Joint vibration analysis in mandibluar movements in asymptomatic volunteers

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Abstract

Temporomandibular joint sounds are one of the signs of the temporomandibular disorders. Their identification is important to establish and /or diagnose pathologic changes that occur in the temporomandibular joints (TMJ). Because of the few studies relative to vibrations in asymptomatic volunteers, it is the intention of this study to evaluate vibrations during the opening and closing mandibular movements in asymptomatic individuals.In this study, 29 asymptomatic volunteers were examined clinically and submitted to anamnestic evaluation[6]. After initial testing the volunteers were submitted to evaluation with electrovibratography (SonoPAK/I). The control group was established with five individuals selected in which it was positioned the transducers to record the TMJ vibration without movement. Another group of recoders was obtained with transducers put inside a cardboard box and in environment with minimum sounds. Analysis of the vibratory energy less than 300 Hz (<300Hz) demonstrated minimal vibrations. The end of the mandibular opening and closing produced the larger vibratory energy in the group with mandibular movement. The conclusions were: a) vibrations in the tempormandibular joint are present in asymptomatic individuals. b) temporomandibular joint vibratory energy is greatest when the mandible is near the end of the opening cycle and near the end of the closing cycle. c) the vibratory energy without mandibular movement is minor and stays stable during the positions analysed.

Uniterms

Temporomandibular joint; joint vibrations analysis; asymptomatic volunteers

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Resumo

O ruído articular é um dos sinais de desordens temporomandibulares. Sua identificação é importante para estabelecer o diagnóstico de mudanças patológicas que ocorrem na articulação temporomandibular (ATM). Como há pouco estudos relativos a vibrações em indivíduos assintomáticos, o objetivo dessa investigação foi avaliar as vibrações durante os movimentos de abertura e fechamento mandibular. Nesse estudo, 29 voluntários assintomáticos foram submetidos ao exame clínico e ao teste de Fonseca[6]. Depois do exame inicial, os voluntários foram submetidos à avaliação através da eletrovibratografia (SonoPAK/I). O grupo controle foi estabelecido com cinco indivíduos selecionados nos quais foram posicionados os transdutores para gravar a vibração da ATM sem movimento mandibular. Outro grupo de gravações foi obtido com os transdutores colocados dentro de uma caixa de papelão e em meio ambiente com o mínimo de ruídos possível. Os resultados foram tabulados e notou-se que os valores aumentavam próximo ao final da abertura e final do fechamento mandibular. As conclusões foram: a) as vibrações na ATM estão presente em indivíduos assintomáticos; b) A energia de vibração da ATM é maior quando a mandíbula está próxima do final da abertura e final do fechamento mandibular; c)A energia vibratória sem movimen-

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to mandibular é menor e permanece estável durante as posições analisadas; d) O pico de freqüência esteve situado entre 56 e 99 Hertz. As freqüências analisadas neste estudo não foram detectadas pelo ouvido humano e confirma que o líquido sinovial foi realmente gravado.

Unitermos

Articulação temporomandibular; análise das vibrações articulares; voluntários assintomáticos.

Introduction

Etiologic studies of temporomandibular joint (TMJ) vibrations (sounds) have indicated that vibrations can originate from an incorrect relationship between the mandibular condyle and articular disk, and deficiencies of the articular ligaments[5,30]. Some suggest vibrations may be caused by an imbalance between the superior and inferior branches of the lateral pterygoid muscle in relation to the elevator muscles[13]. Others consider vibrations to be the result of alterations in the lubrication and stretching of the ligaments of the disk[7,18]. Still others indicate irregularities and adhesions in the surfaces of the TMJ, as well as disk displacement with reduction[16,21-3].

Vibrations can be classified as either clicking or crepitus[10,16-7,28] and can be subdivided as high or low depending on the the intensity of the sound. Further, vibrations can be identified by position as initial, middle or end depending on its position in the opening and closing cycles relative to the position of intercuspal position[29].

Clicking can be the result of the passage of the condyle on the anterior band (adhesion) or posterior band (displacement) of the disc and characterized as a clear sharp noise[1]. Crepitus is a complex and lingering noise similar to the tactile and acoustic sensation produced by the friction of fresh snow or atriction of leather[1,18] and is associated with degenerative changes of TMJ[12,28-9].

The prevalence of clicking increases with age[14-5] and is more prevalent in young females[28]. The clicking has been defined as a sign of local thickning of the layers of the articular surfaces, substantial macroscopic remodeling, deviation in the form, subluxation, perforation and/or disc displacement[31]. Some authors suggest that the mechanism of the click in a patient that has functional malocclusion can be the lack of coincidence of the mandibular position originated from the hypertonicity of one bunches of the lateral pterygoid muscle[13]. The reciprocal clicking has been defined as a noise of low amplitude during the opening mandibular followed by a clicking during the closing[4,11].

Evaluation of TMD patients with respect to a potential internal derangment is important for the diagnosis as well as for the treatment of that individual. Through the electrovibratography (SonoPAK/I) it is possible to: a) identify the position of the vibration (noise) occurring during the opening and closing movement; b) visualize of the wave form created by the vibration; c) analyze any vibrations occuring in the opposite joint, and d) identify the frequencies (Hertz) as well as the amplitude (Pascal) of the vibration[12,20].

Treatment such as physiotherapy applied to the muscles of the stomatognatic system and splint therapy are logical and justified when attempting to resolve symptoms and retore stomatognathic balance in patients with TMJ problems[10,28-9]. However, the permanence of some vibrations after the treatment can be indicative of alterations in the form of the condyle or the disk[23-6].

Vibrations in the TM joint can occur in asymptomatic individuals. Understanding these vibrations occurring in an asymptomatic TMJ may be important for comparision to vibrations occurring in a symptomatic TMJ. Because of the few studies relative to vibrations in asymptomatic volunteers, it is the intention of this study to evaluate vibrations during the opening and closing mandibular movements in asymptomatic individuals.

Material and Methods

To accomplish this study 29 dental students without symptoms were selected. The age varied from 17 to 22 years old (average age was twenty years old). Twenty of twenty nine were female.

To evaluate the degree of the temporomandibular disorders, the questionnaire introduced by Fonseca et al.[6] was used.

Clinical evaluation included the amount of vertical, lateral and protrusive mandibular movements. The maximum vertical opening was measured between the incisal edges of the maxillary and mandibular right central incisors. Maximum lateral movements were measured from the buccal of the maxillary canine to the lingual of the mandibular canine. Protrusive movements were measured between the ipsilateral buccal surface of the maxillary incisor and the buccal surface of the mandibular incisor. The dynamic occlusion was verified to determine the type of lateral guidance the student had: canine guide, group function or another type.

Following the questionnaire and the clinical evaluation described above, the students were submitted to joint vibration analysis through the SonoPAK/I (BioResearch Ass., Inc., Milwaukee, WI). After having positioned the transducer, it was requested that the student accomplished mandibular movements of opening and closing accompanying a metronome cursor on the screen of the monitor. The joint vibration was recorded and three opening and three closing positions (early, middle and end) of each cycle were selected for analysis.

After it was done the analysis of : a) the median distance in millimeters corresponding to the selected point of jaw opening and closing; b) the median vibration energy measured in Hertz (0 - 1000 Hz) at the selected points of jaw opening and closing; c) the amount of vibration energy less than of 300 Hertz (<300 Hz) at the selected points of jaw opening and closing; d) the amount of vibration energy greater than 300 Hertz (> 300 Hz) at the selected points of jaw opening and closing; e) the peak frequency of the vibration at the selected points of jaw opening and closing.

The control group was established with five individuals selected in which it was positioned the transducers to record the TMJ vibration without madibular movement. For this recorder put in the equipment with average mandibular opening.

Another group of recorders was obtained with tranducers put inside a cardboard box and in environment with minimum sounds.

The values was put in tables and their averages was obtained to verify the alterations in the many positions studied.

RESULTS

Analysis of the questionnaires and the clinical evaluations indicated that the individuals were asymptomatics and they presented “normal” mandibular movements. These movements are shown Table 1.

Also noted in the clinical evaluation was that most of the individuals had a disocclusion guided by the canine (Table 2).

Table 1 - Vertical, lateral and protrusive movements in millimeters (mm)

Sex	Opening (mm)	Right Lateral (mm)	Left Lateral (mm)	Protrusion (mm)
Male	48.7	4.4	4.6	5.4
Female	46.7	4.7	5.1	4.7
Mean	47.7	4.6	4.7	5.1

Table 2 - Type of discclusion: canine function (CF), group function (GF), no working side contact (NW)

Sex	Right Side			Left Side		
	CF	GF	NW	CF	GF	NW
Male	9	2	1	8	4	1
Female	13	3	1	14	2	0
Total	22	5	2	22	6	1

Table 3 shows the median values of the selected mandibular positions in each of the opening and closing positions.

When the total amount of vibratory energy was analyzed during the mandibular movements in the asymptomatics individuals it was noted that the values increase near the end of the opening and the end of the closing movement (Table 4).

Analysis of the vibratory energy less than 300 Hz (<300Hz) demonstrated minimal vibrations. The end of the mandibular opening and closing produced the larger vibratory energy. On the other hand, the recorders of the vibration with the transducer fixed in the volunteers without movement and without the transducers (in the box) maintained the minor values and similar between the mandibular positions analysed (Table 5).

Table 3 - Distance in millimeters (mm) of the opening and closing movements for vibratory evaluation

Mandibular Positions	Median Distance (mm)
Early Opening	9.7
Middle Opening	22.1
End Opening	40.7
Early Closing	38.3
Middle Closing	22.1
End Closing	10.6

Table 4 - Median total vibratory energy found in the selected mandibular positions

MANDIBULAR POSITIONS	TOTAL VIBRATORY ENERGY IN HERTZ (Hz)					
	MANDIBULAR MOVEMENT		WITHOUT MOVEMENT		WITHOUT TRANSDUCERS (BOX)	
	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE
Early Opening	7.0	8.9	5.4	6.7	4.8	6.0
Middle Opening	7.4	8.7	5.4	6.8	4.9	6.0
End Opening	8.6	9.7	5.1	6.8	4.9	6.3
Early Closing	7.5	8.2	4.9	6.7	4.7	6.4
Middle Closing	8.6	9.4	5.1	6.8	4.7	6.3
End Closing	8.7	9.7	5.0	6.9	4.7	6.7

Table 5 - Median total vibratory energy found in the selected mandibular positions

MANDIBULAR POSITIONS	VIBRATORY ENERGY LESS THAN (Hz)					
	MANDIBULAR MOVEMENT		WITHOUT MOVEMENT		WITHOUT TRANSDUCERS (BOX)	
	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE
Early Opening	5.4	5.6	3.2	3.8	2.9	3.6
Middle Opening	5.2	5.9	3.2	4.0	2.8	3.6
End Opening	6.0	6.7	3.0	4.0	2.9	3.8
Early Closing	4.4	5.3	2.9	4.0	2.7	3.8
Middle Closing	5.7	6.2	2.9	4.1	2.8	3.8
End Closing	6.5	6.6	2.9	4.0	2.8	4.0

Analysis of the vibratory energy greater than 300 Hz (> 300 Hz) demonstrated smaller values when compared to the less than 300 Hz (<300 Hz) values in all analyzed positions. Further, the values show consistency in magnitude at all analyzed positions of opening and closing movements of the jaw. In the control group without movement and without transducers (in the box), the results were smaller than mandibular movement and similar among the positions studied (Table 6).

When the peak frequency (largest intensity of vibrations) was analyzed, it was noticed that the early opening and the early closing positions had the hightest peak frequency. The recorder´s analysis of the control group without mandibular movement showed larger than group with mandibular movement. The largest values was observed in the group with transducers into the box (Table 7).

Table 6 - Median vibratory energy greater than 300 Hz (>300Hz) found in the selected mandibular positions

MANDIBULAR POSITIONS	VIBRATORY ENERGY GREATER THAN (Hz)					
	MANDIBULAR MOVEMENT		WITHOUT MOVEMENT		WITHOUT TRANSDUCERS (BOX)	
	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE
Early Opening	2.4	3.0	2.2	2.9	1.9	2.5
Middle Opening	2.3	2.7	2.1	2.8	2.0	2.4
End Opening	2.5	2.8	2.1	2.8	2.1	2.5
Early Closing	2.4	2.9	2.0	2.7	2.0	2.6
Middle Closing	2.5	2.8	2.2	2.7	1.9	2.5
End Closing	2.3	2.7	2.1	2.8	1.9	2.7

Table 7 - Peak Frequency (Hertz) found in the selected mandibular positions

MANDIBULAR POSITIONS	PEAK FREQUENCY (Hz)					
	MANDIBULAR MOVEMENT		WITHOUT MOVEMENT		WITHOUT TRANSDUCERS	
	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE	RIGHT SIDE	LEFT SIDE
Early Opening	99	99	197	372	242	400
Middle Opening	83	78	278	296	462	126
End Opening	80	89	443	369	123	291
Early Closing	90	92	351	239	447	298
Middle Closing	64	56	278	362	162	462
End Closing	64	56	466	245	162	240

Discussion

Recordable TMJ vibrations in asymptomatic patients can originate from the vibratory energy emitted during the movement of the disk or the movement of the condyle on the disk border[12,20] or may be due to the movement of the synovial liquid and intra-articular structures[12,20]. The energy registered during opening and closing mandibular movements is similar to that noted by Wabeke et al.[26] and Tallents et al.[25]. The authors agree these vibrations do not represent the presence of an internal derangment, but are related to the movement of the articular structures or the synovial fluid. The hypothesis of vibrations emitted by the articular structures during movement is further supported by Drum & Litt[3]. The hypothesis of vibrations due to the movement of the synovial fluid during lubrication of the articular structures is further supported by Walker et al. [27].

On the other hand, the absence of vibrations does not necessarily mean a lack of pathology in the TMJ[8]. Inflammatory and other pathologic conditions such as disc displacement without reduction states can turn joints silent[9]. We observed an increase of vibratory energy (<300Hz) in the end of the opening and in the end of the mandibular closing. This finding is suggestive that compression of the synovial fluid in the anterior supra and infra-meniscal cavities occurs and the synovial fluid is forced to pass to the posterior spaces. This movement of the fluid probably produces an increase in the amount of vibrations. The same phenomenon will then occur when the condyle/disk relationship returns to the initial position of maximum intercuspation as the synovial fluid is compressed in the posterior area and is forced to pass to the anterior joint spaces producing an increase of the vibratory energy [27].

The energy vibratory (<300Hz) showed small when it was recorded without mandibular movement and when the transducers weren´t installed in the individual. The diference among the groups suggested that the increase of vibratory energy was relacioned with synovial liquid movement because the structures were in motion during all the stages of mandibular movement.

When the vibration due to decompression occurs with larger intensity in the end of the mandibular opening, it can be considered to be similar to the eminence click. That type of vibration can be verified at the end of the mandibular opening by arthrographic examination of the normal condyle/disk function[19]. The authors verified that the vibratory characteristics of eminence vibrations are a deviation in the length of the vibration.

Analysis of the frequency patterns demonstrated low peak frequency values which are not in the human hearing range. The frequencies analyzed in our study were not, therefore, capable of detection by the human ear. We found the frequency range to be 56 to 99 Hz with the higher peak frequencies at the beginning of the opening and the beginning of closing of the mandible[2,25].

The environment sounds were more clear in the group with the transducers into the box[24].

Based on our statiscal analysis, values were found to be equivalent and confirmed that in any phase of mandibular opening and closing, the movement of synovial fluid was recorded.

Conclusions

The analysis of the averages of the vibratory energy in asymptomatics patients allowed the following conclusions:

a) vibrations in the temporomandibular joint are present in asymptomatic individuals;

b) temporomandibular joint vibratory energy is greatest when the mandible is near the end of the opening cycle and near the end of the closing cycle;

c) The vibratory energy without mandibular movement is minor and stays stable during the positions analysed;

d) The peak frequency fell between 56 and 99 Hz. The frequencies analyzed in our study were not capable of detection by human ear and confirm that we recorded the synovial liquid movement. The understanding of the vibrations that happen in the temporomandibular joint is important to prevention and treatment of the joint pathologies.

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