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JOURNAL ARTICLE

Sampling factors influencing accuracy of sperm kinematic analysis

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Sampling conditions that influence the accuracy of experimental measurement of sperm head kinematics were studied by computer simulation methods. Several archetypal sperm trajectories were studied. First, mathematical models of typical flagellar beats were input to hydrodynamic equations of sperm motion. The instantaneous swimming velocities of such sperm were computed over sequences of flagellar beat cycles, from which the resulting trajectories were determined. In a second, idealized approach, direct mathematical models of trajectories were utilized, based upon similarities to the previous hydrodynamic constructs. In general, it was found that analyses of sampling factors produced similar results for the hydrodynamic and idealized trajectories. A number of experimental sampling factors were studied, including the number of sperm head positions measured per flagellar beat, and the time interval over which these measurements are taken. It was found that when one flagellar beat is sampled, values of amplitude of lateral head displacement (ALH) and linearity (LIN) approached their actual values when five or more sample points per beat were taken. Mean angular displacement (MAD) values, however, remained sensitive to sampling rate even when large sampling rates were used. Values of MAD were also much more sensitive to the initial starting point of the sampling procedure than were ALH or LIN. On the basis of these analyses of measurement accuracy for individual sperm, simulations were then performed of cumulative effects when studying entire populations of motile cells. It was found that substantial (double digit) errors occurred in the mean values of curvilinear velocity (VCL), LIN, and MAD under the conditions of 30 video frames per second and 0.5 seconds of analysis time. Increasing the analysis interval to 1 second did not appreciably improve the results. However, increasing the analysis rate to 60 frames per second significantly reduced the errors. These findings thus suggest that computer-aided sperm analysis (CASA) application at 60 frames per second will significantly improve the accuracy of kinematic analysis in most applications to human and other mammalian sperm.

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