An insight into temporo-mandibular joint evaluation using joint vibration analysis: A review.

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Abstract
The advent of Magnetic Resonance Imaging (MRI) and Cone Beam Computed Tomography (CBCT) have made the evaluation of the temporomandibular joint (TMJ) far more definitive than the previous X-ray technologies. However, there is a large gap between what can be accomplished diagnostically in a clinical practice setting compared to utilizing these sophisticated imaging technologies. While the history and clinical examination procedures reveal important information, too often they are inadequate to arrive at even a tentative diagnosis of TMJ status. JVA tool is helpful for diagnosing joint pathology or abnormality by detecting the vibration between the joint surfaces. It is useful for diagnosis and educating patients during treatment.

Keywords: Temporomandibular joint, Cone Beam Computed Tomography, Hertz, Electrovibratography, Joint Vibration Analysis.

Introduction

In private practice, it may not be practical to obtain CBCT or MR imaging on every new patient, but it is important to have a reliable indication of any present damage in any new patient's TMJs. The patient's medical history report and clinical examination results, while necessary and valuable, are often insufficient to provide an accurate indication of TMJ status. [1–10] Joint Vibration Analysis (JVA) is a computerized process of recording vibrations bilaterally from the TMJs and processing the vibrations in software to arrive at a reliable indication of whether the TMJs are normal or damaged. The recording step involves first measuring the range of motion (ROM) and denoting any deflection at a maximum opening of 3 mm or more. Deflections of less than 3 mm have commonly been measured within normal control subjects,[10, 11] or 2 mm in children.[12] During the physiological functioning and action of joints, there is very less friction. [13–17] But any pathological or unseen situation of the joints can develop friction and little tremor. The JVA instrument is specialized to capture such vibrations and tremors of the temporomandibular joint. [18, 19]

In degenerative joint disease longer, vibration occurs.[20–22] The temporomandibular joint consists of certain cartilage, whose damage also increases friction in the joint. Advancement of the disease process leads to increase changes in the joint, leading to increased rubbing of joint surfaces leading to increase friction and so the vibration of increased amplitude. In disc displacement, without reduction, there is increased rubbing of bone, hence an increase in vibration amplitude. As this is a continuous process as the joint surfaces wear off, leads to decreased friction and decreased amplitude of the sound.

JVA Protocol

The patient is made carefree and seated in an

upright position. It helps the joint to be in a stable position. Subjects' maximum opening and lateral deflections of the jaw were noted down in a solitary state. The author of the article mentioned that they have used a special device called BIO-PAK. This device is used to register the joint vibration analysis in a computer. To conduct the analysis the headset device was set up on the patient's head. Then the authors made sure that the sensing element rested on the TMJs. A monitor was used to display the opening and closing movements of the patient's jaw. It helps the patient to perform the movements correctly. The authors mentioned that the movement should be as wide as possible and followed by tapping the teeth together during closing the jaw. Alongside the monitor, the movements were also tracked by the metronome, and it needs to happen concurrently. The accelerometers attached to the individual condyles perceived the generated vibration and registered it on the computer. There were two in-dependent sets of JVA tracings diagrams that were recorded for a duration of thirty minutes. Each JVA tracings diagram follows the Research Diagnostic Criteria examination.[23] These measurements help to detect the status of the temporomandibular joint.[24–26] The authors discussed the total integral which represents the total amount of energy in the vibration. The authors used 300 Hz as the baseline vibration frequency and registered the frequencies below and above the baseline vibration frequency.

Discussions

In this section, we will discuss the various outcomes of studies conducted by different authors. The authors conducted a study on patients with temporomandibular disorder (TMD). [26] The authors observed that patients with TMD exhibit notably higher vibration energy at each 50Hz interval. This occurs due to inadequacy of lubrication leading to lengthening of ligaments, which causes the change of relationship of the condyle or disk.

Traditionally most dentists used sound by auscultation or palpation to diagnose TMD. The authors presented a study to diagnose TMD using electrovibratography (EVG). EVG detects solid-borne vibrations which are seen in patients with abnormal joint anatomy and internal derangement.[27] Authors proved that EVG has superior accuracy compared to traditional techniques such as the use of sounds in detecting TMD.

Brooks in his study concluded that significantly 100% of subjects who have articular inflammation due to trauma of TMJ, manifest frequencies of lower amplitude between 0-25 Hz. [28]

Pain, sounds, and limitation of movement are the classic findings in the case of TMD. As it is very difficult to diagnose based on pain and sounds authors have come up with accelerometers that detect joint vibration. Dr. Albert Owen III in his study cited that 18 to 63 percent of adolescents have TMD signs and symptoms. [29] Another author List showed in his study that seven percent of adolescents between the age of 12 to 18 years diagnosed with TMD.[30] As we know this is a vital age for orthodontic treatment so the clinician must perform a thorough joint evaluation prior to treatment. Also, keep in mind pain is the second reason after aesthetics for which one seeks orthodontic treatment. Hence any TMJ screening should be fast, perfection, non-invasive, recordable, repeatable, and can be stored for a prolonged duration.[27, 31–33] JVA meets all the above criteria. TMJ vibration consisted of four factors pitch, amplitude, duration, and location JVA is well efficient to record all these and simultaneously detects the side where vibration is arising.[34–36] Monitoring and recording the internal joint status are possible because of JVA. Tallents RH et al. conducted a study on 50 subjects and found that only 44% of joints were recorded by JVA, whereas regular MRI could recognize only 16% of cases. [37]

Conclusion

The experiments described by the authors show that the JVA data is very reliable. With prior training or knowledge, it is very easy to

comprehend and evaluate the readings of the device and help in the diagnosis of joint pathology. Apart from reliability, the authors also mentioned thatJVA data can be obtained in a very short period, and it is also cost-effective. JVA records and produces a pictorial representation of the vibration data from individual condyle. It is very specific and unambiguous, and the data can be stored for a long duration for further comparison of the same patient. It can easily distinguish from which condyle; the vibrations are originating. It is also unharmful[18, 38] and can easily be performed by the assistant.

Though JVA data helps to identify disc displacements and degenerative joint disease in a short- term and low-cost manner, it cannot completely eliminate the need for high-expense imaging. As these are a very wide of diseases, it is difficult to generalize the disease assumptions based on only the JVA data.

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