

Clinical Measurement of Maximal Mouth Opening in Children: A Pioneer Method

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Objectives: To determine the maximal mouth opening (MMO) in children aged 3 to 5 years from Indian population and to examine the possible influence of age, gender, height and body weight on MMO. **Study Design:** Assessment of MMO is accomplished with a modified Vernier Caliper by measuring the distance between the incisal edge of upper and lower incisor during maximal mouth opening upto the painless limit. Participants of the study were healthy children selected among regular students from local schools. Age, gender, height and body weight of each child were also recorded at the same time. **Results:** The results of the present study revealed that MMO in Indian children were 41.61 mm, 44.9 mm and 46.81 mm for boys and 40.09 mm, 44.22 mm and 46.2 mm for girls at age of 3,4 and 5 years respectively. Further significant associations were noted in between age, height, body weight and MMO. However, no gender difference was observed. **Conclusion:** A definite relationships exist between MMO, age, height and body weight in Indian children with primary dentition.

Keywords: Maximal mouth opening, Primary dentition, Vernier caliper.

INTRODUCTION

Clinical measurement of normal range of maximal mouth opening (MMO) in children is an important diagnostic criterion for evaluation of stomatognathic system especially for those with temporomandibular problems.¹ Odontogenic infections, oral malignancies, temporomandibular disorders¹¹ (injuries, ankylosis), mandibular or midface fractures as coronoid impingement by the fractured zygomatic arch, myopathies (including those resulting from maxilla-mandibular immobilization) and trauma can lead to reduced mouth opening.² Further inability to open mouth may occasionally create legal problems¹⁰ and all pediatric dentists dealing with the oral cavity of a child are faced with varying degrees of difficulty when MMO is limited. MMO is also beneficial in providing

requisite information for designing an oral instrument/prosthesis for measurement.

Despite the clinical significance of MMO limited studies have been reported on this subject especially in pediatric population. Pioneer studies regarding mouth opening in small children credited to Nevakari¹² (1960), Shephard and Shephard¹³ (1965), Ingervall⁷ (1972) and Agerberg¹⁴ (1974) but with smaller sample size. Certainly, more studies with larger sample size are needed to draw a conclusion regarding the MMO and its relationship with age, sex, height and weight of a child.

Recently it has been shown that measurement of MMO can vary age,^{3,4} sex^{3,5} and height^{6,7} of a child. Yao *et al*⁵ (2009) reported that both age and sex have significant influence on the MMO values in Chinese adult population. Similar findings were also found by Hirsch *et al*⁸ (2006) in 10-17 year old German children and adolescents. Abou-Atme *et al*⁹ (2008) demonstrated moderate to strong correlation between MMO and height, weight and age in children using the width or three or four fingers measuring method while no gender difference was observed in MMO by these workers. No link was found between mouth opening and stature in Irish adult population by Gallagher (2004).⁶

So far, most of the studies are available to show the relationship between MMO with age, sex and height in foreign population. However, in the best of our knowledge no such studies are available in Indian population particularly in children. Therefore, the present study was undertaken to measure and analyze the MMO in children from Indian population and to examine the possible relationship between age, gender, height and body weight with Maximal Mouth Opening.

MATERIALS AND METHOD

A total of 527 subjects from various public schools in the city of Rohtak (Haryana) India, 288 boys and 239 girls between ages of 3-5

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Table 1. MMO (mm), Height (cm) and Body Weight (kg) in boys and girls of age 3 to 5 years. (Data presented as Mean + SEM).

Age (years)	Gender	MMO (mm)	Height (cm)	Weight (kg)
3 (n=177)	Boys (n=112)	41.61 + 0.32	105.74 + 0.75 π	15.96 + 0.28 @
	Girls μ (n= 65)	40.09 + 0.34	104.20 + 1.16	14.47 + 0.33
4 (n=169)	Boys (n=90)	44.98 + 0.38*	112.46 + 0.80* π	19.09 + 0.31* @
	Girls μ (n= 79)	44.22 + 0.42*	109.87 + 0.88* π	17.24 + 0.26*
5 (n=181)	Boys (n=86)	46.81 + 0.35*	114.00 + 0.81* π	19.71 + 0.36* @
	Girls μ (n= 95)	46.22 + 0.36*	114.87 + 0.93* π	18.86 + 0.35* @

* p < 0.01 when compared with mean readings of 3 years (student's 't' test)
 π p < 0.01 when MMO compared with height (chi-square test).
 @ p < 0.01 when MMO compared with weight (chi-square test).
 μ p > 0.05 when MMO compared in between boys and girls (student's 't' test).

years (mean age 4.01) participated in the study.

Clinical examination was performed after obtaining informed consent from the respective school authorities, and the following inclusion criteria were met: no history of jaw, head and face trauma, no history of pain in the jaw, face and neck, either at rest or during function, no history of severe bruxism, no facial and dental abnormalities, no history of temporomandibular joints sounds and no dental prosthesis on the anterior teeth. Subjects with severe orthodontic problems (anterior crossbite), neurologic disorders & craniofacial deformities, systemic diseases (juvenile rheumatoid arthritis) & neck pain which have been reported to create limited mouth opening were excluded from the study.

Measurement of MMO was recorded by asking the subjects to open their mouth as wide as possible, while examiner measured the maximum distance from the incisal edge of maxillary central incisor to incisal edge of mandibular central incisor at the midline. For each subject three readings were recorded in millimeters (mm) and the mean value was considered. MMO measurements were taken using a modified Vernier Caliper, while the subject rested their heads against a firm wall surface in an upright position (Figure 4).

Body weight was recorded in kilograms using weighing balance (equinox). Height was measured in centimeters using metric scale and without shoes.

All measurements were performed by a single examiner to avoid intra-examiner variability. Measurements of MMO were compared in children of different age groups i.e 3, 4 and 5 years. Similarly a correlation between MMO and body weight and height were also observed.

Study protocol

Children were randomly allocated into 3 groups based on the age:

- Group I: Children age 3 years.
- Group II: Children age 4 years.
- Group III: Children age 5 years.

MMO, body weight and height were recorded in all three groups. Measurements of MMO were correlated with body weight and height of children in different age groups.

Results were analyzed by using the statistical package for the Social Sciences (SPSS 17, Inc; Chicago). Mean, standard error of mean (SEM) were calculated for MMO. Student's 't' test and chi-square test were used. P values < 0.05 were considered as significant.

Vernier Caliper and its Modification

A vernier caliper is a precise instrument for measuring linear dimension (length) of any object to an accuracy of a tenth of a millimeter or better. It comprises of two jaws, one for measuring outer dimensions (larger jaw) and other for measuring inner dimension (smaller jaw) which are attached to a fixed scale and a sliding (Vernier) scale (Figure 1 and 2).

For the present study, Vernier Caliper has been modified:

1. Jaw used for measuring inner dimension has been removed by machine grinding (Figure 3).
2. Jaw used for measuring outer dimension has been modified in such a way that it can be used for measuring both inner and outer dimension. This is achieved by grinding the outer edges of the larger jaw to make them straight, engaging the inner edges of an object (eg. inter-incisal distance) to measure its dimension. Distance between the two outer straight edges of larger jaws is 9 mm when zero reading of vernier scale and main scale coincides. (Figure 3).

In course of modifying the Vernier Caliper, a new formula has been derived for measuring the inner dimension, using larger arm that is being modified for the purpose. Final Readings were taken after adding 9 mm to the original reading (Figure 3).

$$\text{Final Reading} = \text{Original Reading} + 9 \text{ mm}$$



Figure 1. Vernier Caliper (Original form) comprises of two jaws, larger and smaller and two scales, vernier (sliding) scale and main scale.

This is a pioneer method used for measuring MMO in children. The method is safe and simple to execute, reproducible, reliable even in small children, does not affect sensitivity of caliper and it is easy to calculate final reading by adding simple numerical value to original measurement. Further, modified caliper is much lighter in weight, compact, easy to manipulate and less fearful particularly to children.

RESULTS

MMO was measured in boys and girls aged between 3-5 years (Table 1). The estimated average MMO measured for boys and girls at the age of 3 years was 41.61 ± 0.32 mm and 40.09 ± 0.34 mm respectively. The estimated average MMO measured for boys and girls at the age of 4 years was 44.98 ± 0.38 mm and 44.22 ± 0.42 mm respectively. The estimated average MMO measured for boys and girls at the age of 5 years was 46.81 ± 0.35 mm and 46.22 ± 0.36 mm respectively. There is a gradual increase in MMO with age i.e from 3 to 5 years. Statistically significant difference was not observed in MMO between boys and girls at various age groups. However, MMO was found to be statistically significant when compared between 3 to 5 years (Table 1).

As shown in table 1 there was a gradual increase in height of both boys and girls with age. MMO was also found to increase with age. When compared statistically a significant difference was observed between MMO and height of children at age of 3, 4 and 5 years.

There was a gradual increase in weight of both boys and girls with age. MMO was also found to increase with weight. A statistically significant difference was found between MMO and weight at different ages. Results are shown in table 1.

DISCUSSION

The results of the present study revealed that MMO in Indian children were 41.61 mm, 44.9 mm and 46.81 mm for boys and 40.09 mm, 44.22 mm and 46.2 mm for girls at age of 3, 4 and 5 years respectively. Our results are in agreement with the findings reported by Shephard and Shepard,¹³ Bernal *et al*¹⁵ and Gaviao *et al*¹⁶ with

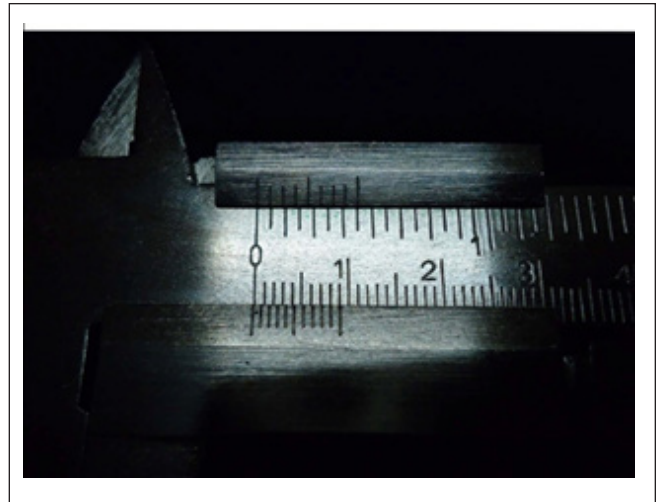


Figure 2. Showing Sliding (Vernier) and Main Scale Readings.

MMO of 42.4 mm, 42 ± 4.6 mm and 45.72 mm respectively in primary dentition. Similarly, Rothenberg¹⁷ recorded a mean of 40.47 mm for children aged 4 to 6, and Alamoudi *et al*¹⁸ found MMO of 41.2 ± 5.6 mm for children aged 3 to 7 years old, measurements which are closest to this study at age of 3 years. On the other hand, Muhtarogullary *et al*¹⁹ and Cortese *et al*²⁰ reported lower values of MMO i.e 38.2 mm and 38.59 mm, respectively in children with primary dentition. The difference in MMO values reported by these workers could be due to different methodology used. In contrast, Vanderas²¹ and Ingerval⁷ reported higher values of MMO i.e 54.8 mm and 51.3 mm respectively among children between the age of 6 and 10 years. The higher values of MMO in children reported by these authors could be explained on the basis of higher age of children i.e 6 to 10 years. However, Landtwig²² reported a mean value of 45.9 mm, regardless of the fact that age range of the children was wider: 5 to 19 years.

MMO has been described either as the inter-incisal distance^{13,26,27} or as the inter-incisal distance plus the overbite.¹⁴ Measurement of the inter-incisal distance plus overbite means measurement of the vertical distance traveled by the mandible. However, as pointed out by Mezitis *et al*²⁶ the functional opening of the mouth is more important, because this is the value that actually affects chewing and dental treatment. Hence, the inter-incisal distance was used as a measurement of MMO in this study. Further, the inter-incisal distance during active opening was used as the MMO measurement in most studies.^{13,27} An advantage of the incisal edge distance measurement is that the measuring point is relatively more permanent and more easily determined. An extra-oral measurement was also used in some studies.²⁸ Wood and Branco²⁸ compared direct and extraoral measurements, and suggested that direct measurements using ruler or vernier caliper were more precise and accurate.

In relation to the horizontal mandibular movements in the primary dentition, few data²⁹ is available in the literature. In the present study horizontal mandibular movements were not recorded since it was difficult to get small children to perform these movements. Similarly, Bernal and Tsamtouris¹⁵ did not record protrusive and lateral movements in children with primary dentition. In



Figure 3. Modified Vernier Caliper. (Smaller jaw is removed; outer edges of larger jaw are straightened. Distance between two outer straight edges of larger jaw is 9 mm when zero reading of vernier scale and main scale coincide. Final Readings taken after adding 9 mm to the original measurement)

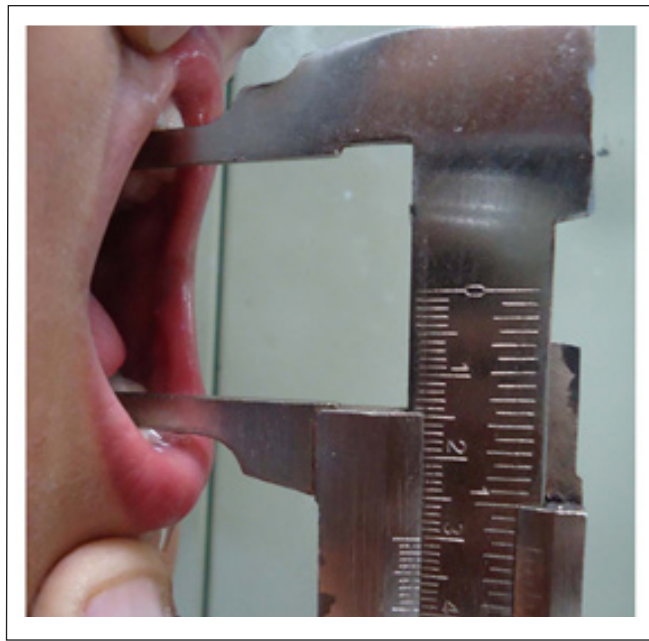


Figure 4. Showing method for measuring MMO in children using a modified Vernier Caliper method.

contrast, Bonjardin *et al*²⁹ trained 99 Brazilian children aged 3 to 5 years before measuring MMO, but it was not feasible to train every child before measuring MMO when the study consists of comparable larger sample size as in present case.

Head position is an important factor while measuring MMO.²³ Higbie *et al*²⁵ described how MMO decreases in the order of forward, natural and retracted head positions. In our study, MMO was measured while the subject rested their heads against a firm wall surface in an upright position in order to eliminate the possible influence of different head positions.

Studies have shown that MMO steadily increases after birth until adolescent^{7, 13, 23} and then gradually decreases as aging progresses.^{14, 26} Present study reported a gradual increase in MMO with age i.e from 3 to 5 years. Findings were in agreement with Hirsch *et al*,⁸ Cortese *et al*²⁰ and Vandera²¹ where MMO was correlated with age. Abou –Atme *et al*⁹ reported moderate to strong correlation between MMO and age in 102 Lebanese children aged 4 to 15 years. Rothenberg¹⁷ noted significant relationship of maximum vertical opening of mouth with age in 189 Caucasian children, aged 4 to 14 years. Sousa *et al*³² reported a weak significant correlation between mandibular range of movement and age in 303 Brazilian children aged 6 to 14 years. Certainly, it would be expected that with increase of age, MMO also increases particularly in children.

Only few studies reported gender difference in MMO in children.^{8,17} In present study, statistically significant difference was not observed in between boys and girls at various age groups. However, MMO was found to be significant different when compared between 3 and 5 years. These findings were similar to the ones reported by many authors^{14, 20, 21} in children with primary dentition. Bonjardin *et al*²⁹ found no statistically significant difference of mandibular movements between 99 Brazilian boys and girls, aged 3 to 5 years. Similarly, Abou –Atme *et al*⁹ reported no gender difference for measurement of MMO in 102 children aged 4 to 15 years. In contrast,

Ogura *et al*³⁰ and Gazit *et al*³¹ reported a 5 mm difference in vertical mandibular opening between young men and women. Similar findings were noted by other authors^{8, 17} also. The possible reason for the positive correlation between MMO and gender for such studies is that low number of children included in each age category that might have reduced the significance of the result. Further these studies measure MMO in adolescent and young men and women with larger age as compared to the present study including children aged 3 to 5 years. Still a large overlap is present. The fact that children did not diverge much for measurement of MMO, differs from the result of studies on adults, suggests that such diversity develops later in life, probably due to late growth of young men.

Results of the study revealed a definitive correlation between MMO with height and weight. Rothenberg¹⁷ also observed a positive correlation between MMO values in relation to weight and height in subjects with ages between 4 and 14 years old. Similar results were obtained by, Landtwing²², Sousa *et al*³², Henrikson *et al*³³ and Ingervall.⁷ Agerberg¹⁴ (1974), however, found the correlation of MMO to height and weight weak in all age groups.

In the present study the observed gradual increase in MMO with increasing age, height and body weight may be due to changes in temporomandibular joint apparatus, facial morphology, muscle development, growth of cranial base and mandible particularly in length. At present, it is difficult to propose the exact mechanism responsible for this increase in MMO. However, this study uses a modified vernier caliper method for the first time to measure MMO in Indian children aged 3 to 5 years and suggest a positive relationship between MMO, age, height and body weight.

Data presented in the study in combination with clinical expertise serves as available approach for clinical decision making to diagnose severe divergences. Further, these results are applicable in routine dental practice and for dental public health imparting awareness.

CONCLUSION

On the basis of the findings we may suggest that MMO increases gradually with age, height and body weight among children of 3 to 5 years. However, no gender difference is observed.

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