Nonlinear Head-Neck Dynamics at Small Amplitude Perturbations
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It has been previously reported that head-neck neuromechanical system demonstrates nonlinear characteristics in its response to small amplitude perturbations by looking at the sign of the largest Lyapunov exponent of the system dynamics and the correlation dimension estimates computed at the Poincaré sections [9,21]. Twelve healthy young adults seated on a linear sled randomly received anterior-posterior sinusoidal translations with ±15 mm and ±25 mm peak displacements at 0.81, 1.76 and 2.25 Hz. Head angular position data was used to reconstruct the system dynamics in m-dimensional embedded phase space. Correlation dimension estimates (Dk) from head angular displacement data have been computed by using the method of time delays (τ). The optimum τ for expanding the reconstruction of the attractor has been found by using the average displacement method [10]. Head-neck dynamics has been verified to involve at least two degrees of freedom in the range of stimulations experimented but subjects, demonstrating three degrees of freedom head-neck dynamics especially by increasing the amplitude of perturbation also existed. Furthermore, a knee-like behavior has been observed at the log C(τ) versus log r plots, which is manifested by increasing the perturbation amplitude. The nonlinear behavior observed at the plots has been interpreted as the existence of not-coupled dynamics slightly interacting [11].

Keywords: Head oscillations, Correlation dimension, Time delays, Knee-like behavior