their groups have fallen under our first group (first decade) and the lowest age in their first group is neonatal age and the eldest subject is 3years. Contrary to our grouping system, the lowest age in our first group (first decade) is 2years and the highest is 10years. Similarly on the left side of the nasal cavity LPBW did not show any statistical significance between genders of each group and between adjacent groups. This is similar to what Groblewski*et al.,* 2005, got in the first and second decades of life on the right and left side of the nasal cavity. We could not lay our hands on literatures that reported similar or contrary values for BCAW, RPBW or LPBW in older age groups.

V. Conclusions

From the study, the following conclusions can be made; a) there were no sexual dimorphism;
b)there was symmetry between right and left side of the nasal cavity in all the parameters measured;c) the only significant difference was noticed between the two extreme age groups;
d)it is analytically possible to measure the Mean and Reference values of the following parameters of the nasal cavity: BCAW, RPBW and LPBW; e) using the results obtained in this study, reference values could be established for the above variables in Sokoto, North-Western part of Nigeria

References

[1]. Belden, C.J., Mancuso, A.A. and Schmalfuss, I,M. (1999). CT features of congenital nasal pyriform aperture stenosis: initial experience, Radiology, 213:495–501.
[2]. Broadbent, B. H. A new x-ray technique and its application to orthodontia (1931): Angle Orthodontics, 1: 45–66.
[3]. Brodie, A. G. (1938). Cephalometric Appraisal of Orthodontic Results: A Preliminary Report .Angle Orthorhinolaryngology., 8: 261-351.
[4]. Charan, J. and Biswas, T. (2013). How to Calculate Sample Size for Different Study Design in Medical Research: International Journal of Pschological Medicine., 35(2): 121-126.
[5]. Chinwuba, C., Wallman ,J. and Strand, R. (1986). Nasal airway obstruction: CT assessment. Radiology, 159:503–6.
[6]. Contencin, P., L. Gumpert, J., Sleiman, L., Possel, I. and De Gaudemarand C. A. (1999). Nasal fossae dimensions in the neonate and young infant: a computed tomographic scan study, Archives of Otolaryngology—Head and Neck Surgery, 7 (125):777–781.
[7]. Groblewski, J., Pena, M., Govari, E., Gottschall, J., Vezina, G. and Zalzal, G. (2005). Nasal Cavity Dimensions in the Normal PaediatricPopulation Poster produced by Faculty & Curriculum Support (FACS), Georgetown University Medical Center.
[8]. Krishan, K. and Kumar. R. (2007). Determination of stature from cephalo-facial dimensions in a North Indian population: Legal Medicine, 9(3): 128-133.
[9]. Likus, W., Bajor, G., GruszczyNska, K., Baron, J. and Markowski, J. B. (2014). Nasal Region Dimensions in Children; A CT Study and Clinical Implications:BioMed Research International, 125810-21.
[10]. Moyers R. Handbook of Orthodontics (1988). Chicago, Ill: Mosby, 67.
[11]. Patil, K. R. and Kumar, R. (2005). Determination of sex by discriminant function analysis and stature by regression analysis: a lateral cephalometric study. Forensic Sci Int., 147:175-80.
[12]. Rossini, G., Cavallini, C., Cassetta, M., Barbato, E. (2011). 3D cephalometric analysis obtained from computed tomography. Review of the literature Annali di Stomatologia, 2 (3-4): 31-39.
[13]. Royal, S. A., Hedlund, G. L. and Wiatrak, B. J. (1999). Single central maxillary incisor with nasal pyriform aperture stenosis—CT diagnosis prior to tooth eruption PediatrRadiol., 29:357–59.
[14]. Sk´ora, W., Kozłowski, Z., Dąbrowska, K. and Mazerant, M. (2008). "Clinical evaluation of CT scans of nasal cavity and paranasal sinuses: OtolaryngologiaPolska, 62 (5): 553–557.
[15]. Umar, M. B.T., Singh, R. and Shugaba, A., I. (2006). Cephalometric Indicies among Nigerians: Journal of Applied Science,6: 939-942.
[16]. Varrela, J. (1990). Effects of attritive diet on craniofacial morphology: A cephalometric analysis of a Finnish skull sample. Eur. J. Orthodonl., 12: 219-223.
[17]. Wuerpe,l. E. On facial balance and harmony (1936). Angle Orthod., 7:81-89.