JVA RESEARCH PART II - ACQUISITION OF VIBRATION DATA
ACCELEROMETERS VS. MICROPHONES

- Bessette, R.W.: A Clinical Study of Temporomandibular Joint Vibrations in TMJ Dysfunction Studies. *Presentation - American Academy of Head, Neck Facial Pain, and TMJ Orthopedics. Kansas City, MO. August 15, 1992*

  Vibration recording with accelerometers has distinct advantages over recording with microphones. It reduces room and environmental artifacts. It minimizes the inherent electrical noise found in microphones.

#416

- Christensen, L.V.: Physics and the Sounds Produced by the Temporomandibular Joints (Part I). *J Oral Rehab, 1992;19:471-483*

  In clinical dentistry, the sounds and noises produced by the temporomandibular joints usually signify dysfunction or disease of the mandibular locomotor system.

  In **sonography, these sounds are recorded as airborne vibrations with condenser microphones**. The condenser microphone is highly sensitive to "irrelevant" sound fields leading to artifactual registration of any airborne wave.

  In **vibratography, vibrations are recorded by two skin-contact transducers (accelerometers)**, highly sensitive to "relevant" vibration fields.

  In general, **microphones should not be used for recording TMJ sounds - only accelerometers can be advocated** for the recording of solid borne TMJ vibrations.

#416

- Christensen, L.V.: Physics and Sounds Produced by the Temporomandibular Joints (Part II). *J Oral Rehab, 1992; Volume 19:615-617*

  Errors were found in sound frequency measurements recorded with airborne recording condenser microphones. Comparable measurements made with skin-contact vibration transducers were accurate.

#400

- Gay, T. et al: The Acoustical Characteristics of the Normal and Abnormal Temporomandibular Joint. *J Oral Maxillofac Surg 1987;45:397-407*

Researchers found that **a major artifact of their recording technique with a microphone was the detection of spurious sound caused by high levels of ambient room sounds**.

#502

- Ishigaki, I., Bessette, R.W., Maruyama, T.: Vibration of the Temporomandibular Joints With Normal Radiographic Findings: Comparison Between Asymptommatic Volunteers and Symptomatic Patients. *J Craniomandib Prac, 1993, Vol. 11 Number 2; 88-94*

Recordings were made from sensors **(BioResearch model 207 accelerometers)** not attached to subjects and sensors attached to subjects without any movement. These recordings showed very small energy density, nearly 0, through the entire frequency range.

These accelerometers exhibit no appreciable background noise which could interfere with the true joint vibration.

#610

- Kernohan, W.G., Beverland, D.E., McCoy, G.F. et al.: Vibration Arthrometry. *Acta Orthopaedica Scandinavia 1990; 61:70-79*

This review article traces the development of various techniques to evaluate sounds from human joints during function.

The conclusion through the principals of biophysics is that **recording air-borne joint vibrations with a microphone leads to artifactual (erroneous) recordings** of joint sounds anywhere in the human body.

An accelerometer, recording solid-borne vibrations, results in accurate, artifact free recording of joint vibrations.

#424

- Lewin, A.: Discussion: Temporomandibular Joint Vibration Analysis in a Sample of Non-Patients. *J Craniomandib Prac, 1992, Vol. 10 No. 1 41-42*

Piezoelectric transducers (accelerometers) can be used to measure fine vibrations at the surface of the skin in the proximity of the TM joint. This method does not depend on the movement of air, as does a microphone, and is therefore relatively free of "noise" from extraneous sounds.

For the patient with complaints of noisy joints, researchers or clinicians may want more than an estimated discrete rating on "how noisy do you think" scale. **For the desired objective assessment, vibratography, using accelerometers, seems a better choice than sonography, which relies on microphones.**

#614

- Mollan, R.A.B., et al: A Critical Appraisal of Auscultation of Human Joints *Clinical Orthopaedics & Related Research, Number 170, October, 1982*

  Researchers attempted to accurately record joint sounds using a B&K 4125 microphone with a linear response of 20 Hz to 20 kHz.

  The authors show that vibration emission from human joints occur at the lower end of the frequency spectrum. The conclude that **"the microphone was a poor transducer in terms of frequency and dynamic sensitivities for use with human joint emission."** This was because in a skin-air interface, a major part of sound energy is reflected. Also, skin friction noise and ambient room noise were fundamental limitations.

- Sutton, D.I. et al: Temporomandibular Joint Sounds and Condyle/Disc Relations on Magnetic Resonance Images. *Am J Orthod Dontofac Orthop 1992; 101, 70-78*

  In evaluating TMJ sounds, the authors state that different recording methods are important considerations in assessing the differing results. **Accelerometers**, used in this study, **may help determine that all the significant sound energy is being picked up by events propogated within the joint.**

  The study found that **with accelerometers, cross vibration from the pathologic joint to the contralateral joint was not recorded**.