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JOINT VIBRATION ANALYSIS OF TEMPOROMANDIBULAR JOINT IN ASYMPTOMATIC PATIENTS IN THE AGE GROUP BETWEEN 18-25 YEARS: AN IN-VIVO STUDY

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ABSTRACT

Background: Vibrations in the temporomandibular joint can occur in asymptomatic and symptomatic individuals and a comparison is needed between these two. JVA is a tool for diagnosing such vibrations and also for educating patients. This study aimed to check the TMJ vibrations produced in the normal temporomandibular joint using Electrovibratography [Bio-JVA]. **Materials and Methods**: 20 asymptomatic subjects of age group 18-25 years with equal male to female ratio were selected for the study. Firstly, all volunteers were asked to answer a questionnaire and then their acceptance was obtained to receive a detailed clinical examination. The JVA headset was placed snugly on the subject's head with the sensors positioned over the TMJ in front of the ears. They were instructed to open as widely as possible and close fast to the intercuspal position with rhythmic speed according to a metronome on the screen. This was to ensure that opening and closing movements are synchronized with the cursor movement. The subject were examined in the resting position, seated upright with feet flat on the ground, looking straight ahead with the Frankfurt plane parallel to the floor. These movements were recorded and saved on the computer and was analysed using the software. **Results**: Out of 20 asymptomatic subjects, 15 had normal joints whereas 5 subjects had underlying temporomandibular disorders when evaluated by Bio-JVA. **Conclusion**: Vibrations in the TMJ are present in asymptomatic individual and Bio-JVA can be used as a diagnostic tool to measure these vibrations in the joint.

KEYWORDS: Temporomandible joint; temporomandibular sounds; temporomandibular disorders; clicking; crepitus; electrovibratography

INTRODUCTION

Temporomandibular joint (TMJ) consists of mandibular condyle fitting into the mandibular fossa of temporal bone separated by a non-ossified articular disc which permits complex movements of joint, hence known as compound joint. Disc divides the joint space into 2 compartments-upper and lower, surfaces of which are lubricated by synovial fluid, so called synovial joint. TMJ is capable of producing hinge and gliding type of movements, therefore called ginglymo-arthroidal joint.[1] In healthy joint, synovial fluid permits smooth gliding motion without any vibration which are caused in case of any degeneration, perforation or mechanical displacements.[2] This sound may be described as clicking, grating, popping, cracking or rubbing type depending on the etiology.[3] Over the past several years, many objective and subjective methods[4] have been developed to record and analyse the TMJ sounds ranging from simple palpation and auscultation to complex Electromyography (EMG), Jaw Tracking, Thermography, Sonography, Dopper Ultrasound, Magnetic Resonance Imaging (MRI), Arthrography, Arthroscopy, Computerized Tomography (CT) scan[5] which are expensive and provide static information.[6] In search of an inexpensive method which provides dynamic information[3,6] about joint, a personal computer

Fig. 1: Patient with BIO-JVA and amplifier

Fig. 2: Recordings of TMJ as seen on the computer screen using

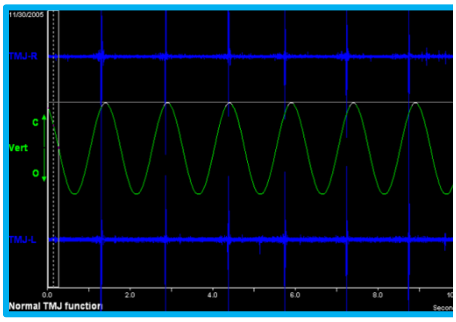


Fig. 3: Sweep view of normal TMJ

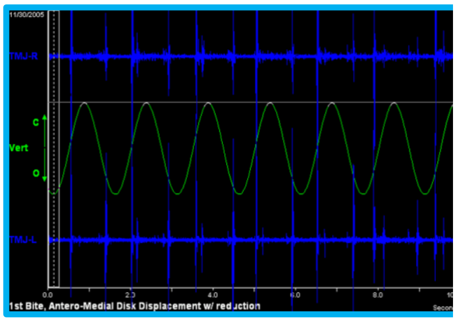
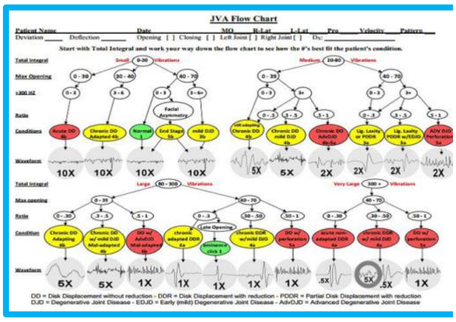


Fig. 4: Sweep view of pathological TMJ



JVA Flow Chart

based tool – JVA^2 was developed based on principles of motion and friction.[2,3,6] It is a precise, quick, non-invasive,[2,7] passive device that objectively records all the vibrations of the underlying tissue during function,[8,9] distinguishes which side the vibration originates on,[10] creates a visual image of the vibration and measures its intensity. The modern JVA records sounds waves by two highly sensitive skin contact transducers called piezoelectric accelerometer (which generates surface electric charge when subjected to pressure or stretching). The accelerometer is silicone based, therefore extraneous sounds are damped and only TMJ vibrations are recorded.[7] Limited literature exist on the effect of joint vibration analysis in patients with asymptomatic temporo-mandibular joints. Therefore, this study aims to evaluate the temporo-mandibular joint vibration in clinically asymptomatic subject in the age group of 18-25 years by using Bio-JVA device of Bio-Research Company.

MATERIALS & METHODS

INSTRUMENTATIONS

1. Bio- jva with amplifier
2. Vernier caliper
3. Thera bite (range of motion scale)
4. Computer system with necessary softwares.

METHODOLOGY

1. The subjects should have all 28 permanent teeth (excluding wisdom teeth) with class I molar and cuspid relation, overbite minimum of 1 mm and overjet of 4 mm, mouth opening of at least 45 mm (females) and 48 mm (males) and straight protrusion of at least 7 mm.
2. Every subject went through a complete intra-oral and extra-oral examination and a detailed case history was taken.
3. The system was directly connected to an internal circuit using a compatible computer, which has the Bio-JVA software installed.

The device was placed over the subject’s head so that both the accelerometer were located at the same distance from the middle of the head over the TMJ area.[11] This step was completed with the help of an equalizing system with the displayed numbers that were equal on both sides of the head and the amplifier was hung on to the subject's neck.

4. The subjects were then asked to sit in resting position, seated upright with feet flat on the ground, looking straight ahead. The mouths were closed and the posterior teeth were in centric occlusion. At first, slow opening and quick closing and the quick opening and slow closing was recommended. Then TMJ sounds were recorded during the mouth opening and closing cycles at a rate of 40 cycles/min. The jaw movements were standardized by having the subjects following the silent signals of a metronome and the recordings of the TMJ sounds were recorded using BioJVA.[8,9]
5. These movements were analysed using the Biopak software that selected the six vibrations of highest intensity to verify the following variables. a)The maximum opening of mouth. b)Total amount of vibration energy in the TMJ joint. c) Amount of energy below 300 Hz (>300 Hz). d)Amount of energy above 300Hz (<300 Hz). e)Ratio of energy above and below 300Hz (>300Hz /<300Hz). Peak amplitude, indicating the point of highest vibration intensity, was measured in Pascals; and peak frequency, measured in Hz, indicated the point at which the highest intensity of energy of vibration occurred.[10]
6. Specific wave forms of vibrations were analyzed in order to identify specific joint conditions, so different vibrations could be distinguished and categorized as inflammation, disk movement, disk displacement with reduction, disk displacement without reduction, and degenerative joint disease.[11]

PIPER'S CLASSIFICATION

Stage I: Structurally Intact TMJ- Disk alignment is normal at both the poles.

Stage II: Intermittent Click- Is characterized by the beginning of laxity of the lateral discal ligament in combination with lateral pterygoid muscle hyperactivity. Disk displacement is reversible if muscle coordination is re-established.

Stage IIIa: Lateral Pole Click- Sign of muscle tension on the disc and elongation of the posterior ligament at the lateral pole.

Stage IIIb: Lateral Pole Click- Locking phase of the lateral pole of the discal tissue.

Stage IVa: Medial Pole Click- Laxity of the medial collateral ligament manifest as click.

Stage IVb: Medial Pole Lock- Significant deformation of the disc at the medial pole which may cause locking of the joint.

Stage Va: Perforation with Acute Degenerative Joint Disease- Acute perforation in their Retrodiscal attachment. They have high levels of pain because of inflammation.

Stage Vb: Perforation with Chronic Degenerative Joint Disease- The patient have adapted to their perforation. They have lower level of pain overall.

BIO-JVA AND PIPER'S CLASSIFICATION

Longer vibrations occur with degeneration in the joint. If friction increases in the joint, it means there has been cartilage damage. During the progression of disease the vibration amplitude increases. When there is no reduction and the perforation of disc or the retrodiscal tissue takes place, bone rubs against bone and causes the increase in vibration amplitude. But when bone becomes smooth, there is comparatively less noise or the vibration amplitude is reduced. Thus, the cycle of the noise spectrum in the progressive disease in the joint will be from a quiet joint (normal), to a noisy joint (disk displacement with reduction), to very noisy (with perforation), to less noisy (increasing chronicity) and back to quiet (end stage of the disease).This cycle follows Piper's classification of events from Stage I to Stage V with TMJ internal derangements.

STATISTICAL ANALYSIS

The data collected was analysed statistically. The mean and percentages of different variable were calculated .The 't' test was applied to determine the significance. Karl Pearson's correlation coefficient was used to establish relationship between different variables.

RESULTS

The diagnostic results from BIO-JVA analysis are shown on Tables. Number of respondents with different Pathological stages by Piper's Classification (Table 1). Comparison of normal and Pipers IIIa, Vb classifications with respect to total integral and its component scores in left side by 't' test. A significant difference was observed between normal and Pipers IIIa, Vb classifications with respect to: Total integral scores ($t= -2.1762$, $p<0.05$). Integral <300Hz scores ($t= -2.2238$, $p<0.05$) at 5% level of

Table 1

Classification	No. of Respondents(20)		Total	% of respondents
	Male	Female		
Normal	7 (70%)	8 (80%)	15	75 %
Piper stage IIIa	1 (10%)	2 (20%)	3	15 %
Piper stage Vb	2 (20%)	_	2	10 %
Total	10 (50%)	10 (50%)	20	100 %

Table 2

Measurements	Normal		Pipers IIIa, Vb		t-value	P-value
	Mean	Std. Dev.	Mean	Std. Dev.		
Total integral	7.12	4.72	14.92	11.78	-2.1762	0.0431*
Integral <300 Hz	6.35	4.54	13.94	11.15	-2.2238	0.0392*
Integral >300 Hz	0.76	0.35	0.98	0.74	-0.9125	0.3736
>300/<300 Hz Ratio	0.14	0.09	0.07	0.06	1.4640	0.1604

Table 3

Measurements	Normal		Pipers IIIa, Vb		t-value	P-value
	Mean	Std. Dev.	Mean	Std. Dev.		
Total integral	7.54	5.06	16.46	8.89	-2.8207	0.0113*
Integral <300 Hz	5.92	4.80	15.20	8.51	-3.0804	0.0065*
Integral >300 Hz	1.99	5.27	1.30	0.43	0.2860	0.7781
>300/<300 Hz ratio	0.15	0.13	0.09	0.02	0.9126	0.3735

Table 4

Measurements	Normal		Pipers IIIa, Vb		t-value	P-value
	Mean	Std. Dev.	Mean	Std. Dev.		
Peak amplitude	1.13	1.15	2.00	1.63	-1.3281	0.2007
Peak frequency	28.03	19.65	25.00	9.80	0.3268	0.7476
Med frequency	73.07	35.61	75.20	37.80	-0.1144	0.9102
Distance at CO	14.20	30.84	22.46	21.48	-0.5511	0.5883

Table 5

Measurements	Normal		Pipers IIIa, Vb		t-value	P-value
	Mean	Std.Dev.	Mean	Std.Dev.		
Peak amplitude	1.09	1.11	10.90	12.48	-3.1860	0.0051*
Peak frequency	26.29	13.81	35.20	14.50	-1.2357	0.2325
Med frequency	73.73	32.27	60.00	17.20	0.8987	0.3807
Distance at CO	15.69	36.68	21.28	21.45	-0.3196	0.7529

significance. Thus, the total integral and integral <300Hz scores are significantly higher in Pipers IIIa, Vb classifications as compared to normal classification (Table 2). A significant difference was observed between normal and Pipers IIIa, Vb classifications with respect to: Total integral scores ($t= -2.8207$, $p<0.05$) at 5% level of significance; Integral <300Hz scores ($t= -3.0804$, $p<0.05$) at 5% level of significance. Thus, the total integral and integral <300Hz scores are significantly higher in Pipers IIIa, Vb classifications as compared to normal classification (Table 3). A non-significant difference was observed between normal and Pipers IIIa, Vb classifications with respect to: Peak amplitude ($t= -1.3281$, $p>0.05$); Peak frequency scores ($t= 0.3268$, $p>0.05$); Medium frequency scores ($t= -0.1144$, $p>0.05$); Distance at CO at 5% level of significance. Thus, the peak amplitude, peak frequency, medium frequency scores are similar in normal and Pipers IIIa, Vb classification. Whereas distance at CO scores slightly higher in Pipers IIIa, Vb classifications as compared to normal classification (Table 4). Comparison of normal and Pipers IIIa, Vb classifications with respect to amplitude,

Table 6

Measurements	Normal		Pipers IIIa, Vb		t-value	P-value
	Mean	Std. Dev.	Mean	Std. Dev.		
Maximum opening	52.20	5.56	52.20	3.19	0.0000	1.0000
Lateral detection	0.00	1.13	0.60	1.34	-0.9820	0.3391

Table 7

Variables	Male		Female		t-value	p-value
	Mean	SD	Mean	SD		
The maximum opening of Mouth	54.30	5.21	50.20	5.07	1.4491	0.1710
Total amount of vibration energy in the TMJ joint	10.76	6.20	12.08	9.21	-0.3764	0.7110
Amount of energy below 300 Hz (<300 Hz)	9.70	6.03	12.29	8.38	- 0.7791	0.4466
Amount of energy above 300 Hz (>300 Hz)	1.01	0.50	1.03	0.48	- 0.1033	0.9189
Ratio of energy above and below 300 Hz (>300/<300 Hz)	0.16	0.12	0.09	0.04	1.6813	0.1110
Peak amplitude	3.11	5.00	2.16	1.79	0.5415	0.5952
Peak frequency	25.80	10.96	28.50	18.59	- 0.3956	0.6970
Medium frequency	82.40	29.53	64.40	29.33	1.3676	0.1883
Distance of CO	36.57	6.00	32.10	19.44	0.3765	0.7195
Velocity	41.97	35.61	58.10	15.02	- 0.9228	0.3917

Table 8

Variables	Male		Female		t-value	p-value
	Mean	SD	Mean	SD		
The maximum opening of Mouth	-	-	-	-	-	-
Total amount of vibration energy in the TMJ joint	8.18	7.58	6.06	5.22	0.7032	0.4915
Amount of energy below 300 Hz (<300 Hz)	16.15	30.27	5.38	4.99	1.0519	0.3076
Amount of energy above 300 Hz (>300 Hz)	0.82	0.47	0.68	0.30	0.7779	0.4473
Ratio of energy above and below 300 Hz (>300/<300 Hz)	0.18	0.14	0.18	0.09	0.1153	0.9095
Peak amplitude	1.15	1.08	3.97	9.79	- 0.9068	0.3772
Peak frequency	34.70	17.35	27.10	9.24	1.2224	0.2373
Medium frequency	87.50	54.20	83.80	40.62	0.1727	0.8648
Distance of CO	37.03	11.00	18.35	14.07	1.6902	0.1896
Velocity	65.40	13.63	77.05	12.09	- 0.9713	0.4030

frequency and distance at CO scores in right side by ‘t’ test. A significant difference was observed between normal and Pipers IIIa, Vb classifications with respect to peak amplitude (t= -3.1860, p=0.05) at 5% level of significance. Thus, the peak amplitude are higher in normal and Pipers IIIa, Vb classification (Table 5). Comparison of normal and Pipers IIIa, Vb classifications with respect to maximum opening and lateral detection scores by ‘t’ test. A non-significant difference was observed between normal and Pipers IIIa, Vb classifications with respect to Maximum opening (t= 0.0000, p>0.05). Lateral deflection (t= -0.9820, p>0.05) at 5% level of significance. Thus, the maximum opening and the lateral deflection scores are almost similar in normal and Pipers IIIa, Vb classifications (Table 6). Comparison of male and females with respect to different measurements in left side by ‘t’ test. No significant difference was seen between male and females with respect to above mentioned variables on left side. Thus, they both have similar maximum mouth opening and other variables on left side (Table 7). Comparison of male and females with respect to different measurements in right side by ‘t’ test. No

Table 9

Variables	The maximum opening of mouth	Total amount of vibration energy	Amount of energy <300Hz	Amount of energy >300Hz	Ratio of energy >300/<300 Hz	Peak amplitude	Peak frequency	Medium frequency	Distance of CO	Velocity
The maximum opening of mouth	-									
Total amount of vibration energy	r=0.7033	-								
Amount of energy < 300 Hz	r=0.7513	r=0.9897*	-							
Amount of energy >300Hz	r=0.4479	r=0.0264	r=0.1148	-						
Ratio of energy >300/<300 Hz	r=0.1500	r=0.1819	r=0.0485	r=0.9242*	-					
Peak amplitude	r=0.6331	r=0.0493	r=0.0587	r=0.2380	r=0.0251	-				
Peak frequency	r=0.3062	r=0.2779	r=0.3692	r=0.5299	r=0.3640	r=0.3515	-			
Medium frequency	r=0.1967	r=0.3355	r=0.2235	r=0.8438	r=0.8939*	r=0.4025	r=0.0126	-		
Distance of CO	r=0.1688	r=0.0318	r=0.0512	r=0.2657	r=0.4241	r=0.4315	r=0.5825	r=0.6275	-	
Velocity	r=0.5566	r=0.8994*	r=0.9288	r=0.1789	r=0.0674	r=0.2712	r=0.6081	r=0.2526	r=0.1430	-

significant difference was seen between male and females with respect to above mentioned variables in right side. Thus, they both have similar maximum mouth opening and other variables on right side (Table 8). Correlations among different measurements by Karl Pearson's correlation coefficient method. Among all the variables, the joint vibration analysis shows the significant correlation with total integral (r=0.9897) in relation to integral <300Hz. Among all the variables, the joint vibration analysis shows the significant correlation with integral above 300 Hz (r=0.9242) in relation to >300/<300 Hz ratio. Among all the variables, the joint vibration analysis shows the significant correlation with ratio of energy above and below 300 Hz (r=0.8939) in relation to median frequency. Among all the variables, the joint vibration analysis shows the significant correlation with total integral (r=-0.8994) in relation to velocity. r value is positive with * indicates , the relationship between them is positive and significant (p<0.05). r value is negative with * indicates, the relationship between them is negative and significant (p<0.05). r value is positive without * indicates, the relationship between them is positive and not significant (p>0.05). r value is negative without* indicates , the relationship between them is negative and not significant (p>0.05).

DISCUSSION

Temporomandibular joint is a complex joint with condyle articulating with the articular fossa and between the joint and the articular fossa is the articular disc. A well lubricated joint produces minimum friction.[2] Any aberration in the disc or joint produces a sound which can manifest as click, crepitus, grating or rubbing. Detection of these joint sounds are critical in diagnosing the TMDs. Complex sounds produced by TMJ can be analyzed in 2 modes: 1) Time Domain, which gives a measure of total energy versus time and includes vibrations at all frequencies simultaneously. Such recording is useful to establish the time between specific events and the rates of damping as vibrations die out, and it may provide a signature to distinguish a particular type of sounds. 2) Frequency Domain, which gives the spectrum of energy of a given sound portioned among different frequencies.[12,13] Traditionally, palpation and auscultation have been used to detect TM joint sounds. A widely used method for the joint sound detection is the clinical examination of the joint with light finger palpation of the TMJ during motion. Palpation is a skill with a steep learning curve that requires great tactile sensitivity and suffers from a low specificity. Even though it is usually done bilaterally, it can be very difficult to distinguish which side is causing the joint sound. Studies have indicated that clinical detection of TMJ sounds frequently provides inaccurate data. Other clinical studies used either the digital palpation or stethoscope techniques which is dependent upon the hearing ability of the examiner and is limited to unilateral testing with no permanent record. Auscultation demonstrated marginally acceptable agreement for detection of joint sounds associated with mouth opening, but the examiner agreement was less than acceptable during lateral and protrusive jaw movements.[14] Electronic TMJ sounds recordings have potential to be a diagnostic value, however, they can be as unreliable as auscultatory findings if recording are made with methods that fail to record.[15] The first device used for receiving and recording sounds were the so called electrosonographs, with a set of highly sensitive microphones placed around 3mm from the skin. Other methods of assessing TMJ sounds are by using CT and MRI. Identification of all these morphological structures in magnetic resonance is very difficult, in such condition computer assisted tomography should be performed. CAT will be definitely more efficient in the evaluation of the hard tissues whereas, the magnetic resonance in evaluating the soft tissues. These examinations cannot be performed on every individual due to a very high cost. Thus, the advent of joint vibration analysis (JVA) paved way to a cheap, non-invasive diagnostic method, which supplements basic clinical examination and allows for detecting structural abnormalities of the joint during movement. The advantages of JVA is to objectively record vibrations of underlying tissues, to distinguish which side the vibration originates, to create a visual image of the vibration and to measure the intensity of vibrations, precisely quantify the frequency content and provides a permanent record for future purpose. This study involves the use of Bio-JVA in asymptomatic patients and the following variables were measured in each patients which were later compared and results were interpreted. In the present study, 75% of subjects were asymptomatic and 25% were diagnosed as having abnormal joints using Bio-JVA. Out of 25% diagnosed, 20% of females and 10% of male subjects had Partial Disc Displacement with Reduction (Piper’s IIIa) and 20% of male subjects had Chronic Disc Perforation (Piper's Va) in Piper’s classification. This is in accordance with the study performed by Tallents RH *et al*.,[16] who concluded that out of 50 volunteers only 44% of the joints were recorded with electronic device (Bio-JVA), and 16% of the joint shows abnormality when detected by MRI. Also El-Essawy M T *et al*.,[17] conducted a study where 20 asymptomatic subjects had undergone for MRI examination, in which 18 subjects were diagnosed as normal and in 2 subjects, MRI showed anterior disc displacement with reduction. Similarly in this study 15% of the abnormal joints subjects were diagnosed as partial disc displacement with reduction and 10% were diagnosed as chronic disc perforation. In the present study a comparison of left and right joints of the subjects showed a significant difference obtained between normal and abnormal joints of the subjects in total integral and integral <300Hz. The mean of the total integral for normal joint was less than the total integral of abnormal joints. These findings are in an agreement with the result of Olivieri KA *et al*.,[19] who in their study on joint vibrations analysis concluded that the averages of the vibratory energy in the symptomatic subjects presented higher values in all stages of the mandibular movement when compared to the averages of vibratory energy registered in the asymptomatic subjects. Ishigaki *et al*., used the parameters for joint vibration in a diagnostic framework and compared to the patient’s and doctor’s perception of TMJ sounds, EVG showed a higher diagnostic sensitivity. They also reported that a disc displacement with reduction generates

a "click" in the lower frequencies (<300 Hz) and a degenerative condition generates "crepitus" in the higher frequencies (>300 Hz). He found out that in an integral >300/<300 Hz ratio it is conceivable that the higher the integral >300 Hz/<300 Hz ratio number, a more advanced degenerative condition exists. The integral <300 Hz indicates soft tissue changes which usually manifests as click. Integral >300Hz indicates high frequency energy that is the energy commonly seen in hard tissue vibration which manifests as crepitus. Our study also showed that higher integral were present in symptomatic joint. Other studies also showed that vibration do not represent the presence of an internal derangement, but are related to the movement of the articular structures or synovial fluid. The vibration due to synovial fluid during lubrication of the articular structures is further supported by Walker *et al*.[16]
The present study showed no significant difference when normal joints and abnormal joints of the subjects were compared with respect to amplitude, frequency and distance at CO in left and right joint by "t" test. The only exception was on right joint where a significant differences was obtained with respect to peak amplitude. The same observations were also made by Sano T *et al*.,[18] in their study which showed that TMJ sounds from symptomatic subjects had a larger amplitude than sounds from asymptomatic subjects. On comparing subjects with normal joints and abnormal joints with respect to maximum opening and lateral deflection by "t" test, there was no significant difference observed. Similar results were obtained by Olivieri KA *et al*.,[19] that 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 and the vibratory energy without mandibular movement is minor and stays stable during the positions analyzed. Karl Pearson's correlation coefficient method correlates between the variables, i.e. increase in any variable by one unit will effect the other variables. The results of Karl Pearson's correlation coefficient analyzes different variables related to the evaluation of the severity of joint vibrations and helps in the formulation of diagnosis and assessment of severity of articular TMD. Study by Rodrigues C A have confirmed that higher the integral variables, a more advanced degenerative condition are seen. From the above discussion it is clear that JVA provides the clinician with the visible patterns of TMJ vibrations for patient management and the value and ratio of which helps in deciding the starting point of the treatment for TMJ vibrations.

CONCLUSION

The following conclusions were drawn within the limitations of this study: 1) JVA is able to identify TMJ degenerative changes in asymptomatic subjects who were unable to detect weak (early symptoms of TMJ dysfunctions) and possibly disease. 2) By using JVA, it is possible to differentiate total vibration values among asymptomatic subjects to detect vibrations associated with TMJ degenerative changes, which cannot be detected by clinical examinations. 3) Most vibrational energy from TMJ dysfunction occurs in the vicinity of 100 Hz where it is practically undiscernible by the human ear, even with a stethoscope and the ear is most sensitive in the 500 to 5,000 Hz range. As the values observed in the present study are less than 100 Hz level, it was concluded that the frequencies analysed in the present study were not capable of being detected by the human ear. 4) Understanding of different types of joint vibrations, characterized by analysing total integral vibrations, peak amplitude, peak frequency and mouth opening etc., observed in the present study are important for prevention and treatment and even follow up of the joint pathologies. Bio-JVA is an accurate and reproducible means to record and maintain all the above characteristics permanently for each subject. 5) Lastly, Bio-JVA is an effective tool for diagnosing TMDs in apparently asymptomatic subjects, and could be useful in screening examination to identify degenerative changes and to start treatment plan at the earliest.

Thus, JVA is a great screening test since it has such a high specificity. It is also the ideal, low cost way to monitor joint function during the course of treatment. While it does not eliminate the need for expensive imaging, it allows the practitioner to make a more informed decision whether the cost of imaging is justified.

CONFLICT OF INTEREST & SOURCE OF FUNDING

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