Afr. J. Med. Med. Sci. (2019) 48, 519-524

Cephalometric values of sickle cell anaemia individuals in a Nigerian population.

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Abstract
Objective: To establish cephalometric values in HbS individuals and compare with those of HbA individuals.
Methods: Lateral cephalometric radiographs were taken for HbS and HbA participants and hard tissue tracings obtained manually on a 0.003 inch thick cellulose acetate tracing paper over a light viewing box.
Results: Sixty HbS and sixty HbA participants were recruited for the study. In group 1 (HbS) 29 (48.3%) of the participants were males, 31 (51.7%) females while in group 2 (HbA) 27 (45.0%) were males and 33 (55.0%) females. The mean age of the participants was 21.55 ± 2.55 years for the HbS group and 22.15 ± 2.52 years for the HbA group. The mean SNA angle measured for the HbS participants was 85.66 ± 4.93 while SNB angle was 80.56 ± 4.41°. The ANB angle ranged between -3 and 10°. The HbS group had a mean ANB value of 5.10 ± 3.32° as compared to 3.93 ± 1.63° for the HbA group. Significant differences were observed between the mean SNB and ANB values in the HbS and HbA groups. The mean SNB for HbS was lower than that of HbA participants while mean ANB was higher.

Keywords: *Sickle cell anaemia, cephalometric radiograph, jaw protrusion*

Résumé
Objectif : Pour établir les valeurs céphalométriques chez les individus HbS et les comparer à celles des individus HbA.
Méthodes Des radiographies céphalométriques latérales ont été prises pour les participants HbS et HbA et les tracés de tissus durs ont été obtenus manuellement sur un papier calque en acétate de cellulose à 0,003 pouce d'épaisseur sur une boîte d'observation lumineuse.
Résultats : Soixante participants HbS et soixante participants HbA ont été recrutés pour l'étude. Dans le groupe 1 (HbS), 29 (48,3%) des participants étaient des hommes, 31 (51,7%) des femmes, tandis que dans le groupe 2 (HbA), 27 (45,0%) étaient des hommes et 33 (55,0%) des femmes. L'âge moyen des participants était de 21,55 ± 2,55 ans pour le groupe HbS et de 22,15 ± 2,52 ans pour le groupe HbA. L'angle moyen du SNA mesuré pour les participants à l'HbS était de 85,66 ± 4,93 tandis que l'angle du SNB était de 80,56 ± 4,41°. L'angle ANB variait entre -3 et 10 °. Le groupe HbS présentait une valeur moyenne d'ANB de 5,10 ± 3,32° par rapport à 3,93 ± 1,63° pour le groupe HbA. Des différences significatives ont été observées entre les valeurs moyennes de SNB et d'ANB dans les groupes HbS et HbA. La moyenne du SNB pour l'HbS était inférieur à celui des participants de l'HbA, tandis que la moyenne d'ANB était plus élevé.

Mots - clés : *falciforme anémie, radiographie céphalométrique, saillie de la mâchoire*

Introduction

Sickle cell disease (SCD) is a group of blood disorders which have in common a tendency for red blood cells to sickle (or distort into a crescent shape) under conditions of low oxygen tension [1]. It is a generic term for the family of haemoglobin (Hb) disorders having in common the inheritance of the sickle cell beta-globin gene (HbS) from at least one parent. Sickle cell anaemia results from the inheritance of the haemoglobin S gene from both parents, resulting in the homozygous state (HbS) [2]. It is a hereditary and familial haemolytic disease, the most common genetic disorder amongst black people and one of the major chronic non-communicable diseases affecting children [3].It is the most common worldwide symptomatic Haemoglobinopathy [4] and has an incidence of about 3% in Nigeria [5].

The sickle cell haemoglobin formed as a result of this disorder is destroyed more rapidly than normal red blood cells. The resulting anaemia from erythrocyte destruction leads to compensatory mechanisms associated with hyperplasia and expansion of bone marrow of long bones [6]. Sickle cell anaemia is known to affect hard tissues of the body, the dental structures inclusive. The mandible

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and the maxilla, just like the rest of the bony structures of the body, play a role in the haemopoiesis.

Sickle cell anaemia has been reported to have an effect on the bones of the jaw.To investigate the degree of severity of this effect on the jaw bones, lateral cephalometric radiograph, which is a tool used in the assessment of jaw relationship in orthodontics, can be employed. This radiograph is a standardized true lateral radiograph which provides both research and clinical tools for study of malocclusion and underlying skeletal disproportion and can also be used to investigate the effect of sickle cell anaemia on the jaws. This tool has been used to establish norms for different races and ethnicity in individuals with HbA and has been found to be very useful in treatment planning and clinical practice in general.

Nigeria has the highest burden of sickle cell disorder in the whole world [7] and the burden is increasing with increase in overall population [8]. The survival of sickle cell anaemia patients with access to good care is also steadily improving because of general improvement in health care delivery [1,7,9,10]. A substantial proportion of patients with sickle cell anaemia have severe malocclusions and this may be a reflection of the degree of craniofacial abnormalities found in them [11]. These malocclusions may have functional and psychosocial effects such as poor self-esteem [12].

Previous studies have been carried out on cephalometric values in sickle cell anaemia in other populations and these have shown that the degree of severity of the disease varies among races [13]. The only study found in literature carried out on cephalometric findings in sickle cell anaemia patients in this environment was 27 years ago [14].As a result of the high burden of SCA in Nigeria [7], a revalidation of cephalometric measurements in HbS individuals is necessary. Also, with the increasing awareness of orthodontic treatment in recent times, there is an increase probability that these individuals will present for the management of malocclusion.

Materials and methods

The study was carried out at the Haematology and the Orthodontic clinic of a tertiary health care facility in the South Western region of Nigeria.The study population comprised of a total of 120 participants divided into two groups of 60 HbS individuals (previously diagnosed with sickle cell anaemia by haemoglobin electrophoresis) and 60 HbA individuals attending the orthodontic clinic. Both groups were matched for age and gender.The control group was sent to the hematology clinic for confirmation of their genotype by haemoglobin electrophoresis. Ethical approval (UI/EC/14/0106) was obtained from the University of Ibadan/ University College Hospital Ethical Review board. Written informed consent was obtained from all participants.

The inclusion criteria included for group 1 was 18-25 years old confirmed sickle cell anaemia patients with no other known systemic disorder who are Nigerian by origin. For group 2, inclusion criteria was 18- 25 years old confirmed HbA individuals (with haemoglobin electrophoresis) who are Nigerians by origin with Angles class 1 malocclusion on skeletal pattern 1.

Procedure

Each consecutive individual that met the inclusion criteria was comfortably seated on a chair and their oral cavity was examined for eligibility and occlusal presentation (Angle's Class I molar relationship) with the use of gloved hands, dental mirror and dental probe.

During exposure of the participants for radiographs, theywere required to wear a protective lead lined apron after which the lateral cephalometric radiograph was taken using an analogue Pan-Blue-Oris machine (Blue-X Imaging S.R.L BLD XP PAN CEPH METRIC 71680000700: S/No 2402kk0164 ASSAGO, ITALY) with participants' head held in a cephalostat, looking forward with the Frankfort horizontal plane parallel to the floor, ear rods placed in both ears and the teeth in complete intercuspation. The distance from mid-sagittal plane of each participant to the source of radiation and the film was maintained at 150cm and 15cm respectively. Hard tissue tracings were obtained manually on a 0.003 inch thick cellulose acetate tracing paper and a sharpened 2H pencil over a light viewing box.

The following angles were measured

- Sella-Nasion-A-point angle (SNA): evaluates the antero-posterior position of the maxilla relative to the anterior cranial base.
- Sella-Nasion-B-point angle (SNB): evaluates the antero-posterior position of the mandible relative to the anterior cranial base.
- A-point-Nasion-B-point angle (ANB): indicates the magnitude of the skeletal jaw discrepancy.
- Upper incisors to Nasion-A point line (UiNA): establishes the relative protrusion of the maxillary dentition.
- Lower incisor and chin to Nasion-B point line (LiNB): establishes the relative protrusion of the mandibular dentition.

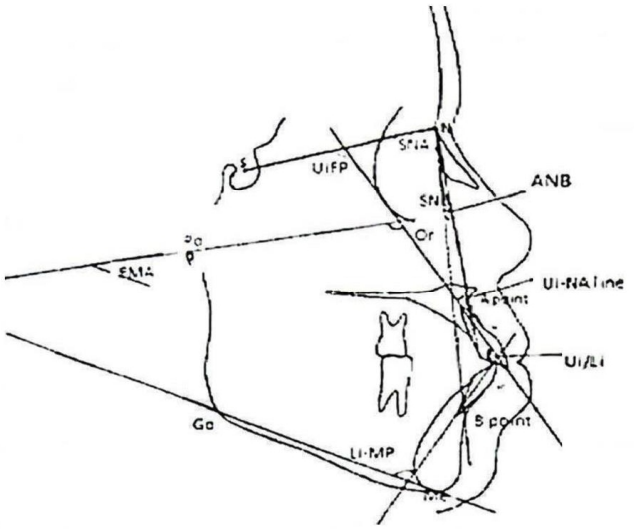

Fig.1: Angles measured on lateral cephalometric radiograph

- Frankfort-mandibular plane angle (FMA): establishes the degree of inclination of the mandible to the Frankfort horizontal plane
- Upper incisor to Frankfort plane (UiFP): establishes the relative proclination of the upper incisors in relation to the Frankfort plane
- Lower incisor to mandibular plane (LiMP): establishes the relative proclination of the lower incisors in relation to the mandibular plane.
- Upper incisor to lower incisor (Ui/Li): establishes the relationship of the upper central incisor to the lower central incisor.

Each measurement was taken at least twice and the average of the measurements recorded.

Data analysis

The collected data were analyzed using the Statistical Package for Social Sciences (SPSS Inc. Chicago IL) version 22. Frequency distribution of variables was generated and measures of central tendency calculated to summarize the numerical data. The data generated were presented as tables. The differences in means of cephalometric values of HbS patients and HbA patients were assessed using Student t-test.

Results

In group 1, 29 (48.3%) of the participants were males, 31 (51.7%) females while in group 2, 27 (45.0%) were males and 33 (55.0%) females. The mean age of the participants was 21.55 ± 2.55 years for the HbS group and 22.15 ± 2.52 years for the HbA group (Table 1).

The minimum SNA angle measured was 73.50° while the maximum was 100.00°. The mean SNA and SNB angle were 85.66 ± 4.93° and 80.56 ± 4.41° respectively.Comparison of the mean SNA angle in both groups, it was observed to be higher in HbA than HbS with a mean difference of -0.72° (t = -0.75, p= 0.46).The SNB values for HbS and HbA revealed a mean difference of -2.18° which was statistically significant (t = -2.47, p= 0.02). The ANB angle ranged between -3 and 10° with a mean value of 5.10 ± 3.32°.The mean difference in ANB value was found to be statistically significant 1.17° (t = 2.45, p= 0.02). In addition, the mean UiNA, LiNB and FMA measured 26.75 ± 6.77°, 38.63 ± 5.74° and 28.71 ± 5.84° respectively.The mean differences between the two groups for the UiNA (-0.99) and LiNB (2.03) were not statistically significant with p values of 0.44 and 0.08 respectively. The FMA value measures ranges between 16 – 46 degrees with a mean value of 28.71±5.84°

Discussion

The mean SNA angle for HbS participants in this study was found to be within the standard deviation for this variable in a Nigeria norm [15]. The interpretation of this is that maxillary protrusion which is a common feature among HbS individuals was found to be absent. A similar finding had been reported by Maia *et al* [16] in a study to characterize the craniofacial features of HbS patients in Brazil where they found the average value for SNA to be within the standard deviation for the variable in Brazilians. The possible reason for this might be connected to increased awareness of this disorder and the willingness of HbS individuals to accept treatment. More so, this current study population is hospital based and they receive treatment on regular

Table 1: Mean age and gender of participants by genotype.

	HbS	HbA	p value
Mean age ± SD (years)	21.55 ± 2.55	22.15 ± 2.52	0.20*
Gender Female n (%)Male n (%)	31 (51.7%)29 (48.3%)	33 (55%)27 (45%)	0.71**

*SD: Standard deviation; * Student t-test; ** Chi square test*

Table 2. Comparison of mean cephalometric values of HbS and HbA participants.

Angles	HbS Mean (SD)°	HbA Mean (SD)°	Mean difference	*t* value	p value
SNA	85.66 (4.93)	86.38 (5.55)	-0.72	-0.75	0.46
SNB	80.56 (4.41)	82.74 (5.25)	-2.18	-2.47	0.02*
ANB	5.10 (3.32)	3.93 (1.63)	1.17	2.45	0.02*
UiNA	26.75 (6.77)	27.75 (7.35)	-0.99	-0.77	0.44
LiNB	38.63 (5.74)	36.59 (6.84)	2.03	1.76	0.08
UiFP	120.59 (6.85)	119.26 (9.00)	1.33	0.91	0.36
LiMP	102.33 (8.11)	101.87 (7.42)	0.47	0.33	0.74
Ui/Li	109.16 (8.70)	110.08 (11.44)	-0.92	-0.49	0.62
FMA	28.71 (5.84)	27.53 (5.12)	1.18	1.17	0.24

basis hence there is the likelihood of a reduction in the participation of jaw bones in haemopoiesis. Comparison of the mean SNA between HbS and HbA participants in this study showed a lower value for the HbS participants but the mean difference was not statistically significant. Similar findings had been reported by Adekile *et al* [14] who found the SNA value to be higher in HbA than in HbS individuals though this difference is not statistically significant [16]. Also, Brown and Sebes [17] in their study of lateral cephalometric radiographs of fifty HbS and twenty five HbA individuals found a similar results. Contrasting findings were however reported by Altemus and Epps[18] where the mean SNA value was higher in the HbS group than the HbA group, though the difference was not significant.Improvement in healthcare in recent times which include early diagnosis of sickle cell disease, more consistent follow-up from childhood leading to long survival rates [7,10] may be responsible for the lack of significant maxillary protrusion in HbS individuals in this study. The improvement in healthcare leads to reduction in the frequency of crises which eventually reduces the need for compensatory hyperplasia of the bones due to chronic hemolysis.

Concerning the mean SNB, the value recorded in this study was significantly lower in the HbS group than the HbA group thus, presenting a mandibular retrusion in relation to the cranial base in the HbS group. Similarly, Adekile et al [14]in a study observed that the mean SNB value was higher in HbA than in HbS individuals but the mean difference was not statistically significant. Furthermore, Bandeen [19] observed that craniofacial dimensions were reduced in sickle cell disease and subjects presented with small mandible. The reason for this could be the result of vaso-occlusive crises common in the acute phase of bone involvement in sickle cell anaemia [20,21]which results in compromised blood supply to the mandible, and hence hypoplasia of the mandible [14].

The ANB angle represents the antero-posterior relationship of the maxilla to the mandible and indicates the magnitude of skeletal jaw discrepancy. The mean ANB was significantly greater in the HbS than in HbA group. Adekile et al [14] also found the mean ANB of HbS individuals to be greater than that of the HbA though not statistically significant. Similar findings were observed by Pithon et al [22] who found a statistically significant difference in ANB values between the HbS, HbAS and HbA group in their studied population. Likewise, Altemus and Epps[18] found the ANB angle to be significantly greater in HbS than HbA. The degree of skeletal discrepancy observed in this study is due to the lower value of mean SNB as compared to the close to normal SNA value in the HbS group.

The significantly reduced SNB with consequent increase in ANB in the sickle cell anaemia patients require special consideration during treatment planning in orthodontics. When these patients present with retrusion of the mandible, the treatment should be aimed at bringing the mandible forward as much as possible in order to correct the skeletal discrepancy.

The UiNA and LiNB angles indicate the degree of proclination of the upper and lower incisors relative to the NA line and NB line respectively. The mean UiNA angle in this study was greater in the HbA group than HbS group though not statistically significant. This is similar to the measurements results (HbS 21.5°, HbA 23.0°) in a study by Altemus et al [18] in North American black children with sickle cell disease. Pithon et al [22] however noticed a statistically significant difference in UiNA values (HbS 20.5 ± 7.3°, HbA 26.7 ± 4.8°) in Brazilians with the HbA participants having a higher value. The

UiNA value in this current study is lower though not statistically significant when compared with that of HbA. This lower values noticed in the HbS group could be attributed to mandibular retrusion, hence a need for the maxillary incisors to compensate by retroclination for functional occlusal reasons.

The mean LiNB angle was greater in HbS group as compared with HbA group but not significant. Similar findings were reported by Altemus et al [18] and Pithon et al [22]. This higher LiNB angle value in HbS participants in this study can be ascribed to dental compensation for the retruded mandible.

The FMA angle which is a measurement of the facial height and a relationship between the Frankfort horizontal plane and the mandibular plane was larger in HbS than HbA participants. A steeper mandibular plane observe in the HbS group may have being responsible for this. Similar findings were noted by Licciardello et al [13] and Bandeen [19] in the HbS populations they studied at different times. The increase in FMA indicates an increased tendency towards open bite in the HbS individuals and this has being documented by a study in literature [23]. The increase in FMA has been attributed to hyperdivergence of the face in sickle cell anaemia [19].

Conclusion

The cephalometric findings showed that there was a significant difference between the mean SNB and ANB values in the HbS group compared to the HbA. The mean SNB was lower in HbS compared to HbA thereby increasing the mean ANB value. Therefore, during treatment, attempt at correction should be directed towards correcting the retrognathic mandible especially in HbS individuals under good care for the sickle cell condition since all the HbS sample were drawn from the hematology clinic.

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