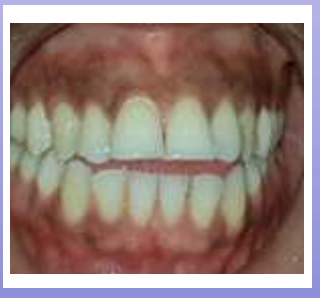
WEST AFRICAN JOURNAL OF ORTHODONTICS

Print ISSN: 2315-9634
E-ISSN: 3141-5822

VOLUME 8, NUMBER 1

JUNE 2019

Digit Sucking and Hyoid Bone Position



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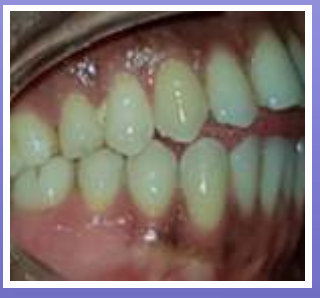

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Impact of Digit-Sucking Habit on the Hyoid Bone Position in Nigerian Children.

Njokanma A, Otuyemi OD, Kolawole KA

Abstract

Background: Digit sucking is the most common oral habit in children but its influence on the hyoid bone is not well established. This study aimed to determine the effect of digit-sucking habits on the vertical and horizontal position of the hyoid bone in Nigerian children.

Methods: Thirty children (4-12 years) with a digit-sucking habit were matched for age, sex and skeletal pattern with 30 children without any oral habit. Lateral cephalometric x-rays were used to determine the hyoid position. Data was analyzed using SPSS version 20.0. The percentages and frequencies of the categorical variables were determined. Assessment for data normality was carried out using Shapiro-Wilk's test. The association between categorical variables was determined using Chi-square and Fisher's exact test. Quantitative variables were analyzed and presented as means and standard deviation when normally distributed and median with interquartile range when skewed. Inferential statistics was done using the independent sample t- test to compare means. Statistical significance was set at $p<0.05$.

Results: There was a difference in the vertical and horizontal hyoid bone position, reflected by a significant increase in the mean values for the vertical and horizontal hyoid position in the digit-sucking group. ($p<0.05$).

Conclusions: The hyoid bone was significantly more inferiorly and anteriorly positioned in relation to the mandible and the third cervical vertebrae respectively, ($p<0.05$) among children with a digit-sucking habit.

Keywords: Digit sucking, Oral Habit, Hyoid bone position

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ORIGINAL ARTICLE

Introduction

Oral habits, including digit sucking, are repetitive involuntary actions that utilize the oral cavity.[1] Digit sucking (DS) is the most common form of oral habit seen in children and is considered normal in infants and young children.[2-4] These habits can influence the developing occlusion and skeletal structures.[5]

The human hyoid bone is a horseshoe-shaped bone located in the neck opposite the lower portion of the third cervical vertebrae. The hyoid bone plays a role in mastication, deglutition, respiration, and speech.[6] The antero-posterior position of the hyoid bone is determined by the action of the muscles attached to the structures above and below it, and not by the position of the teeth.[7-9] The attachment of these muscles may affect the position of the hyoid bone through the tongue and mandibular movements.[10] The hyoid bone has shown considerable variation in positions, notably adapting to antero-posterior changes in head and mandibular positions.[11-14]

Adesina et al found the average values of the distance of Hyoid to mandibular plane (H-MP) to be 13.3mm ± 11.6mm in a Nigerian adult population with Bi maxillary proclination. Other values reported in the literature include the H-Ml values of 14.5mm ± 4.6mm vs 11.8mm ± 3.1mm; hyoid-third cervical

vertebra (Hy-C3ai) distance of 35.4mm ± 5.6mm vs 29.0mm ± 4.3mm; and the hyoid - retrognathion (Hy-Rgn) distance of 30.7mm ± 7.4mm vs 31.9mm ± 6.3mm in a Colombian population of children with digit-sucking habits vs the controls, respectively.

However, the hyoid position is not influenced by respiration or skeletal malocclusion.[15, 16] Prolonged digit sucking interferes with the correct motion of the tongue and may result in an incorrect swallow pattern and tongue thrusting habit.[17, 18] An altered tongue position may then influence the position of the hyoid bone because of the attachment of the muscles of the tongue to the hyoid.[7]

Despite the interest in the position of the hyoid bone, there is a dearth of information on the possible influence of digit sucking in the literature. Therefore, the purpose of this study was to evaluate the impact of digit sucking on the position of the hyoid bone in Nigerian children aged 4-12 years, who currently indulge in this habit. .

Materials and methods

Ethical approval was obtained from the Ethics and Research Committee of the OAUTHC Ile-Ife, Nigeria (ERC/2016/10/04) and signed informed consent was obtained from the parents or guardians of the subjects, while assent was obtained from subjects aged 7-12.[19]

The sample size for this study was calculated using the formula for calculating sample size for comparative research studies.[20] The study sample consisted of sixty subjects recruited from patients who presented at the Child Dental Health clinic, Obafemi Awolowo University Teaching Hospital, Ile-Ife, Nigeria. They were divided into two equal groups based on their eligibility (DS and non-DS groups).

A pilot study was conducted to assist the calibration of the investigator, to ensure appropriate data collection and familiarize the investigator with the research protocol. Three subjects with digit-sucking habits were recruited into the DS group. Three other subjects who matched the subjects in the DS group for age and gender and who did not have a digit-sucking habit were recruited into the non-DS group. The investigator obtained and traced the lateral cephalometric radiographs of all subjects in the pilot study. A consultant orthodontist who is an expert in cephalometric studies also traced the same lateral cephalometric radiographs. Inter-examiner consistency was determined by calculating the intra-class coefficient scores (ICC). The ICC score calculated for all the cephalometric variables (hyoid bone) in the pilot study ranged from 0.86 to 0.91.

Subjects who met the following criteria were recruited into the study. (1) Subjects aged 4-12 years (2) Subjects who fell within the 5th to 85th percentile of the Center for Disease Control BMI to percentile chart[21] (3) Subjects whose parents gave consent.

Subjects who had a history of any other oral habit, previous history of orthodontic treatment, history of trauma, or congenital anomaly to the lips, face or craniofacial complex were excluded from the study.

The subjects in the DS group were recruited from patients who presented at the Child Dental Health Clinic with a digit-sucking habit. They were matched for age (+/- 12 months), sex, and skeletal pattern (based on lateral cephalometric analysis) through a convenience sampling method with a population of patients who had no history of engaging in digit-sucking habit (non-DS). Each participant was weighed wearing light clothing on a digital weighing scale, and their height measured using a stadiometer. Body Mass Index, (BMI) was calculated using the formula:

$$BMI = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

The Center for Disease Control and Prevention (CDC) chart[21] was used to categorize the BMI scores into underweight (below the 5th percentile),

normal/healthy (5th- 85th percentile) and overweight (above 85th percentile). Only those patients within the normal/healthy percentile range were recruited into the study.

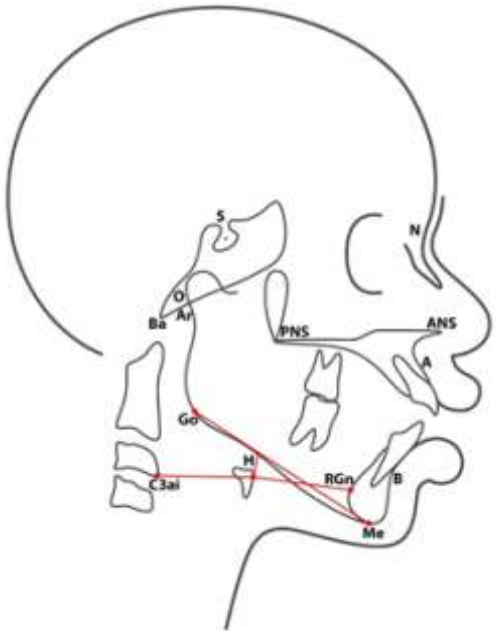
Information was collected via a questionnaire which included the number of digits sucked, the periods of the day the habit is practiced, the duration of the habit (number of hours per day/ or years) and severity of the habit based on the classification by Kolawole *et al.*[19]

Standardized lateral skull radiographs were taken for all the subjects using a Pan- Blue-Oris Machine (BlueXTM Imaging SRL BLD XP PANCEPH METRIC 71680000700 ASSAGO, ITALY). The cephalometric radiographs were traced manually using a sharp HB lead pencil on a 0.003" matte finish acetate sheet placed over the radiograph and secured with masking tape on an illuminated viewing box. All radiographs were traced by the principal investigator (A.N)

Linear measurements were recorded in millimeters (mm). The landmarks shown in Table 1 and Figure 1 were identified on the cephalometric radiograph of each participant in this study and the values obtained were compared between subjects in the DS group and the non-DS group.

Table 1: Skeletal reference points and planes

Measurement	Abbreviation	Definition
Hyoid–Mandibular line. (vertical position)	H-ML	Perpendicular distance of the hyoid point from the mandibular plane
Hyoid-third cervical vertebra (horizontal position)	H-C3ai:	Linear distance from the hyoid to the third cervical vertebra
Hyoid-retrognathion (horizontal position)	H-Rgn:	Linear distance from the hyoid to the retrognathion



Measurement	Description
Vertical position of the hyoid bone	H-Ml
Horizontal position of the hyoid bone	H-C3ai
Horizontal position of the hyoid bone	H-Rgn

Figure 1: Diagram showing the cephalometric hyoid parameters measured.

The random errors during tracing, landmark selection, and measuring were determined by repeating the tracings of 25 randomly selected radiographs two weeks after completion of the sample collection. Dahlberg's formula,[22]

$$D = \sqrt{\sum_{i=1}^{N} \frac{d_i^2}{2N}}$$

was used to calculate measurement error, where *d* is the difference in the measurement between the first and second tracings and *n* is the sample size.[23] The error of linear measurements were minimal, ranging from 0.1 to 0.5mm. Systematic errors were determined by using a paired t test and the differences between the first and second measurements were not statistically significant.

Data was analyzed using IBM SPSS version 20, while the association between categorical variables was determined using Fisher's exact test. Quantitative variables (vertical and horizontal hyoid positions) were analyzed and presented as means and standard deviation. Independent sample t-test was used to compare the means of the various hyoid positions between both groups. Statistical significance was inferred at $p < 0.05$ and based on a 95% confidence interval.

Results

A total of 60 subjects were recruited into the study, 30 subjects in each group, with each group comprising 16 males and 14 females . The mean age of subjects in the DS and non-DS group were 7.7 ± 2.2 years and 8.1 ± 2.1 years respectively. There was no statistically significant difference between both groups in age and gender ($p>0.05$). (Table 2

Table 1: Skeletal reference points and planes

	DS group (n=30) n(%)	Non-DS group (n=30) n(%)	Total n(%)	χ2	p-value
Age group (Years)					
4-6	9(30.0)	8(26.7)	17(28.3)	0.466	0.451
7-9	16(53.3)	13(43.3)	29(48.3)		
10-12	5(16.7)	9(30.0)	14(23.3)		
Mean±SD	7.70±2.2	8.27±2.2	7.98±2.2	-0.682	0.320
Gender					
Male	16(53.3)	16(53.3)	32(53.3)	0.000	1.000
Female	14(46.7)	14(46.7)	28(46.7)		

†Fisher's Exact test

Most of the subjects (25;83.3%) sucked while asleep while 14 (46.6%) subjects sucked at other times during the day (excluding school time). Four (13.3%) subjects sucked across all three-time periods; while at school, during the day, and while asleep. The majority of the subjects (60.0%) had a moderate digit-sucking habit while 16.7% and 23.3% had mild and severe sucking habits respectively (Figure 2).

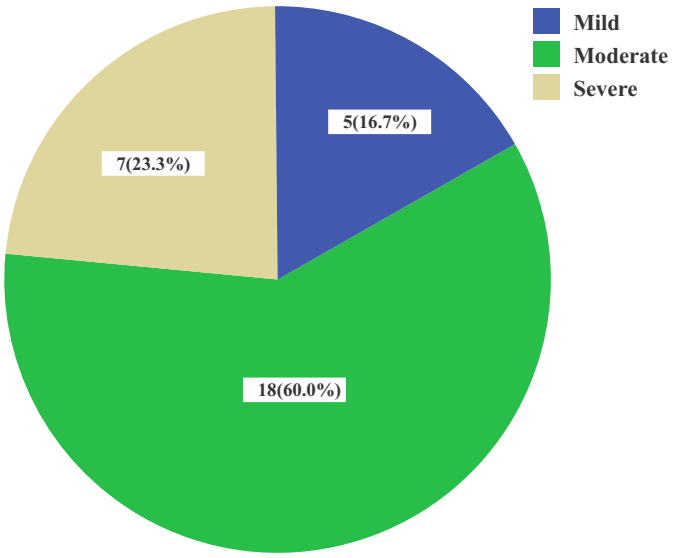


Figure 2: Pie chart showing classification of habit severity in the study population.

Table 3 shows the comparison of the mean hyoid bone position in the DS and non-DS groups. The mean vertical linear distance between the hyoid and mandibular plane (H-ML) and the horizontal position (HC3ai) were significantly increased in the DS group respectively when compared with the non-DS group ($p<0.05$). However, the mean horizontal linear distance between the hyoid and the retrognathion (H-Rgn) was reduced in the DS group compared to the non-DS group, although the difference was not significant ($p>0.05$).

Table 3. Comparison of the mean hyoid bone position in the DS and non-DS groups

	Hyoid bone position	DS group Mean±SD (mm)	t-value	p-value
H-ML	11.23±3.6	9.43±2.8	2.205	0.031*
H-C3ai	34.83±4.0	31.93±4.9	2.509	0.015*
H-Rgn	31.93±6.9	34.57±5.0	-1.703	0.094

Discussion

In this study the hyoid bone was significantly lower (H-ML) and more anteriorly positioned (H-C3ai) in the DS group compared to the non-DS group. This supports the evidence from the literature that the hyoid position changes in response to mandibular movement.[10, 11, 24] When the mandible moves posteriorly, as a compensatory functional mechanism, the hyoid bone is guided to an inferior position to avoid compromising the airway space.[25] During digit sucking, the tongue moves downward and forward to allow for passage of air and the mandible assumes an inferior and posterior habitual position.[26] The anterior tongue displacement and tongue thrusting associated with digit-sucking habit[17, 18] may also influence the position of the hyoid bone due to the attachment of the muscles of the tongue to the hyoid.[9] This may be responsible for the more anterior position of the hyoid bone as observed among the digit-sucking group in this study.

Salazar-Arboleda *et al*[26] reported a significant increase in the mean values of the vertical (H-ML) and horizontal positions (H-C3ai) of the hyoid bone among a population of children with a digit-sucking habit, similar to the finding in this study. An inferiorly positioned hyoid bone in respect to the mandible has

been reported in patients with reduced airway dimensions.[27,28] Genta *et al*[28] and Sforza *et al*[29] reported that a more inferiorly positioned hyoid bone is strongly associated with the presence and severity of obstructive sleep apnea syndrome (OSA) which is a sleep disorder characterized by a repetitive collapse of the upper airway during sleep. Their findings were in agreement with other reported studies.[30]

This could possibly suggest that digit suckers are at risk of developing OSA, which has been associated with significantly impaired quality of life, poor cognitive and social functioning, and high morbidity.[31,32] The possible association between digit-sucking habits and OSA validates the need for proper upper airway assessment in children with a history of prolonged digit-sucking habit. Further research in children with digit-sucking habits, which may entail sleep studies are needed to explore any defined relationship between the presence of digit sucking and obstructive sleep apnea.

Although the intensity of the digit-sucking habit was not assessed in the subjects of this study, the majority of subjects sucked their digits mostly when asleep, which could have influenced the intensity of digit sucking.

One of the limitations of this study is the fact that lateral cephalograms are limited by inherent errors accompanying the two dimensional representation of a three dimensional structure, including distortion, differences in magnification, and superimposition of bilateral craniofacial structures. Therefore, the use of cone beam computed tomography in the evaluation of the upper airway would further enhance understanding of the upper airway changes seen in patients with digit-sucking habits . However, in our environment, lateral cephalometric radiographs is still a cost effective means for assessing craniofacial morphology. In this study, the use of the same machine in taking the lateral cephalometric radiographs ensured minimal problems with magnification errors.

Conclusion.

In conclusion, the authors of this study found that digit-sucking habits influenced the vertical and horizontal position of the hyoid bone (more inferiorly and anteriorly positioned hyoid bone in relation to the mandible and the cervical vertebrae respectively) as seen among the DS group. Further studies would be welcome to determine the effects of the hyoid position, especially in relation to Obstructive sleep apnea.

Contributors

All the authors contributed to the design, data collection, analysis and write-up of the manuscript.

Funding/Grants

Self-funded

Conflict of Interest

Nil

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