Jaw Mechanics and its Relationship with Oral Habits, Temperomandibular Disorders and Sleep Disordered Breathing in Children: A Cross Sectional Study

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ABSTRACT

Introduction: Perfect occlusion is an indefinable concept in a system based upon neuromuscular control that is always adapting and responding to function, trauma and higher central nervous system.The old methods of occlusal assessment have made it very difficult to preciselydetect and assess the simultaneous contact, and none of them measure both biting time and force. **Aim:** Study was aimed at assessment of oral habits through history, bite force and mandibular position using T –scan; skeletal discrepancies and craniofacial measurements through clinical examination and to enable probable diagnosis and association of these with TMDs and SDB symptoms in children aged 6-14 years. Results: **Materials and Methods:** Cross-sectional study data was collected from 670 children in the age group of 6-14 years. The study was carried out by the personal interview method using the questionnaire for parents and an examination of the children. Different Parameters were determined using T scan for various habits present in children with or without TMDs/SDB. The results were statistically analyzed. **Results:** The study concluded that a large number of children were suffering from TMDs and SDB without the parents or clinicians diagnosing it as age advanced. Significant difference was found between the above mentioned parameters. Conclusion: The above parametres lead to various craniofacial abnormalities, pain and muscle dysfunction in adulthood. Therefore, they should be diagnosed early in life so that future damage can be prevented or minimized.

KEYWORDS: TMDs, SDB, T scan, Occlusion, Craniofacial Morphology

INTRODUCTION

Most of us have little rituals that we perform throughout the day that make us feel more comfortable. They relax and reassure us and help us feel that even during stressful times there are some things that do not change. Similarly, children also have certain involuntary or voluntary praxis which makes them feel complacent but may be detrimental to their general well-being. Some of the oral deleterious habits in children such as thumb sucking, nail biting, mouth breathing, and bruxism commonly go unnoticed due to ignorance of the parents, school teachers as well as practitioners. As the pressure among school children increases due to growing competition, there is an alarming increase in deleterious habits in them. These habits play a role in the etiology of temporomandibular joint dysfunctions (TMDs). Parafunctional habits may also play a role in the etiology of TMD. Certain parafunctional habits such as sleep-bruxism (SB) may be missed by the parent or caretakers. Such habits are invariable, though not always, associated with Sleep-disordered Breathing (SDB). One of the cause for morbidity in young children is SDB.[1,2] Craniofacial measurements, occlusal force, and mandibular positions are altered in both TMD and in SDB.[3] Even though most symptoms of TMDs and SDB in children are mild, there is always a risk that they may develop into higher severity as the child matures. Perfect occlusion is an indefinable concept in a system based upon neuromuscular control that is always adapting and responding to function, trauma and higher central nervous system.The old methods of occlusal assessment have made it very difficult to preciselydetect and assess the simultaneous contact, and none of them measure both biting times and force.[4] Computerized occlusal analysis has been presented as an innovative, computer- aided device, capable of providing exact information regarding position, strength, and frequency of occlusal contacts. Since there is a high possibility of alteration of occlusal forces in children with TMDs and SDB, use of computerized occlusal analysis in this age group should be initiated to provide a quick assessment of occlusion for intercepting problems of TMDs and SDB. Thus the study was aimed at assessment of oral habits through history, bite force and mandibular position using T –scan;skeletal discrepancies and cranio-

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facial measurements through clinical examination and to enable probable diagnosis and association of these with TMDs and SDB symptoms in children aged 6-14 years in Karnataka, India.

MATERIALS AND METHODS

The Cross-sectional study data was collected from 670 children in the age group of 6-14 years and their parents. Ethical clearance was obtained from theinstitutional ethical review board before the start of the study. Permission from the concerned authorities was obtained. Parents and school authorities were informed about the study objectives, and methodology and informed consent was obtained from the guardians' of the children. The Cluster sampling method was followed to select the sample. The study population was selected randomly from Primary, Secondary and High School levels in Dharwad district, Karnataka State.

The study was carried out by the personal interview method using the questionnaire for parents and an examination of the children. Prior to the examination brief history of the children and parents was obtained.The children were clinically examined for craniofacial morphology; bite force and mandibular position were determined using T-scan. The investigator was calibrated to record all the clinical parameters with good intro and inter-examinerkappa reliability.

Questions regarding the presence of oral parafunctional habits among children were asked to the guardians and confirmed through clinical examination. Bite force and mandibular positioning were recorded using T-Scan .Each subject was asked to occlude into and through the recording sensor, to hold their upper and lower teeth firmly intercuspated together for 1-2 seconds and two more times repeating that same firm intercuspation followed by a 1-2 -second intercuspated hold. These Multiple recording contained 3 intercuspation, made in succession. This 3-closure recording technique ensured that at least one maximum force closure was obtained from each subject. The balance of forces was determined by checking the maximum force. This gave the exact percentages of forces on both sides of the arches and also gave the values of maximum forces of individual teeth. Skeletal discrepancies and craniofacial measurements were assessed by clinical examination.

Statistical Analyses: Data collected were analyzed using SPSS software.The significance level was fixed at $p \leq 0.05$.Data followed a normal distribution when subjecteda normality test. Pearson chi -square test was used to analyzethe association between the parameters distributed in percentages.

RESULTS

From the total of 670 children, the majoritywere boys (60%)followed by girls (40%)(Table 1). Among them 6.1% had thumb-sucking habit, 21% had mouth breathing habit, 15.7% had a nail-biting habit, and 7.6% had bruxism (Table 2). Except for mouth breathing all other habits were highly prevalent among females. Most of the children showed a hyperleptoproscopic facial index. The results were statistically significant (Table 3). Hyperdolicephalic cranial form was found in a significantly higher number of children (Table 4).The balanced and unbalance bite forces were almost equally distributed among the children (Table 5).Majority of children showed eccentric mandibular positions on closing, but the results were not statistically significant. (Table 5).

SEX		TOTAL
Male	Female	
402	268	670

Table 1: Age and Gender wise Distribution of Children

SEX	THUMB SUCKING				TOTAL	P VALUE
	Present	%	Absent	%		
M	19	4.7	383	95.3	402	0.065
F	22	8.2	246	91.8	268	
TOTAL	41	6.1	629	93.9	670	

Table 2: Age wise distribution of Thumb-sucking Habit

SEX	MOUTH BREATHING				TOTAL	P VALUE
	Present	%	Absent	%		
M	89	22.1	313	77.9	402	0.395
F	52	19.4	216	80.6	268	
TOTAL	141	21	529	79	670	

Table 3: Age wise distribution of Mouth Breathing Habit

SEX	NAIL BITING				TOTAL	P VALUE
	Present	%	Absent	%		
M	62	15.4	340	84.6	402	0.828
F	43	16	225	84	268	
TOTAL	105	15.7	565	84.3	670	

Table 4: Age wise distribution of Nail biting Habit

SEX	BRUXISM				TOTAL	P VALUE
	Present	%	Absent	%		
M	28	7	374	93	402	0.439
F	23	8.6	245	91.4	268	
TOTAL	51	7.6	619	92.4	670	

Table 5: Age wise distribution of Bruxism Habit

30.9% of children showed symptoms of TMDs. Prevalence of TMDs was higher among Girls (33.2%) compared to boys. Among children showing symptoms of TMDs,22% had thumb-sucking habit, 36.2% had mouth breathing habit, 32.4% had a nail-biting habit, and 37.3% had bruxism (Table 6).

Most of the children showing symptoms of TMDs had a hyperleptoproscopic facial form which was found to be statistically significant (Table 7). Among children showing symptoms of TMDs most of them had a hyperdolicocephaliccranial form, but the results were not significant (Table 8). Balanced and unbalanced bite forces were equally distributed regardless ofthe presence or absence of TMD symptoms (Table 9).Among children showing symptoms of TMDs majority had centric rather than eccentric mandibular positions, but the results weren't statistically significant (Table 9).

SEX	FACIAL INDEX									TOTAL	P VALUE	
	A	%	B	%	C	%	D	%	E	%		
M	0	0	2	0.5	21	6	50	12.4	326	81.1	402	0.00*
F	5	1.9	5	1.9	44	15.3	58	21.6	159	59.3	268	
Total	5	0.7	7	1.0	65	9.7	108	16.1	485	72.4	670	

Table 6: Correlation of Facial Index with Gender.
A= Hypereuryproscopic, B= Euryproscopic, C=Mesoproscopic, D= Leptoproscopic,E= hyperleptoproscopic

SEX	CEPHALIC INDEX										TOTAL	P VALUE
	G	%	H	%	I	%	J	%	K	%		
M	4	1	4	1	65	16.2	53	13.2	276	68.7	402	0.00*
F	0	0	5	1.9	57	21.3	80	29.9	126	47	268	
Total	4	0.6	9	1.3	122	18.2	133	19.9	402	60	670	

Table 7: Correlation of Cephalic Index with Gender
G= Hyperbrachycephalic, H= Brachycephalic, I= Mesocephalic, J= Dolicocephalic, K= Hyperdolicocephalic

SEX	BITE FORCE				TOTAL	P VALUE
	Balanced	%	Unbalanced	%		
M	227	56.5	175	43.5	402	0.17
F	137	51.1	131	48.9	268	
Total	364	54.3	306	45.7	670	

Table 8: Correlation of Bite Force with Gender.
No statistically significant results

SEX	MANDIBULAR POSITION				TOTAL	P VALUE
	Centered	%	Eccentric	%		
M	113	28.1	289	71.9	402	0.070
F	93	34.7	175	65.3	268	
Total	206	30.7	464	69.3	670	

Table 9: Correlation of Mandibular Position with Gender.
No statistically significant results

38.2%of children showed symptoms of SDB. Among children showing symptoms of SDB, 51.2% had thumb-sucking habit, 55.3% had mouth breathing habit which was statistically significant (p=0.00), 48.6% hada nail-biting habit, and 66.7% had bruxism (Table 10).

SEX	TOTAL				TOTAL	P VALUE
	n	%	y	%		
M	284	70.6	118	29.4	402	0.290
F	179	66.8	89	33.2	268	
Total	463	69.1	207	30.9	670	

Table 10: Distribution of Children with Respect to Presence or Absence of Symptoms of TMD and its Correlation with Gender.
n= no, y= yes; significant difference found; p=0.014

Among children showing symptoms of SDB most of them had a hyperleptoproscopic facial form (Table 11), andthe majority of them had a hyperdolicocephalic cranial form. (Table 12). Balanced and unbalanced bite forces were equally distributed regardless of presence or absence of SDB symptoms,and the mandibular positions were not significantly related to thepresence or absence of SDB (Table 13).

TS	SEX	TMD				TOTAL	P VALUE
		n	%	y	%		
ABSENT	M	271	70.8	112	29.2	383	0.132
	F	160	65	86	35	246	
	total	431	68.5	198	31.5	629	
PRESENT	M	13	68.4	6	31.6	19	0.166
	F	19	86.4	3	13.6	22	
	total	32	78	9	22	41	
TOTAL	M	284	70.6	118	29.4	402	0.290
	F	179	66.8	89	33.2	268	
	total	463	69.1	207	30.9	670	

Table 11: Distribution of Children with Respect to Presence or Absence of Symptoms of TMD and its Correlation with Gender and thumb-sucking habit.

MB	SEX	TMD				TOTAL	P VALUE
		n	%	y	%		
ABSENT	M	222	70.9	91	29.1	313	0.501
	F	151	69.9	65	30.1	216	
	total	373	70.5	156	29.5	529	
PRESENT	M	62	69.7	27	30.3	89	0.069
	F	28	53.8	24	46.2	52	
	total	90	63.8	51	36.2	141	
TOTAL	M	284	70.6	118	29.4	402	0.290
	F	179	66.8	89	33.2	268	
	total	463	69.1	207	30.9	670	

Table 12: Distribution of Children with Respect to Presence or Absence of Symptoms of TMD and its Correlation with Gender and mouth breathing habit

NB	SEX	TMD				TOTAL	P VALUE
		n	%	y	%		
ABSENT	M	243	71.5	97	28.5	340	0.185
	F	149	66.2	76	33.8	225	
	total	392	69.4	173	30.6	565	
PRESENT	M	41	66.1	21	33.9	62	0.695
	F	30	69.8	13	30.2	43	
	total	71	67.6	34	32.4	105	
TOTAL	M	284	70.6	118	29.4	402	0.290
	F	179	66.8	89	33.2	268	
	total	463	69.1	207	30.9	670	

Table 13: Distribution of Children with Respect to Presence or Absence of Symptoms of TMD and its Correlation with Gender and Nail Biting Habit

DISCUSSION

The first classification based on cranial morphology was given in 1840 and is attributed to Professor of anatomy Anders Retzius, and was called the cranial index. The index used in anthropometry to describe the face proportions is the facial index.[5]In this study, the values used for the facial and cephalic index were based on studies by Dr. Anitha in 2009[6] that were targeted for the Indian population.

The hyperleptoproscopic facial form was seen in 72.1% of children followed by theleptoproscopic form which was seen in 16.1% cases. Hyperdolicocephalic was the most common cranial form, seen in 60% ofchildren, followed bythedolicocephalic form which was seen in 19.9%cases. Similar results were found in studies by Prassana L. C[7] among SouthIndian males, Shah T[8] in 2015 among on Gujarati males and Jeremic D[9] among malesand females in Serbia, wherethe dominant facial form was leptoproscopic. In contrast tothis, adominant facial form was hypereuryscopic among Gujarati males, and femalesaccording to Shah T; mesoproscopic and euryproscopic among males and females of Iranas studied by Jahanshahi et al[10] mesocephalic among males and brachycephalic amongfemales in Andhra Pradesh as reported by Lakshmi K.[11]

The useof articulating paper is a common method to determine excessive forces in differingocclusal contacts. However, these methods lack precision. Occlusal analysis needs tobe assessed qualitatively and quantitatively. This is possible using an innovativesystem developed by Maness in 1989. He developed the T- Scan system, which isconsidered as a computerized device capable of interpreting occlusal contact informationqualitatively and quantitatively. [12]

Over the years, the T-scan system has evolved. The T-Scan III computerized occlusal analysis system uses an electronically-charged, mylar-encasedrecording sensor that is scanned in 0.003 second time increments, to acquire occlusalcontact relative force variances, excessively forceful tooth contacts, and occlusal contacttiming sequences.[12,13]The recording sensor is placed intraorally between the upper and lower dental arches, to capture real-time occlusal force and time-sequence data, when a subjectbites teeth, or makes excursive movements, across sensor recording surface. The softwareprocesses the occlusal data in any recorded occlusal event for graphical display in 2 and3 dimensions. The T-scan recorded occlusal force data informs the operator improved informationabout occlusal contact locations that shows excessive occlusal force. The balance of the occlusion can be viewed in the 2D Force View, using a graphic Center of Force (COF) target and COF trajectory line. The mandibular deviation on closing is determinedby tracing the period starting from first tooth contact to maximum intercuspation.[5] The T-scan III system was used to assess the balance of bite force on both sides and todetermine the mandibular position on closure. Few researchers used this system in someareas in dentistry and found T-scan to be a reliable occlusal analysis system.[14,15,16]

The bite forces and mandibular position on closing wereassessed with the help of the T-scansensor. The forces were measured on the right and leftsides. The bite force on either side in the range of 40% to 60% wasconsideredbalanced. It was found that most children had a balanced bite force. The antero-posteriorposition of the mandible on closing, on first occlusal contact, depends upon the headposture.[17] Head posture is influenced by a number of craniofacial dimensions andTMDs.[18] There is scanty literature on assessment of bite force and mandibular position inchildren. The majority of childrenshowed an eccentric mandibular position on closing, whereas few showed centered mandibular position on closing. As theage advanced number of children showed eccentric mandibular positions. Nodifferences were seen among gender.

Okeson, in 1996, [19] defined occlusion as the relationship between the upper and lower teeth in functional contact during activity of the mandible. The determinants of functional changes in the stomatognathic system may lead to an imbalance among the occlusion, masticatory muscles, and TMJ. TMDs may also be caused by occlusal macrotraumas and micro-traumas.[20-24] They are more prevalent among adults and may berelated to high degrees of stress during activities of daily living as well as the prolongedmaintenance of occlusal problems and parafunctional habits.[25,26] Even in this study itwas seen that number of children of an older age group showed symptoms ofTMDs. Though the early diagnosis of TMD in young individuals is more difficult, agrowing number of studies have reported the occurrence of this disorder in the youngerpopulation, which is 20-34%;[21,27,28,29] include-ing this study where 30.9% childrenshowed sympt-oms of TMDs. TMDs have a multifactorial etiology out of whichocclusion is considered as one of the main factors. Occlusal conditions such as deepbites, cross bites, and dual bites are predisposing factors for TMDs.[27,30]

In this study,symptoms of TMDs were assessed by history taking format adopted by the Standards for temporomandibular evaluation in the pediatric patient.[31] Most of these questions werebased on pain which is the most common complaint of patients with TMDs.[32] Gender hasa significant effect on the subjective evaluat-ion of pain due to biological, psychosocial,or educational factors.[19,33,34] Similar to a study by Dao T et al.In 2000,[35] our studyshowed ahigher prevalence of females having TMDs. A study by Franco et al. in2013 on adolescents, included headache asa potential risk factor inpainful and chronic TMD diagnosis. Frequent headaches were considered to be another symptom of TMD in our study. The trauma, emotional stress, bruxism, and certain systemic conditions may be also responsible for the development of TMD. This suggests that even if a child’s occlusal condition was improved, a TMDmight still develop unless all other etiologic factors were controlled.[27] In 2006, Winocur E investigated the prevalence and interrelationship of severalparafunctional activities and evaluated their association and contribution to the presenceof various signs and symptoms of TMD. He concluded that ‘Jaw Play’ habit waspositively associa-ted with joint disturbance, noises, catching and joint tension andshowed targeted effects on the TMJ. The crushing of ice and icepops had a detrimentaleffect on the muscles examined.[3] Some studies have linked bruxism, and oralparafunctional habits to disturbances and diseases of the TMJ.[25, 36-43]Magnusson etal.[44] included up to three evaluations during a 10-year period and, indicated the existenceof a causal relationship between parafunctions and signs of TMJ dysfunction.In our study, TMDs were shown to have some correlation with thumb-sucking, mouth-breathing, nail -biting, and bruxism.

The anthropometric technique is more effective in describing the craniofacial morphology of humans than any other techniques used to study the growth and characteristics of the head .[45] An instrument-based technique was preferred in our study from among themany existing anthropometric techniques, since the direct quantitative measurement ofsoft-tissues using Hrdlicka's guage is non-invasive, enables access to areas covered byhair and avoids distortion caused by other indirect anthropometric techniques, such asphotography. The children showing symptoms of TMDs were signify-cantly higher in the older age group. A significant association was found between TMDs and the facial index. Similarly, Sonnesen L et al. In 2001reported a'long face' type of craniofacial morphology and a lower bite force in childrenaged 7-13 years showing symptoms of TMDs though no firm conclusion could bemade.[46] In contrast to this, no conclusions were made regarding the particular type ofmorphology associated with TMDs in studies by Dibbets et al.in 1985,[47] Nebbe et al. in1999[48] and Muto et al. in 1998;[49] in pre-orthodontic children and adolescents; though alarger mandibular plane angle was found in these individuals.Maximum children showed balanced bite force,in this study. No significant associa-tion was found between bite force and symptoms of TMD. Most children in all age groups, irrespective of gender,showed eccentric mandibular positions. No significant association was found between mandibular position and symptoms of TMD.

The Sleep apnoea in infants was first described in 1975 in relation to sudden infant death syndrome, and obstructive sleep apnoea (OSA) was described in 1976 in school children.[50] School- age children,snoring, night waking, a parasomnia, or nocturnal enuresis as in younger age groups arepresent, but the diversity of presentation increases.[51] In our study, 38.2% of children showed symptoms of SDB, as opposed to 1-4% reported by Sinha D in 2009.[3] Higher number of females showed symptoms of SDB which increased with age. Most of these symptoms were related to snoring. Similarly, Lumeng JC in 2008 in a meta-analysis concluded that snoring had been used as a marker of SDB and the prevalence of snoring in children had been reported as 7.45%.[52]

Most of the children with symptomsof SDB showed a hyperleptoproscopic facial index in all age groups, with no statistical significance .Majority of children with SDB had a hyperdolicocephalic cranial form. Males showing symptoms of SDB were significantly higher than females .Similar results were reported by Parkkinen K P, who concluded thatchildren with SDB had a significantly larger palato-mandibular angle (PL–ML) due to avertical growth pattern.[45] These findings have also been reported by Ågren et al., 1998;[53] Löfstrand-Tideström et al., 1999;[54] Zucconi et al., 1999;[55] Kawashima et al. 2002;[56] Zettergren-Wijk et al., 2006.[57] A vertical growth direction of the mandible is a commonfinding in children with adenotonsillar hypertrophy according to Linder-Aronson, 1970;[58] Adamidis and Spyropoulos, 1983;[59]Behlfelt et al., 1990.[60] Kawashima in 2012reported that micrognathia and nasal obstruction were among the risk factors for OSA inpreschool children.[61] No significant differences were found between the bite force andmandibular position among children with symptoms of SDB.Petit et al.[62] evaluated 100 adult patients diagnosed with OSA and found 2% of patientshad significant signs and symptoms of TMD. Cunali P A et al.[63] evaluated 87 adult patientswith mild to moderate SDB and found 52% had TMD based on the Research DiagnosticCriteria for TMD. Excessive daytime sleepiness wasmore frequent among masticatory myofascial pain patients.[64] In our study, 22.7% of children exhibited symptoms of TMDs, and 38.2% of children reported symptoms of SDB. It is verylikely that SDB in children may have been a causative factor for TMD in these children. Craniofacial dimension, habits, and occlusion also contribute to TMDs which aremanifested later on in life.

Further studies utilizing large case-control designs are warranted to explore the relationship between TMDs and SDB with bite force, mandibular positions and parafuctional habits.

CONCLUSION

The conditions of TMDs can be diagnosed by manifest-ations of typical symptoms which are easily missed out by the parents or clinicians. It is observed that a large number of children exhibited symptoms of TMDs as age advanced. Changes in the balance of bite forces on both sides and mandibular deviations on closure may also aid in the diagnosis of TMDs and SDB. These parameters can be accurately determined by the computerized occlusal analysis technology, which gives accurate and reliable results. Among the causative factors, deleterious oral habits play a major role.Suchconditions affect the child's craniofacial morphology and growth. These habits also affect the proper functioning of the TMJ thus resulting in TMDs. In adulthood, the symptoms become clearer, but by that age very little can be done to cure thecondition. Thus, the early diagnosis of problems that may predispose individual's tocraniofacial growth abnormalities, pain and muscle dysfunction in adulthood, is essential so that the condition is corrected in the early stages and further damage is prevented.

Recommendations: More long term studies are required to assess TMDs and SDB inchildren. Larger sample size will enable more reliable and accurate results. More studies should be done in children using the computerized occlusal analysis system.

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