COMMENTS ON THE MYOELASTIC-AERODYNAMIC THEORY OF PHONATION

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The myoelastic-aerodynamic theory of phonation has been quantified with computer models of varying complexity during the past decade. Mathematical statements of physical laws were used to simulate air and tissue movement in the larynx, as well as wave propagation in the vocal tract. The feedback mechanism by which oscillation of the vocal folds is produced appears to be a result of pressure distributions which are asymmetric with respect to the medial surface velocity of the tissue. Upward and lateral movement during opening is associated with a substantially different pressure profile than downward and medial movement. This mechanism, when sustained, allows energy to be transferred from the air stream to the tissue. In the simplest one-mass model, the asymmetry usually begins with voice onset transients, but may be sustained in the steady state by the inertial inductance of the air in the glottis, or by the vocal tract input impedance. Since these may vary with the direction of flow acceleration (which in turn varies with medial surface tissue velocity), an asymmetric pressure profile can be maintained. With additional degrees of freedom in tissue movement (multiple-mass or continuum models), the pressure distribution becomes asymmetric primarily as a result of combinations of normal mode displacements.

The fundamental frequency seems to be myoelastically controlled. Theoretical models do not support the view that F_O is controlled by an effective aerodynamic stiffness. Physiologically and phenomenologically, subglottal pressure does affect F_O, as has been repeatedly demonstrated experimentally, but it appears to be an amplitude related phenomenon which is governed by nonlinear properties of tissue elasticity. Recent measurements on various tissue layers of the vocal folds, as well as the entire literature on the viscoelasticity of human tissue, confirm that the common exponential stress-strain curves can easily account for the observed frequency-amplitude dependence. The negative Bernouilli pressure, which pulls the vocal folds medially prior to glottal closure, is short-range. Over the entire glottal cycle it resembles a mechanical impulse, which imparts momentum, but has little effect on the natural frequency of oscillation.