EFFECT OF OCCLUSION ON JOINT SOUNDS IN ASYMPTOMATIC INDIVIDUALS

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ABSTRACT

Occlusion is a predisposing factor for Temporomandibular Dysfunctions (TMD) of the joint, whose first sign and/or symptom is usually joint sound. To verify the effect of occlusion on joint sounds, temporomandibular joints (TMJ) were analyzed in 78 asymptomatic individuals with various dental conditions. Electrosonography was used to determine the intensity of the vibration in the temporomandibular joint (TMJ) on opening and closing the mouth. Transducers (piezoelectric accelerometer) were placed on the right and left joints. Results were tabled and analyzed using the Kruskal-Wallis test (α=0.05). It was concluded that TMJ vibration in partly edentulous individuals from Kennedy classes I, II and III is statistically higher than in dentate and fully edentulous subjects.

Key words: temporomandibular joint, joint instability, temporomandibular joint disc.

O EFEITO DA OCLUSÃO SOBRE OS RUÍDOS ARTICULARES EM INDIVÍDUOS ASSINTOMÁTICOS

RESUMO

A oclusão é um fator que predispõe as DTMs articulares cujo primeiro sinal e/ou sintoma geralmente é o ruído articular. Para se verificar o efeito da Oclusão sobre os ruídos articulares, foram analisadas as ATMs de 78 indivíduos assintomáticos com várias condições dentárias. Realizou-se a eletrovibratografia para verificar a intensidade de vibração presente na articulação temporomandibular (ATM) durante os movimentos de abertura e fechamento da boca. Para isso, foram instalados transdutores (acelerômetro piezoelétrico) nas articulações direita e esquerda. Em seguida os resultados foram tabulados e submetidos à análise estatística pelo teste de Kuskal-Wallis (α=0,05). Os resultados permitiram concluir que as vibrações das ATMs dos indivíduos parcialmente desdentados, classes I, I e III de Kennedy são estatisticamente mais elevadas que os dentados e desdentados totais.

Palavras chave: articulação temporomandibular. instabilidade articular. disco da articulação temporomandibular.

INTRODUCTION

The etiological factors that lead to the development of TMD can be grouped into three categories and seem to be related to anatomical factors, including occlusion and TMJ, neuromuscular and psychological factors[1].

To verify the effect of systemic alterations, Gage[2] evaluated the presence of hydroxyproline in the urine of 10 young patients with joint sound. Excretion of hydroxyproline indicates the existence of rapid cell differentiation that enables faster formation of a type of collagen that is younger and more elastic than normal (type I collagen). Gage suggests that in young people with alterations in collagen metabolism (due to hormonal variation) the structure formed has greater condyle and disc mobility with relation to the temporal bone, producing joint sound.

The prevalence of sounds in the population is variable, occurring in 21.5%[3] to 86%[4], and appears to depend on the group of individuals studied. It may even be found in young adults, and in some cases indicates vibrations produced by movement of the synovial fluid[5] or precocious TMJ disorders due to systemic alterations[6].

Joint overloading that occurs after losing the back teeth, or the habit of teeth clenching or grinding may alter the lubrication mechanism and increase attrition between the joint structures, as observed by Nitzan[7]. The reduction of lubrication and the overloading of joint surfaces increases attrition between the structures and may cause the development of tissue fibrillation[8]. In addition, it may cause temporary or permanent adhesions of the joint disc. These are some of the causes leading to the alteration of TMJ biomechanics and joint sounds[9]. The effect of overloading the temporomandibular joint seems to be more evident after the loss of posterior teeth, and is more significant in older

Table 1: Groups of patients selected for the study and their characteristics.

Group	Dental condition	Age group	Mean age	Characteristics of the group
Group I	Dentate	10 to 12	11.62	Patients at the end of mixed dentition whose molar and premolar ratio allowed them to be classified as having "normal" occlusion.
Group II	Dentate	19 to 25	22.08	Subjects all of whose maxillary and mandibular teeth have erupted, except for third molars. with a molar and premolar ratio that allowed them to be classified as having "normal" occlusion.
Group III	Class I	33 to 70	57.08	Kennedy class I patient with only six remaining anterior teeth, but all maxillary teeth.
Group IV	Class II	33 to 57	45.61	Patients with absence of five posterior mandibular teeth on one of the hemi-arches, but fully maxillary dentate.
Group V	Class III	23 to 50	37.76	Patients with absence of at least three posterior mandibular teeth on one of the hemi-arches, but with posterior molar support and fully maxillary dentate.
Group VI	Totally Edentulous	55 to 87	67.46	Completely edentulous patients who had used dentures for at least six months

patients, particularly patients with arthritis whose most common joint characteristic is crepitation[10].

The prevalence of sound in Kennedy class I and II partially edentulous patients, according to Martinez et al.[11], occurs in 44.3%; and its incidence is higher in bilaterally edentulous patients, at the end of mandible opening and the beginning of closing (55.7%). Barghi et al.[12] found that clicking was more frequent in unilaterally edentulous patients on the side of the free end. Studies on completely edentulous patients showed that joint sound is rare, but if present it is of the crepitation type and is related to the erosion type alteration of the shape of the joint surface[13].

In addition to joint overload, the effect of occlusion has been analyzed in Angle class II division 1 patients, and the effect of retraction and retroinclination of anterior maxillary teeth after orthodontic treatment[14]. Contacts between anterior teeth develop proprioceptive activities in the periodontal support structures and the muscle retracts the mandible. In this position the mandibular condyle may compress the posterior edge of the joint disc, producing morphological alterations and instability of the disc on the condyle, causing joint sound[15].

Comparison of the vibration energy emitted by TMJs in symptomatic and asymptomatic subjects shows higher values at all stages of mandibular movement in subjects in the TMD[5] group and seems to increase with age[16].

A study by Keeling et al.[17] reports that crowded anterior teeth, deep bite and mouth opening capacity from 52 to 70 mm are associated to the presence of joint vibrations. The sounds may also be related to unbalanced occlusal contacts between sides. This may cause hyperactivity of the mastication muscles, particularly those responsible for closing, and seems to promote joint clicking[18].

It was also found that joint vibration is more frequent at the end of mouth opening and closing in partially edentulous patients, and that vibration is significantly reduced after the second year of occlusal treatment[19].

In view of the fact that according to the literature, occlusion seems to be related to joint sounds, the aim of this study is to compare vibration intensity of TMJs in asymptomatic patients to verify the harmful effect of occlusion on vibrations in TMJs. Identifying the characteristics of joint sounds in certain occlusal patterns or dental arch configurations may contribute towards the diagnosis of certain joint pathologies.

MATERIALS AND METHODS

For this study, 78 individuals were selected and divided into 6 groups (n=13) as shown in Table 1.

Table 2: Dental condition of the groups of patients and mean joint vibration on left (L) and right (R) sides of the patient at the beginning, middle and end of mouth opening and closing cycles.

Patients	Opening Cycle			Closing Cycle		
	Beginning	Middle	End	Beginning	Middle	End
	L/R	L/R	L/R	L/R	L/R	L/R
Dentate 10 to 12 years	7.80[b]	8.02[b]	7.92[b]	7.75[b]	7.62[c]	7.93[c]
Dentate 18 to 25 years	7.80[b]	7.79[b]	8.20[b]	7.80[b]	8.98[bc]	9.18[bc]
Cl – I	9.58[a]	9.62[a]	15.27[a]	14.81[a]	10.08[a]	16.42[a]
Cl – II	9.02[a]	9.17[a]	12.10[a]	11.30[a]	10.01[ab]	12.90[ab]
Cl – III	8.68[a]	9.29[a]	11.92[a]	10.09[a]	9.06[ab]	14.39[ab]
Edentulous	7.26[b]	7.41[b]	8.71[b]	7.15[b]	7.38[c]	8.23[c]

Mean values followed by different letters in the column show statistically significant difference ($p<0.05$). L = Left, R = Right

Fig. 1: Front and lateral view of patient with transducers on temporomandibular joints.

Their history was taken and they underwent clinical examination to verify that they were asymptomatic and identify their dental condition (Table 1).
Electrosonography was used to determine the intensity of the vibration in the temporomandibular joint (TMJ) during mouth opening and closing movements. Transducers (piezoelectric accelerometer) were placed on the right and left joints (Fig. 1). The system was connected directly to the internal circuit of a computer compatible with the SonoPAK/I software (Bio-Research, INC, Milwaukee, Wisconsin, USA) installed.
After positioning the transducers, the mandibular opening capacity (interincisal distance) was measured with a millimeter ruler, and was used to calibrate the device. The patient was immediately requested to carry out mandibular opening and closing movements following a cursor on the monitor screen. All patients were allowed one minute to practice.
After checking the synchronization of the movement with the cursor, the record was accepted and saved on hard and floppy disc.
For the analysis, the direct reading of the joint vibration was used, selected with the help of the computer's mouse, at the points in the cycle corresponding to beginning, middle and end of mouth opening and closing (Fig. 2).
For each patient, the analysis was repeated three times in each position in the cycle, and mean values (between the various measurements and

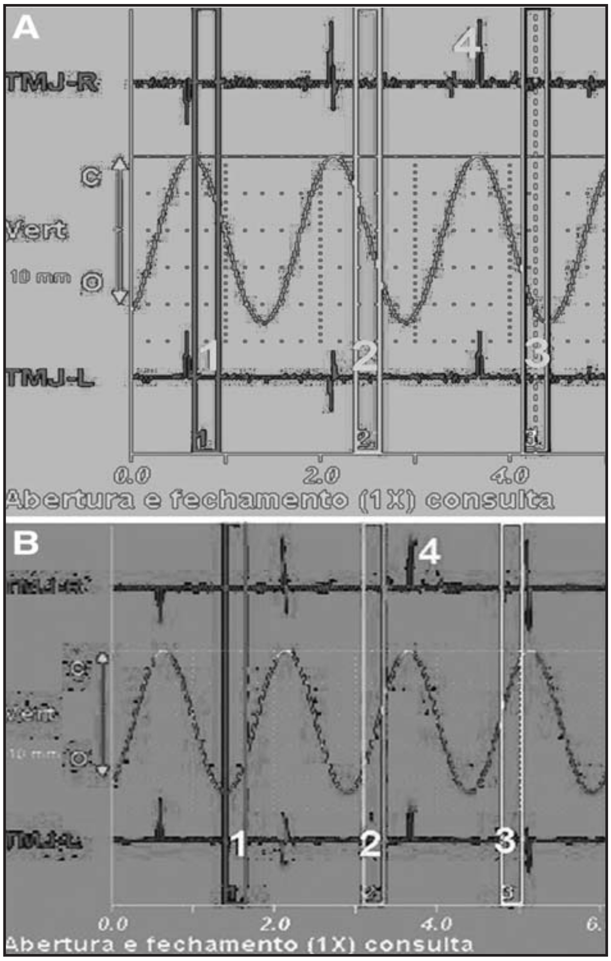

Fig. 2: Electrosonography recording. Numbers 1, 2 and 3 show the positions of the movement cycles (A – Opening, B – Closing) at which joint vibrations were analyzed. Number 4 indicates the position equivalent to occlusal contact in mouth closing at maximum intercuspation.

between sides of the patients) were printed and considered as amount of vibration energy measured in Hertz (0 - 1000 Hz).
The results were then tabled and subject to statistical analysis using the Kruskal-Wallis test ($\alpha = 0.05$).

RESULTS

Table 2 presents the mean values for joint vibration in the different groups, showing that there was no significant difference in the mouth opening and closing cycle between asymptomatic dentate individuals and those using full dentures (totally edentulous) ($p>0,05$). Similar results were found among groups III, IV and V of partially edentulous subjects ($p>0.05$).
On comparing partially edentulous subjects (classes I, II and III) to completely dentate subjects and those using full dentures, statistically significant differences were found at the middle and at the end of the mouth closing cycle, as follows:
The group of class I partially edentulous subjects had the greatest joint vibration and differed statistically from the other groups ($p<0.05$).
The vibrations recorded in the class II and III groups were the same as those for subjects in the 18 to 25-year-old age group ($p>0,05$).
The vibrations recorded in subjects with full dentures were statistically similar to those in the group of young subjects aged 10-12 years ($p>0.05$).

DISCUSSION

Among the etiological factors that can lead to the development of joint sounds, those reported by Farrar[15]; Berry and Watkinson[14] and Nitzan[7] seem to be the most important. Our results show that joint vibrations occur under various kinds of dental conditions, analyzed in patients both in the 10 to 12-year-old age group, and in the group of old people, as shown by Christensen and Ziebert[10]. Nevertheless, the vibrations are stronger in partially edentulous patients, mainly those in Kennedy class I, than in dentate and completely edentulous individuals. The loss of some teeth might cause mandibular imbalance, which promotes damage to the posterior edge of the disc, increasing its instability on the condyle, as confirmed by Farrar[15]. Its effects are clearer in absence of bilateral molar support when associated to teeth clenching. This hypothesis is supported by studies by Baleeiro et al.[19].
Our results show that joint vibration is usually weak in asymptomatic dentate patients, indicating movement of joint structures and synovial fluid as discussed by Olivieri et al.[5], and therefore should not be considered as an isolated diagnostic criterion, but it is useful when analyzed together with the mandibular function. Moreover, studies such as Rohlin et al.[20] report that a silent TMJ does not always indicate "normality", but the evaluation of the condylar biomechanics may suggest internal disorder that tends to increase with age[16].
Among the etiological factors found in literature, occlusal condition seems to be significant in the development of joint vibrations. Our results match those in literature which report that the partial loss of posterior teeth affects condylar dynamics[12] more than situations in which the subject has full dentition or is totally edentulous do. However, if the distribution of forces generated by the condyle against the posterior aspect of the temporal bone exceeds functional limits, even in orthopedically balanced dentate individuals, it can affect joint structures causing damage such as altered lubrication[7] and joint surface erosion[8]. These alterations may modify the bone, becoming more apparent in older subjects[10], and may be important factors causing the increase in joint vibration. This might explain some of the stronger vibrations recorded from the TMJs of asymptomatic patients in the group of dentate individuals.
Our results match those of Barghi et al.[12] and indicate that vibrations are statistically significantly stronger in partially edentulous individuals, particularly those in Kennedy class I, in whom the absence of molar support tends to retract the condyle, which increases the pressure on the posterior edge of the disc, altering its morphology and that of the inferior retrodiscal ligament. This leads to greater movement of the joint disc, generating more vibrations than in dentate individuals[15].
On the other hand, stronger vibration was recorded in the Kennedy class III patient, and occurred at the end of mouth opening and closing. This vibration is characteristic of internal TMJ disorder (dislocation of the disc with reduction) and probably originates from the dental condition producing lateral-protrusive deviation of the mandible and joint overload. In this case, only one of the mandibular condyles retracts, compresses the posterior edge of the disc and promotes forward displacement of the disc[15]. Furthermore, the intracapsular ligaments that connect the disc to the condyle undergo elongation

which, associated to the physical deconditioning of the mandible elevator muscles, allows louder sound at the end of mouth opening. Thus at every maximum intercuspation, the disc is displaced at the end of mouth closing. A study by Baleeiro et al.[19] shows that after the partially edentulous patient's teeth are replaced and mandibular support restored, joint vibrations tend to be reduced with the use of dentures, and this becomes statistically significant after two years of occlusal therapy.

The lowest vibrations recorded in totally edentulous patients (below 20 Hz) were similar to those found by Goiato[21] and are inaudible to the human ear[6]. In edentulous patients, the position of mandibular balance might be kept more easily. On the other hand, this group was made up of asymptomatic individuals and was part of a group with lower stress level, where compression in the joint structures was functional, with no significant damage to the occlusal surfaces.

The partial absence of posterior teeth without teeth clenching rarely produces pain in the temporomandibular joint, but it is a significant factor in the origin of joint disc instability. Moreover, dentate patients who clench their teeth can have alterations such as disc adherence to the condyle or temporal bone[9], fibrillation or erosion of joint surfaces[8] which might be responsible for the increase in joint vibrations. These are conditions that can sometimes explain why some patients with malocclusion have no joint sound while others with "ideal" occlusion do. We would like to stress that joint vibration analysis using electronic equipment is not considered an adequate diagnostic means for temporomandibular disorders[22], and therefore the purpose of its use in this study was not to establish a diagnosis but to evaluate joint vibration in different clinical situations and contribute towards understanding its characteristics.

CONCLUSION

Based on the methodology employed and the results obtained, it may be concluded that:

Joint vibrations recorded for TMJs in asymptomatic patients are weak; nevertheless they were stronger in the group of partially edentulous individuals.

Joint vibrations were stronger in Kennedy class I individuals for all the positions of the cycle examined and weaker in completely edentulous individuals.

The individual's dental condition is important for the health of the temporomandibular joints.

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