

Assessment of the Effects of Digit Sucking Habit on the Circumoral Musculature using Motion Mode Ultrasonography

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ABSTRACT

Objective: This comparative study assessed the thickness and fractional shortening of the circumoral musculature in children with and without digit sucking habit using motion mode ultrasonography.

Methods: One hundred children aged 7-12 years were divided into two equal groups of active digit sucking (experimental) and non-sucking (control). The groups were matched for age groups and gender. Ultrasonographic evaluation (2 D and motion mode) of the circumoral muscles was performed using a linear probe of 7.5 MHz. The thickness at contraction/relaxation and fractional shortening for each muscle was determined. Data were analyzed using IBM SPSS version 20.0 for windows. Descriptive statistics and multivariate linear regression were used. Statistically significance level was set at $p < 0.05$.

Results: There was no statistically significant differences in muscle thickness during contraction and fractional shortening between the two groups ($p > 0.05$). However, significant difference was observed during relaxation ($p < 0.05$). No significant difference was observed between both groups when each sex was compared to one another ($p > 0.05$). Generally, circumoral muscles did not show any significant association with the frequency of sucking except for duration of sucking for the lower circumoral muscle during relaxation ($r = 0.237$; $p = 0.018$) and fractional shortening ($r = -0.208$; $p = 0.038$).

Conclusion: The thickness and fractional shortening between sucking and nonsucking groups was found to be similar, however, increased duration of sucking significantly increased the lower circumoral muscle thickness which reflects excessive muscle activity.

Keywords: Digit sucking, Circumoral muscle, Motion-mode ultrasonography

INTRODUCTION

Although sucking behaviours are normal in infants and young children, prolonged duration of these behaviours might have consequences for the developing orofacial structures and occlusion. (Johnson, 1993). Treatment planning in Orthodontics is not based entirely on biomechanical considerations, but also requires an awareness of the craniofacial muscular environment of each patient.

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The teeth are positioned between the lips or cheeks on one side and the tongue on the other, and opposing forces or pressures from these structures can be determinants of tooth position. (Jung et al., 2003). The main function of the lips such as oral competence, is

controlled by the orbicularis oris muscle (Zide, 2000), which is a concentric, sphincter-like muscle around the mouth that closes, withdraws, and protrudes the lips. It has been demonstrated that the characteristics of the lips have an influence on lip responses to the retraction of the upper and lower incisors. (Oliver, 1982). Oliver (Oliver, 1982). observed that patients with thin lips or a high lip strain displayed a significant correlation between incisor and lip retraction, which was not observed in patients with thick lips or low lip strain. Wisth (Wisth, 1974), observed that lip response, as a proportion of incisor retraction, decreased as the amount of incisor retraction increased.

Breitner stated that there should be a balance between the forces of the tongue from within the dental arches and which is compensated by the musculature of the lips and cheek. He called this functional equilibrium. (Singh, 2009).

Ultrasonography utilizes sound waves within the frequency of 2-18 MHz that bounce off tissue to provide the depth and density of the image conventionally captured on the screen as a real time image. It was developed for Medical use in the 1940's with parallel developments across the Atlantic in the United States of America and Sweden. It has since been widely accepted as the safest investigating tool and is applied widely in Obstetrics; it has applications across several medical disciplines including physiotherapy (Bakke et al., 1992; Close et al., 1995; Ikai & Fukunaga, 1970; Fukunaga & Matsuo, 1986; Fukunaga et al, 1989; Esformers et al, 2002; Kubo et al., 2006). Furthermore, ultrasound is superior to radiographs for soft tissue evaluation in real time and definitely overcomes the radiation hazards (Serra et al, 2008).

Digit sucking habit results in deformation of the occlusion and the severity of this deformation increases markedly if the habit continues beyond forty-eight months of age. (Bishara et al., 2006). The perioral musculature is important in this process by way of compensatory activity of the disturbed occlusion, thus accentuating the deformity (Sanguida et al., 2017). The oral dysfunction results in altered activity of the orofacial musculatures during sucking (Sridhar, 2009). Intensive activity of the orofacial musculatures which includes the circumoral muscles in children with digit sucking habit may result in increased thickness of these muscles which could perpetuate the development of malocclusion. (Agnihotri et al., 2010; Sanguida et al., 2017). The aim of this study was to assess and compare the thickness and fractional shortening of the circumoral musculature among a group of Nigerian children with and without digit sucking habit using motion-mode ultrasonography.

Materials and methods

This research was approved by the research ethics Committee of the Hospital, protocol number ADM/E 22/A/VOL, VII/1216. Sample size was determined using

convenience sampling technique. One hundred children were selected from primary and secondary schools in Benin city from which 50 children with active digit sucking habit and 50 (non sucking or control) were selected. Sucking habit participants were 23 males while 27 were females, while the non-sucking comprised of 23 males and 27 females. Consent was obtained from parents and assent was obtained from each child in order to participate in the study. Participants in this study experienced no direct benefit and no compensation was paid to them. Selection criteria for digit sucking group included, active digit sucking habit, age 7-12 years, consent from parent/guardian and child, no previous orthodontic treatment. Selection criteria for non-sucking group were: no history of digit sucking, no history of any oral habit, age 7- 12 years, no previous orthodontic treatment, consent from parent/guardian and child.

Ultrasonographic evaluation (2D and Motion mode) of the circumoral musculature as described by Agnihotri et al (Agnihotri et al., 2010) 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. 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. The right side was assessed with the subject in the left lateral decubitus position and vice versa. To reduce intra-observer variation the measurements were taken thrice and the mean values obtained.

All data was recorded in the proforma (questionnaire) designed for the study. Data was processed and analysed using IBM SPSS version 20. Comparison of muscle thickness in both groups was carried out using unpaired t-test. Comparison between both group by sex and each side of the face was carried out using unpaired t-test. Level of significance was set at $P < 0.05$.

RESULTS

A total of 100 children from various schools (primary and junior secondary) in Benin city participated in the study, comprising two groups, the sucking habit group consisted of 50 children made up of 23 males and 27 females, the non sucking group consisted of 50 children (control group), made up of 23 males and 27 females. The study participants ages ranged from 7-12 years, with mean age of 8.0 ± 1.3 years for the sucking habit group and 8.8 ± 1.6 years for the control group. The mean thickness at relaxation was higher in the sucking group, and was statistically significant ($p < 0.05$) (Table 2). The mean thickness at relaxation was significantly higher in digit sucking group on the right side when compared to the same side in the control group ($p < 0.05$) (Table 3). Table 4 shows unpaired t-test of

circumoral muscle thickness and fractional shortening in relation to gender. There was no statistically significant difference between both groups when each sex was compared ($p > 0.05$).

Table 5 shows Two-way ANOVA of the relationship between frequency of digit sucking and thickness and fractional shortening of the circumoral musculature. In the lower circumoral muscle, thickness at contraction

and relaxation was highest at sucking frequency of 9-12 hours/day, which was statistically significant ($p < 0.05$). There was weak positive correlation ($r = 0.237$), between duration of sucking and thickness at relaxation of lower circumoral muscle and weak negative correlation ($r = -0.208$) between duration of sucking and fractional shortening of lower circumoral muscle, which were statistically significant ($p < 0.05$) (Table 6).

Table 1: Distribution of subjects according to Socio Demographic Characteristics.

Characteristics	Sucking habit group (experimental)	Non-Sucking group (control)
Age(years)		
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: Comparison of muscle thickness and fractional shortening of circumoral musculature in sucking and non-sucking subjects using unpaired *t*-test

Circumoral muscle	Sucking (n=50)	Non-sucking (n=50)	<i>p</i> value
Contraction (mm)			
Upper	6.8 ± 1.0	6.6 ± 0.8	0.191
Lower	6.8 ± 1.0	6.6 ± 0.8	0.200
Mean	6.8 ± 0.8	6.6 ± 0.6	0.099
Relaxation (mm)			
Upper	4.6 ± 1.0	4.3 ± 0.6	0.060
Lower	4.4 ± 0.9	4.2 ± 0.5	0.087
Mean	4.5 ± 0.8	4.3 ± 0.5	0.025*
Fractional shortening (%)			
Upper	33.4 ± 6.6	34.6 ± 4.8	0.146
Lower	36.4 ± 7.4	37.0 ± 5.5	0.548
Mean	34.9 ± 5.8	35.8 ± 3.8	0.210

$p < 0.05$ - * Statistically significant,

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

Circumoral Muscles	Right (Mean ± SD)		P-value	Left (Mean ± SD)		P- value
	Sucking (n=50)	Non-Sucking (n=50)		Sucking (n=5)	Non-Sucking (n=50)	
Contraction(mm)						
Upper	6.8 ± 0.8	6.6 ± 0.7	0.321	6.9 ± 1.2	6.7 ± 0.8	0.378
Lower	7.0 ± 1.0	6.8 ± 0.8	0.238	6.6 ± 1.0	6.5 ± 0.7	0.525
Mean	6.9 ± 0.6	6.7 ± 0.6	0.148	6.7 ± 0.8	6.6 ± 0.7	0.347
Relaxation (mm)						
Upper	4.5 ± 0.8	4.3 ± 0.5	0.165	4.6 ± 1.2	4.4 ± 0.7	0.188
Lower	4.6 ± 0.9	4.3 ± 0.5	0.034*	4.1 ± 0.9	4.0 ± 0.5	0.733
Mean	4.6 ± 0.6	4.3 ± 0.5	0.022*	4.3 ± 0.9	4.2 ± 0.5	0.283
Fractional shortening (%)						
Upper	33.4 ± 6.4	34.4 ± 4.6	0.351	33.4 ± 6.8	34.7 ± 5.0	0.269
Lower	34.4 ± 6.8	36.5 ± 5.4	0.090	37.5 ± 5.5	38.4 ± 7.5	0.455
Mean	33.9 ± 5.3	35.5 ± 3.7	0.091	35.1 ± 6.1	36.1 ± 3.9	0.866

$p < 0.05$ - * Statistically significant,

Table 4: Comparison of muscle thickness and fractional shortening of circumoral musculature according to gender.

	Male (Mean ± SD)		P value	Female (Mean ± SD)		P- value
Circumoral muscle	Sucking (n=23)	Non-Sucking (n=23)		Sucking (n=27)	Non-Sucking (n=27)	
Contraction (mm)						
Upper	6.9 ± 0.9	6.6 ± 0.5	0.275	6.8 ± 0.8	6.7 ± 0.7	0.617
Lower	6.8 ± 1.0	6.5 ± 0.7	0.319	6.8 ± 0.7	6.8 ± 0.6	0.619
Mean	6.8 ± 0.7	6.6 ± 0.5	0.196	6.8 ± 0.6	6.7 ± 0.6	0.552
Relaxation (mm)						
Upper	4.7 ± 0.9	4.4 ± 0.5	0.174	4.5 ± 0.7	4.3 ± 0.5	0.383
Lower	4.4 ± 0.8	4.1 ± 0.5	0.106	4.3 ± 0.7	4.2 ± 0.4	0.626
Mean	4.6 ± 0.7	4.3 ± 0.4	0.080	4.4 ± 0.6	4.3 ± 0.4	0.419
Fractional shortening (%)						
Upper	31.9 ± 5.8	33.6 ± 4.4	0.295	34.6 ± 5.1	34.6 ± 5.1	0.488
Lower	34.7 ± 5.2	36.6 ± 4.7	0.204	37.3 ± 3.6	37.9 ± 5.7	0.653
Mean	33.3 ± 4.5	35.1 ± 3.5	0.149	36.3 ± 4.8	36.3 ± 2.9	0.912

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

Circumoral muscles	Frequency of sucking (hours/day)				P- value
	1 – 2 hours (n=11)	3 – 4 hours (n=13)	5 – 8 hours (n=23)	9 – 12 hours (n=3)	
<i>Contraction (mm)</i>					
Upper	6.5 ± 0.8	6.6 ± 1.3	6.7 ± 0.7	6.7 ± 0.7	0.723
Lower	6.2 ± 0.5	6.7 ± 1.2	6.8 ± 0.6	6.8 ± 0.8	0.017*
Mean	6.4 ± 0.6	6.6 ± 1.2	6.7 ± 0.5	6.8 ± 0.6	0.087
<i>Relaxation (mm)</i>					
Upper	4.3 ± 0.5	4.3 ± 0.7	4.4 ± 0.6	4.4 ± 1.0	0.982
Lower	3.9 ± 0.4	4.1 ± 0.7	4.3 ± 0.5	4.3 ± 0.6	0.036*
Mean	4.1 ± 0.5	4.2 ± 0.8	4.3 ± 0.4	4.3 ± 0.5	0.349
<i>Fractional shortening (%)</i>					
Upper	35.0 ± 4.2	34.9 ± 5.0	34.1 ± 4.6	33.9 ± 5.0	0.817
Lower	38.2 ± 4.7	37.1 ± 5.7	37.0 ± 5.2	36.7 ± 5.7	0.939
Mean	36.2 ± 3.3	36.0 ± 3.5	35.8 ± 4.0	35.5 ± 4.1	0.960

$p < 0.05$ - * Statistically significant

Table 6: Relationship between duration of sucking and thickness and fractional shortening of circumoral musculature assessed with pearson correlation test.

Circumoral muscles	Pearson correlation (r)	p value
Contraction		
Upper	-0.014	0.894
Lower	0.129	0.202
Mean	0.069	0.495
Relaxation		
Upper	-0.016	0.872
Lower	0.237	0.018*
Mean	0.122	0.228
Fraction shortening		
Upper	0.016	0.878
Lower	-0.208	0.038*
Mean	-0.139	0.168

$p < 0.05$ - * Statistically significant

DISCUSSION

The teeth are positioned between the lips or cheeks on one side and the tongue on the other side, and

opposing forces or pressures from these structures can be determinants of tooth position. (Jung et al, 2003). The main function of the lips which is oral competence,

is controlled by the orbicularis oris muscle, which is a concentric sphincter-like muscle around the mouth that closes, withdraws and protrudes the lips (Zide, 2000).

This study assessed the effects of digit sucking habit on the circumoral musculature among 7–12-year-old children in Benin City using motion-mode ultrasonography.

There was no statistically significant difference in thickness and fractional shortening of circumoral musculature between digit sucking and non-sucking subjects. This is similar to a previous study (Sanguida et al., 2017), which recorded higher thickness and lower fractional shortening in digit sucking subjects which was not statistically significant. There was no significant difference between both groups when each sex was compared.

This study recorded reduced fractional shortening of the lower circumoral muscle with increased sucking duration. This is similar to findings in previous studies (Agnihotri et al., 2010; Sanguida et al., 2017), which recorded increased thickness and reduced fractional shortening with sucking duration in upper and lower circumoral muscles.

It was observed that increased duration of digit sucking resulted in increased thickness of lower circumoral muscle. This may result in hyperactive lower lip and mentalis activity which would lead to placement of lower lip lingual to upper anterior teeth which would result in their proclination. These sequelae were reported in previous studies (Davidson, 1967; Bhalajhi, 2009). This is consistent with the results of previous studies (Klein, 1952; Baril & Moyers, 1960; Linder and Hellsing, 1991; Ahlgren, 1994; Agnihotri et al, 2010; Sanguida et al., 2017). A possible explanation for the increased thickness and reduction of the fractional shortening of the circumoral muscles recorded in this study for digit sucking subjects may be increased activity of the muscles from the prolonged digit sucking habit.

CONCLUSION

In conclusion, this study revealed that in study participants with digit sucking habit, increased duration of the habit resulted in significant increase in thickness and reduction in fractional shortening of the lower circumoral muscle.

Source of support

None

Conflict of Interest

None

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