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DIAGNOSTIC METHODS: ORIGINAL RESEARCH

Correlations between the Helkimo indices and the maximal mandibular excursion capacities of patients with temporomandibular joint disorders

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ABSTRACT

Temporomandibular disorders (TMD) may present with diverse signs and symptoms, and one very significant is the limitation of mandibular movements. Additionally, the Helkimo indices allow for the reliable quantification of the signs and symptoms of TMD. The purpose of this study was to ascertain whether there are any correlations between the Helkimo indices and the maximal mandibular excursion capacity in a group of patients with TMD. Eighty patients (72 women and 8 men, mean age 33.6 years) with diagnosis of TMD according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were evaluated to obtain the Helkimo indices and their maximal mandibular excursion capacities. Normal or decreased maximum mandibular movements, i.e., opening, lateral and protrusion were compared with the anamnestic index, muscular pain symptoms, joint pain symptoms and the dysfunction index. Chi-squared analysis was used to compare normal and decreased movement capacities in terms of the Helkimo indices, and the muscle and temporomandibular joint (TMJ) pain. The statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 19.0. There were statistically significant differences in the clinical dysfunction index with the maximum opening ($p = .011$) and lateral movements ($p = .024$) but not with the maximum protrusion. There were no significant differences in the anamnestic index or the muscle pain and TMJ pain items of the clinical dysfunction index according to the mandibular excursions. The occurrences of limitations in the maximum opening and lateral movements are indications of greater TMD intensity.

1. Introduction

Temporomandibular disorders (TMD) may present with diverse signs and symptoms. The most frequent symptoms are facial pain, headache, joint noises and difficulty with jaw function. Additionally, many signs may be verified in these patients, such as tenderness, limited range of motion, deviation of motion and joint noise (Yekkalam and Wänman, 2014). The limitation of mandibular movements is one very significant symptom of TMD. This symptom has been described as painfully restricted jaw opening. Significant associations of some signs and symptoms related to the TMD and abnormal vertical and horizontal excursions have been reported (Luz et al., 1995; Miller et al., 2014).

Measurements of mandibular border positions have been purported to indicate the functional status of the stomatognathic system (Luz et al., 1995; Miller et al., 2014). One of the criteria used is the consideration of the limited maximal opening when this opening is smaller than 40 mm (Miller et al., 2014). Moreover, studies of the efficacies of therapies for TMD have been based on mandibular movement measurements (Alajbeg et al., 2015; Gawriolek et al., 2015), including pain-free maximum mouth opening (Calixtre et al., 2016).

In contrast, the use of indices allows for the reliable quantification of the signs and symptoms of these disorders based on symptomatology and standardized clinical examination. One of the

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most used indices is that proposed by Helkimo (1974a). This index includes the anamnestic index and the clinical dysfunction index. The former is based mainly on the chief complaint, and the latter analyses items such as impaired range of movement, impaired temporomandibular joint (TMJ) function, muscle pain, TMJ pain and pain upon movement of the mandible. The values obtained can be used to classify the dysfunction according to its severity (Helkimo, 1974b).

The purpose of this study was to ascertain whether there are any correlations between the Helkimo indices and the maximal mandibular excursion capacity in a group of patients with TMD.

2. Materials and methods

A total of 80 consecutive patients (72 females and 8 males), who had been diagnosed with TMD and were referred to the Temporomandibular Disorders and Orofacial Pain Clinic of the Oral and Maxillofacial Surgery Department were included regardless of race or social status. The patients came from public dental or medical health services with provisional, previously given TMD diagnosis. TMD was diagnosed based on the chief complaint presented by the patients followed by a clinical examination that was conducted according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Schiffman et al., 2014). The TMD diagnosis was established using the DC/TMD diagnostic decision tree, the completed clinical examination form and the symptom questionnaire. The cases who presented with previous orthodontic treatment, maxillofacial trauma, orthognatic or temporomandibular joint surgery, fibromyalgia syndrome, neurological disorders or congenital craniofacial abnormalities, as well those with histories of any form of treatment involving splints or physiotherapy in the period of three months before the evaluations were excluded from the study. All participants have read and signed informed consent form. This study was approved by the Research Ethics Committee of the institution.

The Helkimo (1974a) anamnestic and clinical dysfunction indices and the maximal mandibular excursion capacity were obtained for each patient. The data were collected before treatment.

To acqusition of the indices of Helkimo (1974a) began with the anamnestic dysfunction index (Ai), which comprises the following classes: Ai0 - absence of subjective symptoms of dysfunction; AiI - mild symptoms, such as TMJ sounds, including clicking and crepitation, and feelings of stiffness or fatigue of the jaws; and AiII - severe symptoms of dysfunction, such as difficulty in opening the mouth wide, locking, luxations, pain on movement, and facial and jaw pain.

Subsequently, the clinical index of dysfunction (Di) was obtained based on the clinical examination and comprised the following classes that were based on the following data from an objective examination of the masticatory and cervical musculatures and the TMJ. 1) Impaired range of movement/mobility index, which was scored as follows: normal = 0 points, slightly impaired = 1 point, and severely impaired = 5 points. 2) Impaired TMJ function as follows: smooth movements without TMJ sounds and deviation on opening or closing movements of ≤2 mm = 0 points; TMJ sounds in one or both joints and/or deviation >2 mm = 1 point; and locking and/or luxation of the TMJ = 5 points. 3) Muscle pain as follows: no tenderness to palpation in the masticatory muscles = 0 points; tenderness to palpation at 1–3 sites = 1 point; and tenderness to palpation at 4 or more sites = 5 points. 4) TMJ pain: no tenderness to palpation = 0 points; tenderness to palpation laterally = 1 point; and tenderness to palpation posteriorly = 5 points. 5) Pain upon movement of the mandible as follows: no pain on movement = 0 points; pain on one movement = 1 point; and pain on two or more movements = 5 points (Helkimo, 1974a).

These points were summed and enabled the classification of the patients into the following groups: 0 points (dysfunction group 0) clinically symptom free = Di0; 1–4 points (dysfunction group 1) mild dysfunction = DiI; 5–9 points (dysfunction group 2) moderate dysfunction = DiII; 10–13 points (dysfunction group 3); 15–17 points (dysfunction group 4); and 20–25 points (dysfunction group 5), all of them classified as severe dysfunction = DiIII (Helkimo, 1974a).

The maximal mandibular excursions were registered during active opening, right and left latererotrusion and protrusion. The mandibular opening was measured as the distance in millimetres between the incisal edges of the upper and lower left central incisors. The maximum opening was obtained by including the vertical overbite. The maximum extent of the lateral mandibular movement was measured as the distance between the maxillary incisor midline and a vertical line inscribed on the mandibular incisors at the position at which the former line falls in occlusion. During laterotrusion, the individual was instructed to move the mandible maximally to the right and to the left while keeping the opposing teeth in contact. The lateral movement value was obtained as the sum of right and left maximal movements. Finally, the individual was instructed to protrude the mandible while also keeping the opposing teeth in contact. The protrusion was measured as the horizontal distance between the buccal borders of the upper and lower left central incisors. The maximum protrusion was corrected by including the horizontal overbite (Luz et al., 1995). The capacity of the maximum mandibular opening movements was considered normal when the measurement was equal to or more 40 mm, was considered decreased when the movement was less than this value, and the lateral movements and maximal protrusion were considered normal when the measurements were equal to or more 14 mm and 7 mm respectively; otherwise these parameters were considered to be decreased (Fricton and Shiffman, 1987).

The following (simplified) formula was used to calculate the sample size (minimum size), for the proposed data collection (Pocock, 1983), in order to fulfill the objectives of the research:

$$n = \frac{[p_1 \times (100\% - p_1) + p_2 \times (100\% - p_2)] \times f(\propto;\beta)}{(p_1 - p_2)^2}$$

where: n = desired sample size; p1 = expected success percentage in the Normal group (mandibular movements), in the '5' category of clinical dysfunction (4.55%); p2 = expected success percentage in the Diminished group (mandibular movements), in the '5' category of clinical dysfunction (35.71%); difference between p1 and p2 = 31.16%; $\alpha = 0.05$ (type 1 error); $\beta = 0.10$ (type 2 error) or power of 0.90 (90%); f (α; β) = 10.5, for the respective values of α and β. From this, it follows that if we want to observe a difference of 31.16%, we need a minimum sample size of 30 sample elements.

The statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 19.0 (IBM Software Group, Chicago, USA). The data were cross-tabulated between each maximum mandibular movement and the anamnestic index of dysfunction, the clinical index of dysfunction, and the muscle pain and TMJ pain that are components of the clinical index of dysfunction. Chi-squared analysis was used to compare normal and decreased movement capacities in terms of the Helkimo's indices, and the muscle and TMJ pain. The level of significance was set at 5% ($p < .050$).

3. Results

There was a predominance of the anamnestic dysfunction index AiII (53.8%), which indicated severe symptoms of dysfunction. Relative to the clinical index of dysfunction, there was a

predominance of patients in dysfunction group 2 (DiII) (27.5%), which indicated moderate dysfunction. Muscle pain scores of 5 points (55.0%), which indicated tenderness to palpation in 4 or more sites, and TMJ pain scores of 5 points (53.6%), which indicated tenderness to posterior palpation, the latter being components of the clinical index of dysfunction, predominated in this sample.

There was a predominance of normal maximum mandibular opening (82.5%), and only a few cases presented with decreased opening (17.5%). The cross-tabulation between the classification of the maximum mandibular opening and the anamnestic dysfunction index is presented in Table 1. There was no significant difference ($p = .475$). The cross-tabulation between the classification of the maximum mandibular opening and the clinical index of dysfunction is presented in Table 2. There was a significant difference ($p = .011$). However, in the cross-tabulations between the classification of mandibular opening with muscle pain ($p = .973$) and with TMJ pain ($p = .860$), there were no significant differences.

There was a predominance of decreased lateral movements (55%), and the remaining cases presented with normal lateral movements (45%). The cross-tabulation between the classification of the lateral movements and the anamnestic dysfuntion index is presented in Table 3. There was no significant difference ($p = .264$). The cross-tabulation between the classification of the lateral movements and the clinical index of dysfunction is presented in Table 4. There was a significant difference ($p = .024$). However, in the cross-tabulations of the classification of lateral movements with muscle pain ($p = .175$) and TMJ pain ($p = .079$), there were no significant differences.

There was a predominance of decreased maximal protrusion (77.5%), and the remaining cases presented with normal maximal protrusion (22.5%). The cross-tabulation between the classification of the maximal protrusion and the anamnestic dysfunction index is presented in Table 5. There was no significant difference ($p = .454$). The cross-tabulation between the classification of the maximal protrusion and the clinical index of dysfunction is presented in Table 6. There was no significant difference ($p = .601$). Moreover, in the cross-tabulations of the classification of lateral movements with muscle pain ($p = .519$) and TMJ pain ($p = .550$), there were no significant differences.

4. Discussion

With the purpose of verifying whether there are any correlations between the Helkimo indices and the maximal mandibular excursion capacity in a group of patients with TMD, this study demonstrated that there were statistically significant differences in the clinical dysfunction index according to the maximum opening and lateral movements measures. These findings allow for the interpretation that the occurrences of limitations of maximum opening and lateral movements are indicators of greater TMD intensity. These results support the concept that the limitation of mandibular movements is a frequent sign of the TMD and results in significant functional impairment among patients (Miller et al., 2014; Gawriolek et al., 2015).

The Helkimo anamnestic and clinical dysfunction indices are reliable and have been widely used in the literature (Helkimo, 1974a, 1974b; Rodrigues et al., 2016). These indices have been used in epidemiological studies of TMD, which was their initial purpose (Helkimo, 1974a, 1974b). Moreover, these indices have been used to verify the results of splint therapy for TMD (He et al., 2014) and ortognathic surgery (Antonarakis et al., 2017), and in the search for correlations between TMD and factors such as age,

Table 1
Cross-tabulation between the maximum mandibular opening and the Helkimo's anamnestic index of dysfunction n(%).

Maximum opening n(%)	Anamnestic dysfunction index			Total
	Ai0	Ai1	Ai2	
Normal	5	27	34	66
	7.6	40.9	51.5	100.0
Decreased	0	5	9	14
	0.0	35.7	64.3	100.0
Total	5	32	43	80
	6.3	40.0	53.8	100.0

Normal = opening ≥ 40 mm; Decreased = opening < 40 mm.

Table 2
Cross-tabulation between the maximum mandibular opening and the Helkimo's clinical index of dysfunction according to the group n(%).

Maximum opening n(%)	Group of clinical dysfunction index						Total
	0	1	2	3	4	5	
Normal	2	9	19	19	14	3	66
	3.0	13.6	28.8	28.8	21.2	4.6	100.0
Decreased	0	3	3	1	2	5	14
	0.0	21.4	21.4	7.1	14.3	35.7	100.0
Total	2	12	22	20	16	8	80
	2.5	15.0	27.5	25.0	20.0	10.0	100.0

Normal = opening ≥ 40 mm; Decreased = opening < 40 mm.

Table 3
Cross-tabulation between the lateral movements and the Helkimo's anamnestic index of dysfunction n(%).

Lateral movements n(%)	Anamnestic dysfunction index			Total
	Ai0	Ai1	Ai2	
Normal	4	14	18	36
	11.1	38.9	50.0	100.0
Decreased	1	18	25	44
	2.3	40.9	56.8	100.0
Total	5	32	43	80
	6.3	40.0	53.8	100.0

Normal = lateral movement ≥ 14 mm; Decreased = lateral movement < 14 mm.

Table 4
Cross-tabulation between the lateral movements and the Helkimo's clinical index of dysfunction according to the group n(%).

Lateral movements n(%)	Group of clinical dysfunction index						Total
	0	1	2	3	4	5	
Normal	0	2	11	12	10	1	36
	0.0	5.6	30.6	33.3	27.8	2.8	100.0
Decreased	2	10	11	8	6	7	44
	4.6	22.7	25.0	18.2	13.6	15.9	100.0
Total	2	12	22	20	16	8	80
	2.5	15.0	27.5	25.0	20.0	10.0	100.0

Normal = lateral movement ≥ 14 mm; Decreased = lateral movement < 14 mm.

Table 5
Cross-tabulation between the maximal protrusion and the Helkimo's anamnestic index of dysfunction n(%).

Maximal protrusion n(%)	Anamnestic index			Total
	Ai0	Ai1	Ai2	
Normal	0	8	10	18
	0.0	44.4	55.6	100.0
Decreased	5	24	33	62
	8.1	38.7	53.2	100.0
Total	5	32	43	80
	6.3	40.0	53.8	100.0

Normal = protrusion ≥ 7 mm; Decreased = protrusion < 7 mm.

Table 6
Cross-tabulation between the maximal protrusion and the Helkimo's clinical index of dysfunction according to the group n(%).

Maximal protrusion n(%)	Group of clinical dysfunction index						Total
	0	1	2	3	4	5	
Normal	0	3	5	6	4	0	18
	0.0	16.7	27.8	33.3	22.2	0.0	100.0
Decreased	2	9	17	14	12	8	62
	3.2	14.5	27.4	22.6	19.4	12.9	100.0
Total	2	12	22	20	16	8	80
	2.5	15.0	27.5	25.0	20.0	10.0	100.0

Normal = protrusion ≥ 7 mm; Decreased = protrusion < 7 mm.

malocclusion and activity of the involved muscles (Lauriti et al., 2014; Munhoz and Hsing, 2014). Severe symptoms of dysfunction were predominant in terms of the anamnestic index, moderate dysfunctions were predominant in terms of the clinical index of dysfunction, the muscle pain measure at many sites, and TMJ pain upon posterior palpation, which indicated that the sample exhibited typical TMD symptomatology (Yekkalam and Wänman, 2014).

There was a significant difference in the cross-tabulation between the classification of the maximum mandibular opening and the clinical index of dysfunction. There were more cases with higher degrees of dysfunction in the group with limitations of maximum mandibular opening. The limitation of maximum mouth opening is an important clinical finding in TMD and may be related to myalgia and/or anterior displacement of the articular disc (Miller et al., 2014; Alajbeg et al., 2015; Gawriolek et al., 2015). In general, the treatment of TMD with splint therapy, which may be associated with physical therapy, leads to improvement in the symptomatology together with improvement in the maximal mandibular opening (Miller et al., 2014; Alajbeg et al., 2015; Gawriolek et al., 2015; Calixtre et al., 2016; Sault et al., 2016).

There was also a significant difference in the cross-tabulation between the classification of the lateral movements and the clinical index of dysfunction. There were more cases with higher degrees of dysfunction in certain groups among those with limitations of the lateral movements. The limitation of lateral movements is another clinical finding in TMD that may be related to myalgia and/or anterior displacement of the articular disc (Luz et al., 1995; Miller et al., 2014; Gawriolek et al., 2015). The use of a sublingual relaxation splint has been effective in the improvement of lateral movement range (Gawriolek et al., 2015).

There was no significant difference in the cross-tabulation between the classification of the maximum protrusion and the clinical index of dysfunction. Although there was no correlation between this diminished movement and the clinical index of dysfunction, the limitation of maximal protrusion is a clinical finding in TMD and may be related to myalgia and/or anterior displacement of the articular disc (Miller et al., 2014; Gawriolek et al., 2015). Although the treatment of TMD with splint therapy and physical therapy can improve maximal protrusion (Luz et al., 1995; Miller et al., 2014), such results have been less frequently reported (Gawriolek et al., 2015).

In this study, statistically significant differences between the clinical dysfunction index and the maximum opening and lateral movements were observed, but no such difference was observed for the maximum protrusion. These findings lead to the interpretation that the occurrences of limitations of maximum opening and lateral movements are indications of TMD of greater intensity. However, it is interesting to note that with respect to movement dysfunction, the Helkimo index is simpler and involves only three categories, i.e., normal, slightly impaired and severely impaired mobility (Helkimo, 1974a), whereas other more complete indices, such as the CMI comprise sixteen items such as the values for the movements, the presence of deviations in opening and closing and pain upon movements (Fricton and Shiffman, 1987). One limitation of this study was the non-use of subjects without complaints of TMD for evaluation of correlation. It was decided not to include subjects without TMD issues that were considered healthy due to the fact that the values of the Helkimo indexes are very low or zero value, precluding the assessment of correlation.

Regarding therapeutic implications of limitation of mandibular movements, it has been shown clinically that physical therapy exercise regimen for the treatment of myogenic TMD is effective in relieving myogenic symptoms as function impairment, pain and maximum mouth opening (Morell, 2016).

Conflicts of interest

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