ASSESSMENT OF THE EFFECTS OF DIGIT SUCKING HABIT ON THE MASTICATORY MUSCULATURE USING MOTION MODE ULTRASONOGRAPHY.

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ABSTRACT

OBJECTIVE: This study assessed the effect of active digit sucking on muscle thickness and fractional shortening of the masseter, lateral pterygoid, and temporalis in a population of Nigerian children using motion mode ultrasonography.

METHODS: The sample consisted of 100 selected children aged 7-12 years, divided into two equal groups of digit sucking and non-sucking. Participants were matched for age groups and gender. Ultrasonography evaluation (2 D and motion mode) of the masticatory muscles was performed using a linear probe of 7.5 MHz. The muscle thickness at contraction/relaxation and fractional shortening was determined. Independent t-test, Pearson correlation coefficient, and Two-way ANOVA were used for data analysis.

RESULTS: Whilst temporalis and lateral pterygoid muscles demonstrated a significant increase in thickness during relaxation ($p<0.0001$), a significant reduction in fractional shortening was observed ($p<0.0001$) in the sucking when compared to the non-sucking group. Similarly, only the temporalis muscle was significantly reduced during the contraction phase ($p<0.01$). For masseter mid-belly, both right and left sides in digit sucking subjects showed a significant increase in the thickness at contraction. At the same time, a reduction was observed in fractional shortening ($p<0.05$). Males and females with digit habit showed significantly greater muscle thickness in temporalis and lateral pterygoid during contraction and relaxation phases, whereas a reduction was observed in fractional shortening. Significant associations were observed between the frequency of sucking and muscle thickness in masseter and temporalis in fractional shortening ($p<0.05$).

CONCLUSION: Our findings corroborate the assumption that persistent digit sucking in children can affect the morphology and function of the masticatory muscles.

KEY WORDS: Digit sucking habit, masticatory muscles, 7-12 year-olds

INTRODUCTION

Sucking behavior in infants and young children is mainly derived from their psychological need for nutrients. Current understanding of child development suggests that sucking behavior also arises and persists in part because of psychological needs. Usually, developed infants have an inherent biologic drive for sucking.[1] This sucking urge can be satisfied through nutritive sucking, including breast and bottle feeding, or non-nutritive sucking on objects such as digits, pacifiers, or toys.[2]

Digit sucking is common in children and is reported to be harmless for up to four to five years.[3] The growth and development of jaws are significantly interfered with by the oral habits that may result in the onset of malocclusion. The factors including frequency, duration, facial patterns, and intensity cause changes in the patterns of normal swallowing and speech.[4,5] There are other causes for this problem, among these children, which include the use of pacifiers, the neurological status, and the resting position of the head in atypical swallowing, hyperextension, and digit sucking.[6] However, the harmful habits are likely to result in an open bite in the anterior region.[5]

The occurrence of non-nutritive sucking habits is 17% to 50% among preschool children.[7] A previous study showed the occurrence of anterior open bite and increased overjet between study and controls, in addition, digit sucking habit increased the likelihood of development of the anterior open bite, increased overjet and posterior crossbite by 39 folds, 40 folds, and 3 folds respectively.[8]

The masticatory muscles are often recruited in sucking and are of paramount importance in the etiology and active treatment of malocclusions and jaw deformities and also for the stability of such treatment.[9,10,11] Masticatory muscle function and form correlate with the morphologic features of the craniomandibular apparatus to which the muscles are attached.[12] Intensive use of any skeletal muscles including masticatory muscles may cause changes in the muscle fiber size which in turn will increase the strength of the muscle and resistance to fatigue.[13,14] Prolonged high activity of these muscles results in increased ultrasonographic thickness.[15] The importance of masticatory muscle function has been observed in anthropologic studies in which a low frequency of malocclusions was found in populations with primitive living conditions.[16,17]

Muscles of mastication have been studied extensively with ultrasound which has been considered to be a valuable, precise technique for analyzing muscle shape.[18,19] Furthermore, ultrasound is adjudged to be superior to radiographs for soft tissue evaluation in real-time and definitely overcomes the radiation hazards.[20]

Digit sucking habit results in deformation of the occlusion and the severity of this deformation increase markedly if the habit continues beyond forty-eight months of age.[2] Sucking habits like thumb and pacifier sucking, and bottle feeding could deliver excessive abnormal inward force from cheek muscles "buccinators" on the posterior teeth in Maxilla and Mandible with the absence of outward balancing forces from the tongue that accompany these habits, resulting in possible dentoalveolar arch narrowing that could be accompanied by occlusal deviation.[21] The perioral musculature is important in this process by way of compensatory activity on the disturbed occlusion, thus accentuating the deformity.[10] The oral dysfunction results in altered activity of the orofacial musculatures during sucking.[22]

Abnormal oral habits such as digit sucking result in unbalanced functional forces which in turn affect normal dentofacial growth and development.[23] Much of this damage occurs during the transition period from primary to permanent dentition. Elimination of aberrant pressure of oral habits such as digit sucking habit creates a stable occlusion and prevents orthodontic relapse as well as unnecessary orthodontic treatment.[23]

The intensive activity of the orofacial musculature which includes the masticatory muscles, in children with digit sucking habits may result in an increased thickness of these muscles which can perpetuate the development of malocclusion.[10] Therefore, this study aimed to assess the effects of the digit sucking habit on the thickness and fractional shortening of the masticatory muscles of a group of Nigerian children using motion-mode ultrasonography

MATERIALS AND METHOD

This research was approved by the Research Ethics Committee of the University of Benin Teaching Hospital, protocol number ADM/E 22/A/VOL, VII/1216. The sample size was determined using the convenience sampling technique. Fifty children with active digit sucking habits were identified and recruited into the study from twelve schools (9 primary and 3 junior secondary schools) in Benin City. Similarly, the 50 non-sucking groups (control) were also recruited from the same group of primary and junior secondary schools. The children with and without digit sucking habits were identified by the school teachers and confirmed by their parents through the use of a questionnaire designed for the study. Sucking habit participants were 23 males and 27 females matched with the control group. Written consent was obtained from children's parents and verbal assent was obtained from each chtor to participate in the study. Participants in this study experienced no direct benefit and no compensation was paid to them. The selection criteria included; age group 7-12 years, consent from parent/guardian, no previous orthodontic treatment, and active sucking habit for the experimental group.

Ultrasonographic evaluation (2D and Motion mode) of the masticatory muscles (masseter, temporalis, lateral pterygoid) as described by Agnihotri et al,[11] was performed by one of the authors (JO) using the ultrasound machine (Sonoscape A6T/A6/A5 Portable ultrasonic diagnostic system, 2008, China) using a linear probe of 7.5 MHz. (fig 1 &2)

Fig 1: Scanning the right Masseter Mid Belly in a 9-year-oldd boy without digit sucking habit using the ultrasound machine (Sonoscape A6T/A6/A5).

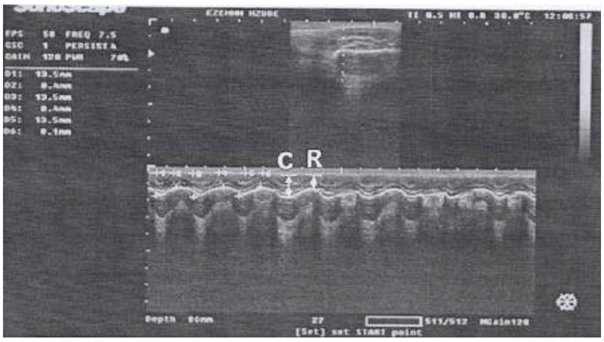

Fig 2: Ultrasound Scan of Masseter Mid Belly in an 8 years old child with digit sucking habit showing contraction (C) and relaxation ®.

The thickness at contraction/relaxation and fractional shortening for each muscle was determined. The participants were positioned in the lateral decubitus position on an examination couch throughout the assessment period. A pilot study was carried out using 10 children (5 with digit sucking habits and 5 controls). This was donetoo establish reliability for all measurements carried out. The Cronbach's Alpha for intra-examiner reliability was 0.7.

STATISTICAL METHOD

All data were recorded in the proforma (questionnaire) designed for the study. Data were processed and analyzed using Statistical Software Package for Social Sciences-Chicago (SPSS) version 20. A comparison of muscle thickness in both groups was carried out using an independent t-test. Comparisons between both groups for the right, left and gender differences were carried out using an independent t-test. The level of significance was set at P<0.05

RESULTS

The experimental (sucking) and control (non-sucking) groups in the study population consisted of 23 males and 27 females in each group with a mean age of 8.0±1.3 years for the sucking habit group while the mean age for the control group was 8.8± 1.6 years (Table 1). .

Table 1 Distribution of subjects according to socio-demographic characteristics.

Age(yrs)	Sucking habit group (experimental) n = 50	Non -sucking group (control) n = 50
Mean age	8.0±1.3	8.8±1.6
Age range	7-12	7-12
Median	7	7
Gender		
Male	23	23
Female	27	27

Table 2 shows the comparison of muscle thickness and fractional shortening of masticatory muscles in sucking and non-sucking subjects.

Table 2 Comparison of muscle thickness and fractional shortening of masticatory muscles in sucking and non-sucking subjects.

Masticatory muscles	Sucking (n=50)	Non-sucking (n=50)	p-value
Masseter			
Contraction (mm)			
Origin	13.4 ± 1.1	13.2 ± 1.0	0.105
Mid belly	13.7 ± 1.2	13.2 ± 1.4	0.003**
Insertion	13.0 ± 1.4	12.9 ± 1.1	0.577
Mean	13.2 ± 1.0	13.2 ± 0.9	0.644
Relaxation (mm)			
Origin	9.6 ± 1.0	9.4 ± 0.9	0.126
Mid belly	9.4 ± 1.3	9.2 ± 1.0	0.204
Insertion	9.0 ± 1.0	8.9 ± 1.0	0.538
Mean	9.4 ± 0.9	9.2 ± 0.7	0.131
Fractional shortening (%)			
Origin	28.4 ± 4.5	28.0 ± 5.7	0.634
Mid belly	29.5 ± 4.4	31.8 ± 5.9	0.002**
Insertion	30.4 ± 5.5	30.3 ± 6.0	0.890
Mean	29.4 ± 3.4	30.0 ± 4.6	0.285
Temporalis			
[Contraction (mm)			
Horizontal	11.3 ± 0.5	11.0 ± 0.9	0.001**
Vertical	11.3 ± 0.5	11.1 ± 1.0	0.035*
Mean	11.3 ± 8.4	11.0 ± 0.8	0.003**
Relaxation (mm)			
Horizontal	7.3 ± 1.1	6.7 ± 1.1	<0.0001***
Vertical	7.4 ± 1.2	6.7 ± 1.1	<0.0001***
Mean	7.4 ± 1.1	6.7 ± 1.1	<0.0001***
Fractional shortening (%)			
Horizontal	33.3 ± 8.8	40.5 ± 7.6	<0.0001***
Vertical	33.3 ± 9.2	40.8 ± 7.7	<0.0001***
Mean	33.3 ± 8.7	40.7 ± 7.5	<0.0001**
Lateral pterygoid			
Contraction (mm)			
Retrusion and protrusion	11.3 ± 0.5	11..2 ± 0.7	0.436
Mediolateral excursion	11.3 ± 0.4	11.2 ± 0.9	0.113
Mean	11.3 ± 0.4	11.2 ± 0.7	0.150
Relaxation (mm)			
Retrusion and protrusion	8.1 ± 0.8	6.8 ± 1.1	<0.0001***
Mediolateral excursion	7.4 ± 1.2	6.7 ± 1.1	<0.0001***
Mean	7.7 ± 0.8	6.8 ± 1.1	<0.0001***
Fractional shortening (%)			
Retrusion and protrusion	28.0 ± 4.8	40.0 ± 8.2	<0.0001***
Mediolateral excursion	33.9 ± 9.1	40.7 ± 8.1	<0.0001***
Mean	30.9 ± 5.5	40.3 ± 7. 9	<0.0001***

p< 0.05 - * Statistically significant, P<0.01 - **highly Statistically significant, p<0.001 - *** very highly statistically significant, Analysis – unpaired t-test

There was an increase in the thickness of masticatory muscles (masseter, temporalis , and lateral pterygoid) at contraction and relaxation as well as a reduction in fractional shortening of the muscles in digit sucking subjects. The increased thickness of masticatory muscles in the digit sucking subjects was statistically significant in the masseter mid-belly, temporalis (horizontal and vertical) at contraction. A significant difference was observed in temporalis (horizontal and vertical), lateral pterygoid (retrusion/protrusion and mediolateral excursion) at relaxation (p<0.05). The reduction in fractional shortening of the masticatory muscles in digit sucking subjects was statistically significant in the masseter mid-belly, temporalis (horizontal and vertical), and lateral pterygoid (retrusion/protrusion and mediolateral excursion) (p<0.05).

The thickness of the masticatory muscles (masseter, temporalis and lateral pterygoid) was higher on the right and left sides in digit sucking subjects at contraction and relaxation when compared to the control subjects. This difference was statistically significant for masseter mid-belly, temporalis (horizontal) at contraction and in temporalis (horizontal and vertical), lateral pterygoid (retrusion/protrusion and mediolateral excursion) at relaxation (p<0.05). There was a reduction in fractional shortening of the masticatory muscles (masseter, temporalis, and lateral pterygoid) in digit sucking subjects on the right and left sides when compared to the control subjects. This difference was statistically significant in masseter mid-belly, temporalis, and lateral pterygoid muscles (p<0.05) (Table 3)

Table 3 Comparison of muscle thickness and fractional shortening of the masticatory musculatures in sucking and non-sucking group on the same side

Masticatory muscles	Right (Mean ± SD) Sucking (n=50)	Right (Mean ± SD) Non sucking (n=50)	*P* value	Left (Mean ± SD) Sucking (n=50)	Left (Mean ± SD) Non-sucking (n=50)	P value
Masseter						
Contraction (mm)						
Origin	13.3 ± 1.1	13.0 ± 0.9	0.119	13.5 ± 1.2	13.3 ± 1.1	0.435
Mid belly	13.5 ± 1.0	13.0 ± 1.3	0.041*	13.9 ± 1.2	13.4 ± 1.5	0.034*
Insertion	13.0 ± 1.4	12.6 ± 1.0	0.157	13.1 ± 1.1	12.9 ± 1.4	0.589
Mean	13.0± 1.1	13.0 ± 0.8	0.758	13.4±0.9	13.3±1.2	0.381
Relaxation(mm)						
Origin	9.7 ± 1.1	9.5 ± 0.9	0.410	9.6 ± 1.0	9.4 ± 0.9	0.183
Mid belly	9.4 ± 1.3	9.1 ± 0.9	0.220	9.5 ± 1.3	9.3 ± 1.1	0.563
Insertion	9.2 ± 1.0	8.9 ± 0.9	0.141	8.9 ± 1.2	8.8 ± 1.1	0.669
Mean	9.4 ± 0.8	9.2 ± 0.6	0.109	9.3 ± 0.9	9.2 ± 0.8	0.552
Fractional shortening (%)	27.1 ±4.5	27.6 ± 5.2	0.597	28.5 ± 6.3	29.7 ± 4.2	0.259
Origin						
Mid belly	29.1 ± 3.8	31.2 ± 6.1	0.045*	29.8 ± 4.9	32.4 ± 5.8	0.020*
Insertion	29.1 ± 5.6	29.3 ± 4.6	0.854	31.5 ± 6.2	31.5 ± 6.2	0.977
Mean	28.5±2.8	29.3±4.3	0.269	30.3±3.8	30.8±4.8	0.624
Temporalis						
Contraction (mm)						
Horizontal	11.3 ± 0.5	11.0 ± 1.0	0.072	11.3 ± 0.4	10.9 ± 0.8	0.004**
Vertical	11.3 ± 0.4	11.1 ± 1.0	0.156	11.3 ± 0.5	11.1 ± 0.9	0.120
Mean	11.3 ± 0.5	11.0 ± 0.9	0.073	11.3 ±0.4	11.0 ±0.8	0.015*
Relaxation (mm)						
Horizontal	7.3 ± 1.2	6.8 ± 1.2	0.017*	7.3 ± 1.1	6.7 ± 1.0	0.009**
Vertical	7.4 ± 1.3	6.8 ± 1.2	0.012*	7.4 ± 1.2	6.7 ± 1.0	0.002**
Mean	7.4±1.1	6.8±1.2	0.010*	7.3±1.0	6.7±1.0	0.002**
Fractional shortening (						
Horizontal	33.2 ± 9.0	40.2± 8.1	0.000***	33.4 ± 8.8	40.8 ± 7.1	0.000***
Vertical	33.2 ± 9.7	40.3 ± 8.4	0.000***	33.3 ± 8.9	41.3 ± 6.8	0.000***
Mean	33.2±9.1	40.3±8.2	0.0001***	33.3±8.3	41.0±6.9	0.0001***
Lateral Pterygoid						
Contraction (mm)						
Retrusion and protrusio	11.3 ± 0.6	11.2 ± 0.6	0.500	11.3 ± 0.4	11.2 ± 0.8	0.672
Mediolateral excursion	11.3 ± 0.4	11.2 ± 0.8	0.643	11.4 ± 0.4	11.1 ± 1.0	0.096
Mean	11.3 ± 0.4	11.2 ± 0.6	0.479	11.3 ± 0.4	11.2 ± 0.8	0.205
Relaxation(mm)						
retrusion and protrusion	8.1 ±0.8	6.8 ± 1.0	0.000***	8.1 ± 0.8	6.8 ± 1.2	0.000***
Mediolateral excursion	7.3 ± 1.0	6.7 ± 1.0	0.004**	7.4 ± 1.3	6.8 ± 1.2	0.011*
Mean	7.7±0.8	6.7±1.0	<0.0001***	7.8±0.8	6.8±1.1	0.0001***
Fractional shortening(mm)	28.8± 4.9	40.0 ± 8.1	0.000*	27.3 ± 4.6	39.9 ± 8.4	0.000***
Retrusion and protrusio						
Mediolateral excursion	34.4 ± 8.7	40.5 ± 8.0	0.000***	33.4 ± 9.6	40.8 ± 8.2	0.000***
Mean	31.6±5.0	40.3±7.8	<0.0001***	30.3±5.9	40.4±8.0	0.479

p< 0.05 - * Statistically significant, P<0.01 - **highly Statistically significant, p<0.001 - *** very highly statistically significant, Analysis – unpaired t-test

Males and females who sucked their digit showed an increase in the thickness of the masticatory muscles (masseter, temporalis, and lateral pterygoid) at contraction and relaxation compared to the control subjects. This difference was statistically significant in males for temporalis and lateral pterygoid muscles at relaxation. At the same time, in females, it was statistically significant for temporalis and lateral pterygoid muscles at contraction and in lateral pterygoid (retrusion/protrusion) at relaxation (p<0.05). There was a reduction in fractional shortening in both male and female subjects with digit sucking habits compared to the control subjects. This difference was statistically significant in males for temporalis and lateral pterygoid muscles and females for masseter mid-belly and lateral pterygoid muscles (p<0.05) (Table 4).

Table 4: Comparison of muscle thickness and fractional shortening of masticatory muscles according to gender

Masticatory muscles	Male (Mean ± SD) Sucking (n=2	Male (Mean ± SD) Non-sucking (n=23)	p-value	Female (Mean ± SD) Sucking (n=27	Female (Mean ± SD) Non-sucking (n=27)	*p-value*
Masseter						
Contraction (mm)						
Origin	13.3 ± 0.7	13.2 ± 0.9	0.854	13.5 ± 1.2	13.1 ± 0.9	0.157
Mid belly	13.1 ± 0.9	12.8 ± 1.1	0.490	13.4 ± 1.3	13.1 ± 1.0	0.380
Insertion	12.7 ± 1.0	12.6 ± 0.7	0.622	13.3 ± 1.5	13.0 ± 0.9	0.383
Mean	13.0 ±0.9	12.9 ±0.6	0.665	13.4 ± 1.2	13.1 ± 0.8	0.243
Relaxation (mm)						
Origin	9.5 ± 0.8	9.7 ± 0.9	0.429	9.6 ± 0.9	9.3 ± 0.8	0.328
Mid belly	9.1 ± 0.8	9.2 ± 1.2	0.680	9.6 ± 1.1	9.3 ± 0.8	0.287
Insertion	8.8 ± 0.9	8.8 ± 0.5	0.839	9.2 ± 0.9	9.0 ±0.7	0.352
Mean	9.2 ±0.7	9.2 ±0.7	0.664	9.5 ± 0.8	9.2 ± 0.6	0.219
Fractional shortening (						
Origin	26.8 ± 5.0	27.9 ± 3.5	0.398	28.8 ± 3.7	29.1 ± 4.9	0.812
Mid belly	30.0 ± 3.5	31.4 ± 5.1	0.284	29.0 ± 3.3	32.1 ± 4.7	0.008*
Insertion	30.2 ± 4.5	30.3 ± 4.1	0.936	30.5 ±4.4	30.4 ± 5.1	0.926
Mean	29.4 ±2.9	29.5 ±4.0	0.947	29.4 ±2.8	30.5 ±4.2	0.275
Temporalis						
Contraction (mm)						
Horizontal	11.2 ± 0.5	11.2 ± 0.3	0.911	11.4 ± 0.4	10.7 ± 0.9	0.002**
Vertical	11.2 ± 0.7	11.2 ± 0.2	0.925	11.4 ± 0.5	11.0 ± 0.9	0.032*
Means	11.2 ±0.5	11.2 ±0.2	0.992	11.4 ±0.4	10.9 ±0.8	0.005**
Relaxation (mm)						
Horizontal	7.8 ± 0.9	6.5 ± 0.8	0.0001***	6.9 ± 0.9	6.9 ± 1.2	0.930
Vertical	7.7 ± 1.0	6.5 ± 0.7	0.0001**	7.2 ± 1.3	6.9 ± 1.3	0.536
Means	7.7 ±0.8	6.5 ±0.8	0.001***	7.0 ±1.0	6.9 ±1.2	0.762
Fractional shortening (						
Horizontal	31.1 ± 7.0	42.2 ± 6.5	0.0001***	35.1 ± 9.5	39.0 ± 8.2	0.109
Vertical	31.5 ± 7.3	42.4 ± 6.2	0.0001***	34.7 ± 9.9	39.4 ± 8.4	0.065
Mean	31.3 ±6.8	42.3 ±6.3	0.0001***	34.9 ±9.5	39.2 ±8.2	0.080
Lateral pterygoid						
Contraction (mm)						
Retrusion& protrusion	11.3 ± 0.5	11.2 ± 0.3	0.535	11.4 ± 0.4	11.2 ± 0.6	0.156
Mediolateral excursion	11.3 ± 0.6	11.3 ± 0.2	0.580	11.4 ± 0.4	11.0 ± 0.8	0.036*
Mean	11.3 ±0.5	11.3 ±0.2	0.501	11.4 ±0.4	11.1 ±0.6	0.041*
Relaxation (mm)						
Retrusion& protrusion	8.3 ± 0.5	6.5 ± 0.9	0.0001***	7.9 ± 0.7	7.0 ± 1.2	0.001*
Mediolateral excursion	7.8 ± 1.0	6.5 ± 0.9	0.0001***	7.1 ± 1.2	6.9 ± 1.2	0.672
Mean	8.0 ±0.6	6.5 ±0.9	0.0001***	7.5 ±0.7	7.0 ±1.2	0.051
Fractional shortening (%)						
Retrusion& protrusion	26.7 ± 3.0	42.2 ± 7.1	0.0001***	29.2 ± 4.6	38.1 ± 8.5	0.0001**
Mediolateral excursion	31.6 ± 7.1	42.2 ± 6.9	0.0001***	35.8 ± 9.6	39.4 ± 8.6	0.153
Mean	29.1 ±4.1	42.2 ±6.9	0.0001***	32.5 ±5.3	38.7 ±8.3	0.002**

P<0.05- * Statistically significant, p<0.01- ** highly statistically significant, p<0.001-*** very highly statistically significant using unpaired t-test.

Table 5 shows a Two-way ANOVA of the relationship between the thickness and fractional shortening of the masticatory muscles and the frequency of sucking.

Table 5: Relationship between frequency of sucking (hours/day) and thickness and fractional shortening of masticatory muscles

Masticatory muscles	Frequency of sucking (hrs/day) 1 – 2 hrs (n=11)	3 – 4 hrs (n=13)	5 – 8 hrs (n=23)	9 – 12 hrs (n=3)	P value
Masseter					
Contraction (mm)					
Origin	12.7 ± 0.8	12.7 ± 1.0	13.2 ± 1.0	13.6 ± 1.2	0.010*
Mid belly	13.2 ± 0.4	13.6 ± 1.3	13.7 ± 1.1	14.0 ± 1.3	0.379
Insertion	12.5 ± 1.1	12.7 ± 1.0	12.9 ± 1.1	13.1 ± 1.1	0.419
Mean	12.8 ± 0.8	13.0 ± 0.8	13.3 ± 0.9	13.6 ± 1.0	0.066
Relaxation (mm)					
Origin	8.8 ± 0.7	9.1 ± 0.8	9.6 ± 0.9	9.7 ± 0.9	0.016*
Mid belly	8.6 ± 0.6	9.2 ± 0.8	9.3 ± 1.2	9.4 ± 1.1	0.352
Insertion	8.2 ± 0.9	8.9 ± 1.0	9.0 ± 1.0	9.1 ± 1.1	0.230
Mean	8.5 ± 0.4	9.1 ± 0.8	9.2 ± 0.7	9.4 ± 0.8	0.053
Fractional shortening (%)					
Origin	30.6 ± 2.5	28.6 ± 4.5	28.5 ± 4.0	27.9 ± 4.9	0.538
Mid belly	31.5± 4.6	29.9 ± 4.2	29.7 ± 4.1	28.2 ± 4.9	0.291
Insertion	34.4 ± 7.1	30.8 ± 5.2	30.2 ± 6.7	29.0 ± 4.1	0.155
Mean	32.2 ± 2.9	29.5 ± 3.7	29.5 ± 3.5	28.6 ± 3.0	0.142
Temporalis					
Contraction (mm)					
Horizontal	10.7 ± 1.2	11.0 ± 0.8	11.2 ± 0.5	11.3 ± 0.3	0.120
Vertical	10.3 ± 1.5	11.1 ± 0.8	11.1 ± 1.1	11.3 ± 0.3	0.147
Mean	10.7 ± 0.7	10.9 ± 1.1	11.0 ± 0.7	11.3 ± 0.3	0.249
Relaxation (mm)					
Horizontal	6.8 ± 1.1	7.2 ± 1.1	7.7 ± 1.0	8.0 ± 0.7	0.013*
Vertical	6.9 ± 1.2	7.4 ± 1.0	7.5 ± 1.0	7.6 ± 1.4	0.226
Mean	6.9 ± 1.1	7.4 ± 1.2	7.6 ± 0.9	7.7 ± 0.4	0.095
Fractional shortening (%)					
Horizontal	39.7 ± 8.3	32.9 ± 8.7	29.7 ± 7.4	28.3 ± 4.6	<0.0001***
Vertical	39.1 ± 9.4	32.1 ± 7.4	31.8 ± 9.6	27.9 ± 2.7	0.005**
Mean	39.4 ± 8.7	32.3 ± 8.7	30.9 ± 7.0	28.1 ± 2.5	0.001**
Lateral pterygoid					
Contraction (mm)					
Retrusion and protrusion	10.9 ± 0.8	10.9 ± 0.8	11.4 ± 0.2	11.4 ± 0.8	0.032*
Mediolateral excursion	10.8 ± 1.0	10.9 ± 1.4	11.3 ± 0.4	11.3 ± 0.8	0.250
Mean	10.9 ± 0.7	10.9 ± 1.0	11.3 ± 0.6	11.4 ± 0.3	0.038*
Relaxation (mm)					
Retrusion and protrusion	7.8 ± 0.6	7.9 ± 0.8	8.1 ± 0.9	8.5 ± 0.4	0.070
Mediolateral excursion	6.7 ± 1.0	7.4 ± 1.3	7.6 ± 0.4	7.7 ± 1.3	0.029*
Mean	7.6 ± 0.6	7.7 ± 0.4	7.7 ± 0.9	7.9 ± 0.8	0.536
Fractional shortening (%)					
Retrusion and protrusion	30.3 ± 6.4	28.7 ± 5.4	28.0 ± 4.5	26.0 ± 2.4	0.097
Mediolateral excursion	40.5 ± 7.7	32.2 ± 9.5	32.2 ± 7.8	29.8 ± 5.4	0.001**
Mean	33.2 ± 4.8	30.5 ± 5.9	30.1 ± 4.8	30.0 ± 5.5	0.167

p< 0.05 - * Statistically significant, p<0.01 - **highly Statistically significant, p<0.001 - *** very highly statistically significant, Analysis– ANOVA

An increase in the frequency of sucking resulted in increased thickness at contraction/relaxation and a reduction in fractional shortening of masticatory (masseter, temporalis, and lateral pterygoid) muscles in digit sucking subjects. This was statistically significant for masseter origin, lateral pterygoid at contraction, masseter origin, temporalis (horizontal), lateral pterygoid (mediolateral excursion) at relaxation, and fractional shortening of temporalis and lateral pterygoid (mediolateral excursion) (p<0.05).

There was a moderate positive and significant correlation between duration of sucking and thickness of masseter origin (r = 0.318, p<0.05). A weak positive but significant correlation was observed (r=0.207, p<0.05)) between sucking duration and thickness at the contraction of lateral pterygoid in the mediolateral excursion. However, a weak negative correlation (r= -0.219) was recorded between sucking duration and fractional shortening of masseter insertion, which was statistically significant (p<0.05). There was also a moderate negative correlation (r= -0.247) between the duration of sucking and fractional shortening of temporalis horizontal, and this was statistically significant (*p*<0.05) (Table 6).

Table 6: Relationship between duration of sucking and thickness and fractional shortening of masticatory muscles using Pearson correlation test.

Masticatory muscles	Pearson correlation (r)	*p-value*
Masseter		
Contraction		
Origin	0.318	0.001**
Mid belly	0.113	0.264
Insertion	0.014	0.889
Mean	0.176	0.081
Relaxation		
Origin	0.168	0.094
Mid belly	0.031	0.761
Insertion	0.147	0.145
Mean	0.015	0.881
Fractional shortening		
Origin	-0.287	0.287
Mid belly	-0.107	0.205
Insertion	-0.219	0.029*
Mean	-0.220	0.028*
Temporalis		
Contraction		
Horizontal	0.082	0.418
Vertical	0.085	0.402
Mean	0.094	0.352
Relaxation		
Horizontal	0.169	0.094
Vertical	0.100	0.324
Mean	0.143	0.156
Fractional shortening		
Horizontal	-0.247	0.013*
Vertical	-0.174	0.083
Mean	-0.219	0.029*
Lateral pterygoid		
Contraction		
Retrusion and protrusion	0.049	0.625
Mediolateral excursion	0.207	0.039*
Mean	0.164	0.104
Relaxation		
Retrusion and protrusion	0.043	0.674
Mediolateral excursion	0.021	0.833
Mean	0.005	0.960
Fractional shortening		
Retrusion and protrusion	-0.006	0.949
Mediolateral excursion	-0.146	0.147
Mean	-0.125	0.217

p< 0.05 - * Statistically significant, p<0.01 - **highly Statistically significant

DISCUSSION

Treatment planning in orthodontics depends not only on biomechanical considerations but also on each patient's craniofacial muscular environment. These muscles also play a significant role in the aetiology of malocclusion and are clinically relevant to orthodontic treatment outcome and stability.[9] It is also established that masticatory muscle function and form correlate with the morphologic features of the cranio-mandibular apparatus to which the muscles are attached.[10]

This study assessed the effects of digit sucking habit on the masticatory muscles among a group of Nigerians using motion-mode ultrasonography. Fractional shortening provides correct information about the contractility and functional status of the muscles.[11, 24]

In the present study, the increased thickness of the masticatory muscles at contraction and relaxation and reduction in fractional shortening was higher in digit sucking subjects than in the non-sucking group. This was significant for masseter mid-belly, temporalis at contraction, temporalis, and lateral pterygoid muscles at relaxation. This is similar to findings from a previous study.[11] Fractional shortening of the masticatory muscles (masseter, temporalis, and lateral pterygoid) was reduced in digit sucking subjects compared to the control subjects. The difference was statistically significant in masseter mid-belly, temporalis, and lateral pterygoid muscles. This was also similar to findings in a previous study.[11] A possible explanation for the increased thickness and reduction of the fractional shortening of the masticatory muscles recorded in this study for digit sucking subjects may be increased activity of the muscles due to the prolonged digit sucking habit. This is consistent with previous studies by Sanguida et al. [10], Ramirez-Yanez and Farrel[23] and Klein et al[25] These studies reported that intense activity of the orofacial musculature, which includes the masticatory muscles, in children with persistent digit sucking habits results in increased thickness of the muscles. These studies reported that intense activity of the orofacial musculature, which includes the masticatory muscles, in children with persistent digit sucking habits results in increased thickness of the muscles.

This study recorded increased thickness of the masticatory muscles at contraction and relaxation on the right and left sides in digit sucking subjects compared to the control subjects. The difference was statistically significant for the masseter mid-belly, temporalis muscles at contraction, and temporalis and lateral pterygoid muscles at relaxation. The fractional shortening of the masticatory muscles was reduced on the right and left sides in digit sucking subjects compared to the control subjects. This difference was statistically significant in the masseter mid-belly, temporalis, and lateral pterygoid muscles.

Gender comparison in this study showed an increase in the thickness of the masticatory muscles at contraction and relaxation with reduced fractional shortening in males and females with digit sucking habits compared to male and female control subjects. This difference was statistically significant in males for temporalis and lateral pterygoid muscles at relaxation, in females for temporalis and lateral pterygoid muscle at the contraction, and in lateral pterygoid (retrusion/protrusion/protrusion)) at relaxation. The fractional shortening of the masticatory muscles, as noted in the total population studied, was reduced in males and females with digit sucking habits compared to male and female control subjects. The difference was statistically significant in males for temporalis and lateral pterygoid muscles and females for masseter mid-belly and lateral pterygoid muscles. Gender comparison findings were not available from the literature searched. However, this study noted increased muscle thickness and reduced fractional shortening within the male and female groups with digit sucking habits assessed independently.

The thickness of the masticatory muscles at contraction and relaxation increased with the increasing frequency of digit sucking. It was statistically significant in the masseter origin, lateral pterygoid muscles at contraction, and in the masseter origin, and lateral pterygoid (mediolateral excursion) at relaxation. There was a reduction in fractional shortening of the masticatory muscles with increasing frequency of sucking, which was statistically significant in the temporalis and lateral pterygoid (mediolateral excursion) as previously documented in a study by Agnihotri et al.[11] In this study, it was found that increased duration of sucking resulted in a significant increase in the thickness of masseter origin and lateral pterygoid muscles (mediolateral excursion) at contraction, and a significant reduction in the fractional shortening of masseter and temporalis muscles. This was similar to findings in the Agnihotri et al. study.[11]

In conclusion, the masticatory muscles were thicker during contraction and relaxation, reducing fractional shortening in digit sucking subjects. An increase in the frequency and duration of sucking resulted in increased thickness and reduction of fractional shortening.

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