

EVALUATION OF MOLAR BITE FORCE IN CARIOUS AND NON-CARIOUS PRIMARY DENTITION AMONG 4 TO 6 YEAR OLD CHILDREN.

Evaluación de la fuerza de mordida molar en dentición temporal cariada y no cariada en niños de 4 a 6 años.

Nandini K.¹
Shankar Paulindraraj.²
Hemalatha Ramkumar.²
Senthil Dakshinamurthy.²
Trophimus Gnanabagyan.²
Nancy Solomon.²

AFFILIATIONS:

¹Department of Pediatric and Preventive Dentistry, Chettinad Dental College and Research Institute. Chennai, India.

²Department of Pediatric and Preventive Dentistry, SRM Dental College, Ramapuram, Chennai, India.

CORRESPONDING AUTHOR:

Shankar Paulindraraj. Department of Pediatric and Preventive Dentistry, SRM Dental College, Ramapuram, Chennai 600 087, India. **Phone:** (91) 9884 585808. **E-mail:** pedoshankar@gmail.com

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ABSTRACT:

Objective: The aim of the study was to evaluate the maximum molar bite force in children aged 4 to 6 years with and without dental caries.

Material and Methods: This cross sectional study was carried out from May 2018 to December 2018. A total of 288 children aged between 4 to 6 years were randomly selected from six different primary schools in Chennai city, India and divided into two groups of 144 children each, based on the presence and absence of caries: Group A children with non-carious dentition and Group B children with carious dentition. Bite force measurement was performed using standardized custom made occlusal force gauge.

Statistical analysis used: Data were expressed as the mean \pm SD. Student's t-test (two tailed, independent) and ANOVA were used to find the significance of study parameters between the groups.

Results: Occlusal bite force of non-carious dentition ($367.94 \pm 33.71N$) was higher than the carious dentition ($326.73 \pm 27.83N$) and it was statistically significant ($p \leq 0.01$). Overall occlusal bite force of boys ($350.44 \pm 35.84N$) was significantly higher than that of girls ($344.22 \pm 38.25N$). Flush terminal plane molar relationship showed higher occlusal bite force ($380.54 \pm 27.36N$) followed by mesial step ($350.82 \pm 22.25N$) and distal step ($310.63 \pm 20.82N$) molar relationship.

Conclusion: Non-carious dentition showed significantly higher bite force than carious dentition in children 4 to 6 years of age. Boys had higher bite force than the girls and flush terminal plane molar relationship showed higher bite force than mesial and distal step molar relationship.

KEYWORDS:

Dental caries; tooth, deciduous; bite force; child; india; schools.

RESUMEN:

Objetivo: El objetivo del estudio fue evaluar la fuerza de mordida molar máxima en niños y niñas de 4 a 6 años con y sin caries dental.

Material y Métodos: Este estudio transversal se llevó a cabo entre mayo de 2018 y diciembre de 2018. Se seleccionó aleatoriamente un total de 288 niños y niñas de entre 4 y 6 años de seis escuelas primarias diferentes en la ciudad de Chennai, India, y se dividieron en dos grupos de 144 niños cada uno según la presencia y ausencia de caries: El grupo A incluye niños con dentición no-cariada y el grupo B incluye niños con dentición cariada. La medición de la fuerza de mordida se realizó utilizando un medidor de fuerza oclusal estandarizado hecho a medida.

Análisis estadístico utilizado: Los datos se expresaron como la media \pm SD. Se utilizó la prueba t de Student (dos colas, independiente) y ANOVA para encontrar la importancia de los parámetros de estudio entre los grupos.

Resultados: La fuerza de mordida oclusal de la dentición no cariada ($367,94 \pm 33,71$ N) fue mayor que la de la dentición cariada ($326,73 \pm 27,83$ N) y fue estadísticamente significativa ($p \leq 0,01$). La fuerza de mordida oclusal global de los niños ($350,44 \pm 35,84$ N) fue significativamente mayor que la de las niñas ($344,22 \pm 38,25$ N). La relación molar en el plano terminal al ras mostró una mayor fuerza de mordida oclusal ($380,54 \pm 27,36$ N), seguida de una relación molar de escalón mesial ($350,82 \pm 22,25$ N) y escalón distal ($310,63 \pm 20,82$ N).

Conclusión: La dentición no cariada mostró una fuerza de mordida significativamente mayor que la dentición cariada en niños de 4 a 6 años de edad. Los niños tenían una mayor fuerza de mordida que las niñas y la relación molar en el plano terminal mostró una mayor fuerza de mordida que la relación molar escalonada mesial y distal.

PALABRAS CLAVE:

Caries dental; diente primario; fuerza de la mordida; niño; india; instituciones académicas.

INTRODUCTION.

Bite force is a measure of the effective state of the masticatory system that results from the action of jaw elevator muscles altered by the craniomandibular biomechanics.¹ Measuring bite force can provide valuable information regarding the masticatory system² Analysis of each bite force level is being largely utilized in dentistry, to evaluate masticatory muscle function, movement of the mandible and to determine the mechanics of prosthetic device during use.¹

The factors influencing the bite force measurements are age, gender, masticatory muscle function, temporomandibular joint and oral health status of the individual³ The other parameters which can affect the bite force are dental caries, malocclusions and deleterious oral habits such as bruxism.⁴

Dental caries is one of the most common diseases affecting children across the globe. If left

untreated, it can affect mastication, speech and the overall quality of life of the child.⁵

It is widely supported that masticatory and chewing functions have the capacity to influence dietary selection, which is notably linked with the quality of life⁶ previous studies have recorded bite force in relation to angles molar relation and dietary preferences in children.^{7,8}

But, studies measuring bite force in children with regard to dental caries and gender in subjects less than 18 years of age are scarce and particularly very few data are available in relation to primary dentition hence. Thus, the present study was performed to evaluate the maximum molar bite force in children aged 4 to 6 years with and without dental caries. The objective of this study was to investigate the bite force among the gender and to find the association between primary molar relation and bite force.

MATERIALS AND METHODS.

Subjects

This cross sectional study was carried out from May 2018 to December 2018. The study was approved by the Institutional Review Board (SRMDC/IRB/2015/MDS/802).

After obtaining consent from the parent/guardian 1000 children aged 4 to 6 years attending 6 different primary schools in Chennai city, India were screened and 288 participants were randomly selected for the study and divided into two groups of 144 children each based on the inclusion and exclusion criteria. Group A consisted of children without dental caries. Group B consisted of children with unrestored dental caries in primary molars.

Inclusion and Exclusion Criteria

Inclusion Criteria

1. Age range 4-6 years
2. Fully erupted second deciduous molar
3. Children with ICDAS I score 0 or 1 were selected for Non carious group
4. Children with ICDAS I score 2, 3 or 4 present in either maxillary or mandibular second deciduous molar on both sides were considered for the carious group.
5. Symmetrical face
6. Minimum mouth opening of 30mm
7. Healthy and cooperative children.

Exclusion Criteria

1. Decayed second deciduous molar with ICDAS I score 5 and 6
2. Mobile teeth, root stumps and missing molars.
3. Swelling and/or abscess formation.
4. Developmental anomalies.
5. Systemic disease
6. Malocclusion

Sample size The sample size was evaluated using G power software (version3.1.9.2) by taking mean values from previous study done by Mountain *et al.*,⁹ at power of 90 using G power software

Occlusal Bite Force Measurement

Occlusal bite force was measured using custom made occlusal force gauge (Figure 1), tested and

standardized by National Test House (Chennai, India) Using standard dead weights of E2 accuracy class and proving ring 500N. [Calibration certificate number-NTH(SR)/CAL(M)/2017/0060].

The maximum bite force recordable using this device is around 620N as the two beams of the biting fork come in contact with each other at 620N. The device has a set-zero pointer, which allows the exact control of the principles obtained and also peak schedules, that allows the measurement of the maximal force. The biting fork was made of strain gauge. The device helps to calculate the amount of strain in the device electrical in accordance with electrical resistance.

The metallic strain gauge includes metallic foil built in a grid pattern which is encased in plastic tubing. This grid pattern construction maximizes the amount of the metallic foil subject to strain in the parallel direction.

Method of Recording Maximum Occlusal Bite Force

Patient Positioning

The subjects were asked to be comfortably seated with straight head position and unsupported where the Frankfort horizontal plane is in plane with ground. The subjects were informed regarding the study and were made to bite on the biting fork as hard as they could when asked to.

Procedure

To measure the bite force the biting fork was made parallel to the occlusal plane on the primary second molar and the participants were made to bite on the biting fork as hard as they could (Figure 2).

Before the commencement, the participants were shown the right way of biting on the bite fork in the intercuspal position which was monitored by a single trained pediatric dentist who was involved with the study. Then, maximum bite force values were measured thrice on both right and left side alternately, with an interval of 2 minutes in between each trail.

The biting fork was disinfected using Clorox disinfecting wipes and the sleeve was discarded after each subject.

Measurement

The values displayed were recorded for each trial using the 'peak hold register' setting of the instrument¹⁰ The bite force was measured in Newton (N). The value displayed on the LED digital display was recorded for each trail by a trained person not involved with the study.

The highest value of the three trials was obtained for the both right and left side of each subject. Child's occlusal bite force was obtained by calculating the mean values of both the sides.¹¹ Measurement of bite force following the above mentioned procedure was done for 10 children every day to minimize the errors due to operator fatigue.

The biting fork was calibrated for accuracy after every 5 subjects using the calibration set up and standard weights. The measurements were tabulated and subjected to statistical analysis

Evaluation of Molar occlusion

Molar relation of each selected participants were recorded as given by Baume in 1950

Flush Terminal plane

The distal surface of maxillary and mandibular primary second molar lie in the same vertical plane.

Mesial step

The distal surface of mandibular primary second molar was mesial to that of the maxillary primary

second molar.

Distal step

The distal surface of the mandibular primary second molar was distal to that of the maxillary primary second molar.

Statistical analysis

Data were expressed as the mean \pm SD. Student's *t*-test (two tailed, independent) and ANOVA were used to find the significance of study parameters between the groups.

SPSS software 25.0 (Armonk, NY: IBM Corp) was used to analyze the data. The $p \leq 0.01$ was considered as significant.

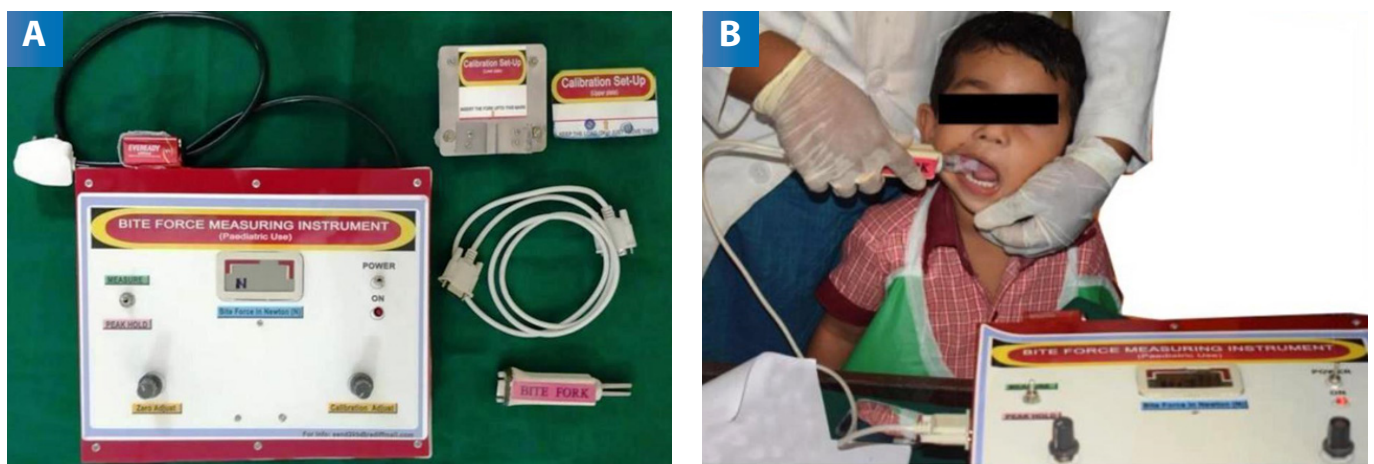
RESULTS.

A total of 288 children 144 Boys and 144 girls participated in the study with a mean age of 5.2 years. Overall occlusal bite force of boys ($350.44 \pm 35.84N$) was significantly higher than that of girls ($344.22 \pm 38.25N$) (Table 1).

Occlusal bite force of Non carious dentition ($367.94 \pm 33.71N$) was higher than the carious dentition ($326.73 \pm 27.83N$) and it was statistically significant (Table 2).

Flush terminal plane molar relationship showed higher occlusal bite force ($380.54 \pm 27.36N$) followed by mesial step ($350.82 \pm 22.25N$) and distal step ($310.63 \pm 20.82N$) molar relationship (Table 3).

Figure 1. Occlusal bite force.



A: Custom made bite force measuring device. B. Measuring bite force using the device.

Table 1. Comparison of overall mean occlusal bite force between girls and boys.

Gender		N	Mean	Standard Deviation	p-value
Girls	Right Side Bite Force	144	349.67	38.71	0.007
	Left Side Bite Force		338.77	38.02	
	Occlusal Bite Force		344.22	38.25	
Boys	Right Side Bite Force	144	355.32	35.92	
	Left Side Bite Force		345.57	36.18	
	Occlusal Bite Force		350.44	35.84	

N: Number of participants. p-value ≤ 0.05 was considered significant.

Table 2. Comparison of mean occlusal bite force between non-carious and carious dentition.

	Carious Status	N	Mean	Standard Deviation	p-value
Non-Carious	Right Side Bite Force	144	373.15	34.32	0.009
	Left Side Bite Force		362.72	33.45	
	Occlusal Bite Force		367.94	33.71	
Carious	Right Side Bite Force	144	331.83	27.70	
	Left Side Bite Force		321.62	28.42	
	Occlusal Bite Force		326.73	27.83	

N: Number of participants. p-value ≤ 0.05 was considered significant.

Table 3. Comparison of mean occlusal bite force between different terminal planes.

Terminal plane	N	Mean	Bite Force SD	p-value
Mesial Step	96	350.82	22.25	0.001
Distal Step	96	310.63	20.82	
Flush Terminal Plane	96	380.54	27.36	

N: Number of participants. p-value ≤ 0.05 was considered significant. SD: Standard deviation.

DISCUSSION.

Bite force has the capability to elevate the mandibular muscles to exhibit maximum force of lower teeth touching the upper teeth, under favorable conditions.¹ Maximum bite force was considered to be the maximum force exhibited in individuals during breakup of food particles, associated to chewing and is determined by many factor.¹²

It is the force applied by the masticatory muscles in occlusion.¹ To measure the bite force devices like Gnathimeter, The bite force dynamometer, Dentoforce, or GM have been used.¹⁰⁻¹³ These devices can be either mechanical or electrical or a combination of both. The oldest known device was mechanical and was reported in 1681 by Giovanni Alphonso Borelli, considered the father of biomechanics.

He studied the force exerted by human musculature on mastication by developing a device named 'Gnathimeter'.¹³ His method was to add weights to a chord passed over the molars to measure the maximum molar bite force. In recent times, sensitive electronic devices are used in most of the bite force devices which are both accurate and precise¹² but there were no specialized devices available for children thus a specifically designed and standardized device with the bite fork harmonious with deciduous second molars was used in this study.¹⁴ Gudipani *et al.*,¹⁵ have advocated that maximum bite force decreases with progression of dental caries in first permanent molars.

In the present study occlusal bite force in boys was found to be comparatively higher than that of girls similar to the previous studies conducted by Takaki *et al.*,¹² Subramaniam,¹¹ Medhat *et al.*¹⁶ This could be due to the larger tooth size and greater muscle mass in males compared to females.^{17,18}

With regard to dental status few studies have stated that the bite force was negatively related to the caries index^{19,20,21} Subramaniam *et al.*,²² showed significant increase in bite force following dental restorations. Dental caries if left untreated destructs the inorganic component and thereby weakens the tooth structure.²³ In addition, periodontal infections

can be a sequel of dental caries, which further deteriorates the tooth support thus reducing the bite force.²⁰ In the present study non carious group showed significantly higher occlusal bite force compared to carious group. This finding is in agreement with Su *et al.*,¹⁹ Singh *et al.*,²⁰ and Kaya *et al.*,²¹ they stated that the bite force was negatively correlated to the caries index. Another important attribute to be assessed in dental status in children is primary molar relationship.

This could give valuable information regarding the future dental arch. Flush terminal plane relationship showed highest occlusal bite force than mesial and distal step in the current study. According to Koolstra *et al.*,²⁴ the course of the lines of action of the muscle elements may increase or decrease with respect to the position and direction of the mandible. Thus, better action of masticatory muscles in the flush terminal plane could be contributing to the higher occlusal bite force.

Limitations

Due to the cross sectional nature of the study, observations noted limitations. Age and gender can influence the result which was not considered.

Even though a 2 minute interval was given between each measurement, fatigue due to repeated movements of the jaw could have influenced the bite force. Other factors like time of the day the measurement was taken and body mass index, which could influence the result, were not considered.

CONCLUSION.

Within the limitation of the current study it could be concluded that non-carious dentition showed significantly higher bite force than carious dentition in children aged 4 to 6 years of age, Boys had higher bite force than the girls and flush terminal plane molar relationship showed highest bite force than mesial and distal step molar relationship.

The findings observed in the current study are important since it has helped to determine maximum occlusal bite forces in healthy children with non-carious and carious primary dentitions and could be used for further research in the field of pediatric dentistry.

Conflict of interests:

None declared.

Ethics approval:

Study was approved by the Institutional Ethical Review board of the SRM Dental College, Ramapuram, Chennai, India. (SRMDC/IRB/2015/MDS/802).

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Authors' contributions:

All authors participated in the study design, implementation and writing of the manuscript.

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