Influence of maxillomandibular relationship, vertical dimension and posterior retainer in temporomandibular disorders

Influência da relação maxilomandibular, dimensão vertical e retentor posterior nas desordens temporomandibulares

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ABSTRACT
Introduction: There are professionals who believe in the relation between occlusal parameters and the presence of temporomandibular disorders (TMD) in the face of the controversy among the findings of numerous studies about this topic. Objective: to evaluate the association between maxillomandibular relationship (MMR), vertical dimension (VD) and posterior retainer (PR) with the presence of TMD. Methods: Of the 148 patients in the sample, 78 presented a diagnosis of TMD and 70 comprised the control group, from an examination with the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD - Axis I). The MMR relationship was evaluated by the frontal manipulation method of Ramfjord associated with swallowing and it was verified with carbon paper if they presented occlusion in centric relation (CR) or maximal habitual intercuspation (MHI); for the VD was used the metric method associated to phonetic; for PR, individuals with 0 to 2 occlusal units (OU), 3 to 5 OU (reduced dental arch) and 6 or more OU were categorized. Results: the majority of patients with altered Vertical Dimension of Occlusion (VDO) presented TMD (52.5%); there was no statistically significant association (p=0.495). Regarding MMR, 100% of patients with TMD occluded in MHI, while 95.7% of patients without TMD presented occlusion in MIH. The PR variable and the presence of TMD also had no association (p=0726 and p=0.054). Conclusion: In this way, there was no association between the occlusal parameters evaluated and the presence of TMD, although it was observed that the prevalence of TMD increased as the occlusal support was reduced.

Key words: Central Relationship, Dental Occlusion, Temporomandibular Joint Disorders.

RESUMO
Introdução: Há profissionais que acreditam na relação entre parâmetros oclusais e a presença de disfunção temporomandibular (DTM) frente a controversa entre achados de inúmeros trabalhos acerca desse tema. Objetivo: avaliar a associação entre a relação maxilomandibular (RMM), dimensão vertical (DV) e contenção posterior (CP) com a presença de DTM. Metodologia: Dos 148 pacientes da amostra, 78 apresentaram diagnóstico de DTM e 70 compuseram o grupo controle, a partir de exame com o *Research Diagnostic Criteria for Temporomandibular Disorders* (RDC/TMD - Eixo I). A relação RMM foi avaliada pelo método da manipulação frontal de Ramfjord associado ao da deglutição e verificou-se com o papel carbono se apresentavam oclusão em relação cêntrica (RC) ou máxima intercuspidação habitual (MIH); para a DV utilizou-se o método métrico associado ao fonético; para CP, categorizou-se os indivíduos com 0 a 2 unidades oclusais (UO), 3 a 5 UO (arco dental reduzido) e 6 ou mais UO. Resultados: a maioria dos pacientes com alteração da dimensão vertical de oclusão (DVO) apresentaram DTM (52,5%), não houve associação estatisticamente significativa (p=0,495). Quanto à RMM, 100% dos pacientes com DTM ocluíam em MIH, enquanto 95,7% dos pacientes sem DTM apresentavam oclusão em MIH. A variável CP e presença de DTM também não apresentaram associação (p=0726 e p=0,054). Conclusão: Desta forma, não houve associação entre os parâmetros oclusais avaliados e a presença de DTM, embora tenha se observado que a prevalência de DTM aumentou a medida que o suporte oclusal foi sendo reduzido.

Palavras chaves: Relação Central, Oclusão Dentária, Transtornos da articulação temporomandibular.

1 INTRODUCTION

Temporomandibular disorder (TMD) is considered a set of joint and muscular alterations that affect the orofacial region and is multifactorial in nature, without determination of a specific etiological agent[1]. It is represented by episodic pictures of musculoskeletal pain also involving other signs and symptoms, such as: headache, otologic manifestations (tinnitus, ear fullness and vertigo), muscle and TMJ sensitivity to palpation, alterations in mandibular movements and joint noises (clicks and crepitations). It is estimated that the prevalence of TMD in the world population is between 5% and 12%, although only about 2% require some intervention or treatment[2,3].

Pain has a prominence in dental care, as its involvement is high and increasing, being responsible for generating impact on quality of life due to situations of suffering and limitations. Chronic pain can cause secondary psychiatric disorders such as anxiety, depression, social phobia, decreased ability to work, and isolation and suffering from loss of concentration and self-confidence[1,4].

The stomatognathic system undergoes several changes, physiological or even pathological, among which alterations in the maxillomandibular relationship (MMR) can be verified. Thus, in addition to the patient presenting a habitual adaptive occlusion called the maximal habitual intercuspation (MHI), it often presents with a vertical dimension (VD) of the face altered by the absence of posterior teeth, which are responsible for the support and/or posterior retainer (PR)[1].

The centric relation (CR) consists of an MMR in which the condyles would be in their most antero-superior positions in the mandibular fossae, supported on the posterior slopes of the articular eminences with the properly positioned discs[1], while the MIH is the intermaxillary position where the largest number of dental contacts and is independent of the CR[5] position. There are differences regarding the influence of MMR on the etiology of TMD, since some authors have evaluated that the difference between CR and MHI values greater than 2 mm does not fit the normal functional occlusion criterion, that is, they can cause damage to the stomatognathic system and result in the appearance of TMD[5-7].

Certain signs and symptoms of an altered vertical dimension of occlusion (VDO) coincide with clinical characteristics suggestive of TMD, such as the difficulty of some movement of the mandible, painful symptoms and articular noises, and this may have a direct association between the alteration in VDO and to TMD[8]. However, some authors have observed that moderate alterations do not cause signs and symptoms of muscular disorder and hyperactivity, and that TMJ has the capacity to adapt to different occlusal situations after remodeling[9,10].

The absence of PR and the consequent alteration of VDO as etiological factors of temporomandibular disorders is still quite controversial in the literature. There are two currents of authors: the occlusion current, which argues that the absence of dental elements and other alterations in occlusion will develop occlusal instability and may cause TMD, since occlusal, muscular and articular changes may transcend the adequacy threshold of the stomatognathic system[11]; and the non-occlusion current, which argues that the occlusal factor alone will not be related to the TMD symptomatology, since this disorder is multifactorial[5].

In this context, in order to better elucidate these issues, this study investigated the association between VD, MMR and PR with the presence of TMD.

2 MATERIALS AND METHODS

The research was approved by the Ethics Committee in Research of the Federal University of Rio Grande do Norte (UFRN), under the opinion no 1.353.441, and Certificate of Presentation for Ethical Appreciation 51049815.0.0000.5537. All the participants signed the Informed Consent Form (ICF) after clarifying the study.

A case-control study performed in the Department of Dentistry of the Federal University of Rio Grande do Norte (UFRN), in the integrated clinics and in the extension project of the Integrated Care Center of Patients with Stomatognathic Apparatus Dysfunction (CIADE). Sample size calculation was performed using the OpenEpi version 2 program, with a 33% factor frequency, 5% confidence limit and drawing effect 1, using a 85% confidence interval.

A total of 148 adult patients, of both sexes with and without TMD, were selected, regardless of occlusion type. The individuals' dental arches ranged from totally dentate to partially dentate in both arches.

The individuals who used myorelaxant plaque and fully edentulous, bimaxillary or unimaxillary patients were excluded from the study.

The examiners were calibrated with respect to four clinical variables: MMR, VD, PR and presence of TMD.

2.1 MAXILOMANDIBULAR RELATIONSHIP

It was evaluated if the patient was occluding in MIH or had occlusion in CR. To do this, the patient's dental contacts were marked with the black side of the carbon paper (*Accu Film*, edgewood NY, USA) in the habitual occlusion position, and then the patient was manipulated to CR by the frontal manipulation methods of Ramfjord, associated with that of swallowing[12], asking

the patient to occlude in the manipulated position and marking the dental contacts with the red face of the carbon paper, to verify if there was a coincidence between the manipulation position and the habitual occlusion position. To verify the CR, when it was deemed necessary, the anterior bite device (Long Strips)[13] was used to deprogram the occlusion and subsequently CR was verified.

2.2 VERTICAL DIMENSION

For the evaluation of VD, the metric method associated with the phonetic method was used and the measurements of the rest vertical dimension (RVD) and VDO were verified by the interocclusal distances between two fixed points, one in the mandible and the other in the maxilla, measured with a dry point compass (ICE, Pirituba SP, Brazil) and millimeter ruler.

The records were performed with the patient sitting, with head and torso upright, in orthostatic position, facing forward (Frankfurt plane parallel to the ground) and relaxed.

The RVD was recorded when the mandible was in a physiological rest position, determined by the semi-contraction state of the muscles responsible for
keeping it in position, generally perceived when the head is kept upright[14]. Then, with the muscles relaxed and after the patient repeated the letter "M" several times, the distance between the marks was measured. The VDO was recorded by the same measurements of two previously selected points with the patient in the habitual occlusion position. RVD and VDO measurements were performed 3 times for greater reproducibility of the data.

After determining the VDO and RVD, it was possible to verify the measure of the Freeway Space (FWS), which corresponded to the disparity between RVD and VDO. When this space was greater than 4mm, it was considered that the VDO was decreased, and when the FWS was smaller than 2mm, it was considered that the OVD of the patient was increased[5,15].

Therefore, in this item, it was evaluated whether the VDO of the patient was within the standard of normality (FWS between 2 to 4 mm), decreased (FWS greater than 4 mm) or increased (FWS less than 2 mm).

2.3 POSTERIOR RETAINER

This item was evaluated by counting occlusal units (OU), with the exclusion of third molars.

Knowing that one OU corresponds to one pair of premolars in occlusion and one pair of molars corresponds to two OUs, PR was evaluated and individuals with reduced dental arch were

categorized with 3 to 5 OU [16-18]; 0 to 2 OU and 6 or more OU. In addition, individuals were grouped in users and non-users of removable partial denture (RPD) restoring posterior teeth.

2.4 PRESENCE OF TMD

The diagnosis of TMD was performed by the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD - Axis I).

2.5 STATISTICAL ANALYSIS

The association between the variables was verified using the chi-square statistical test, using confidence intervals (95%) through SPSS® software (Statistical Package for Social Sciences) version 22.0.

3 RESULTS

Of the 148 patients, 78 presented a diagnosis of TMD (mean age 30 years old, standard deviation of 14.63) and 70 did not present such disorder (age was 37 years old, standard deviation of 10.88). However, 8 of the patients with TMD were evaluated only in relation to the PR criterion, and the other variables were not evaluated.

Regarding gender, the majority were females, 84.29% belonging to the TMD group (n =59) (Table 1).

Table 1. Distribution of the studied sample according to gender and the diagnosis of TMD. Absolute and percentage values. Natal-RN, 2017

	Masculino		Feminino		Total	
	n	%	n	%	n	%
Sem DTM	30	42,86%	40	57,14%	70	100
Com DTM	11	15,71%	59	84, 29%	70	100
Total	41	29,29%	99	70,71%	140	100

Legend: Male, Female, Total, Without TMD, With TMD, Total

Evaluating the patients in relation to VDO, it was observed that the majority of the individuals with TMD had an alteration of this (decreased or increased) (52.5%) (Table 2), but there was no statistically significant association (p = 0495).

Table 2. Distribution of the studied sample according to VDO and the diagnosis of TMD. Absolute and percentage values. Natal-RN, 2017.

	Without TMD		With TMD		Total		p*
	n	%	n	%	n	%	
Normal VDO	32	53.3%	28	46.7%	60	100	0.495
Altered VDO	38	47.5%	42	52.5%	80	100	
Total	70	50%	70	50%	140	100	

* Chi-square test.

Regarding MMR, 100% of patients with TMD occluded in MIH, while 95.7% of patients without TMD presented occlusion in MHI. Thus, as almost all of the sample presented occlusion in MHI, it was not possible to evaluate the association of this factor with TMD by means of statistical analysis, but the descriptive analysis of the data was performed for evaluation and comparison of the results with the literature (Table 3).

Table 3. Distribution of the studied sample according to the maxillomandibular relationship and the diagnosis of TMD. Absolute and percentage values. Natal-RN, 2017.

	Without TMD		With TMD		Total	
	n	%	n	%	n	%
CR	3	4.3%	0	0	3	2.1%
MIH	67	95.7%	70	100%	137	97.9%
Total	70	100%	70	100%	140	100%

Of the 148 subjects in the sample, as to PR evaluation, 28 had RPD, and 16 (57.1%) did not present TMD and 12 (42.9%) were diagnosed with disorder.

In the evaluation of the absence of PR, it was observed that the highest percentage of patients with 3 to 5 OU (in the groups with and without RPD) belonged to the group without TMD (Table 4).

On the other hand, the individuals with remaining 0 to 2 OU were the majority of the group of patients with TMD who used RPD by replacing posterior teeth (75%). In the non-RPD group, the prevalence of patients with 0 to 2 OU was higher in the group with TMD (40.9%) than in the group without TMD (20.4%) and the proportion of individuals with 6 or more OU was higher in patients without TMD (66.7%) than patients with TMD (48.5%). It was also observed that as the occlusal support is reduced, with dental losses, the prevalence of TMD is increasing. However, the PR variable and the presence of TMD did not present any association, although the chi-square value for patients who did not use the RPD by placing posterior teeth was close to 0.05 ($p = 0.054$) (Table 4).

Table 4. Distribution of the studied sample according to the use of RPD restoring posterior teeth, presence of occlusal units (OU) and diagnosis of TMD. Absolute and percentage values. Natal-RN, 2017.

RPD restoring posterior teeth		Without TMD		With TMD		Total		
		n	%	n	%	n	%	p*
YES	.6 or + OU	2	12.5%	2	12.5%	4	14.3%	0.726
	. 3 to 5 OU	3	18.8%	1	8.3%	4	14.3%	
	. 0 to 2 OU	11	68.8%	9	75%	20	71.4%	
	Total	16	100%	12	100%	28	100%	
NO	. 6 or + OU	36	66.7%	32	48.5%	68	56.7%	0.054
	. 3 to 5 OU	7	13%	7	10.6%	14	11.7%	
	. 0 to 2 OU	11	20.4%	27	40.9%	38	31.7%	
	Total	54	100%	66	100%	120	100%	
Total		70	100%	78	100%	148	100%	

* Chi-square test.

3 DISCUSSION

There was a high prevalence of female gender in the group with TMD (84.29%), this distinction between genders can be explained by some factors, such as: difference in threshold and perception of pain; greater demand of women for health services and existence of association between orofacial pain and menstrual period, where there is hormonal difference [19]. In addition, there is a greater demand for dental services by the female public[5] and the predominant age group is also similar to that found in the literature, which shows a higher prevalence of TMD between the ages of 20 and 40 years old, young adults[20-22].

In the study by Agerberg and Viklund[8], signs and symptoms of patients with altered VDO coincided with some clinical characteristics of TMD, and in the face of the alteration, there was difficulty in some movement of the mandible, painful symptoms and joint noises. However, other authors have observed that moderate alterations do not cause signs and symptoms of muscle disorder and hyperactivity, and that TMJ has the capacity to adapt to different occlusal situations after remodeling[9,10].

In the evaluation of the prevalence of MMR, in this research, only 3 of the 140 patients occluded in CR, and these patients did not present TMD.

Usually, in the population there is a difference between the positions of CR and MIH is not large[5], but there are still divergences regarding their influence on the etiology of TMD, since some authors have evaluated that the difference between CR and MIH values greater than 2 mm does not fit the criterion of normal functional occlusion, that is, they can cause damage to the

stomatognathic system and result in the appearance of TMD[6]. It is also suggested that the MIH anterior to the CR, associated with a bilateral occlusal stability, is a factor of protection to the system[23].

CR recording may be a questionable step for occlusal plaques in patients with TMD and occlusal stability, since the neuromuscular position seems to be located between MHI and CR[24]. There is no evidence that a theory alone would explain the beneficial effect of an occlusal device or that one hypothesis stands out in relation to another, but it may be reported that placebo effect and cognitive effect are feasible hypotheses, to the detriment of the theory of occlusal condition alteration, which proved to be without foundation. The MHI position, therefore, can be a viable option because it is easier to locate, requires less costs and a shorter clinical time[25].

Considering the scarcity in the researched literature of studies that evaluate the relation between the alteration of VDO (in dentate or partially dentate patients) and MMR with the presence of TMD, this study may contribute with some parameters for future research in this area. Perhaps to find statistical differences with these parameters we should increase the sample size even more.

Regarding the PR, there is also no consensus between absence of PR and the presence of TMD signs and symptoms[26], and different methodologies were adopted by the authors to investigate the relationship of this factor with TMD, as will be discussed below.

It was established by the World Health Organization (WHO), in 1982, as the ideal "permanence, through the life, of natural dentition of at least 20 teeth without the need of prosthetic resources". Thus, a relevant index that represents oral health is the number of natural teeth, since dental loss may impair masticatory function[27].

For Pullinger (2000),[5] the absence of posterior teeth can cause a compression in the anterior region of the condyle positioned against the temporal bone slope, initially occurring an adhesion to the articular disc, initially limiting the buccal opening. However, with the repetition of this event, the disc may undergo a morphological alteration, causing its dislocation to the anterior region with a slide from the condyle to the distal region, and with the permanence of this compressive load, there is a disc displacement.

A study by Tallents et. (2002)[28], in which the prevalence of lower mandibular posterior teeth and intra-articular TMD were evaluated in 82 asymptomatic individuals and 263 with symptomatic TMD, showed a relation between the absence of lower mandibular posterior teeth and the presence of disc displacement. Barghi et al. (1987)[29], in turn, evaluated the occurrence, type and location of articular clicks in 150 patients with a history of at least 5 years of unilateral

and bilateral posterior tooth loss, finding a higher incidence of clicking in the patients with absence of posterior teeth compared with patients with posterior teeth. In addition, the types of clicks were significantly different in patients without the posterior teeth.

Wang et al. (2009)[26] observed that in terms of signs and symptoms in individuals with absence of posterior teeth, female and younger individuals were more susceptible to TMD, and the greater the number of dental quadrants with missing posterior teeth, the greater the risk of presenting the disorder. The number of missing posterior teeth was not significant by the simple logistic regression analysis ($p = 0.645$), but through a multivariate logistic regression model, the results suggested that when the variables number of dental quadrants with absence of posterior teeth and number of missing posterior teeth worked together, their effect on the TMD would increase.

Ciancaglini, Gherlone and Radaelli (1999)[30] observed that the disorder was significantly more prevalent in individuals with loss of support (75.3%) than in individuals without loss of occlusal support (58.9%) and the prevalence of symptomatology increased progressively with the extent of the loss. In this study, loss of support was considered as any loss of premolars and/or first and second molars

In the study by Selaimen et al. (2007)[31], the number of anterior and posterior teeth did not have significant differences between groups with and without TMD, and therefore did not present as a risk factor for TMD, as in the study by Sousa et al. (2015)[32], where the loss of five or more posterior teeth also did not contribute to TMD.

All the studies mentioned above present very varied methodologies, but the studies that will be described below considered as shortened dental arch (SDA) those that have 3 to 5 occlusals, given that this served as reference for the methodology of this study. The current research showed a higher percentage of patients with SDA belonged to the group without TMD, and may suggest that SDA does not cause an increase in the prevalence of TMD, corroborating with the conclusions of the studies of Witter et al.

Witter, Van Elteren and Käyser, in 1988[17] compared, in relation to signs and symptoms of TMD, 60 patients who presented with SDA with 72 patients with complete dentition. The results of this study suggested that a shortened dental arch does not increase the incidence of TMD signs and symptoms, and that the presence of bilateral pre-molar support appears to be sufficient for mandibular stability.

In 1994, Witter et al.[33] in a longitudinal clinical study (6 years of follow-up) evaluated a group of 55 individuals with a shortened dental arch, 17 with SDA users of RPD and 52 with

complete dental arch (DA), and with that study, it was concluded that SDA comprising 3 to 5 OU is not a risk factor for TMD and that the presence of lower RPD does not prevent signs and symptoms of TMD.

In a more recent investigation[34], the results of a 9-year longitudinal study evaluated a control group composed of patients with complete DA (n = 72) and the SDA group (n = 74) composed of patients with dental arch presenting 3 to 5 OU. During the 9-year follow-up, it was concluded that patients from both groups presented similar prevalence, severity and fluctuation of TMD signs and symptoms.

Thus, most cross-sectional and longitudinal epidemiological studies have shown that, in general, there are no significant differences between individuals with shortened dental arches (3 to 5 OU) and those with complete dental arches in terms of TMD signs and symptoms[16], which is in accordance with this research, which did not show a statistically significant association between the loss of OU and TMD. Thus, the relation between posterior retainer (and other occlusal variables studied) with TMD remains controversial.

Although altered VD and PR reduced were more prevalent in TMD patients, the association found was not statistically significant between groups. Because this subject is still controversial in the literature, it is suggested that the sample of this study be increased mainly for the mentioned factors, as well as that the type of TMD and the degree of pain be included since these data are obtained through the RDC/TMD questionnaire and can be compared with other authors cited in this discussion. In addition, it is suggested that further studies evaluate the quality of the prostheses used by the patients.

4 CONCLUSION

Within the limitations of the study, there was no statistically significant association between the occlusal parameters evaluated and the presence of TMD, although it was observed that as the occlusal support was reduced, the prevalence of TMD increased.

REFERENCES

1. Okeson JP. The classification of orofacial pain. Oral & maxillofacial Surgery clinics of north America 2008; 20: 133-144

2. Schiffman E, Ohrbach R, Truelove E, et al. Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for clinical and research applications: Recommendations of the International RDC/TMD Consortium Network* and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache 2014; 28: 6–27.

3. Goulet, J. P., Lavigne, G. J., & Lund, J. P. Jaw pain prevalence among French- speaking Canadians in Quebec and related symptoms of temporomandibular disorders. Journal of Dental Research, 1995; 74(11), 1738–1744.

4. OKESON JP (Ed.). Orofacial Pain. Guidelines for Assessment, Diagnosis and Management. Chicago, Ill: Quintessence; 1996. p. 119–127.

5. Pullinger AG, Seligman DA. Quantification and validation of predictive values of occlusal variables in temporomandibular disorders using a multifactorial analysis. J Phrostet Dent 2000; 83: 66-75.

6. Okeson JP. Management of Temporomandibular Disorders and Occlusion. 7º ed. Mosby Elsevier, 2012.

7. Haralur S. B. Digital Evaluation of Functional Occlusion Parameters and their Association with Temporomandibular Disorders. J Clin Diagn Res. 2013 Aug; 7(8): 1772–177.

8. *Agerberg G, Viklund L. Functional disturbances in complete denture patients. Int. J of Prosthod.* 1989; 2(*1*): 41-50.

9. Lipp MJ. Temporomandibular symptoms and occlusion: a review of the literature & the concept. N Y State Dent 1990; 56: 58-66.

10. Olthoff LW, Van Der Glas HW, Van Der Bilt A. Influence of occlusal vertical dimension on the masticatory performance during chewing with maxillary splints. J Oral Rehabil 2007; 34: 560-565.

11. Santos-Pinto A, Buschang PH, Throckmorton GS, Chen P. Morphological and positional asymmetries of young children with functional unilateral posterior crossbite. Am J Orthod Dentofacial Orthop, 2001; 120: 513-520

12. Shanahan TEJ. Physiologic vertical dimension and centric relation. J. Prosthet. Dent., 1956; 6(6):741-747.

13. Long, J.H. Location of the terminal hinger axis by intraoral means. J Prosthet Dent. 1970; 23 (1): 11-24.

14. Prosthetics AOD. The Glossary of Prosthodontic Terms. The Journal of Prosthetic Dentistry 2005; 94(1): 10-92.

15. Sato S, Hotta TH, Pedrazzi V. Removable occlusal overlay splint in the management of tooth wear: a clinical report. The Journal of prosthetic dentistry, 2000; 83 (4): 392-395.

16. Kanno T, Carlsson GE. A review of the shortened dental arch concept focusing on the work by the Käyser/Nijmegen group. J Oral Rehabil 2006; 33: 850-862.

17. Witter DJ, Van Elteren P, Käyser AF. Signs and symptoms ofmandibular dysfunction in shortened dental arches. J OralRehabil, 1988; 15: 413–420.

18. Witter DJ, De Haan AFJ, Käyser AF, Van Rossum GMJM. A 6-year follow-up study of oral function in shortened dental arches. Part II. Craniomandibular dysfunction and oral comfort. J Oral Rehabil,1994; 21: 353-366.

19. Berger M, Bakalczuk LM, Bakalczuk G, Bakalczuk S, Szkutnik J. Association between estrogen levels and temporomandibular disorders: a systematic literature review. Prz Menopauzalny. 2015 Dec; 14(4): 260–270.

20. Gauer RL, Semidey MJ. Diagnosis and Treatmente of Temporomandibular Disorders. Am. Fam. Physician. 2015; 91(6): 378-386.

21. Gonçalves DA, Dal Fabbro A L, Campos JA, Bigal ME, Spesiali JG. Symptms of temporomandibular disorder in the population: An epidemiological study. J Orofac Pain. 2010; 24: 270-278.

22. Oliveira SB, Siqueira SRDT, Sandvovski AR, Amaral LMTB, Siqueira JTT. Temporomandibular Disorder in Brazilian Patientes: A Preliminar Study. J Clin Psychol Med Settings . 2008; 15: 338-343.

23. Seligman DA, Pullinger AG, Solberg WK. The prevalence of dental attrition and its association with factors of age, gender and TMJ symptomatology. J Dent Res,1988; 67:1323-1333.

24. Tripodakis AP, Smulow JB, Mehta NR, Clark RE. Clinical study of location and reproducibility of three mandibular positions in relation to body posture and muscle function. J. Prosthet. Dent., 1995;73(2): 190-198.

25. The GL, Aaftink HM, Steenks MH. A clinical protocol for stabilization splint construction. Ned. Tijdschr. Tandheelkd, 2005; 112(9): 318-321.

26. Wang MQ, Xue F, He JJ, Chen JH, Chen CS, Raustia A. Missing posterior teeth and risk of temporomandibular disorders. J Dent Res, 2009; 88: 942-945.

27. Gesch D, Bernhardt O, Mack F, John U, Kocher T, Alte D. Association of malocclusion and functional occlusion with subjective symptoms of TMD in adults: results of the Study of Health in Pomerania (SHIP). Angle Orthod 2005; 75(2): 179-186.

28. Tallents RH, Macher DJ, Kyrkanides S, Katzberg RW, Moss ME. Prevalence of missing posterior teeth and intraarticular temporomandibular disorders. Journal of Prosthetic Dentistry, 2002; 87: 45-50.

29. Barghi N, Aguilar T, Martinez C. Prevalence of types of temporomandibular joint clickings in subjects with missing posterior teeth. J Prosthet Dent, 1987; 57: 617-620.

30. Ciancaglini R, Gherlone EF, Radaelli G. Association between loss of occlusal support and symptoms of functional disturbances of the masticatory system. J Oral Rehabil 1999; 26: 248-253.

31. Selaimen CMP, et al. Occlusal risk factors for temporomandibular disorders. Angle Orthodontist, 2007; 77(3): 471-477.

32. Sousa ST, Mello VV. Magalhães BG, Morais MPA, Vasconcelos MM, Caldas AFJr, et al. The role of occlusal factors on the occurrence of temporomandibular disorders. Cranio, 2015; 33(3): 211-216.

33. Witter DJ, De Haan AFJ, Käyser AF, Van Rossum GMJM. A 6-year follow-up study of oral function in shortened dental arches. Part I. Occlusal stability. J Oral Rehabil, 1994; 21: 113-125.

34. Witter DJ, Kreulen CM, Mulder J, Creugers NHJ. Signs and symptoms related to tempomandibular disorders – Follow-up of subjects with shortened and complete dental arches. J. Dent, Guildford, 2007; 35: 521-527.