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Stethoscope Acoustics and Cervical Auscultation of Swallowing

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Abstract. Frequency response characteristics of six popular stethoscopes are reported for the higher frequency range (to 3000 Hz) to supplement equivalent measurements for the lower frequencies (35–1000 Hz) published previously. Spectra of the sounds of swallowing from the throat, transduced with an accelerometer, demonstrate important frequency composition in this higher range. Two stethoscope models were found to have superior transmission characteristics for use in cervical auscultation of swallowing sounds.

Key words: Sound of swallowing — Stethoscope — Auscultation — Deglutition — Deglutition disorders.

Cervical auscultation (listening at the throat with a stethoscope) is being adopted by dysphagia clinicians as a component of clinical evaluation of swallowing [1–9]. As in any observational method, the quality of information obtained depends not only on the perceptual skills of the examiner but on utilization of appropriate instrumentation and technique. Even a seemingly simple procedure such as listening with a stethoscope contains a source of instrumental distortion. That is, the stethoscope is not completely faithful in picking up and transmitting to the listener's ear the sound quality present at the body surface.

Research studies on the acoustics of swallowing have generally recorded the sounds using a microphone or accelerometer [5–7,9–14]. These transducers are designed to have a flat frequency response over a wide range of frequencies. Clinicians have remarked, when listening to recordings of swallowing sounds, that they do not sound quite like what is heard with a stethoscope [15]. If the results of such research studies are to be translated into clinical practice, it is important to take into account the characteristics of the different instruments.

The literature contains limited description of the spectrum of swallow sounds. Logan et al. [11] published spectrograms of liquid swallow sounds. Swallow sounds are broad band, containing transient clicks, with energy up to 8,000 Hz. It can be appreciated from the illustrations, however, that the greatest intensity is in the frequency range below 3,000 Hz, and that clicks with frequency components higher than this contain energy in the low frequencies also. Thus, there would be no loss of temporal detail from filtering out the higher frequencies. Mackowiak et al. [10] described the spectrum of a "dry" swallow as having peak energy at 1,000–1,100 Hz for the entire duration of the swallowing sound. Wet swallow signals began with a low frequency component (400–600 Hz), then increased in intensity and frequency to a peak at 1,000 Hz at the end of the signal. They used a contact microphone over the larynx lateral to the midline. Heinz et al. [4] and Vice et al. [6] described swallow sounds recorded from infants, portions of which were periodic with a high fundamental frequency. Hamlet et al. [12,13] published illustrations of a spectral change within a portion of the sound of swallowing corresponding to fluid flow through the upper esophageal sphincter. Spectral information of this type is contained in the frequency region below 3,000 Hz.

The acoustic spectrum of breath sounds following swallowing were illustrated by Logan et al. [11]. Greatest intensity is in the lower frequency range, below 1,500 Hz. Similarly, sounds of value in the diagnosis of heart and lung disease by thoracic auscultation fall in the low frequency range 20–1,000 Hz [16,17].

A review of the acoustics of stethoscopes, and frequency response data for several currently available

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