An Index for the Measurement of Normal Maximum Mouth Opening

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Abstract

Purpose: *The aim of this study was to evaluate the relationship between the width of 3 or 4 fingers of one hand and maximum mouth opening (MMO) in healthy subjects.*

Methods: *One hundred and forty dental students (age 21 to 42 years, mean 27.4 years) participated in the study. The ability of each subject to position 3 or 4 fingers, vertically aligned, between the upper and lower central incisors up to the first distal interphalangeal folds, was documented. Measurements of MMO and the width of 3 fingers (index, middle and ring fingers) and 4 fingers (index, middle, ring and little fingers) were recorded.*

Results: *All subjects were able to position 3 fingers (of both the right and left hands) between the upper and lower central incisors. Only 12 subjects were able to position 4 fingers (both right and left) in this way. There were no significant differences among the measurements of MMO (mean 48.8 mm), 3 fingers of the right hand (mean 47.3 mm) and 3 fingers of the left hand (mean 47.0 mm) ($p > 0.05$). However, MMO was significantly different from the width of 4 fingers of the right hand (mean 58.1 mm) and 4 fingers of the left hand (mean 57.5 mm) ($p < 0.001$). Moreover, there was a strong positive correlation between MMO and the 3-finger measurements ($p < 0.0001$).*

Conclusions: *These findings strongly suggest that the ability to position 3 fingers in the mouth during dental examination is a convenient index for assessing normal MMO.*

MeSH Key Words: *range of motion, articular; reference values; temporomandibular joint dysfunction syndrome/diagnosis*

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Assessment of mandibular function is performed by means of several diagnostic tests including muscle and joint palpation, occlusal evaluation and radiographic examination. One of the elementary tests to evaluate temporomandibular joint function is measurement of the range of motion of the joints during maximum mouth opening (MMO) and lateral and protrusive movements; limitation of these movements is considered a sign of dysfunction.[1–4]

MMO can be expressed either as 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.[5] **Table 1**, a summary of previously reported mouth opening measurements, shows that the sensitivity of this method as a means of evaluating temporomandibular joint function is low, because there is enormous variability between the sexes, among people of different ages and among individual subjects. Previously reported mean MMO has ranged from 43.3 mm (reported by Posselt[6]) to 59.0 mm (for men only, as reported by Travell[10]). In individual studies, the reported range has been as wide as 32–62 mm[7] (for subjects of both sexes) and 39–75 mm[5] (for women only). Differences have also been observed between men and women.[5,9,10,16,18]

Table 1 **Summary of previously reported values for mouth opening measurements**

Reference	Year	Mouth opening measurement, mean or range (mm)
Posselt[6]	1952	43.3
Braus[7]	1954	32–62
Shore[8]	1959	33–45
Nevakari[9]	1960	Men 57.5; Women 54.0
Travell[10]	1960	Men 59.0; Women 53.0
Posselt[11]	1962	50–60
Sheppard and Sheppard[12]	1965	46.9
Posselt[13]	1968	43.4
Ingervall[14]	1970	51.3
Ingervall[15]	1971	52
Bosman[16]	1974	Men 54.4; Women 53.6
Agerberg[5]	1974	Men 42–77(mean = 58.6); Women 39–75 (mean 53.3)
Rosenbaum[17]	1975	44.9
Rieder[18]	1978	Men 40–60; Women 35–55
Szentpetery[19]	1993	51.7

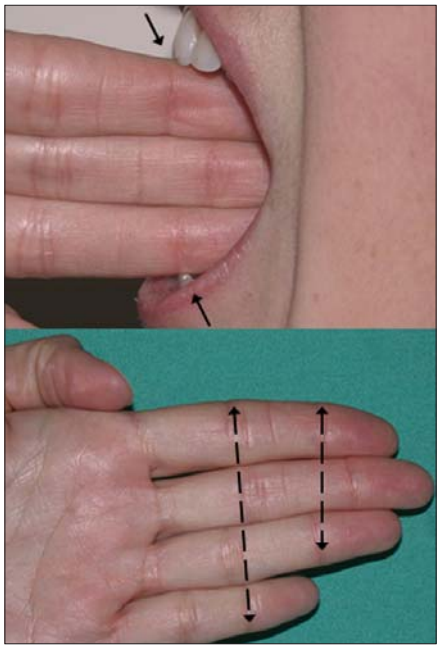

Figure 1: *To assess the ability of each subject to position 3 or 4 fingers (right and left) vertically aligned, the distal interphalangeal folds (arrows) were used as an anatomical landmark.*

For example, Rieder[18] reported that men generally have a wider mouth opening than women: in that study, 83% of men had a mouth opening of 40–60 mm, whereas 87% of women had a mouth opening of 35–55 mm. Other authors have also reported differences between men and women (**Table 1**).

Because the variability in the range of mouth opening is so large, clinicians do not usually have a baseline measurement for a particular individual to determine if there is any limitation in mouth opening. This wide variability may be related to a variety of factors, such as generalized joint hypomobility or hypermobility and differences in body size among subjects. To correct for the latter factor, it would be more appropriate to use a measuring method that is directly proportional to the subject's body size.[20]

To make up for the lack of exact reference values for every patient, Hochstedler and others[21] suggested using the ratio of maximum opening to lateral movement, instead of the simple MMO measurement, to evaluate temporomandibular joint function. This ratio was 4.4:1 in normal subjects.[21] However, in patients with intracapsular and extracapsular disorders, both components of the ratio may be affected similarly, with the risk that limitations in all movements may yield a "normal" ratio, even though dysfunction is present.

This study had 2 objectives: first, to assess the ability of each subject to vertically position 3 fingers or 4 fingers between the upper and lower incisors during MMO, and second, to study the relationship between MMO and the width of 3 and 4 fingers.

Materials and Methods

One hundred and forty students from Tufts University School of Dental Medicine, 60 men and 80 women between the ages of 21 and 42 years (mean 27.4 years, median 27 years) participated in this study. All subjects provided informed consent for participation. Clinical examination was performed at the Craniofacial Pain Center for subjects meeting the following inclusion criteria: no history of jaw, head or face trauma; not more than 1 mm of attrition on the incisal edges; no history of signs or symptoms of jaw or face pain, either at rest or during function; no history of bruxism; no history of temporomandibular joint sounds; no more than 2 absent teeth (excluding wisdom teeth); no facial or dental developmental abnormalities; no dental prosthesis on the anterior teeth; and occlusion in Class I relationship.

The following sites were palpated for signs of temporomandibular disorders and myofacial pain: temporomandibular joint and the masseter, temporalis, and medial and lateral pterygoid muscles bilaterally. The presence of joint sounds on motion was also evaluated.

The ability to position the fingers, vertically aligned, between the upper and lower central incisors up to the first distal interphalangeal folds was documented. For the 3-finger assessment, the index, middle and ring fingers were used. For the 4-finger assessment, the little finger was added (**Fig. 1**).

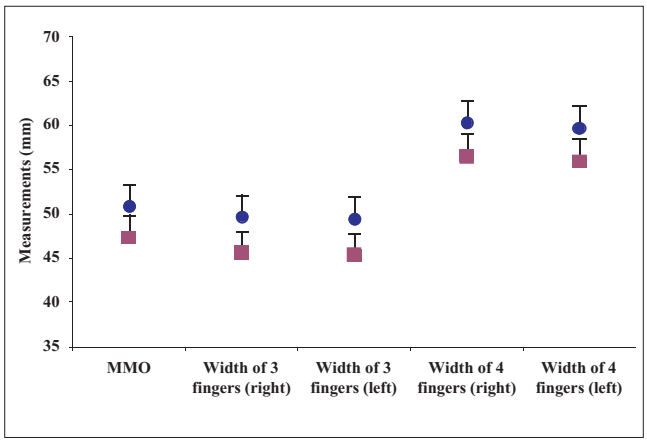

Figure 2: *Mean measurements (and standard error of the mean) of maximum mouth opening (MMO) and the width of 3 and 4 fingers (for right and left hands). Circles = men (n = 60), squares = women (n = 80).*

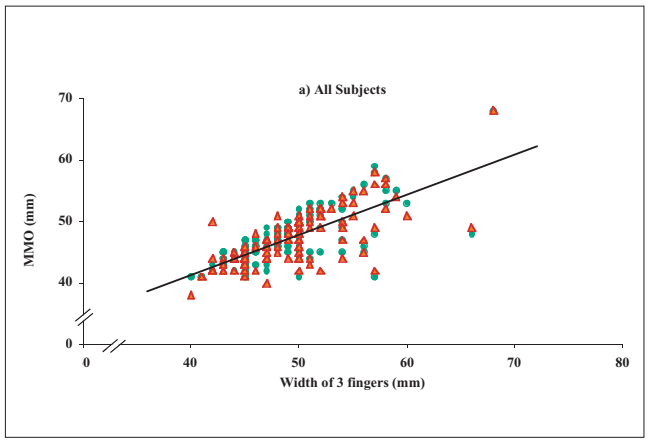

Figure 3a: *Correlation between maximum mouth opening (MMO) and width of 3 fingers for right hand (circles) and left hand (triangles), for all 140 subjects, both men and women. Pearson's correlation coefficient r = 0.75 for right hand and r = 0.76 for left hand (p < 0.001).*

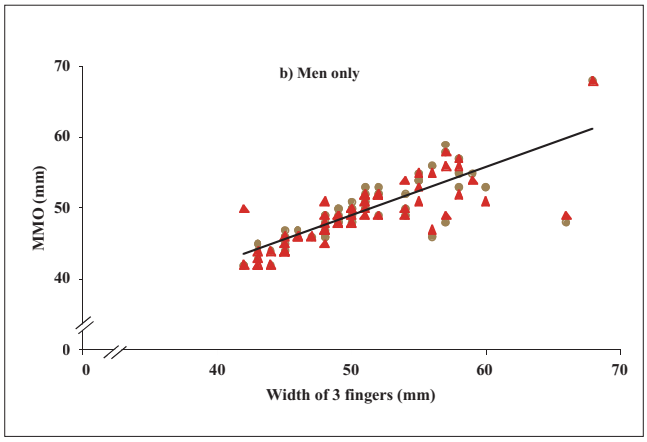

Figure 3b: *Correlation between maximum mouth opening (MMO) and width of 3 fingers for right hand (circles) and left hand (triangles) for men only (Pearson's correlation coefficient r = 0.81 for both right and left hands).*

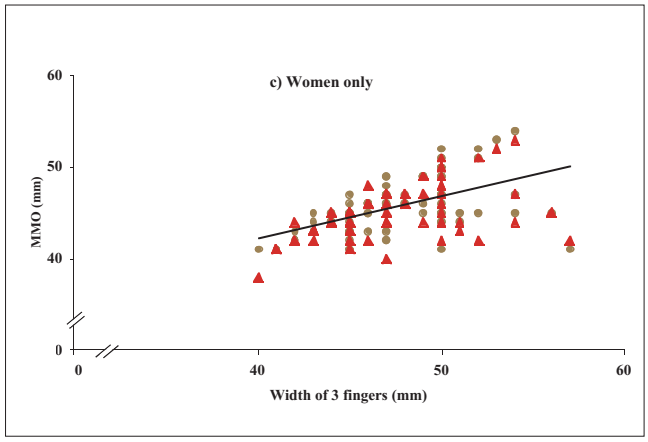

Figure 3c: *Correlation between maximum mouth opening (MMO) and width of 3 fingers for right hand (circles) and left hand (triangles) for women only (Pearson's correlation coefficient r = 0.54 for the right hand and r = 0.55 for the left hand).*

To measure MMO, each subject was asked to open his or her mouth as wide as possible, and the examiner measured the maximum distance from the incisal edge of the maxillary central incisors to the incisal edge of the mandibular central incisors at the midline. A disposable scale was used to obtain this measurement (Therabite range of motion scale, Therabite Corp., West Chester, Penn.). The width of 3 fingers and of 4 fingers was measured with a Boley gauge (Pearson Dental Suppliers Co., Sylmar, Calif.).

The examination and measurements were performed while the subjects were seated comfortably in the dental chair in an upright position. The time of evaluation was kept consistent (between 9 am and noon). To control for inter-examiner and intra-examiner reliability, each step was performed by a single examiner.

Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, Ill.). Analysis of variance (ANOVA) was used to assess differences between recorded measurements. Scheffé's multiple-comparison method was used to assess significant differences between the 5 recorded measurements (MMO; width of 3 fingers, right and left; width of 4 fingers, right and left). The Pearson correlation test was used when appropriate. A stringent level of statistical significance was chosen ($p < 0.01$) for all tests. The results are expressed as mean ± standard error of mean.

Results

All subjects were able to position 3 fingers, vertically aligned, between the upper and lower central incisors up to the first distal interphalangeal folds, but only 12 subjects (8 women and 4 men) were able to position 4 fingers in this way.

Table 2 **Summary of measurements of maximum mouth opening (MMO) and width of 3 and 4 fingers on right and left hands (all measurements in millimetres)**

		3 fingers		4 fingers	
Subject group	**MMO**	**Right**	**Left**	**Right**	**Left**
Women					
Mean ± SEM	47.4 ± 0.4	45.6 ± 0.3	45.4 ± 0.3	56.6 ± 0.5	56.0 ± 0.5
Minimum	40.0	41.0	38.0	46.0	47.0
Maximum	57.0	54.0	53.0	71.0	70.0
Men					
Mean ± SEM	50.7 ± 0.7	49.6 ± 0.6	49.3 ± 0.6	60.1 ± 0.8	59.6 ± 0.8
Minimum	42.0	42.0	42.0	50.0	50.0
Maximum	68.0	68.0	68.0	75.0	76.0
All subjects					
Mean ± SEM	48.8 ± 0.4	47.3 ± 0.4	47.0 ± 0.4	58.1 ± 0.5	57.5 ± 0.5
Minimum	40.0	41.0	38.0	46.0	47.0
Maximum	68.0	68.0	68.0	75.0	76.0

SEM = standard error of the mean.

Table 2 summarizes the measurements of MMO and the widths of 3 and 4 fingers (right and left hands).

There was a significant difference among the 5 recorded measurements (ANOVA, $p < 0.0001$). Post hoc multiple comparisons indicated that the 3-finger measurements (47.3 ± 0.4 for the right hand, 47.0 ± 0.4 for the left hand) were not significantly different from MMO (48.8 ±0.4) ($p > 0.05$), whereas the 4-finger measurements were significantly different from MMO (58.1 ± 0.5 for the right hand, 57.5 ± 0.5 for the left hand) ($p < 0.001$) (**Table 2**, **Fig. 2**).

There was a strong positive correlation between MMO and the width of 3 fingers (Pearson's correlation coefficient $r = 0.75$ for the right hand and $r = 0.76$ for the left hand; $p < 0.0001$) (**Fig. 3a**). This correlation was even stronger when the data for the 12 subjects who were able to position 4 fingers in this way were omitted ($r = 0.90$ for the right hand and $r = 0.88$ for the left hand; $p < 0.00001$).

The correlation between MMO and the width of 3 fingers (for both right and left hands) was also significant when data for women and men were analyzed independently ($p < 0.001$). However, this correlation was stronger for men (**Fig. 3b**; $r = 0.81$ for both right and left hands) than for women (**Fig. 3c**; $r = 0.54$ for the right hand and $r = 0.55$ for the left hand).

Discussion

MMO varies greatly from one subject to another and hence measurement of MMO on its own could be misleading, making it difficult to set criteria for impairment of mandibular movement. In general, the cutoff values for restricted opening are less than 40 mm for muscular disorders and less than 35 mm for joint-related disorders.[2,22] It has previously been reported that measurements of anatomic landmarks correlate with MMO. For example, Landtwing[20] found that body height was strongly correlated with MMO, and this correlation has also been demonstrated by Vanderas[23] and Agerberg.[24] The relationship between mandibular movements and facial morphology was analyzed by Ingervall,[15] who found that mouth opening was correlated with measurements of the cranial base and the mandible. Unfortunately, these measurement methods are rarely used in daily practice and are not considered in the diagnosis of temporomandibular disorders.

In the present study, the ability to place 3 or 4 fingers between the central incisors was investigated; only 8.6% of the subjects (8 women and 4 men) were able to position 4 fingers during MMO, whereas all subjects could position 3 fingers in this way. The correlation between the width of 3 fingers and MMO was significantly greater among men than among women. This finding may be related to women's smaller stature.[20]

This index is proposed as a way to predict normal MMO with reasonable accuracy ($r = 0.75$ for the right hand and $r = 0.76$ for the left hand).

One limitation of this study is that asymptomatic subjects with limitations in mouth opening might have been included in the study sample, which would bias the results to some extent. Moreover, the inclusion criteria did not encompass any specific radiographic or magnetic resonance imaging evaluation of the temporomandibular joint. However, the absence of any history of signs or symptoms of jaw or face pain and the lack of history of temporomandibular joint sounds should have minimized the number of subjects with undetected limitation of mouth opening.

Other limitations related to the interpretation of the data are due to the possibility of disproportionate body size, such that the sample might have included subjects with small MMO and large fingers or large MMO and small

fingers, even in the absence of any abnormality or limitation; if so, the suggested method of assessing normal MMO might yield incorrect results.

Conclusions

A simple, quick method of assessing and recording normal mandibular motion during mouth opening has been presented. The findings of this study strongly suggest that the ability to position 3 fingers in the mouth during dental examination is a convenient and reliable index for assessing normal MMO. Using this method clinicians may be able to more accurately distinguish "normal" from "restricted" mouth opening. However, it must be remembered that this is only one variable, and all aspects of possible dysfunction should be assessed comprehensively before a definitive diagnosis is made. In future investigations, body weight should be recorded and subjects should be classified by racial background and age. In addition, a larger sample size from a multicentre setting should be used, and results should be compared between normal subjects and those with temporomandibular disorders. ◆

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