Scientia Africana, Vol. 14 (No.1), June 2015. Pp 111-117
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria ISSN 1118 – 1931

ALVEOLAR INDEX AS A MEANS OF SKULL CLASSIFICATION: A RADIOLOGICAL STUDY

E. L. Oghenemavwe and J. Williams

Department of Anatomy,
Faculty of Basic Medical Sciences,
College of Health Sciences,
University of Port Harcourt,
P.M.B 5323, Port Harcourt, Nigeria
Rivers State, Nigeria.

Correspondence
Oghenemavwe Ese Loveday
Department of Anatomy
Faculty of Basic Medical Sciences,
College of Health Sciences,
University of Port Harcourt
P.M.B 5323, Port Harcourt, Nigeria.
***E-Mail**: loveday.oghenemavwe@uniport.edu.ng*
***GSM**: +234 (0) 803 335 27090*

Received: 11-12-14
Accepted:05-05-15

ABSTRACT

Alveolar index is an important parameter in intra and inter-ethnic classification of skull and in defining the positional relation of the maxilla to the mandible. The objective of the study was to evaluate the alveolar index of Nigerians using radiographs. 130 (90 males and 40 females) normal lateral view skull radiographs of adult Nigerians were used for this study. To determine the Alveolar Index, the Basion-Nasion (Ba-Na) and Basion to Prothion (Ba-Pr) distances were measured to nearest 0.01mm using a micrometer rule and the ratio between them was calculated in percentage. The mean Ba-Pr length was 88.84mm for males and 78mm for females, the mean Ba-Na length was 82.99mm for males and 73mm for females. The mean alveolar index for males was 107.28% and 106.94% for females. There were no significant differences ($p>0.05$) in the Alveolar Index and distribution of skull type between males and females as indicated by a t-test and Chi-square test. However, the Na-Pr length and Ba-Pr length differ significantly between males and females. Our findings show that most Nigerians have an alveolar index of greater than 103, an indication of prevalence of prognathism in the population. In addition, the extent of prognathism is similar in both males and females. We therefore recommend the consideration of Ba-Pr and Ba-Na lengths for sex determination in forensic examination.

Key Words: Alveolar index, Nigerians, Radiographs, Prognathism, Basion

INTRODUCTION

The ratio between the distance from the basion to the prosthion and that from the basion to nasion is commonly known to as the alveolar index. The basion is the midpoint on the anterior margin of the

foramen magnum. The foramen magnum is a large hole located in the occipital bone and the spinal cord passes through it as it descends into the vertebral column. The nasion is the most anterior point where the frontal and the nasal bone meet to form the frontonasal suture, while the prosthion is the most anterior point on the midline of the maxilla. The alveolar index gives an indication of the extent of proganthism in a population (Bjork, 1947; Barret *et al*., 1963; Hanihara, 2000), and thus it is a major factor in inter and intra classification of skull for different ethnic groups and populations as applied in Forensic Sciences and Biomedical Anthropology. In addition, it aids the evaluation of the positional relationship of the mandible and maxilla to the rest of the face, an essential factor in determining facial harmony by General dentist, Oral and Maxillofacial Surgeons and Orthodontics. Knowing the alveolar index for various populations could be used as a guide in formulating treatment plans especially when the aim is to retain ethnic traits while enhancing beauty and functions. Therefore its usefulness in biomedical anthropology, forensic science and medical disciplines concerned with the treatment of the face cannot be over emphasized.

There are reports of alveolar index in Asians (Barret *et al*., 1963; Hanira, 2000), Australians (Hanihara, 2000), Europeans (Bjork, 1947: (Hanihara, 2000)), North Americans (Hanihara, 2000), South America (Hanihara, 2000) and some African populations (Hanihara, 2000). Some of these reports showed an alveoalar index which indicates facial prognathism in Sub-Sahara Africans (Groves, 1989; Howells, 1989; Lahr, 1996). The most important outcome of these studies was the classification of skull for ethnic determination. Majority of these studies were done with the remains of human skull using direct anthropometry (Yamaguchi, 1973; Hanihara, et al., 1999). In recent times, the importance of employing conventional and digital radiography in physical anthropology have been shown to be of immense benefits (Colongue et al., 2004; Orter, 2003; Mafart et al., 2003). Thus the aim of study is to determine alveolar index in Nigerians using radiographs.

MATERIALS AND METHODS

The sample consisted of 130 (90 males and 40 females) lateral view radiographs of the skull of adult Nigerians. The radiographs were randomly selected from the Radiology Department archives of the Military hospital, St Patrick's hospital and Morning star hospital all in Port Harcourt, Rivers State, Nigeria. Ethical Clearance was given by the Institutions. All radiographs were certified normal as contained in the medical report. To obtain the basion-prosthion and basion-nasion lengths, the anatomical landmarks were clearly identified based on description of Martin (M) number by Brauer (1988). They include;

Nasion - The most anterior part of the frontonasal suture which appear as a radiolucent line between the frontal and nasal bone.

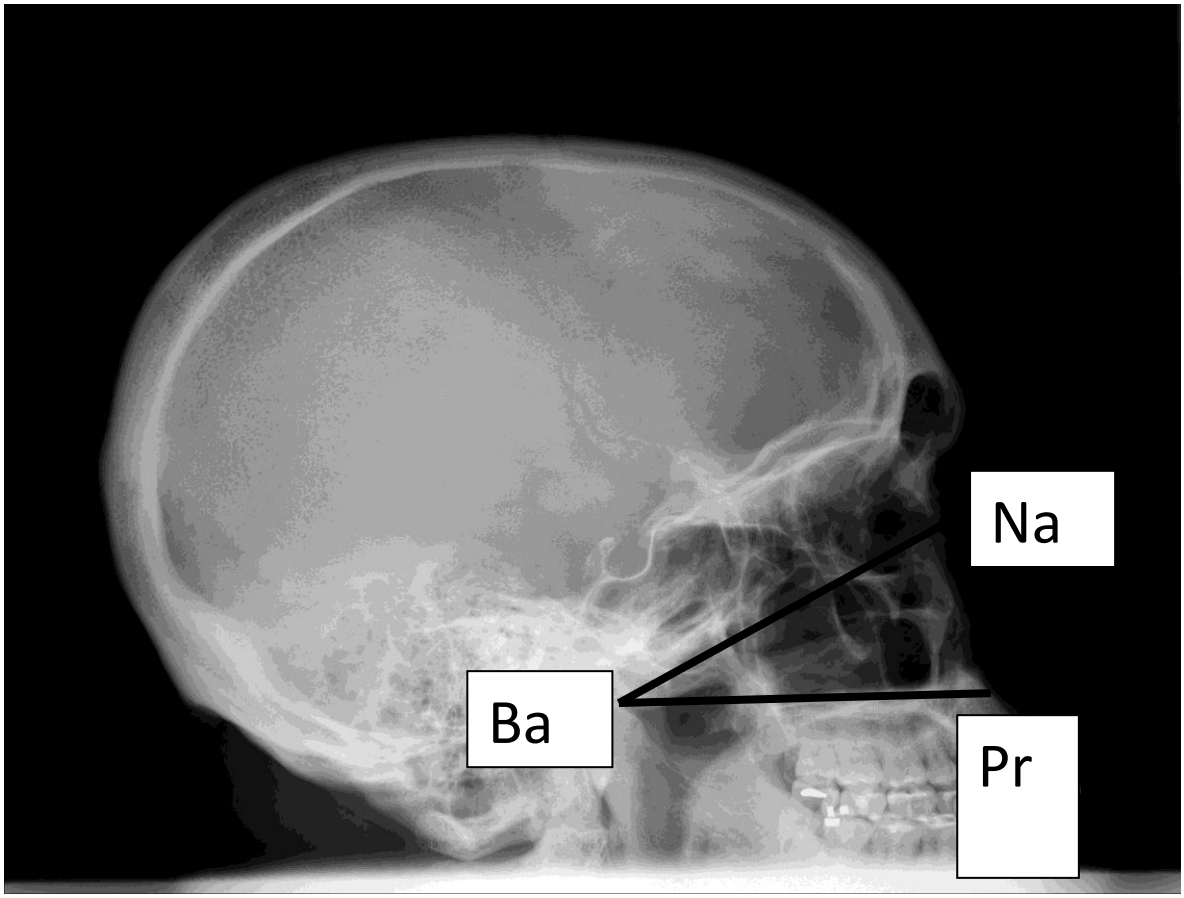
Basion -The midpoint of the anterior margin of the foramen magnum at the base of the skull.

Prosthion - The most anterior point in the midline on the alveolar process of the maxilla

The length of the nasion to the basion and the basion to the prosthion were taken by tracing the appropriate anatomical landmarks on the radiograph which was placed in an X-ray view box, with the aid of a transparent millimeter rule and ball point

Scientia Africana, Vol. 14 (No.1), June 2015. Pp 111-117
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria ISSN 1118 – 1931

pen (see Fig I). In order to ensure high level of accuracy, all measurements were taken twice and the average used as the final value. The data obtained were analyzed using Windows 7 excel statistical tool. Student t test and Chi-square test was used to determine differences in the mean and frequency distribution of the class of alveolar index in males and females respectively.



RESULTS

The descriptive statistics for the measured parameters are shown in tables' I-III. Table I is the result for all subjects irrespective of sex. The mean for AI, Ba-Pr and Ba-Na were 106.77 ±2.69%, 85.34 ±12.3, and 80.03 ±12.08 respectively. The descriptive statistics based on gender is presented in table II. The mean for AI, Ba-Pr and Ba-Na were 106.69 ±2.92%, 88.67 ±10.62 and 83.23 ±10.65 respectively for males and 106.94 ±2.12%, 78 ±12.67, 73 ±12.17 respectively for females. Minimum and maximum of alveolar indexes were 100 and 114.29 respectively. The mean value of AI for females was slightly higher than males, but the difference was not statistically significant ($p>0.05$). On the contrary, the difference in the mean of Ba –Pr and Ba-Na were statistically significant ($p<0.05$). Alveolar index classification shows 93.18% of males were prognathious while for the females it was 95% (table III & IV). Comparative data of alveolar index in other population is shown in table VI

Table I: Descriptive statistics for Basion-Prosthion length, Basion-Nasion length and alveolar index for all subjects

Parameter	N	Mean	SE	SD	Var	Minv	Maxv
Ba-Pr(mm)	128	85.34	1.09	12.3	151.23	58	105
Ba-Na (mm)	128	80.03	1.06	12.08	145.87	54	100
Alveolar index	128	106.77	0.24	2.69	7.24	100	114.29

Ba-Pr = Basion-Prosthion length, Ba-Na = Basion-Nasion length, N = sample size, SE = standard error, SD = standard deviation, Var = variance, Minv = Minimum value, Maxv = maximum value,females, F = females, Ba-Pr = Basion-Prosthion length, Ba-Na = Basion-Nasion length, N = sample size, SE = standard error, SD = standard deviation, Var = variance, Minv = Minimum value, Maxv = maximum value

Table II: Descriptive statistics for Basion-Prosthion length, Basion-Nasion length and alveolar index for all subjects

Parameter	Sex	N	Mean	SE	SD	Var	Minv	Maxv
Ba-Pr(mm)	M	88	88.67	1.13	10.62	112.78	60	105
Ba-Pr(mm)	F	40	78	2	12.67	160.62	58	98
Ba-Na mm)	M	88	83.23	1.14	10.65	113.51	55	100
Ba-Na mm)	F	40	73	1.92	12.17	148.05	54	92
Alveolar index	M	88	106.69	0.31	2.92	8.53	100	114.29
Alveolar index	F	40	106.94	0.33	2.12	4.48	102.22	113.33

Table III: Distribution frequency of Alveolar index classification

Class	Orthognathous (<98)	Mesogathous (98-100)	Prognathous (>103)
Males	0.(0.00%)	6(6.82%)	82(93.18%)
Females	0 (0.0%)	2 (5%)	38 (95%)

Table IV: Test for differences in mean values for males and females

Parameter	SEX	Calculated t test	Critical t score at 0.05 level	Inference
Alveolar index	M	0.55	1.96	not significant (p>0.05)
	F			
Ba-Pr	M	4.64	1.96	significant (p<0.05)
	F			
Ba-Na	M	4.58	1.96	significant (p<0.05)
	F			

Scientia Africana, Vol. 14 (No.1), June 2015. Pp 111-117
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria ISSN 1118 – 1931

Table V: Test for differences in distribution of alveolar index classification or males and females

Parameter	SEX	AI (98-103	AI (>103)	Calculated Chi-score	Critical t score at 0.05 level	Inference
Alveolar index	M	6.82	93.18	0.16	3.84	not significant (p>0.05)
	F	5	95			

Table VI: Alveolar index in other population

Population	Sample Size	Ba-Na	Ba-Pr	Alveolar index	Author
Nigerians (m) (males	88	83.23 ±10.65	88.67 ±10.62	106.69 ±2.92	Present study
Nigerians (f)	40	78 ±12.67	73±12.17	106.94 ±2.12	Present study
Japanese	138	101.4 ±4.64	97.0 ±5.28	95.8 ±3.62	Hanihara, 2000
Ainu	34	106.0 ±3.75	102.9 ±4.89	96.9 ±3.60	Hanihara, 2000
Jormonese	29	1103.3 ±7.20	101.7 ±8.05	98.1 ±4.60	Hanihara, 2000
Northern Chinese	48	100.2 ±3.31	96.7 ±4.46	96.6 ±4.01	Hanihara, 2000
Southern Chinese	64	99.3 ±4.03	96.0 ±4.91	96.7 ±4.32	Hanihara, 2000
Koreans	27	99.7 ±4.40	95.6 ±4.96	95.5 ±4.22	Hanihara, 2000
Mongolians	32	99.7 ±4.24	96.8 ±5.35	97.2 ±4.72	
Filipinos	76	100.3 ±4.30	98.4 ±4.52	97.7 ±4.39	Hanihara, 2000
Eskimos	77	104.9 ±4.13	103.2 ±4.43	98.3 ±3.63	Hanihara, 2000
Malay	50	97.9 ±4.70	97.6 ±4.98	99.3 ±4.22	Hanihara, 2000
Thailand	30	99.1 ±3.84	97.4 ±4.16	98.4 ±4.15	Hanihara, 2000
California	35	99.7 ±4.94	99.1 ±6.08	99.2 ±3.30	Hanihara, 2000
Northwest America	51	99.9 ±4.50	101.0 ±5.77	101.2 ±4.44	Hanihara, 2000
East America	25	103.9 ±3.89	100.4 ±5.23	97.1 ±3.93	Hanihara, 2000
Peruvians	91	98.8 ±3.91	98.3 ±4.55	99.6 ±3.59	Hanihara, 2000
Papua New Guinea	147	99.0 ±3.89	101.2 ±4.93	102.4 ±3.86	Hanihara, 2000
South Australia	98	101.6 ±4.50	106.2 ±5.21	104.9 ±3.82	Hanihara, 2000
Delhi NW India	33	98.7 ±4.33	94.9 ±4.17	95.9 ±3.68	Hanihara, 2000
German	56	99.9 ±4.04	94.9±5.10	95.0 ±3.99	Hanihara, 2000
Holland	36	99.0 ±4.93	94.5 ±5.57	95.6 ±4.05	Hanihara, 2000
French	60	98.7 ±4.44	93.6 ±5.07	94.9 ±3.98	Hanihara, 2000
Kenya	69	100.3 ±4.15	101.5 ±5.32	100.7 ±4.45	Hanihara, 2000
Tanzania	53	101.3 ±4.21	105.3 ±4.53	104.1 ±4.45	Hanihara, 2000
West Africa	33	101.4 ±4.49	104.0 ±6.08	102.6 ±3.90	Hanihara, 2000

DISCUSSION

The findings of this study clearly showed that most Nigerians are prognathous. This basic skull characteristic has been identified to be common also to the Melanesians, Australians and most population indigenous to Sub Sahara African. According to Hanihara (2000), alveolar index varies among different populations in the world, with the greatest contrast found between the Europeans on one hand, sub-Sahara Africans, Australians aborigines and Melanesians on the other hand. The categorization of skulls based on alveolar index indicates that index below 98 were orthognathous and these were mostly found within the European population. Skulls with alveolar index between 98 and 103 were classed as mesognathous and these were mostly found within the Chinese and Japanese populations, while those with alveolar index above 103 were termed prognathious and these were mostly found within the native Australians.

While alveolar index can be used in ethnic classification, our study has shown that the extent of prognathism based on alveolar index cannot be an effective tool in determining gender. However, the basion-prosthion and basion-nasion lengths were sexually dimorphic. These lengths were significantly greater in males than females. The reason for this can be attributed to the greater size of head in males when compared to female. Similar observations were made by Barret et al., (1963) in his study of the Chinese. He reported that the basion-prosthion and basion-nasion lengths were significantly greater in males than females amongst the Chinese. Therefore we recommend the consideration of basion-prosthion and basion-nasion lengths for sex determination in Forensic evaluation.

In conclusion, the research has shown that most Nigerians have an alveolar index of greater than 103 an indication of prevalence of prognathism in the population. In addition, the extent of prognathism is similar in both males and females.

REFERENCES

Barrett, M., Brown,T., & Mac Donald, M. (1963) Dental observation on Australian Aborigines; A Roentgenographic study of prognathism. *Australian.Dental.Journal*. 8(5) 418-427

Bjork, Arne. (1948) The face in profile. An Anthropological X-ray Investigation on Swedish Children and Conscripts. *America Journal of Physical Anthropology*. 6(1): 121-125

Brauer G. (1988) *Osteometrie: a. Kraniometrie*. In: Knußmann R, editor. Anthropologie: Handbuch der Vergleichenden Biologie des Menschen, Band I. Stuttgart: Gustav Fischer. pp 160–192

Conlogue Gerald, Nelsonn Andrew and Guillen Soia (2004) The application of radiography to field studies of in physical anthropology. *Canadian Association of Radiologist Journal*. 55(4): 254-257

Groves C.P. (1989) *Regional approach to the problem of the origin of modern humans in Australasia*. Edinburgh University Press. p 274–285

Hanihara,T. (2000). Frontal and facial flatness of major human populations. *American Journal of, physical Anthropology*. 111: 105-134

Scientia Africana, Vol. 14 (No.1), June 2015. Pp 111-117
© College of Natural and Applied Sciences, University of Port Harcourt, Printed in Nigeria ISSN 1118 – 1931

Howells W.W. (1989) *Skull shapes and the map: craniometric analyses in the dispersion of modern Homo*. Peabody Museum, Harvard University. p 1–189.

Lahr M.M. (1996) *The evolution of modern human diversity: a study of cranial variation*. Cambridge University Press. pp 1–416

Mafart, B., Guipert, G., de Lumley, M.A., and Subsol, G. (2004) *Three-dimensional computer imaging of hominid* fossils: A new step in human evolution studies. *Canadian Association of Radiologists Journal*. 55:264–270.

Orrner, *D. (*2003) *Identification of Pathological Conditions in Human Skeletal Remains*. 2nd ed. Academic Press, New York.

Yamaguchi B. (1973) Facial flatness measurements of the Ainu and Japanese crania. *Bulletin National Science Museum*. 16:161–171.