

RELIABILITY OF DIAGNOSTIC INDEX FOR THE MAXIMUM MOUTH OPENING ASSESSMENT

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ABSTRACT

Objective: The objective of this research was to examine the correlation between the maximum mouth opening range, diagnostic index for the maximum mouth opening assessment and height of subjects.

Subjects and methods: The sample included 60 healthy subjects (students) of either gender in the 20-26 age range. The maximum mouth opening range without vertical overbite, the width of three fingers (the index, middle and ring fingers) and four fingers (with the additional little finger) up to the first distal interphalangeal folds of the right and left hand that the subjects could position vertically between the incisors were measured using a digital caliper precision of 0.001 mm. The body height of all subjects was also recorded.

Results: The mean value of the maximum mouth opening in all subjects was 52.32 ±5.65 mm. There is a positive correlation between the maximum mouth opening and the width of three fingers of the right hand ($r = 0.31$) and the left hand ($r = 0.33$). Also, there is a strong correlation between the maximum mouth opening and the width of four fingers of the right hand ($r = 0.78$) and the left hand ($r = 0.76$). There is also a correlation between the subjects' height and the maximum mouth opening ($r = 0.36$).

Conclusion: There is a correlation between the maximum mouth opening, the width of three and four fingers of the right and left hand and the subjects' height. Therefore, the diagnostic index as a simple method in clinical practice can be used for the normal maximum mouth opening assessment, which facilitates the clinical diagnosis of limited mouth opening in temporomandibular disorders.

Key words: normal maximum mouth opening, mandibular movements, temporomandibular disorders.

Introduction

Maximum mouth opening (MMO) is an indicator of the function of temporomandibular joint and masticatory system [1, 2]. The previous studies have shown that the MMO values are determined by numerous factors (age, gender, height, weight, race) and they are specific for a particular population [3, 4, 5]. Values of the normal MMO show great individual variations in the 32-77 mm range in adults thus making the assessment and diagnostic of limited maximum mouth opening more difficult. On the average, men have greater MMO values by 5mm in relation to women due to different anthropometric characteristics. The MMO values in men are in the 40-77mm range with the most frequent values in the 50-60 mm range, while in women it is in the 32-75 mm range with the most frequent values in the 45-55mm range [3, 6, 7]. Some authors claim that the MMO value is limited if the interincisal distance is less than 40 mm, while others claim that the MMO is limited if the interincisal distance is less than 35 mm in men and less than 30 mm in women, respectively [4,8]. Limited mouth opening is an important diagnostic parameter in numerous pathological clinical conditions, but it is most frequent in patients with temporomandibular disorder (TMD). Therefore, in order to diagnose the limited mouth opening it is important to know the normal MMO values for a particular population [9]. For the assessment of the normal maximum mouth opening it is recommended to use the width, respectively, the ability of vertical positioning of three fingers (the index, middle and ring finger) or four fingers (with the additional little finger) of the hand between the upper and lower central incisors at the maximum mouth opening. The aim of the MMO assessment by using this index, which is proportional to body size, is to find a simple method for the normal MMO assessment in everyday practice [10].

The objective of this research was to examine the correlation between the maximum mouth opening range, the diagnostic index for the maximum mouth opening assessment and height of subjects.

Subjects and methods

The research was carried out in the Department of Prosthodontics, Faculty of Dentistry at Sarajevo University. The sample included 60 healthy subjects

(students) of either gender in the 20-26 age range. The subjects were previously informed about the research and they gave their consent in a written form. The subjects were included according to the following criteria: their upper and lower anterior teeth were preserved; their maxillomandibular relationships were preserved; they had no TMD history; they had no head trauma or tooth abrasion. The subjects who had or were in the process of an orthodontic treatment or those subjects who had orthognatic surgical operations, extensive restoration treatments, especially in the area of anterior teeth, or the subjects with a different vertical position of incisal edges of central incisors, and also those with fixed prosthodontic appliances in the frontal region were excluded. The case history was taken for all subjects as well as a detailed intraoral and extraoral clinical examination. The measurements were taken with a subject sitting in the upright position in a dental chair so that the Frankfurt plane was parallel with the floor. The subject was given instructions to open the mouth maximally three times while the greatest distance between the incisal edges of the central incisors was taken as a reference value. The MMO range was measured as a distance between the incisal edges of the upper and lower central incisors without vertical overbite by using the digital caliper with 0.001 mm precision.

At the maximum mouth opening the subject attempted to vertically positioning of the three and four fingers of the right and left hand up to the first distal interphalangeal folds between the upper and lower central incisors. It was recorded. The measurements of the width of three fingers (the index, middle and the ring fingers) and four fingers (with the additional little finger) respectively, up to the first distal interphalangeal folds of the right and left hand were taken by using the same digital caliper. The height of all subjects was also recorded.

Statistical data evaluation

Statistical data evaluation was done in the SPSS Statistics program, version 21. In data analysis descriptive statistical methods (mean values, standard deviation and standard error, minimum and maximum values) were applied. For the assessment of significant differences in MMO values between men

and women and among four measurements t-test of dependent samples was used. The correlation between the MMO and the width of three and four fingers of the right and left hand, and also the correlation between the MMO and the subjects' height was tested by applying Pearson's linear correlation. The significant level was $p < 0.05$.

Results

Out of the total number of subjects (60) in the 20-26 age range, on average $23, 6 \pm 1, 66$ years old, 29 subjects were males while 31 subjects were females. The mean MMO value in males was 54.78 ± 6.25 mm with a greater standard deviation, in females 50.01 ± 3.87 mm, while in all subjects 52.32 ± 5.65 mm. The difference in mean MMO values between males and females was significant ($p < 0.01$) (Table 1). The mean values of the width of three and four fingers of the right and left hand are presented in the Table 2. All

subjects could position three fingers of the right and left hand vertically between the upper and lower incisors at the maximum mouth opening. The mean MMO value in all subjects was significantly greater than the values of the width of three fingers of the right hand (48.74 ± 3.79 mm) and the left hand (47.74 ± 3.73 mm) ($p < 0.000$). Out of the total of 60 subjects only 35 subjects could position four fingers of the right and left hand between the upper and lower incisors at the maximum mouth opening. The mean value of MMO in all subjects was less (52.31 ± 5.65 mm) than the mean MMO values in subjects who could position vertically four fingers of the hand between the upper and lower incisors (55.21 ± 4.98 mm). The mean MMO value in 35 subjects who could position the four fingers of the right and left hand between incisors was significantly smaller in relation to the width of four fingers of the right hand (62.22 ± 4.50 mm) and the left hand (61.58 ± 4.48 mm) ($p < 0.000$). The great standard deviation indicates to a great inter-individual variation in the maximum mouth

		Maximum mouth opening (mm)					Std. Error	P
		Number	Mean	Standard Deviation	Minimum	Maximum		
Gender	Male	29	54.78	6.25	43.12	68.20	1.159	0.01
	Female	31	50.01	3.87	40.22	55.97	0.695	
Total		60	52.32	5.65	40.22	68.20	0.072	

Table 1. Mean values of maximum mouth opening and gender differences

		The width of three and four fingers of the hand (mm)					
		Number	Three fingers right	Three fingers left	Number	Four fingers right	Four fingers left
Male	Mean±SD	29	51.67±2.37	50.55±2.54	16	65.55±3.89	64.87±3.99
	Minimum		45.54	43.14		58.24	58.28
	Maximum		56.59	54.83		72.31	71.59
Female	Mean±SD	31	46.02±2.66	45.13±2.58	19	59.42±2.76	58.82±2.66
	Minimum		39.95	39.92		52.37	52.79
	Maximum		51.06	51.77		62.14	63.81
Total	Mean±SD	60	48.75±3.79	47.75±3.73	35	62.22±4.51	61.59±4.49
	Minimum		39.95	39.92		52.37	52.79
	Maximum		56.59	54.83		72.31	71.59

Table 2. Descriptive statistical values of width of three and four fingers of the right and left hand

		Mean	Number	Standard Deviation	Standard Error Mean	t	df	Sig.
Pair 1	MMO	52.3155	60	5.65188	0.72965	4.811	59	0.000
	Width of 3 fingers of right hand	48.7475	60	3.79050	0.48935			
Pair 2	MMO	52.3155	60	5.65188	0.72965	6.281	59	0.000
	Width of 3 fingers of left hand	47.7495	60	3.73333	0.48197			
Pair 3	MMO	55.2191	35	4.98203	0.84212	-13.144	34	0.000
	Width of 4 fingers of right hand	62.2226	35	4.50563	0.76159			
Pair 4	MMO	55.2191	35	4.98203	0.84212	-11.599	34	0.000
	Width of 4 fingers of left hand	61.5886	35	4.48622	0.75831			

Table 3. Comparison of mean values of maximum mouth opening measurements and width of three and four fingers of right and left hand

opening range and the width of four fingers of the right and left hand (Table 3).

Correlation between MMO and the width of the three fingers of the right hand ($p < 0.05$) and left hand ($p < 0.01$) was significant, but the low correlation coefficient indicates to a weak correlation between MMO and the width of the three fingers of the right ($r = 0.31$) and the left hand ($r = 0.33$) (Table 4). Correlation between MMO and the width of four fingers of the right and left hand was significant ($p < 0.01$), while the correlation coefficient indicates a strong correlation between MMO and the width of four fingers of the right ($r = 0.78$) and the left hand ($r = 0.76$) (Table 5). The mean value of height in all subjects was 174, 14 cm. The correlation between MMO and the height of subjects was significant, but the correlation coefficient indicates a weak correlation ($r = 0.36$; $p < 0.01$) which was shown in Table 6.

Discussion

Numerous pathological conditions, temporomandibular disorders (TMD), traumas, oral malign diseases, odontogenic infections, congenital and development anomalies are characterized by a limited mouth opening. Therefore, for a correct diagnosis and the implemen-

		MMO	Width of 3 fingers of right hand	Width of 3 fingers of left hand
MMO	Pearson Correlation	1	0.311*	0.336*
	Sig. (2-tailed)		0.016	0.009
	Number	60	60	60
Width of 3 fingers of right hand	Pearson Correlation	0.311*	1	0.947**
	Sig. (2-tailed)	0.016		0.000
	Number	60	60	60
Width of 3 fingers of left hand	Pearson Correlation	0.336**	0.947**	1
	Sig. (2-tailed)	0.009	0.000	
	Number	60	60	60

* Correlation is significant at the 0.05 level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed).

Table 4. Correlation between MMO and width of three fingers of right and left hand in all subjects

		MMO	Width of 4 fingers of right hand	Width of 4 fingers of left hand
MMO	Pearson Correlation	1	0.784**	0.769**
	Sig. (2-tailed)		0.000	0.000
	Number	35	35	35
Width of 4 fingers of right hand	Pearson Correlation	0.784**	1	0.978**
	Sig. (2-tailed)	0.000		0.000
	Number	35	35	35
Width of 4 fingers of left hand	Pearson Correlation	0.769**	0.978**	1
	Sig. (2-tailed)	0.000	0.000	
	Number	35	35	35

** Correlation is significant at the 0.01 level (2-tailed)

Table 5. Correlation between MMO and width of four fingers of right and left hand

tation of treatment for the limited mouth opening, which is a reliable indicator of pathological [11] and traumatic conditions, it is necessary to define the normal values of maximum mouth opening in a particular population [9,12]. In the present research the mean MMO values in all subjects were 52.32 ± 5.65 mm. The previous researches have shown wide variations of MMO values in different populations, so in Croats these values are 50.8 mm [13], in Greek men 52.85 mm [14] and women 48.34 mm, in Irish 42.2 mm [9], in Chinese 49.10 mm [5], in Americans 48.8 mm [10], in Mexicans 46.61 mm [3] and in Malaysians population 45.64 mm [15]. These variations in mean values of the maximum mouth opening could be explained by the influence of various factors on MMO (age, gender, height, weight, gonial angle, ramus length of mandible and race). Differences in research results may also be caused by the use of different methodologies and measurements [3, 6, 9, 11, 16, 17]. The difference in the mean MMO value between genders was statistically significant ($p < 0.01$) (Table 1). In the present research the mean MMO values in men were greater by 4.77 mm in relation to women. Our results are in accordance with the results obtained by Casanova –Rosado et al. [3] Yao et al. [5] Cortese et al. [7], Gallagher et al. [9], Kitsoulis et al. [16]. This difference can be explained by differences in the anatomical characteristics of genders; men are in general taller and bigger than women [3, 5]. The results of previous study found that range of mouth opening reduces with age independently from gender and function of TMJ [9].

All subjects could position three fingers of the right and left hand vertically between the upper and lower incisors up to the first distal interphalangeal folds, while only 35 subjects could position four fingers of the right and left hand. This index is recommended for the normal MMO assessment [10].

		MMO	Height
MMO	Pearson Correlation	1	0.362**
	Sig. (2-tailed)		0.005
	Number	60	60
Height	Pearson Correlation	0.362**	1
	Sig. (2-tailed)	0.005	
	Number	60	60

** Correlation is significant at the 0.01 level (2-tailed)

Table 6. Correlation between MMO and height of all subjects

The mean MMO value in all subjects was significantly greater in relation to the mean values of the width of three fingers of the right and left hand ($p < 0.000$). The mean MMO value in 35 subjects who could position four fingers of the right and left hand between the incisors at the maximum mouth opening was significantly lower in relation to the width of four fingers of the right and left hand ($p < 0.000$). This can be explained by the fact that the subjects could actively and maximally open the mouth more than they did it at the MMO measurement because all subjects could position the three fingers of the hand, while 35 subjects could also position four fingers of the right and left hand between the incisors at the MMO (Table 3.).

The research results have shown a significant but weak correlation between MMO and the width of three fingers of the right and left hand. However, there is a significant strong positive correlation between MMO and the width of four fingers of the right hand and the left hand (Table 4., 5.) In comparison with our results Zawawi et al. [10] found a strong positive correlation between MMO and the width of three fingers of the right and left hand. In the previous study a smaller number of subjects could position four fingers of the right and left hand between the incisors at the maximum mouth opening. The mean values of the width of four fingers of the right and left hand were significantly greater than the mean MMO values while the correlation between these measurements was stronger, and that is in conformity with our results.

Agrawal et al. measured the MMO range and the width of the three fingers of the right and left hand on a sample of 500 healthy subjects. The results of the studies showed that there was a statistically significant difference in the mean MMO values (51 ± 0.62 mm) and the width of three finger of the right (46 ± 0.52 mm) and left hand (45 ± 0.53 mm) in subjects aged 18-29 in the first group (125). Also, there is a significant correlation ($p < 0.05$) between the MMO mean and the width of three finger of the right and left hand [18] corresponding to our findings. The findings of our study suggest that positioning the three and four fingers of the hand at the maximum mouth opening can be used as a positive diagnostic finding for distinguishing normal from the limited opening of the mouth, which facilitates clinical diagnosis.

Examination of the opening mandibular movements have shown a significant difference in the maximum mouth opening capacity between the Class I and the Class II groups (47.8 ± 4.7 mm ; 45.4 ± 5.0 mm ($p \leq 0.05$) and in the protrusive mandibular movements between the groups. The maximum protrusion was 8.6 ± 1.5 mm in the Class I group and 11.2 ± 1.5 mm in the Class II group ($p < 0.001$) [19]. In the present research defining criterion did not include the subjects' malocclusion. Abduo-Atme and associates [6] have shown that the width of three and four fingers of the hand can be used for the MMO assessment in children.

There is a significant correlation ($r=0.36$) between MMO and subjects' height. Our results are in accordance with the results of Muto and Kanazawa [20], Ingervall [21] and Vanderas [22]. Muto and Kanazawa claim that MMO is in a greater correlation with mandible size than body height [20]. The results of the study that included 452 subjects aged 20-35 showed that there was a positive correlation between MMO and the height of the examinees [23].

Conclusion

There is a correlation between the maximum mouth opening, the width of three fingers and four fingers of the right and left hand and the subjects' height. Therefore, the diagnostic index as a simple method in clinical practice can be used for normal maximum mouth opening assessment thus facilitating the clinical diagnosis of limited mouth opening in temporomandibular disorders.

Conflict of interest

The authors declare no conflict of interest.

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