Initial orthostatic hypotension: effects of tilt speed and hand position on finger arterial blood pressure during head-up tilt

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Initial orthostatic hypotension (IOH) is defined on the basis of transient reductions in systolic blood pressure (SBP) or diastolic blood pressure (DBP) of at least 20 or 10 mmHg during the first 15-30 s of upright tilting or standing. The prevalence of IOH in healthy individuals is high, although most evidence is based on non-invasive measurements of arterial blood pressure in a finger. Large declines in blood pressure are observed while the hand is positioned by the side and automatic adjustment for changes in vertical distance between the heart and recording finger ('height-correction') is used. The adequacy of this approach is not clear and reliance upon a height-correction method might contribute to a transient decline in blood pressure, particularly when the change in posture is rapid.

Effects of hand position (heart, side) and rate of tilt (fast, slow) on tilt-induced changes in SBP and DBP were studied in nine subjects (4 males, 5 females; age = 29.0 (9.4) y; height = 1.761 (0.075) m; weight = 75.7 (14.0) kg). The experimental protocol was ~50 minutes long and consisted of five consecutive sets of four head-up tilts (~65 ^{o}), with each set separated by 4-min periods of calibration of the BP recording system. Each tilting manoeuvre lasted ~22-30 s and was preceded and followed by ~90 s in the supine position. For each set of tilts there were four conditions: fast speed with hand on the heart (FH); fast speed with hand by the side (FS); slow speed with hand on the heart (SH); and slow speed with hand by the side (SS). The order of presentation of these conditions was kept consistent between sets within a subject but varied between subjects using a counterbalanced approach. Blood pressure was recorded continuously in the middle finger of the right hand and SBP and DBP were measured on a beat-to-beat basis. For each tilt, a time series of SBP and DBP data beginning 20 s before and ending 20 s after the completion of tilting movement were analysed. For each subject, measurements of tilt speed, rate of change in vertical distance between recording finger and heart, as well as BP-related variables were obtained from each time series, grouped and then averaged to obtain a single estimate of each variable for each of the four conditions. Effects of tilt speed and hand position on these variables were analysed using a two-way repeated-measures ANOVA.

Fast and slow tilts were completed within 1-2 and 7-11 s and the tilt speed ($^{o}\cdot s^{-1}$) was significantly different between fast tilts (mean (SD): FH = 41.0 (5.6), FS = 40.4 (6.5)) and slow tilts (SH = 6.7 (0.4), SS = 6.7 (0.5)). The rate of change in vertical distance between the recording finger and heart during tilting was significantly different ($P < 0.001$) between all four conditions (FH = 0.9 (1.0) $cm\cdot s^{-1}$, FS = 20.9 (4.0) $cm\cdot s^{-1}$, SH = 0.2 (0.2) $cm\cdot s^{-1}$, SS = 4.1 (0.6) $cm\cdot s^{-1}$). Mean SBP and DBP during 20-s baseline periods immediately before tilting were not significantly different between the four conditions. The variabilities of blood pressure about these mean baseline values, represented by 2SD, were also not different between conditions. Tilt-induced changes in SBP and DBP were referenced to the lower limit of normal variation of these variables (*i.e.* mean - 2SD) during the preceding baseline and expressed as a proportion of these lower limits. The decrease in SBP was not significantly affected by tilt speed ($F = 0.1$) and hand position ($F = 1.5$). By contrast, the decrease in DBP was significantly affected ($P < 0.005$) by tilt speed ($F = 9.7$) and hand position ($F = 11.5$), as well as a tendency to an interaction between tilt speed and hand position ($F = 2.3$, $P=0.14$). The decline in DBP was larger for FS (- 17.9 (9.7) %) compared with other conditions (FH = - 6.1 (6.5) %, SH = - 2.3 (4.7) %, SS = - 6.8 (6.8) %). There was also a significant effect of tilt speed and interaction with hand position for the time at which the nadir in DBP occurred after the onset of tilting, being shortest for FS (5.1 (2.6) s) compared with other conditions (FH = 6.3 (2) s; SH = 7.2 (2.6); SS = 9.5 (3.5) s).

This preliminary evidence demonstrates that tilt speed and hand position influence the maximum decline in diastolic blood pressure and timing of this response, suggesting that the use of rapid orthostatic manoeuvres with hand by the side overestimates the decline in blood pressure and prevalence of IOH.