# TWO-DIMENSIONAL FINITE ELEMENT MODEL OF VOWEL PRODUCTION: PROPERTIES OF SELF-OSCILLATING VOCAL FOLDS INTERACTING WITH FLUID FLOW


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The current study concerns finite element (FE) model of flow-induced self-sustained oscillation of the human vocal folds (VF) in interaction with vocal tract (VT) acoustics. Two dimensional (2D) FE model consists of the fluid model (involving the VT and trachea) and the structural model (the VF). Geometry of the VT was converted from magnetic resonance images (MRI) data for production of a Czech vowels. The VF model is based on widely used Scherer's M5 geometry with four-layered structure comprising epithelium, superficial lamina propria (SLP), ligament and muscle. The following mechanisms are included in computational algorithm of the FE model: fluid-structure-acoustic interaction, setting to phonatory position, VF contact and large deformations of the VF tissue. The airflow is modelled by unsteady viscous compressible Navier-Stokes (NS) equations, airflow is separated during the glottis closure and the fluid mesh is morphed according to the VF motion (Arbitrary Lagrangian-Eulerian approach). For solving fluid-structure interaction explicit coupling scheme is applied with separate solvers for the structural and fluid domain. Acoustic wave propagation is obtained from solution of compressible NS equations. Phonation of the Czech vowels [a:], [i:] and [u:] were simulated and influence of thickness and material characteristics of the SLP on VF vibrations and produced sound were analysed. Using this model was also analyzed the effect of turbulence model in fluid flow calculation. The developed FE model can be employed to study the effects of pathological changes in VF tissue such as Reinke's edem on VF movement and on the produced sound.