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MANDIBULAR ASYMMETRY IN PATIENTS WITH TEMPOROMANDIBULAR DISORDER: COMPARATIVE STUDY BETWEEN POSTEROANTERIOR TELERADIOGRAPHS (PA) AND PANORAMIC RADIOGRAPHY

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ABSTRACT

Objective: The aim of the study was to verify the relationship between the predominant side of orofacial pain of a temporomandibular origin and facial asymmetry. **Methods:** Fifty-two patients a acted by temporomandibular disorders from which data were collected on the results of the RDC/TMD evaluation related to pain. Anatomic points (ANS – Anterior nasal spine; LF – Lingual foramen; CP – Coronoid process; GO – Gonial angle) were identified on panoramic radiographs and frontal teleradiographs and bilateral measurements were made. **Results:** No statistically significant differences were found between the sides with/without pain (p=0,560), but a tendency was found for patients with unilateral pain to have larger measurement differences in the comparison of the two sides. However, when using only the difference from one side to the other in cases of bilateral pain, a significant difference in CP/ANS (Coronoid process to anterior nasal spine) distance was found on the panoramic radiographs (p=0,044). **Conclusion:** Correlations were found between the cephalometric measurements on the two radiographic exams, but the measurements on the images did not demonstrate an association with the predominant side of pain.

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INTRODUCTION

Temporomandibular disorder (TMD) encompasses clinical problems that involve alterations in the stomatognathic system, particularly the muscles of mastication and components of the temporomandibularjoint (TMJ). This condition has a multifactor etiology as well as complex signs and symptoms, the most frequent of which are pain in or around the joint, limited and/or asymmetrical mandibular movements and joint sounds. The most common complaints of patients are pain in the TMJs and/or pre-auricular region, headache and earache (Salemi *et al.,* 2015; Mazzetto *et al.,* 2013 and Schiffman *et al.,* 2014). The neuromuscular system responsible for stomatognathic functions has a high potential to adapt to new conditions. When the compensatory resources of this system are overloaded, pain of a temporomandibular origin can emerge unilaterally or bilaterally, triggered by mandibular movements or palpation of the muscles of mastication and TMJ.

This pain can irradiate to different regions, such as the teeth and dental support structures, periodontium, ears, temples and neck muscles (Wieckiewicz *et al.,* 2015; Ries *et al.,* 2014 and Liang *et al.,* 2016). In some individuals, TMD stemming from either a primary cause or predisposing factor may be associated with mandibular asymmetry. Asymmetrical loads can exert an influence on intra-articular pressure, with a negative impact on the structures of the TMJ. Internal alterations can also influence the normal growth/development of mandibular structures, affecting the skeleton, muscles and corresponding facial tissues (Chang *et al.,* 2015; Vasconcelos *et al.,* 2012; Kheir and Kau, 2014 and Thiesen *et al.,* 2015). Asymmetry can be found in the base of the skull, maxillary arch and mandibular arch (Chang *et al.,* 2015) and varies largely among studies. Vasconcelos *et al*. (2012) found a variation of 21 to 85% in the frequency of facial asymmetry. The authors suggest that this considerable variation depends on the characteristics used in different studies for the evaluation of asymmetry. The mandible has one of the highest percentages of asymmetry in the human skull, which, according to Kheir and Kau (Kheir and Kau, 2014), can be as much as 74%. The structures of the lower third of the face are generally more asymmetrical than those of the upper and middle thirds (Thiesen *et al.,* 2015). The diagnosis of facial asymmetry is performed using cephalometry, radiography, a clinical examination, plaster study models and photographs (Vasconcelos *et al.,* 2012; Kheir and Kau, 2014; Almasan *et al.,* 2013; AlHadidi *et al.,* 2011 and Ryu *et al.,* 2015). Despite limitations, the structures of the TMJ can be seen using conventional radiography (panoramic or transcranial), computerized tomography and nuclear magnetic resonance (Salemi *et al.,* 2015; Ferreira *et al.,* 2016; Ladeira *et al.,* 2015; Damstra *et al.,* 2013; Alqattan *et al.,* 2015 and Oh *et al.,* 2013). The aim of the present study was to determine the possible association between the predominant side of orofacial pain of a temporomandibularorigin and facial asymmetries measured on radiographic exams.

MATERIALS AND METHODS

This study was conducted as part of a project entitled "Relationship between craniofacial measurements and stomatognathic functions in individuals with temporomandibular disorder", which was approved by the human research ethics committee of the Paraná Evangelical Beneficent Society (certificate number: 1.468.768). An exploratory, quantitative study was conducted with a random sample of patient charts from the archives of the Center for the Diagnosis and Treatment of the Temporomandibular Joint and Functional Dento-Facial Alterations (CDTMJ) of the T*uiuti University of Paraná* in 2014 and 2015. As part of the CDTMJ protocol, patient data (medical-dental history and the results of a screening questionnaire for orofacial pain) are collected during the patient's first visit to the center. Patients with positive screening for orofacial pain are submitted to an evaluation involving the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), which is an internationally accepted method for research involving TMD. Panoramic radiographs and normofrontal, posteroanterior (PA) teleradiographs are also taken. The present study only involved the analysis of patient charts and radiographic images. Therefore, no patients were submitted to any risk. The purpose of the study was to determine whether it is possible to identify facial asymmetry in routine dental exams that could assist in the diagnosis of TMD and orofacial pain. The following were the inclusion criteria:

- Patients treated at the CDTMJin 2014 and 2015;
- Panoramic radiograph and PS teleradiograph attached to the patient's file;
- Properly completed RDC/TMD questionnaire;
- Attached signed statement of informed consent authorizing the anonymous use of the data.

The following were the exclusion criteria:

- Patients less than 18 years or older than 65 years of age;
- Radiographs that were not in perfect state of storage;
- Radiographs not performed by the same technician and/or same equipment;
- Radiographs and posteroanterior teleradiographs (PA) that were not acquired on the same day;
- Radiograph of poor quality that led to doubts regarding the identification of anatomic structures;
- RDC/TMD questionnaires that had not been filled out correctly or had missing information;
- Information that was unclear regarding the side and duration of pain.

Anatomic points were identified and marked on the panoramic radiographs and posteroanteriortele radiographs (PA) with a red back-projector marker by a single technician who had undergone training and calibration exercises (Figures 1 and 2). The following anatomic points were defined for the measurements:

- ANS–Anterior nasal spine, located on the midline, most radiopaque portion, below the nasal septum.
- LF–Lingual foramen, small radiolucent area, with circular radiopaque halo, located on midline of mandible, below apex of central incisor, appearing in center of genial spines.
- CP – Coronoid process, identified on panoramic radiograph, but overlapping occurs on PA teleradiograph; narrower and radiopaque in front of head of mandible; marking standardized on highest point of coronoid process in both exams.
- GO –Gonial angle, lowest and posterior most point of angle of mandible.

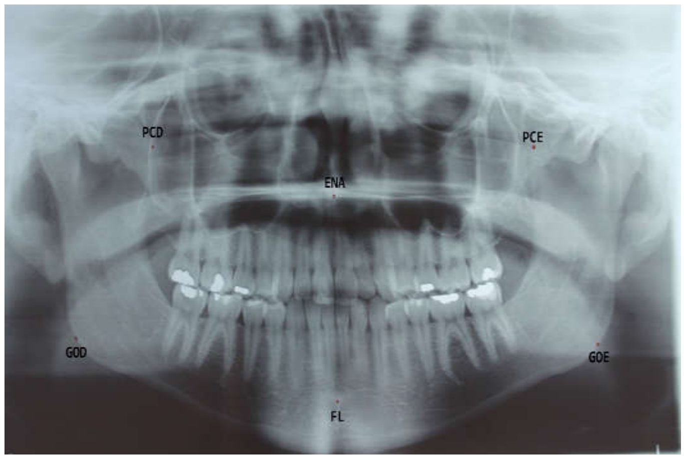

Figure 1.

The following distances were measured:

- Coronoid process to gonium – CP-GO
- Coronoid process to anterior nasal spine – CP-ANS
- Coronoid process tolingual foramen – CP-LF
- Gonium to anterior nasal spine – GO-ANS
- Gonium to lingual foramen – GO-LF
- Anterior nasal spineto lingual foramen – ANS-LF

The measurements were made on the side with pain and the side without pain on both the panoramic radiographs and posteroanterior teleradiographs (PA) (Figures 3 and 4). The distances between points were measured with a transparent plastic millimeter ruler, recorded in a table on A4 sulfite paper and subsequently entered into a table on Excel 2010® with the following information: patient name, age, sex, side with pain, duration of pain (in months) and measurements (in millimeters) on the panoramic radiograph and posteroanterior teleradiographs (PA).

Figure 2.

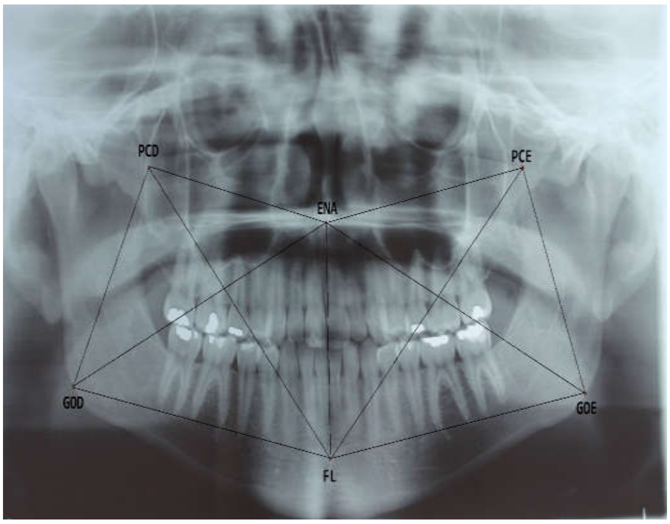

Figure 3.

The data were submitted to statistical analysis using the SPSS 20.0 Statistics IBM®. The nonparametric Mann-Whitney test was used for the categorical variable "side of pain" and measurement differences between the sides with and without pain on both radiographs. The level of significance was set to 5% ($p < 0.05$). Pearson's correlation coefficients were calculated to determine correlations between the measurements performed on the panoramic radiographs and those on the teleradiographs as well as to correlate differences in the measurements in relation to the duration of pain. Correlation coefficients were interpreted as follows: < 0.4 = weak correlation, ≥ 0.4 to< 0.5 = moderate correlation and ≥ 0.5 = strong correlation.

Figure 4.

RESULTS

Fifty-two charts were examined with the respective panoramic radiographs and posteroanterior teleradiographs (PA). Thirteen patients (25%) were male and 39(75%) were female. Twenty-five patients (48.07%) had pain on both sides of the face, 19 (36.58%) reported pain on only one side and eight (15.38%) reported having no pain (GRAPHIC1). Mean age of the patients analyzed was 37 years (range: 18 to 65 years). Patient-reported duration of pain ranged from three months to 30 years (mean: 5 years) The differences in the measurements on the side with pain and side without pain were not significantly associated with duration of pain (Table 1).

Table 1. Differences in the measurements on the side with pain and side without pain and duration of pain (months). (n=52)

	DURATION OF PAIN				
	Mean (SD)	Median	Min	Max	p*
UNILATERAL	64,05 (88,910)	24,00	1	360	0,560
BILATERAL	76,36 (96,507)	36,00	0	360	

*Mann-whitney test

To evaluate the correlation between the side with pain and the side without pain, the Mann-Whitney test was used between the categorical variable "side with pain" and the numeric variables of the measurements between the sides with and without pain. The differences in the measurements between categories were not statistically significant ($p \geq 0.05$) (Table 2). In the comparison of the measurements on the side with unilateral pain and bilateral pain, the difference in the CP/ANS distance was statistically significant on the panoramic radiograph (Table 3).

Table 2. Comparison of side of pain and side without pain and measures the x-ray panoramic and pa radiographs (n=52)

		Measures							
		Panoramic x-ray				Posteroanteriorcephalometric			
		Median	Min	Max	p*	Median	Min	Max	p*
GO/ANS	Unilateral Pain	5	0,5	11	0,199	2	0	6,5	0,599
	Bilateral Pain	2,25	0	14,5		1,5	0	9,5	
GO/CP	Unilateral Pain	2	0	9,5	0,962	2	0	7,5	0,972
	Bilateral Pain	2	0	8,5		2	0	7	
CP/ANS	Unilateral Pain	5,5	0,5	9,5	0,076	2	0	10,5	0,877
	Bilateral Pain	2,75	0	9,5		2	0	8,5	
GO/LF	Unilateral Pain	4,5	0	22	0,618	3	0	8	0,6
	Bilateral Pain	4,25	0	20		2,5	0	13,5	
CP/LF	Unilateral Pain	4	0	17,5	0,943	3	0,5	9	0,311
	Bilateral Pain	3,25	0	13,5		2,25	0	9,5	
ANS/LF	Unilateral Pain	58	39	70	0,749	42	37,5	52	0,441
	Bilateral Pain	58,5	43,5	68,5		45	34	54	

***Mann-Whitney test**[Gonium to anterior nasal spine GO/ANS), Coronoid process to gonium (GO/CP), Coronoid process to anterior nasal spine (CP/ANS), Gonium to lingual foramen (GO/LF), Coronoid process to lingual foramen (CP/LF), Anterior nasal spine to lingual foramen (ANS/LF)].

Table 3. Difference of measures between groups with unilateral and bilateral pain (n=52)

			MEAN	**Median**	**Mín**	**Máx**	**p***
GO/CP	Panoramic x-ray	Unilateral Pain	2,68	2,0	0	9,5	0,957
		Bilateral Pain	2,46	2,0	0	8,5	
	Posteroanteriorcephalometric	Unilateral Pain	2,39	2,0	0	7,5	0,968
		Bilateral Pain	2,4	2,0	0	7,0	
CP/ANS	Panoramic x-ray	Unilateral Pain	4,78	5,5	0,5	9,5	**0,044**
		Bilateral Pain	3,22	3,0	0	9,5	
	Posteroanteriorcephalometric	Unilateral Pain	2,68	2,0	0	10,5	0,860
		Bilateral Pain	2,64	2,0	0	8,5	
GO/LF	Panoramic x-ray	Unilateral Pain	6,86	4,5	0	22,0	0,572
		Bilateral Pain	5,2	4,5	0	20,0	
	Posteroanteriorcephalometric	Unilateral Pain	3,42	3,0	0	8,0	0,552
		Bilateral Pain	3,48	2,5	0	13,5	
CP/LF	Panoramic x-ray	Unilateral Pain	4,34	4,0	0	17,5	0,936
		Bilateral Pain	4,06	3,5	0	13,5	
	Posteroanteriorcephalometric	Unilateral Pain	3,26	3,0	0,5	9,0	0,251
		Bilateral Pain	2,74	2,5	0	9,5	
GO/ANS	Panoramic x-ray	Unilateral Pain	5,15	5,0	0,5	11,0	0,145
		Bilateral Pain	4,16	3,0	0	14,5	
	Posteroanteriorcephalometric	Unilateral Pain	2,36	2,0	0	6,5	0,551
		Bilateral Pain	2,42	1,5	0	9,5	

* Mann-Whiney Gonium to anterior nasal spine GO/ANS), Coronoid process to gonium (GO/CP), Coronoid process to anterior nasal spine (CP/ANS), Gonium to lingual foramen (GO/LF), Coronoid process to lingual foramen (CP/LF), Anterior nasal spine to lingual foramen (ANS/LF)

Table 4. Correlation measurements in panoramic x-ray and posteroanterior cephalometric radiography

	CORRELATION MEASUREMENTS				
	CP/GO Panoramic x-ray	CP/ANSPanoramic x-ray	GO/LFPanoramic x-ray	CP/LFPanoramic x-ray	GO/ANSPanoramic x-ray
CP/GO Posteroanteriorcephalometric	0,751	0,453	0,397	0,540	0,543
CP/ANS Posteroanteriorcephalometric	0,518	0,510	0,420	0,520	0,485
GO/LF Posteroanteriorcephalometric	0,306	0,407	0,321	0,385	0,380
CP/LF Posteroanteriorcephalometric	0,598	0,451	0,308	0,559	0,424
GO/ANS Posteroanteriorcephalometric	0,606	0,493	0,558	0,554	0,625

* Pearson Gonium to anterior nasal spine GO/ANS), Coronoid process to gonium (CP/GO), Coronoid process to anterior nasal spine (CP/ANS), Gonium to lingual foramen (GO/LF), Coronoid process to lingual foramen (CP/LF)

Statistically significant correlations were found for the measurements made on the panoramic radiographs and posteroanteriortele radiographs (PA). A strong correlation was found regarding the CP/GO measurement (0.751) and moderate correlations were found for the CP/ANS (0.510), CP/LF (0.559) and GO/ANS (0.625) measurements ($p \leq 0.001$) (Table 4).

DISCUSSION

The correlations between the measurements performed on the posteroanteriorteleradiographs (PA) and panoramic radiographs were positive, which is in agreement with data described by Agrawal *et al*. (2015), who found comparable differences and a strong correlation, demonstrating that these methods can be used to detect facial asymmetry. Bulhar *et al.* (2014) analyzed the gonial angle on both types of radiographs and found a strong correlation using test Pearson's test. Ordobazari *et al*. (2011) found that facial asymmetry can be measured on posteroanteriorteleradiographs (PA) with the head in the natural position. According to Bavia and Rodrigues Garcia (2016), posteroanteriorteleradiographs (PA) can show asymmetry when both sides are compared. Using the measurement of mandibular segments to determine the proportion of asymmetry, Ribeiro *et al*. (2011) found that the panoramic radiograph is efficient for this purpose due to its simplicity and low cost. The authors found that differences in measurements between one side and the other tend to be greater when a panoramic radiograph is used compared to a posteroanteriorteleradiographs (PA), but the discrepancy is not statistically significant. In the present investigation, no significant differences were found between the measurements made on the side with pain and the side without pain. Although using a different method (mirroring), AlHadidi *et al*. (2011) also found no statistically significant differences in the mean measurements of surface distances between the right and left side. Thiesen *et al*. (2015) state that a difference of 2 mm is not enough for the recognition of asymmetry, whereas Choi (2015) and Santos and Vidor (2015) consider a difference of 3-4 mmto be insufficient for this purpose. No statistically significant differences were found in the comparison of the sides with and without pain, although there was a tendency for patients with unilateral pain to exhibit larger discrepancies in the measurements. Using a similar method and sample as those employed in the present study, Almasan *et al*. (2015) found significant differences in measurements made on posteroanteriorteleradiographs (PA) of patients with unilateral TMD. In the present investigation, a statistically significant difference in the measurement of CP/ANS was found on the panoramic radiograph of patients with unilateral pain when only considering the difference encountered between sides to make the comparison. No significant association was found been the duration of pain and differences between sides with and without pain. One of the hypotheses for this finding is that the mandible adapts to deviations by molding the head of the mandible and mandibular fossa, which suggests that asymmetry may be an adaptive response to functional demands (Lemos *et al.,* 2014) and individuals with some type of asymmetry do not necessarily report pain. According to Ries *et al*. (2014), individuals with pain or TMD exhibit asymmetry in the activation of the muscles of mastication as a compensatory strategy to find stability for the mandibular region or alleviate the intensity of the pain. However, it is believed that long-term nociceptive stimuli of the muscles of mastication can alter the chewing pattern, thereby perpetuating the cycle and generating further pain. Hotta *et al*. (2015) state that there is no evidence that the severity of TMD exerts an influence on the electromyographic activity of the masseter and temporal muscles or the asymmetry index of the muscles at physiological rest or during maximum voluntary contraction. According to Chang *et al*. (2015), one must not interpret facial asymmetry as a direct causal factor of TMD, considering the capacity of the TMJ to meet the functional demand, but a discerning evaluation is needed when this adaptive capacity is exceeded.

Bavia and Rodrigues Garcia (2016) found no association between craniofacial morphology and TMD, although the authors used lateral cephalometric radiographs and Ricketts analysis for the classification of the facial pattern. With regard to the image, Ladeira *et al*. (2012) state the enlargement is an equivalent increase on the horizontal and vertical axes, with no change in the shape of the image. When increases in the horizontal and vertical axes are independent, there is no distortion with the change in shape of the image. As the enlargement factor varies from machine to machine (30), care must be taken for radiographs to be taken by the same equipment. Vertical and transverse measurements were used in this study, since Belluzzo *et al*. (2013) state that the face has transverse growth and this is an important dimension to consider, with a positive mean correlation between transverse and vertical measurements. Moreover, Bhullar *et al*. (2014) report that panoramic radiographs can be used effectively to determine the gonial angle, which is one of the anatomic points used in the present study. As in the study by Al Taki *et al*. (2015), the images were all of adults (≥ 18 years of age) to ensure that mandibular growth had reached adult levels. Although cone beam computed tomography is the most indicated reference standard for the evaluation (Larheim *et al.,* 2015; Santos and Vidor, 2015; Bavia and Rodrigues Garcia, 2016 and Zhang *et al.,* 2016), facial asymmetry can be diagnosed well on panoramic radiographs and teleradiographs and the radiographic analysis is favored with normofrontal radiographs are combined posteroanteriorteleradiographs (PA) (Akhil *et al.,* 2015). Nonetheless, further studies should be conducted with computed tomography to determine the validity of the data observed herein with regard to the CP/ANS measurement.

Conclusion

Correlations were found between the cephalometric measurements on the two radiographic exams, but the measurements on the images did not demonstrate an association with the predominant side of pain.

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