An Introduction to Joint Vibration Analysis (JVA) PART I

Brock Rondeau, DDS, Doug Johnson, BS and John Radke, MBA

In this age of advanced technology, a clinician must rely on more than subjective findings (e.g. palpation and auscultation) when evaluating the temporomandibular joint. We need a way to objectively assess our patient's joint health and document both the pre-treatment conditions and the response to the treatments we provide. One of the personal computer based tools available to evaluate temporomandibular joints is JVA,* Joint Vibration Analysis (Fig. 1). The existence of this type of evaluation of the jaw joint in function is critical for objective, diagnostically driven treatment.

Joint Vibration Analysis (JVA) is based on simple principles of motion and friction: When smooth surfaces rub together, little friction is created... and thus little vibration.

However, if surfaces become rough, then friction causes vibrations when these surfaces articulate (Fig. 2). The TMJ is a ginglymo-arthroidial joint with surfaces that glide together in function. The smooth, well-lubricated surfaces in a healthy joint have a biomechanical relationship that produces very little friction and almost no vibration. Surface changes, such as those caused by subtle degenerations, any perforations or mechanical displacements generally produce friction and some vibration. Different disorders produce different vibration patterns or "signatures". Joint Vibration Analysis helps the clinician identify these conditions from the vibration patterns and helps distinguish a primary TMJ dysfunction from other painful conditions.

FIGURE 1—JVA recorder.

When we hear sounds, we distinguish one sound (vibration) from another by their differing amplitudes (loudness), durations (long vs. short sounds) and pitch, harmonics, etc. (sound qualities). JVA does the same thing, but more accurately, without any subjectivity, with honest reproducibly and providing a permanent record that is available for valid comparisons is the future.

SOUNDS VS. VIBRATIONS

Are Vibrations and Sound the same? Well, yes and no. All audible sounds come from vibrations, but not all vibrations produce an audible sound. In fact, our ears are simply incapable of hearing joint vibrations at the low frequencies that some important joint pathologies produce. We may also be confused by the combined sounds of two conditions present in the same joint or the side it's on. This is probably why research studies show that auscultation has about the same accuracy as random chance.[1-4] Furthermore, ears (and microphones, incidentally) pick up room sound and other artifacts, where JVA picks up only vibrations from the joint itself.

JVA AS A PROCESS

The process of JVA is initiated by recording bilaterally the vibration waveforms in the time domain (Fig. 3a). This provides the measures of amplitude and duration. Next, an FFT is calculated, which supplies the indications of pitch and harmonics (fig. 3b).

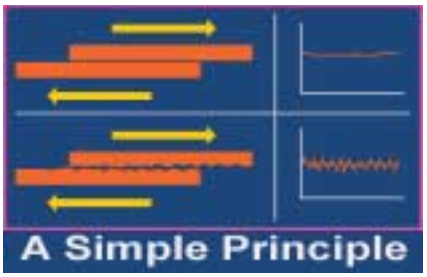

FIGURE 2—Rough surfaces produce vibrations.

What becomes evident to the practitioner is that each TM joint condition is accompanied by a specific combination of amplitude, duration and frequency characteristics.

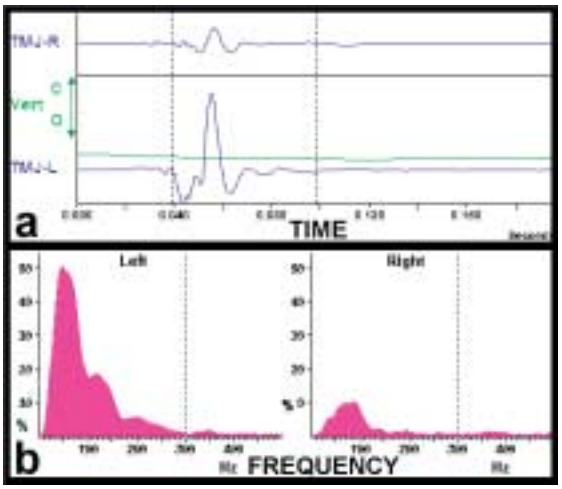

FIGURE 3—A) Time domain; **B)** Frequency domain.

According to Research performed by Dr Albert Owen III,[5] the incidence of TMD signs and symptoms in adolescents has been reported to range from 18 percent to 63 percent. In fact, Widmalm et al[6] found a prevalence of joint sounds of 16.7 percent even among pre-school children (mean age = 5.1 yrs) and Alamoudi et al[7] found a prevalence of 16.5 percent among 3-7 year-olds. More recently, List et al[8] found that seven percent of adolescents aged 12 to 18 years were diagnosed with painful TMD. Since adolescence is the primary age for orthodontic treatment, it behooves the clinician to perform a thorough TMJ diagnosis prior to initiating treatment, as well as monitor the status of the joints during treatment. Similar studies[9-11] in the adult populations have shown that up to 50 percent have at least one sign of TMJ dysfunction.

Traditionally, we have used palpation and auscultation to detect TM joint "sounds". Auscultation is dependent upon the hearing ability of the examiner and is limited to unilateral testing with no permanent record. The interpretation of these "sounds" has been shown to be very difficult — "What type of sound was it?" — "Did it occur upon every opening?" "Which side did the sound occur on?" 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.[12]

JVA, in contrast, is a passive device that; 1) objectively records all of the vibrations of the underlying tissue during function, 2) distinguishes which side the vibration originates on, 3) creates a visual image of the vibration, 4) measures the intensity of the vibration, 5) precisely quantifies the frequency content and 6) provides a permanent record for future comparison. JVA is less invasive and more accurate[13-17] than auscultation or palpation with a repeatable permanent record of TM joint function or dysfunction. And, it can be recorded by a staff member in about a minute.

JVA is a great screening test since it has such a high specificity.[15] 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. **OH**

For author biographies, see page 60.

Oral Health welcomes this original article.

REFERENCES

1. Eriksson, L., Westesson, P-L., Sjobert, H.: Observer Performance in Describing Temporomandibular Joint Sounds. J Craniomadib Prac 1987;5:32-35
2. Paesani, D., Westesson, P-L., Hazala, M.P., et.al. Accuracy of Clinical Diagnosis for TMJ Internal Derangement and Arthrosis Oral Surg Oral Med Oral Path, 1992 Volume 73, Number 3; 360-364
3. Hardison, D.J., Okeson, J.P. Comparison of Three Clinical Techniques for Evaluating Joint Sounds. J Craniomandib Prac., 1990, Vol. A, No. 4
4. deWujen, A. et.al. Reliability of Clinical Findings in Temporomandibular Disorders. J Orofacial Pain, 1995, Vol 9, Number 2; 181-189
5. Owen, A. III. Rationale and Utilization of Temporomandibular Joint Vibration Analysis in an Orthopedic Practice. J Craniomandib Prac., 1996; 14:(2)139-153.
6. Widmalm SE, Christiansen RL, Gunn SM. Crepitation and clicking as signs of TMD in preschool children. Cranio. 1999 Jan;17(1): 58-63.
7. Alamoudi N, Farsi N, Salako NO, Feteih R. Temporomandibular disorders among school children. J Clin Pediatr Dent. 1998 Summer;22(4):323-8.
8. List T, Wahlund K, Wenneberg B, Dworkin SF. TMD in children and adolescents: prevalence of pain, gender differences, and perceived treatment need. J Orofac Pain. 1999 Winter;13(1):9-20.
9. Ingervall B, Mohlin B, Thilander B. Prevalence of symptoms of functional disturbances of the masticatory system in Swedish men. J Oral Rehabil. 1980 May;7(3):185-97.
10. Kemper JT Jr, Okeson JP. Craniomandibular disorders and headaches. J Prosthet Dent. 1983 May;49(5):702-5.
11. Locker D, Slade G. Prevalence of symptoms associated with temporomandibular disorders in a Canadian population. Community Dent Oral Epidemiol. 1988 Oct;16(5):310-3.
12. Widmalm SE, Williams WJ, Yang KP. False localization of TMJ sounds to side is an important source of error in TMD diagnosis. J Oral Rehabil. 1999 Mar;26(3):213-4.
13. Gallo, L, Svoboda, A and Palla, S. Reproducibility of Temporomandibular Joint Clicking. J Orofac Pain (Fall)2000; vol 14:no.4:293-302.
14. Ishigaki S, Bessette RW, Maruyama T. A clinical study of temporomandibular joint (TMJ) vibrations in TMJ dysfunction patients. Cranio. 1993 Jan;11(1):7-13; discussion 14.
15. Ishigaki S, Bessette RW, Maruyama T. Vibration of the temporomandibular joints with normal radiographic imagings: comparison between asymptomatic volunteers and symptomatic patients. Cranio. 1993 Apr;11(2):88-94.
16. Olivieri KA, Garcia AR, Paiva G, Stevens C. Joint vibrations analysis in asymptomatic volunteers and symptomatic patients. Cranio 1999 Jul;17(3):176-83.
17. Radke J, Garcia R Jr, Ketcham R. Wavelet transforms of TM joint vibrations: a feature extraction tool for detecting reducing displaced disks. Cranio 2001 Apr;19(2):84-90.