Title – Understanding the mechanisms of the protective effects of caffeine in cardiac autonomic neuropathy
Program of Study – M.S. Biomedical Science.
Presentation Type – Power Point
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Category – Basic

Abstract: Orthostatic hypotension (OH) is a prominent feature of diabetes mellitus called cardiac autonomic neuropathy (a condition resulting from an imbalance between the heart's sympathetic and parasympathetic influences). OH is thought to be an independent predictor of mortality in these patients, increasing the risk of death by about 36%. Over the years, caffeine (a sympathomimetic) has been employed as an off-label treatment for neurogenic OH, but the exact mechanisms of its effectiveness has yet to be fully explored.

Thus, we seek to utilize heart rate variability (HRV) in identifying the mechanism(s) of caffeine's modulation of the autonomic response to sudden postural changes.

A quasi-randomized study of 42 vicenarians (25 females and 17 males) was conducted using AD Instrument's equipment and HRV/ECG analysis tools to measure HRV during postural changes from sitting to standing with and without caffeine (200mg). HRV measurements include SDRR (the standard deviation of normal RR intervals), RMSSD (root mean square of RR intervals), HF (high-frequency), and LF (low-frequency).

A two-way-repeated-measures ANOVA was run and the mean heart rate 85bpm ($F(3, 123)=103.289, p<0.0005$), SDRR 90.87($F(1.250, 51.248)=8.941, p=0.002$), RMSSD 124.87 ($F(1.218, 49.932)=14.176, p<0.0005$), LF 6836.02 ($F(1.010, 41.424)=4.792, p=0.034$), and HF 20309.60 ($F(1.026, 43.103)=5.422, p=0.024$) levels were statistically significant for postural changes over time in the control trial. These interactions were however diminished in the caffeine trials with mean heart rate 84.70bpm ($F(3, 123)=79.777, p<0.0005$), SDRR 70.885 ($F(2.184, 89.556))=3.529, p=0.030$) and RMSSD 94.24 ($F(1.893, 77.615)=5.919, p=0.005$) levels being likewise significant but not LF 3394.15 ($F(1.340, 54.948)=1.123, p=0.312$) and HF 7773.62 ($F(2.434, 99.791)=1.340, p=0.267$) levels. Caffeine alone did not significantly increase HRV - SDRR ($z(66)=0.360, p=0.720$).

Therefore, whereas caffeine does not significantly impact HRV, it diminishes the increase in HRV produced by postural changes. This observation is due to an increase in baseline sympathetic tone, venous return, cardiac output and a decrease in the rate of drop in blood pressure, consequently mitigating OH.

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Category – Applied Science

Abstract

Introduction: Cardiac auto neuropathy, an impairment of the autonomic regulation of the cardiovascular system which is innervated by the sympathetic nervous system (SNS) via the cardiac plexus, and the parasympathetic nervous system (PNS) via the vagus nerve, can lead to complications such as orthostatic hypotension (OH). OH is characterized as an increased difference in cardiac output (CO) or the impaired capacity to increase systemic vascular resistance from the sitting to standing position.

Objective: This study evaluates the effects of c affeine on the autonomic response to sudden postural changes.

Methods: A quasi-randomized study of 42 healthy college-aged individuals (25 females and 17 males) was conducted using AD Instruments software and equipment to measure HRV (the standard deviation of normal RR intervals - SDRR), which evaluates the balance between the PNS (the root mean square of RR intervals - RMSSD, and high-frequency -HF) and SNS (low-frequency - LF) regulation of the heart during postural changes. 200mg of caffeine were administered 30min before the experimental trial.

Results: A two-way repeated measures ANOVA was run to determine the effect of caffeine over postural changes on HRV. From sitting, SDRR increased by 149% at 10s then decreased by 20% at 20s followed by a 42% decrease after 30s ($F(1.166,43.126)=8.770, p=0.003$) while RMSSD increased by 243% at 10s, decreased by 29% at 20s, and then decreased by 42% at 30s. HR ($F(3,123)=103.289, p<0.0005$) and LF ($F(1.010,41.424)=4.792, p=0.034$) followed the same trend, while HF increased by 171% at 10s, decreased by 25.8% at 20s, then increased by 3.7% at 30s ($F(1.026,43.103)=5.422, p=0.024$).

After caffeine consumption from the sitting position, SDRR increased by 41.7% at 10s then decreased by 18.4% at 20s, followed by a 42% decrease after 30s ($F(1.334,49.340)=3.644, p=0.050$), and RMSSD increased by 81.4% at 10s, 13.3% decrease, then a 60.5% decrease ($F(1.893,77.615)=5.919, p=0.005$). HR ($F(3,123)=79, p<0.0005$) and LF($F(1.340,54.948)=1.123, p=0.312$), followed the same trend, while HF show a different trend with a 27.6% decrease at 10s, a 2% decrease at 20s, then a 91.8% decrease at 30 % ($F(2.434,99.791)=1.340, p=0.267$).

During the first 10s of standing after the caffeine consumption, SDRR ($F(1,37)=3.765, p=0.060$), RMSSD ($F(1,41)=4.001, p=0.052$), and ln of LF($F(1,41)=4.011, p=0.052$) increased but were not statistically significant however the increase in HF($F(1,41)=4.534, p=0.039$) was statistically significant.

Conclusion: We believe that caffeine increased sympathetic stimulation during the seated position in order to maintain the baseline autonomic tone, making caffeine a great protective drug against orthostatic hypotension in patients with cardiac auto neuropathy. We speculate that this autoprotective effect of caffeine is seen during the fist 10s of standing.