The Normal Range of Maximal Incisal Opening in Pediatric Population and Its Association with Physical Variables

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Abstract

Background: Restricted mouth opening is a common complaint in patients suffering from temporomandibular joint disorders, ankylosis, impaired masticatory muscle function, rheumatic disease, infection, or malignancy. As with any disease, the aim of treatment of disorders affecting mouth opening is to restore the mouth opening to its normal value. Objectives: To establish the normal range of maximal incisal opening (MIO) in children aged 4 to 15 years and to investigate the correlation between MIO and age, gender, height, and body weight. Materials and Methods: Six hundred and two children from various schools in Bengaluru, India, participated in the study. The children were divided into the following age groups: 4–5, 6–7, 8–9, 10–11, 12–13, and 14–15 years. MIO for the children was recorded using Therabite® scale. The measurements of MIO were then correlated with gender, body weight, and height of the children in different age groups. Results: It was observed that MIO gradually increased with age with a mean MIO of 41.34 mm at 4–5 years to a mean MIO of 51.73 mm at 14–15 years. The mean MIO value for males (48.90 ± 6.49 mm) was found to be higher when compared to that of females (46.17 ± 5.58 mm). The results indicated a strong positive correlation of MIO with height and weight. Conclusion: MIO gradually increased with age in both the genders, and a strong positive correlation of MIO with height and weight was observed.

Keywords: Children, maximal mouth opening, physical variables

Résumé

Contexte: L’ouverture restreinte de la bouche est une plainte fréquente chez les patients souffrant de troubles de l’articulation temporo-mandibulaire, d’ankylose, d’altération de la fonction musculaire masticatoire, de rhumatisme articulaire, d’infection ou de cancer. Comme pour toute maladie, le traitement des troubles de l’ouverture de la bouche a pour objectif de ramener cette ouverture à sa valeur normale. Il est donc primordial de déterminer la valeur normale. Objectif: Établir la plage normale d’ouverture maximale de l’incision (OMI) chez les enfants âgés de 4 à 15 ans et étudier la corrélation entre l’ouverture maximale de l’incision et l’âge, le sexe, la taille et le poids corporel. Conception de l’étude: Six cent deux sujets de diverses écoles de Bangalore, en Inde, ont participé à l’étude. Les sujets ont été répartis dans les groupes d’âge suivants: 4-5, 6-7, 8-9 ans, 10-11 ans, 12-13 ans et 14-15 ans. L’ouverture incisive maximale des sujets a été enregistrée avec l’échelle Therabite®. Les mesures de MIO ont ensuite été corréllées avec le sexe, le poids corporel et la taille des enfants dans différents groupes d’âge. Résultats: Il a été observé que le MIO augmentait progressivement avec l’âge, avec un MIO moyen de 41,34 mm à 4-5 ans, pour atteindre un MIO moyen de 51,73 mm à 14-15 ans. La valeur moyenne maximale de l’ouverture incisive chez les hommes (48,90 ± 6,49 mm) s’est avérée plus élevée que celle des femmes (46,17 ± 5,58 mm). Les résultats ont montré une forte corrélation positive entre le MIO et la taille et le poids. Conclusion: le MIO a augmenté progressivement avec l’âge chez les deux sexes et une forte corrélation positive entre le MIO et la taille et le poids a été observée.

Mots clés: Ouverture maximale de la bouche, variables physiques, les enfants

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**INTRODUCTION**

All clinicians dealing with the oral cavity are faced with varying degrees of difficulty when mouth opening is limited. The amount of mouth opening is a significant factor in the diagnosis of many clinical conditions and can have implications for the management and treatment of patients. A reduction in the amount of mouth opening is associated with several clinical conditions, with one of the most common being temporomandibular disorder (TMD) syndrome.\(^1\)

In order to make a diagnosis of decreased mouth opening, it is essential to establish what constitutes the normal opening for the populations. A known normal range of mouth opening is necessary to enable the clinician conduct a thorough oral examination conveniently. Early recognition of decreased or limited mouth opening is necessary for a prompt and efficient approach to diagnosis and to plan the treatment options judiciously.\(^2\)

Maximum incisal opening (MIO) can be expressed either as the interincisal distance or as corrected interincisal distance, which is determined by adding the amount of vertical overlap between the upper and lower incisors to the incisal distance. In adults, MIO is stable and does not vary, whereas in children, MIO increases with somatic growth.\(^3\)

Researchers have shown that this measurement varies significantly with age,\(^4-6\) gender,\(^4,7\) and race.\(^8\) Although correlation with age is generally accepted, conflicting reports are found in literature for other variables.\(^3\) Establishing normal age-adjusted values of MIO in children would allow the clinician to objectively evaluate the effects of treatment or interventions.

As little or no established data on age-adjusted values of MIO is available in Indian population, the aim of the present study was to establish the normal range of MIO in children using TheraBite\(^\text{®}\) range of motion scale and to investigate the correlation between MIO and age, gender, height, and weight.

**MATERIALS AND METHODS**

Six schools in North Bengaluru, India, were identified for the participation in the study, and permission from the concerned authorities was obtained. Ethical clearance for the study was obtained from the Institutional Review Board, Sri Rajiv Gandhi College of Dental Sciences and Hospital, Bengaluru, India (No. SRGCDS/2014/485-A). Seven hundred and forty children in the age group of 4 to 15 years for whom written informed consent could be obtained from the parents or guardians participated in the study.

The demographic details and information regarding a history of trauma to the head, neck, or face; a history of neurological disorders; and a history of pain in the jaws, neck, and face were obtained for each participant. The clinical examination was then performed which included temporomandibular joint (TMJ) examination; palpation of masticatory muscles; and intraoral examination for identifying open bite, cross bite, and occlusal wear (indicator for bruxism). Children with orthodontic problems such as anterior cross bite and anterior open bite; neurologic disorders; and systemic diseases such as juvenile rheumatoid arthritis, cleft lip and palate, or other craniofacial anomalies; history of jaw, head, or face trauma; history of pain in the neck, jaw, and face and TMJ sounds, and history of severe bruxism were excluded from the study.

Six hundred and two children (327 males and 275 females) in the age group of 4 to 15 years fulfilling the inclusion and exclusion criteria were identified from the participants examined and were included in the study. The children were then divided into the following six age groups: Group I: 4–5 years; Group II: 6–7 years; Group III: 8–9 years; Group IV: 10–11 years; Group V: 12–13 years; and Group VI: 14–15 years.

Height and weight of each child were recorded with height scale and a calibrated weighing apparatus, respectively. Weight was measured to the nearest tenth in kilograms, with the child standing as still as possible with hands resting at his or her side. Height was measured to the nearest tenth in centimeter on the height scale with the child standing as close to his or her natural head positioning as possible.

For this study, MIO was defined as the vertical distance in millimeters between the incisal edges of the maxillary and mandibular central incisors, where they should be, or as medial to where they should be, when the child naturally opens his or her mouth as wide as possible without eliciting any pain or discomfort, plus the vertical overbite as described by Ying et al.\(^3\) For children with missing anterior teeth, MIO was measured as the distance between the gingiva of the missing incisor minus the amount of space that exists when the patient is in centric occlusion (CO). For partially erupted incisors, MIO was measured as the distance between the partially erupting central incisor and the opposing central incisor minus the amount of space that exists when the patient is in CO.

MIO measurements were recorded using the TheraBite\(^\text{®}\) scale (Platon Medical Ltd.; UK), while the children rested their heads against a firm wall surface in an upright position. Children were asked to open their mouth as wide as possible without discomfort. TheraBite\(^\text{®}\) scale was placed so that the notch of the scale rests on the incisal edge of the lower central incisor. The scale was then rotated until it contacts the incisal edge of the upper central incisor, and reading at the point of contact was noted [Figure 1]. Three readings were recorded for each child, and their average was considered.

For overbite measurement, the facial surfaces of the mandibular incisors were marked at the area of overlap by the maxillary incisors using an indelible pencil, and this demarcation was measured to the mandibular incisal edge using the graded ruler on the side of the TheraBite\(^\text{®}\) scale. The overbite value was then added to the average MIO value to get the child’s final MIO.

All the measurements were done by a single examiner to avoid interexaminer variability. To test the intraexaminer reliability, each day at the end of the examination, 10% of the children...
examined for the day were randomly selected and MIO was measured.

**Statistical analysis**

The collected data were tabulated and imported into Statistical Package for the Social Sciences software version 10.0.5 (SPSS Inc., Chicago, IL, USA) for statistical analysis. Student’s "t" test and one-way analysis of variance were used to determine the differences in MIO in relation to age and gender. Pair-wise comparison of MIO between the age groups was done using Tukey test. Pearson’s correlation coefficients were calculated to determine the correlation between the MIO and height and weight. A multivariable regression model including all the variables individually associated with MIO was estimated to examine the adjusted effects for each variable. In all the above tests, a “P” < 0.05 was accepted as indicating statistical significance.

**RESULTS**

Among the 602 children (327 males and 275 females) enrolled in the study, the minimum mean MIO was recorded as 41.34 mm and the maximum mean MIO was recorded as 51.73 mm. The distribution of mean MIO values in various age groups included in the study is summarized in Table 1.

It was observed that MIO gradually increased with age with a mean MIO of 41.34 mm (standard deviation [SD] 4.14) at 4–5 years to a mean MIO of 51.73 (SD 6.46) at 14–15 years; however, the increase in mean MIO reading was not statistically significant from 10–11 years to 14–15 years. The MIO values were higher in males when compared to those of females in all the age groups, which was statistically significant except for the age group of 4–5 years [Table 2].

Pearson’s correlation coefficient test indicated a strong positive correlation of MIO with height ($r = 0.63$, $P < 0.001$) and weight ($r = 0.60$, $P < 0.001$) [Table 3].

In the multivariable regression model, all the variables included in the study such as age, gender, height, and weight remained significantly associated with MIO [Table 4].

**DISCUSSION**

Patients with TMDs, craniofacial anomalies, maxillofacial trauma, oral malignancies, and those who have been treated for these conditions often complain of restricted mouth opening.
As with any disease or condition, the aim of the treatment of disorders affecting mouth opening is to restore the mouth opening to its normal value. It is thus of paramount importance to determine the normal value.

Research has shown that the mouth opening measurement varies significantly with the age, gender, and stature along with geographical and ethnic variations. Hence, it becomes essential to establish the parameters to be taken into consideration for evaluating normal mouth opening for the population. Moreover, only a few studies have been conducted to determine the maximal mouth opening in children.

Therefore, in the present study, we aimed to establish the normal range of MIO in Indian children and investigate the correlation between MIO and age, gender, height, and weight.

Measurement of mouth opening is used to assess two variables – functional mouth opening (the maximum vertical measurement for access to the oral cavity) and TMJ mobility. Numerous methods have been described in the literature for the measurement of MIO. The most common method used is the measurement of interincisal distance during active opening by the individual. Extraoral soft-tissue landmarks have also been used for the same. However, since the extraoral landmarks are more mobile when compared to the incisal edge of teeth which is relatively more stable and more easily determined, the present study measured MIO as vertical distance in millimeters between the incisal edges of the maxillary and mandibular central incisors.

MIO has been described either as the interincisal distance or as the interincisal distance plus overbite. Gallagher et al. observed that measurement of interincisal distance plus overbite is a more accurate reflection of the vertical distance travelled by the mandible and not including overbite can underestimate the movement of the mandible, especially in individuals with deep overbite. Therefore, in the present study, overbite has been added to the interincisal distance to determine the MIO.

Higbie et al. and Uritani in their research have observed that short-term alterations in head positions can have a significant effect on the amount of vertical mandibular opening and recommended consistency of individuals’ head position in producing reliable measurements. Therefore, all the measurements were made while the individuals rested their heads against a firm wall surface in an upright position.

Few investigators observed that the first measurement of MIO recorded for each individual was generally greatest which they attributed to decreasing muscle power with succeeding measurements. Considering this, in the present study, an average of three measurements was taken as the final MIO value to minimize error.

On analysis of results, the mean MIO in the present study showed a gradual increase with age with a mean MIO of 41.34 mm at 4–5 years to a mean MIO of 51.73 mm at 14–15 years. This is in agreement with the findings of previous studies conducted in pediatric population. Ying et al. reported a mean MIO of 43.80 mm at 4–5 years which showed a gradual increase to 59.34 mm at 14–15 years. However, the mean MIO values recorded in each age group in this study varied when compared to those of other studies. This may be attributed to the difference in the study population, different method in the determination of MIO or due to variation in the tool used to measure the interincisal distance.

In this study, a statistically significant difference in MIO values was observed between boys and girls in all the age groups except for 4–5 years. This is in contrast with the findings of other investigators who observed that the influence of gender on maximal mouth opening is not significant in children. This gender difference observed in our study may be explained by the findings of Westling and Helkimo who pointed out that the differences in MIO may be attributed to the size and length of mandible which is usually greater in males.

A strong positive correlation of MIO with height and weight was noted in the present study which was consistent with the findings of Kumar et al. This increase of MIO with height and weight can be attributed to the positive correlation between mouth-opening capacity and physical development as observed by Ingervall.

On regression analysis, all the variables included in the study such as age, gender, height, and weight remained significantly associated with MIO, suggesting that these variables must be considered during the measurement of mouth opening in children.

**Limitations of the study**

One limitation of this study could be an inadvertent inclusion of asymptomatic children with limitations in mouth opening, which would bias the results to some extent. Moreover, the inclusion criteria did not encompass any specific radiographic evaluation of TMJ. However, the absence of any history of signs or symptoms of jaw or face pain should have minimized the number of individuals with undetected limitation of mouth opening.

**Conclusion**

Within the limits of the present study, the following conclusions were made:

- Normal range of MIO in children of various age groups within the age range of 4–15 years has been established
- The MIO showed a gradual increase with age in both males and females, and both age and gender were found to have significant influence on MIO values
- A strong positive correlation of MIO with height and weight was observed.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients...
understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES
1. McNeill C, Danzig WM, Farrar WB, Gelb H, Lerman MD, Moffett BC, et al. Position paper of the American Academy of Craniomandibular Disorders. Craniomandibular (TMJ) disorders – The state of the art. J Prosthet Dent 1980;44:434-7.
2. Khare N, Patil SB, Kale SM, Sumeet J, Sonali I, Sumeet B, et al. Normal mouth opening in an adult Indian population. J Maxillofac Oral Surg 2012;11:309-13.
3. Ying QV, Bacic J, Abramowicz S, Sonis A. Cross sectional: Normal maximal incisal opening and associations with physical variables in children. Pediatr Dent 2012;35:61-6.
4. Boozer CH, Ferraro EF, Weinberg R. The effects of age, race and sex on the interincisal measurement. Ann Dent 1984;43:5-7.
5. Landtwing K. Evaluation of the normal range of vertical mandibular opening in children and adolescents with special reference to age and stature. J Maxillofac Surg 1978;6:157-62.
6. Mezitis M, Rallis G, Zachariades N. The normal range of mouth opening. J Oral Maxillofac Surg 1989;47:1028-9.
7. Agerberg G. Maximal mandibular movements in children. Acta Odontol Scand 1974;32:147-59.
8. Yao KT, Lin CC, Hung CH. Maximum mouth opening of ethnic Chinese in Taiwan. J Dent Sci 2009;4:40-4.
9. Sohail A, Amjad A. The range of inter-incisal opening among university Students of Ajman, UAE. Pak Oral Dent J 2011;31:37-41.
10. Müller L, van Waes H, Langerweger C, Molinari L, Sauter H, et al. Maximal mouth opening capacity: Percentiles for healthy children 4-17 years of age. Pediatr Rheumatol Online J 2013;11:17.
11. Bonjardim LR, Gavião MB, Pereira LJ, Castelo PM. Mandibular movements in children with and without signs and symptoms of temporomandibular disorders. J Appl Oral Sci 2004;12:39-44.
12. Sousa LM, Nagamine HM, Chaves TC, Grossi DB, Regalo SC, Oliveira AS, et al. Evaluation of mandibular range of motion in Brazilian children and its correlation to age, height, weight, and gender. Braz Oral Res 2008;22:61-6.
13. Kumar A, Dutta S, Singh J, Mehta R, Hooda A, Namdev R, et al. Clinical measurement of maximal mouth opening in children: A pioneer method. J Clin Pediatr Dent 2012;37:171-5.
14. Kumar A, Mehta R, Goel M, Dutta S, Hooda A. Maximal mouth opening in Indian children using a new method. J Cranio Max Dis 2012;1:79-86.
15. Gallagher C, Gallacher V, Whelton H, Cronin M. The normal range of mouth opening in an Irish population. J Oral Rehabil 2004;31:110-6.
16. Higbie EJ, Seidel-Cobb D, Taylor LF, Cummings GS. Effect of head position on vertical mandibular opening. J Orthop Sports Phys Ther 1999;29:127-30.
17. Uritani D. Effect of temporomandibular disorder symptoms on mouth opening in two head positions: A comparative study. Rigakuryoho Kagaku 2009;24:919-23.