CORRELATIONS BETWEEN DENTAL OCCLUSION AND UPPER CERVICAL SPINE

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ABSTRACT

Aim of the study This study aims to determine whether skeletal class and abnormal values of certain variables on cephalometry (cranio-vertebral angle, intervertebral functional spaces, the space between the anterior arch of the atlas and the anterior face of the odontoid process, the C2-7V line and the hyoid triangle) represent possible risk factors for the occurrence of muscle and joint dysfunction. Another objective is represented by the determination of a possible occlusal dysfunction pattern in patients with temporo-mandibular disorder. **Material and methods** Twenty patients with dysfunction and pain in the temporo-mandibular joint and masticatory muscles were included in the study (TMD group). Subsequently, the control group was chosen, which included 20 patients, who did not have joint and muscle damage, but who had occlusion disorders. In order to collect the data, the patient's file was used, with records on both static and dynamic occlusion and also the data regarding the analysis of the muscles and the temporomandibular joint. Rocabado cephalometric analysis was used to evaluate cervical spine parameters. In order to determine the skeletal class, the Steiner analysis was used. **Results** Seventy-five percent of patients in control group were class I, while in TMD group 40% of patients were class I, the others being uniformly divided between class II and III. The mean value of the cervical functional space in C0-C2 area was lower in TMD group compared to control group, while in C1-C2 area presented equal values for both groups. Following the Fisher test analysis of the relationship of the C2-7V line and the hyoid triangle, no statistically significant association was detected between them and groups ($p = 1$; $p = 0.305$). **Conclusions** Skeletal class II is a risk factor for TMD. There is no statistically significant correlation between the values of the variables determined by the Rocabado cranio-cervical cephalometric analysis, and the occurrence of TMD. No pattern has been identified between static occlusion and TMD. Nonfunctional dynamic occlusion does not represent a risk factor for TMD development.

Key words: dental occlusion, cervical spine, temporo-mandibular joint, disorder, cephalometry

INTRODUCTION

The relationship between the dental occlusion and the spine, especially its cervical area, represents an important topic to study nowadays, due to the anatomical and functional proximity between the two. Through the link that is established between these different entities, a new multimodal approach is possible in terms of treatment which targets the therapy of occlusal pathology and cervical spine at the same time, or on the contrary, the therapy of occlusal pathology with favorable repercussions on the condition of the cervical spine [1-4].

Due to the interconnection of important

components of the dento-maxillary apparatus (teeth with occlusal surfaces and incisal edges, periodontium, neuro-muscular complex and temporo-mandibular joint), the malfunction of one component influences the equilibrium of the other elements, determining functional disorders. Thus, a vicious circle occurs, which in the early stages is less alarming, but over time is accompanied by the appearance of morpho pathological changes characteristic for occlusal dysfunction. A pathological occlusion is traumatic causing disturbances of the neuro-muscular and articular complex and thus joint dysfunction [5]. By disturbing the function of the temporomandibular joint and the muscles implicitly, there is a tendency for occlusal correction by changing the cervical posture [6] and therefore possible anatomical abnormalities of the cervical spine. Clinical manifestations, such as chronic muscle pain or headaches, may also occur as a result of these changes. Studies show a positive correlation between cervical, joint and occlusal dysfunction and chronic cranio-cervical pain [7, 8].

Many investigation methods have been proposed for the measurement of the stability of the cranio-cervical articulation, the quantification of the musculoskeletal deficit, and also to serve as a starting point for the evaluation of the efficiency of the therapeutic interventions, such as: goniometer, inclinometers, visual estimation, tape measurements, photographic method and teleradiograph (X-ray) with its cephalometry [9-11].

Rocabado described one of the first cephalometric analyses in teleradiograph. [12] This method has been used in various studies, such as Zepa et al. [13] who evaluated the association between the thoracic kyphosis, posture of the head and craniofacial morphology in young adults and Abreu et al. [14] who analyzed the values of the variables on cephalometric investigation in children and adults with temporomandibular dysfunction.

The motivation of the present study was to contribute to the research and development of stronger arguments in favor of the existence of a link between dental occlusion and the cervical spine. The analysis of some common elements, close both anatomically and functionally: the temporo-mandibular joint and the muscles of the head and neck, more precisely their dysfunction, was taken into account.

The null hypothesis of the current study is that the abnormal functioning of the joint and muscles are a possible consequence of malocclusion and cervical spine pathology. This study aims to determine whether skeletal class and abnormal values of certain variables on cephalometry (cranio-vertebral angle, intervertebral functional spaces, the space between the anterior arch of the atlas and the anterior face of the odontoid process, the C2-7V line and the hyoid triangle) represent possible risk factors for the occurrence of muscle and joint dysfunction. Another objective is represented by the determination of a possible occlusal dysfunction pattern in patients with temporo-mandibular disorder.

MATERIAL AND METHODS

The current research is an observational, analytical and longitudinal, retrospective, case-control study, investigating the diseases with long evolution, such as spinal pathology, related to the pathological aspects of dental occlusion. Data collection was done by sampling. All patients expressed and signed their written consent form for inclusion in the study.

In the initial phase, 68 files of patients from a private clinic in Cluj-Napoca were analyzed. Twenty patients with dysfunction and pain in the temporo-mandibular joint and masticatory muscles were selected, revealing a dysfunctional occlusion with already present consequences. Subsequently, the control group was chosen, which included 20 patients, who did not have joint and muscle damage, but who had occlusion disorders.

Inclusion criteria for the case group consisted in: pain in the masticatory muscles, pain in the temporo-mandibular joint, disc displacement, joint sounds, changes in mandibular dynamics. Only patients in good general health and with complete analysis sheets in terms of occlusion, joint and muscle analysis were selected to be part of the study.

Exclusion criteria for the case group: patients who had tumors in the temporo-mandibular joint region, trauma to the temporo-mandibular joint, growing patients, patients with endocrine disorders, neurological disorders or other systemic conditions impacting the temporo-mandibular joint region. Also, the study did not include patients who had had an orthodontic appliance in the past, who did not have a profile teleradiograph or who did not sign the informed consent for the processing of personal data.

Inclusion criteria for the control group: patients with teleradiograph who presented for dental treatment (usually orthodontic), patients who had complete analysis sheets and general good health.

Exclusion criteria for the control group: patients with general disorders, patients with temporomandibular joint disorders and associated symptoms.

In order to collect the data, the patient's file was used, with records on both static occlusion (sagittal, transverse and vertical analysis at the incisors, canines and molars) and dynamic (propulsion and laterality movement) and also the data regarding the analysis of the muscles and the temporomandibular joint. The presence or absence of muscular and articular pain was noted, at the same time recording the analysis by auscultation for the temporo-mandibular joint, in order to detect the presence of articular sounds.

Rocabado cephalometric analysis was used to evaluate cervical spine parameters. Cephalometric analysis includes drawing different planes on the profile teleradiograph to determine angular or numerical values. More precisely, the following parameters were drawn: the McGregor plane (McG), which reunites the most posterior point of the hard palate with the most caudal point of the occipital curvature; the odontoid plane, which joins the apex of the odontoid process with the most anterior and inferior portion of the axis body. These two parameters are forming the cranio-vertebral angle. The functional spaces C0-C1, C1-C2 and C0-C2 were also measured, drawn between the most caudal point of the occipital curvature denoted C0 and the vertebra C1 and C2, respectively. Another measured space was that between the anterior arch of the atlas and the anterior face of the odontoid process. Cervical lordosis was analyzed using the C2-7 vertical line, drawn from the posterior area of the body of C2 and the posterior area of C7.

The Hyoid triangle was also measured between the most anterior and inferior point of the body of the C3 vertebra, the most posterior and inferior point of the chin symphysis (RGn) and the most anterior and superior point of the hyoid bone (H) [15].

In order to determine the skeletal class, the Steiner analysis was used. The SNA angle was drawn, between the Sellae point, which represents the center of the Turkish saddle, passing through the Nasion point corresponding to the nasal root and point A, ie the steepest point at the level of the anterior concavity of the jaw. The angle of the SNB, formed in the same way as above, with the difference that point B is at the level of the steepest point of the anterior concavity of the chin symphysis.

By determining the SNA and SNB values, the value of the ANB angle was determined, which highlights the skeletal class of the patient [16].

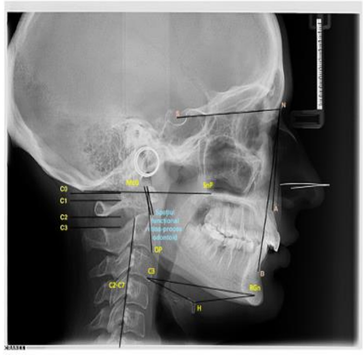

Figure 1. Rocabado and Steiner cranio-cervical cephalometric analysis

Statistical analysis

Histogram type graphs and cross bars were used for the descriptive analysis. The statistical tests aimed to compare the TMD group with the control group. For the analysis of continuous quantitative variables (cranio-vertebral angle values and functional space values) the normality of the data distribution was determined in the first stage by the Shapiro-Wilk test, and then, depending on its result, the difference between the data distribution was determined according to group through the t-student and Mann-Whitney tests. Also, for the interpretation of the t-student test, the equality test of F variants was performed. For the comparison between groups of the ordinal qualitative variables (cranio-vertebral angle, classification of functional spaces, hyoid triangle and skeletal class) the Mann-Whitney, and for the analysis of nominal quality values (C2-7V axis and hyoid triangle) the exact Fisher test. The threshold value for statistical significance was 0.05, a p <0.05 being considered statistically significant. Data collection and processing was performed in the Microsoft Excel version 365 program, and the analyzes were performed in the IBM SPSS version 20 program.

RESULTS AND DISCUSSIONS

The mean age in the TMD group was 34.5 ±9.06 years, while in the control group it was 28.5 ±7.91 years. In both groups most of the patients were women (n=16 (80%) in TMD group and n=13 (65%) in control group).

The results of static occlusion evaluation in both groups are presented in table 1.

Table 1. Static occlusion relations

Static occlusal relations			Group	
			TMD n (%)	Control n (%)
Incisor	Sagittal	N	10 (50)	2 (10)
		P	10 (50)	18 (90)
	Transversal	N	19 (95)	12 (60)
		P	1 (5)	8 (40)
	Vertical	N	8 (40)	5 (25)
		P	12 (60)	15 (75)
Right canine	Sagittal	N	12 (60)	10 (50)

		P	8 (40)	10 (50)
	Transversal	N	15 (75)	12 (60)
		P	5 (25)	8 (40)
	Vertical	N	17 (85)	14 (70)
		P	3 (15)	6 (30)
Left canine	Sagittal	N	9 (45)	12 (60)
		P	11 (55)	8 (40)
	Transversal	N	12 (60)	16 (80)
		P	8 (40)	4 (20)
	Vertical	N	5 (25)	16 (80)
		P	15 (75)	4 (20)
Right molar	Sagittal	N	11 (55)	14 (70)
		P	9 (45)	6 (30)
	Transversal	N	14 (70)	13 (65)
		P	6 (30)	7 (35)
	Vertical	N	13 (65)	12 (60)
		P	7 (35)	8 (40)
Left molar	Sagittal	N	11 (55)	9 (45)
		P	9 (45)	11 (55)
	Transversal	N	17 (85)	15 (75)
		P	3 (15)	5 (25)
	Vertical	N	18 (90)	13 (65)
		P	2 (10)	7 (35)

N= normal; P=pathological.

The results of dynamic occlusion evaluation in both groups are presented in table 2.

Table 2. Dynamic occlusion relations

Dynamic occlusion relations			Group	
			TMD n (%)	Control n (%)
Anterior guidance	Functional		3 (15)	6 (30)
	Working interferences		14 (70)	12 (60)
	Non-working interferences		4 (20)	1 (5)
	Working premature contacts		1 (5)	1 (5)
	Non-working premature contacts		4 (20)	1 (5)
Right lateral guidance	Functional	Canine	17 (85)	17 (85)
		Group	2 (10)	2 (10)
		Antero-lateral	1 (5)	1 (5)
	Working interferences		18 (90)	16 (80)
	Non-working interferences		7 (35)	5 (25)
	Working premature contacts		2 (10)	0 (0)
	Non-working premature contacts		0 (0)	0 (0)
Left lateral guidance	Functional	Canine	16 (80)	14 (70)
		Group	1(5)	4 (20)
		Antero-lateral	3 (15)	2 (10)
	Working interferences		17 (85)	15 (75)
	Non-working interferences		8 (40)	5 (25)
	Working premature contacts		2 (10)	0 (0)
	Non-working premature contacts		0 (0)	0 (0)

The position of the most superior and anterior point of the hyoid bone (H point) was situated lower than normal for 40% of patients in TMD group, while in control group 40% of patients presented a normal position.

Regarding the skeletal class, 75% of patients in control group were class I, while in TMD group 40% of patients were class I, the others being uniformly divided between class II and II.

The mean value of the cervical functional space in C0-C2 area was lower in TMD group compared to control group, while in C1-C2 area presented equal values for both groups (Fig. 2). The analysis of values of the cranio-vertebral angle, of the functional space C0-C1, of the functional space C1-C2 and of the functional space C0-C2, presented a normal distribution (p>0.05). The analysis of values of the space between the anterior arch of the atlas and the anterior edge of the odontoid process revealed a p <0.05, therefore the data do not follow a normal distribution. The normally distributed data had a value of p> 0.05 at the F test, so there are no differences between the data variance and therefore the t-student test was interpreted for equal variances. This was insignificant for all variables taken into account (p> 0.05). The result of the Mann-Whitney test was also statistically insignificant (p = 0.057), however close to the significance limit. Therefore, there is no statistically significant difference between the values of these angles between the studied groups.

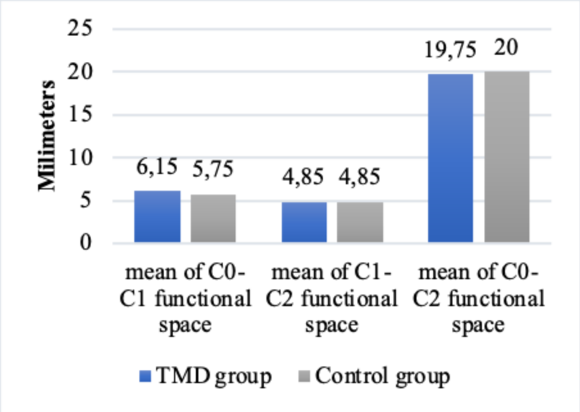

Figure 2. Mean values of cervical functional space analysed on cephalometry

Analyzing the classification of angle values between groups, using Mann-Whitney test, a statistically significant difference between the groups and the skeletal class was identified (p = 0.038). Following the Fisher test analysis of the relationship of the C2-7V line and the hyoid triangle, no statistically significant association was detected between them and groups (p = 1-no difference and p = 0.305).

The odds ratio for skeletal classes and groups was also analyzed and it was determined that patients in class II are 5 times more likely to be in the case group compared to those in class I (CI: 1.03-24.27, p = 0.04), and the chance for those in the third grade to be in the case group is 3.75 times higher compared to the control group, but the latter chance is not statistically significant (CI: 0.56-25.12, p = 0.17). Therefore, only belonging to the second class is a statistically significant risk factor to be part of the case group.

The null hypothesis was partially validated by the results of the current study. A significant statistical association was identified between the skeletal class and temporomandibular joint disorder (IC: 1.03-24.27, p=0.04). A positive correlation was identified between 2nd skeletal class and the presence of TMD. At the same time, abnormal values of variables analyzed on cephalometry (cranio-vertebral angle, intervertebral functional spaces, the space between the anterior arch of the atlas and the anterior face of the odontoid process, the C2-7 vertical line and the hyoid triangle) cannot be considered as risk factors for TMD.

After static occlusal analysis in both groups several aspects were observed: static occlusion relations were very variable and no certain pattern could be detected in any of the two groups, while related to dynamic occlusion, both in the TMD group as well as in the control group, the propulsion and lateral movements were mostly non-functional. Thus, from the present study it cannot be stated that there is a correlation between dental occlusion, muscle and joint dysfunction with parameters that describe aspects of normality or pathology of the cervical spine.

A positive correlation between malocclusion and muscle and joint dysfunction, has been cited in numerous studies [1- 6, 17, 18] therefore, this study only solidifies what other literature data have underlined and demonstrated [3, 19]. It is thus highlighted that, more patients with malocclusion presented both temporo-mandibular dysfunction, outlined by crackling, cracking, joint pain, and pain in the masseter, temporal, lateral and medial pterygoid muscles, compared to patients without malocclusion.

A study conducted in order to evaluate the effect of temporo-mandibular dysfunction through the prism of malocclusion classes on the cervical posture, supports the importance of the temporo-mandibular joint in the connection between dental occlusion and cervical spine pathology. This cross-sectional study considered 296 adolescents distributed in groups according to the presence and severity of temporomandibular dysfunction, using the Angle class of malocclusion and Helkimo-type questionnaires. Digital photogrammetry was used for the analysis and the predefined angle between the protuberance of the spinous process of the C7 vertebra, the sternal manubrium and the chin vertex was measured. The conclusion of the study was that subjects with temporomandibular dysfunction had an increased alteration of the position of the head and thus the cervical spine, compared to those without this type of dysfunction. Moreover, subjects with class II angle of malocclusion were correlated with the most obvious alterations in cervical posture [20].

Numerous studies indicate that cranio-cervical posture is a crucial factor in craniofacial architecture and TMJ dysfunction [1-9, 21, 22], but the results of the current study could not confirm this hypothesis. Research has revealed cranio-cervical postures, such as cranio-cervical angulation and mal-posturing of the first cervical vertebra (C1) and second cervical vertebra (C2), may be associated with the TMJ dysfunction. [23]. C1 is located at the occipital condyle’s joint surface, joining the skull at the atlanto-occipital joint represents an indispensable role for jaw mechanics in the development of head posture. Disturbing the posture of C1 and C2 are linked to spinal and head posture abnormalities [23,24] Mehobi et al reported a possible correlation between skeletal class 3 and cervical spine pathology [25].

A research that analyzes the same cephalometric parameters as the present study, investigates the difference between the values obtained before and after orthognathic surgery performed for the treatment of malocclusion. The results show that patients with class II and class III malocclusion had a low craniocerebral angle initially and then corrected with jaw and mandible repositioning surgery [26]. Therefore, although the present study does not prove the existence of a statistically validated association between the cranio-vertebral angles of patients in the two groups, it illustrates by descriptive data that in the TMD group, patients with Skeletal class II and III presented a lower mean of the cranio-vertebral angles compared to that of the control group.

The present study makes a connection both with the literature data that support the presence of a correlation between dental occlusion and the cervical spine, and with those that demonstrate the lack of reliability of this theory. The small number of patients represents a limitation of the currents study, but, at the same time, the case-control study is among the models of scientific research with medium to low value in the hierarchy of medical studies.

CONCLUSIONS

1. Skeletal class II is a risk factor for TMD.
2. There is no statistically significant correlation between the values of the variables determined by the Rocabado cranio-cervical cephalometric analysis, and the occurrence of TMD.
3. No pattern has been identified between static occlusion and TMD.
4. Nonfunctional dynamic occlusion does not represent a risk factor for TMD development.

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