

# Accuracy of temporomandibular joint disc displacement diagnosis in panoramic radiography: Validation by magnetic resonance imaging

## Acurácia do diagnóstico de deslocamento de disco da articulação temporomandibular por radiografia panorâmica: validação utilizando imagem por ressonância magnética

### Abstract

**Purpose:** To investigate if panoramic radiography would be a suitable tool to diagnose temporomandibular joint disc displacement.

**Methods:** The sample comprised 56 female patients divided into three groups: (1) Control (n=30); (2) disk displacement with reduction (n=17); and (3) disc displacement without reduction (n=9). All patients were evaluated according to the Research Diagnostic Criteria (RDC/TMD). Linear and angular measurements and proportion determinations were obtained from tracings of panoramic radiographs. They were compared with condyle and disc positioning obtained from Magnetic Resonance Imaging (MRI) images to assess any predictive measurement associated with disc displacement with or without reduction. Possible relationship to clinical signs and symptoms of TMD was also evaluated.

**Results:** There was no significant difference among the three groups regarding the radiograph variables. No significant association was found between radiographic variables and clinical signs or between the radiographic and MRIs variables.

**Conclusion:** The use of panoramic radiography imaging exam for diagnostic prediction in clinical practice does not seem advisable.

**Key words:** Temporomandibular joint disorders; panoramic radiography; magnetic resonance imaging

### Resumo

**Objetivo:** Investigar a possibilidade de utilização de medidas obtidas em radiografias panorâmicas como instrumento preditivo para o diagnóstico de deslocamento de disco da articulação temporomandibular.

**Metodologia:** A amostra foi composta por 56 pacientes do sexo feminino divididos em três grupos: (1) controle (n=30); (2) deslocamento do disco com redução (n=17); e (3) deslocamento do disco sem redução (n=9). Todas as pacientes foram avaliadas com base nos Critérios Diagnósticos de Pesquisa para Desordens Temporomandibulares (RDC/TMD). Medidas lineares e angulares, bem como proporções foram obtidas a partir de traçados em radiografias panorâmicas e estas foram comparadas com o posicionamento do côndilo e disco obtidos a partir de Imagens por Ressonância Magnética (MRI). Correlações com sinais clínicos e sintomas de disfunção temporomandibular (DTM) também foram avaliadas.

**Resultados:** Não houve diferença significativa entre os três grupos em relação às variáveis estudadas nas radiografias. Não foram encontradas associações significativas entre as variáveis radiográficas e os sinais clínicos nem entre as variáveis radiográficas e de ressonância magnética.

**Conclusão:** O uso de medidas em radiografias panorâmicas como preditoras do diagnóstico de deslocamento de disco na prática clínica não parece ser aconselhável.

**Palavras-chave:** Disfunção temporomandibular; radiografia panorâmica; ressonância magnética

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## INTRODUCTION

Temporomandibular disorder (TMD) is a multifactorial condition and it has been associated with psychological dysfunctions and sexual dimorphism with coincidental occurrence along the pubertal development (1). The diagnosis of TMD involves a combination of questionnaires, clinical exams and complementary imaging exams (2). For such, magnetic resonance imaging (MRI) is considered the gold standard for disc displacement diagnosis (3-5). The advantages of MRI are evident due to the visualization of both mineralized and non-mineralized structures of the temporomandibular joint (TMJ) and the absence of known accumulative biological effects of radiowaves and magnetism. The main disadvantages of this exam are its high cost as well as the need for sophisticated equipment and specialized personnel (6).

Panoramic radiographs are extremely widespread in the diagnosis and planning of dental treatment due to their easy execution and low cost (7). For the diagnosis of TMD, the information provided by radiographs is reported as being limited (8). Nevertheless, some variables encountered in this type of exam were considered compatible with a diagnosis of internal derangement (9). Studies assessing the reliability and accuracy of panoramic radiographs in patients with TMD are rare and normally focus on the presence of abnormalities in the shape of the bone structures (7,8,10). Studies associating linear, angle and proportion measurements with clinical signs of TMD are also scarce.

The main objective of this study was to investigate if panoramic radiography would be a suitable tool to diagnose temporomandibular joint disc displacement, exploring if any angle or proportion measured in panoramic radiography would be more prevalent in or associated with patients diagnosed with disc displacement by MRI. Measurements and proportion determinations were obtained from tracings of panoramic radiographs and they were compared with condyle and disc positioning obtained from MRI.

## METHODS

The study was approved by the Institutional Ethics Committee (CAAE – 0007.0.380.000-07). The sample was comprised of 56 female subjects, 18 to 60 years old. The patients had a diagnosis of anterior disc displacement with and without reduction by MRI and were divided into three groups: (1) control (non-symptomatic subjects) (n=30); (2) disc displacement with reduction (n=17); and disc displacement without reduction (n=9). All clinical and MRI evaluations have been previously described (11) and are briefly reported below.

### Clinical evaluation

All participants underwent clinical examination based on the Research Diagnostic Criteria (RDC/TMD) (12). The clinical evaluation was performed by a single trained

professional. The RDC/TMD index was used before the MRI exam in order to investigate clinical signs and symptoms of disc displacement that would justify MRI examination. The RDC was also used to standardize jaw amplitude movements and pain scale (13) data collection. In the control group, the clinical exam from Axis 1 of the RDC was used for the selection of non-symptomatic individuals.

### Image assessment

Images were obtained with positions of closed and fully open mouth. All subjects underwent MRI of the TMJ obtained by a 2 Tesla scanner (Elscent Prestige, Haifa, Israel) with surface coils (14).

### Disc position

The position of the disc with the mouth closed was based on the clock face using the thickest part of posterior band as reference (15). Discs located anteriorly to the 11 o'clock position were considered displaced (5,15). Images with mouth open were used to confirm the clinical diagnosis of displacement with or without reduction as well as to assess mandibular excursion. Discs classified as normal were interposed between the lowermost portion of the eminence and the uppermost portion of the condyle (4). Disc displacement was considered to be with reduction when the disc was positioned between the uppermost portion of the condyle and the lowermost portion of the eminence with movement with the mouth open. The diagnosis of disc displacement without reduction was considered when the disc remained anteriorized in relation to the structures of the condyle and eminence in the sagittal images.

### Condyle position

The condyle position in the sagittal images with the mouth closed was determined based on Gelb's template (in postural rest position and maximum intercuspation, since in maximum opening the condylar position was not inside the areas determined by the drawn lines), which classifies the normal position of the condyle tracing five lines – three horizontal and two vertical lines. The template and positions have been described previously (16,17).

### Panoramic radiographs

The bilateral contours of the condyle and ramus in the panoramic radiographs were traced onto Ultrafan® paper. A single investigator performed the tracing on all the radiographs. Seven points were marked on each side, from which six variables were evaluated (3 lines, 1 angle and 2 proportions). All variables were evaluated as described by Ahn et al. (9). The linear measurements consisted of ramus height, condyle height and height of the condyle head. The angle measurement was defined by the angle between the condyle axis and ramus tangent (ACA-RT). The proportions consisted of the relation between the height of the condyle head and ramus height (HCH-RH) as well as the relation between the condyle height and ramus height (CH-RH). For the calculation of measurement error, 15 radiographs

were randomly selected and the tracing was repeated, with a two-week interval between measurements. The Kappa agreement index between measurements was > 0.85.

Statistical analysis

The data for the linear, angle and proportion determinations were analyzed by using analysis of variance (ANOVA), Kruskal-Wallis test, Person's correlation coefficient and Spearman's correlation coefficient, at a 5% level of significance. Bivariate regression model was applied for the identification of factors independently associated with the presence disc displacement with or without reduction. Variables that achieved a *P*-value of ≤0.30 were used as potential predictors of TMD and inserted as covariates in the multivariate analysis. Multivariate logistic regression was performed controlling for age, with a significance level of *P*<0.05. The software SPSS 9.0, (Chicago, USA) was used for all analyses.

RESULTS

There was no statistically significant difference among groups regarding the linear and angular measurements or the proportion determinations in the panoramic radiographs (Table 1).

Table 2 displays the results of the correlation between the proportions and angle obtained in the panoramic radiographs and the following clinical variables: pain (VAS), maximal opening of the mouth and maximal lateral movement. No significant correlations were found between the variables (*P*>0.05). Spearman's correlation analysis between the variables on the panoramic radiographs and condyle position, disc position and condyle excursion obtained on the MRIs revealed no significant correlations (*P*>0.05) (Table 3).

The stepwise backward logistic regression showed no association of radiographic variables with the studied sample (Table 4).

**Table 1.** Comparison of proportions and angles obtained in the panoramic radiographs between the Control, Displacement with reduction and Displacement without reduction groups.

	Mean ± standard deviation			P-value
	Control	Displacement with reduction	Displacement with reduction	
HCH	0.633±0.16	0.641±0.17	0.617±0.26	0.850*
CH	2.138±0.41	1.956±0.39	2.094±0.38	0.127†
RH	4.660±0.443	4.631±0.464	4.389±0.411	0.076†
HCH/RH	0.132±0.03	0.135±0.04	0.140±0.06	0.922*
CH/RH	0.463±0.11	0.421±0.12	0.470±0.13	0.222†
ACA/RT	1.816±10.29	3.093±11.41	3.611±10.89	0.070†

HCH/RH: relation between height of condyle head and ramus height; CH/RH: relation between condyle height and ramus height; ACA-RT angle between condyle axis and ramus tangent.

\* Kruskal-Wallis test; † One-Way ANOVA.

**Table 2.** Correlation (Pearson's coefficient) between proportions and angles obtained on panoramic radiographs and clinical pain (VAPS), maximal opening (mm) and lateral movement (mm).

	Displacement with reduction	Displacement without reduction
HCH/RH and VAPS	r=-0.144 P=0.596	r=-0.410 P=0.274
CH/RH and MO	r=-0.093 P=0.730	r=-0.102 P=0.793
ACA/RT and LAT	r=-0.043 P=0.873	r=0.598 P=0.089

HCH/RH: relation between height of condyle head and ramus height; CH/RH: relation between condyle height and ramus height; ACA-RT angle between condyle axis and ramus tangent; VAPS: visual analogue pain scale; MO: Maximal opening of mouth; LAT: Maximal lateral movement.

**Table 3.** Correlation (Spearman's coefficient) between proportions and angles obtained on panoramic radiographs and variables obtained from MRI.

	Condyle position	Disc position	Condyle excursion
HCH/RH	r=-0.159 P=0.268	r=-0.087 P=0.547	r=-0.037 P=0.795
CH/RH	r=-0.114 P=0.429	r=0.218 P=0.127	r=0.052 P=0.714
ACA/RT	r=0.134 P=0.353	r=0.091 P=0.524	r=-0.165 P=0.250

HCH/RH: relation between height of condyle head and ramus height; CH/RH: relation between condyle height and ramus height; ACA-RT angle between condyle axis and ramus tangent.

**Table 4.** Stepwise backward logistic regression used to test the association of radiographic variables with TMD (disc displacement with and without reduction) as the dependent variable in the studied sample.

Dependent variable	Independent variables	Coef.	P-value	Odds ratio	IC	Significance of the model		
						R <sup>2</sup>	P-value	Power
TMD	constant	2.676	–					
	15-R	–	0.591					
	16-R	–	0.632					
	11-R	–	0.358					
	15-L	–	0.350					
	16-L	–	0.611					
	11-L	–	0.882			0.112	0.055	0.709
	HCH/R	–	0.521					
	CH/R	–	0.992					
	RH/R	–	0.196					
	HCH/L	–	0.293					
	CH/L	–	0.403					
RH/L	–	0.341						

TMD: temporomandibular dysfunction. 11: angle between condyle axis and ramus tangent; 15: relationship between height of the condyle head and ramus height; 16: relationship between condyle head and ramus height. HCH: height of condyle head; CH: condyle height; RH: ramus height; R: right side; L: left side.

## DISCUSSION

Due to its economic advantages, panoramic radiography would be an extremely useful tool if there were an association between the diagnosis performed with this type of imaging and clinical criteria or MRI for patients with internal derangement of the TMJ. However, the present study found no significant differences in the variables obtained in panoramic radiographs in individuals with and without internal derangement. These findings suggest the limitation of using panoramic radiography in the diagnosis of TMD.

With the enormous advance in imaging techniques, panoramic radiography has lost its place with regard to precise diagnoses of the TMJ, mainly due to its limitations regarding the visualization of soft tissues. Even in the diagnosis of mineralized tissues, use of this imaging modality is restricted to delayed bone abnormalities (6). The accuracy and reliability of diagnoses regarding condyle shape in patients with TMD was assessed through a comparison of blind evaluations of the TMJ on panoramic radiographs, using MRIs and the clinical exam as the gold standards. However, the results were discouraging (18).

Morphological bone variations among individuals and superposing artifacts contribute to the absence of relationship between panoramic measurements and disc displacement. Besides, bone remodeling can induce changes similar to those of dysfunction patients, and this could explain the high prevalence of radiological alterations in healthy individuals (19).

In a previous study, individuals with disc displacement without reduction exhibited resorbed, reduced condyles inclined distally when compared to individuals with discs in the normal position or those with displacement with reduction. Internal derangement in the TMJ has been

associated with skeletal changes in the head of the mandible (9). In the present study, however, no significant differences were found in the same variables studied by Ahn et al. (9) when patients with disc displacement with and without reduction were compared to control patients. It should be stressed that the differences between the two studies may be related to the equipment employed (9), resolution of images, sample size regarding disc displacement without reduction in particular and age of patients, since older patients tend to present more pronounced signs of the disease (20).

The combination of a clinical exam and imaging exam of the TMJ are often used in the diagnosis of TMD (21). The relationship between the variables in the panoramic radiographs (ACA-RT, HCH-RH and CH-RH) and the pain scale, range of mandibular movement, condyle position, disc position and condyle excursion was analyzed. There were no significant correlations among these variables in the sample studied. These findings are compatible with previous studies that have sought a correlation between the signs and symptoms of TMD and imaging findings (22,23). The results suggest that the severity of internal derangement has no association with the intensity of pain reported by the patient. This corroborates previous studies that found internal derangement in 30% of asymptomatic volunteers (5) and 13.8% of discs in a normal position in symptomatic patients (24). The number of healthy individuals with abnormalities in disc position ranges from 17.5% to 35% (4,5,20,25). Thus, the fact that the disc is not correctly positioned is not indicative of the presence of signs and symptoms of TMD.

The relation between the presence of signs and symptoms of TMJ and condyle position remains controversial (24). A number of studies on the position of the condyle and its therapeutic implications have shown that pain and limited opening of the mouth are not present in all cases (25).

The assessment of reliability, validity, risk, cost and usefulness of a diagnostic procedure is an essential part of the treatment plan for patients with TMD. Panoramic radiographs are frequently solicited in initial examinations of patients with orofacial pain. These exams may reveal bone or condyle positioning abnormalities. However, even when these conditions are encountered, they do not normally relate to the clinical condition or influence decisions regarding the treatment plan (7). This was evidenced in the present study by the lack of significant associations between clinical variables (pain, range of mandible movement) and condyle position or disc displacement.

In conclusion, there was no relationship between the variables obtained on the panoramic radiographs and

MRIs and clinical signs of internal derangement, thereby contraindicating the use of this type of imaging for diagnostic prediction in clinical practice.

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