Poster No. 6

Title: Reduced Ventricular Contractility Is Associated with Reduced Cardiovascular Fractal Dimension

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Abstract:

Background: Heart rate variability (HRV) measures interbeat complexity, a marker of cardiovascular health, which decreases with age and conditions such as diabetes, hypertension, and obstructive sleep apnea. However, the effect on fractal variability of the heart's ventricular contractility (dp/dt) has not yet been established. Comparing reduced dp/dt versus HRV may reveal feedback loops, and begin to show comorbidities affecting the complexity of the cardiovascular system. Fractal geometry can be used to model this complexity. We hypothesize that reduced contractility states equate with reduced fractal dimension in heart rate as overall cardiovascular health decreases.

Method: After IRB approval, retrospective analysis of 88 patients (25 men, 63 women) with ages ranging from 21 to 72 years undergoing bariatric surgery was performed using de-identified beat-to-beat systolic blood pressure signals obtained from a Nexfin© device (Edwards Lifesciences Corporation, Amsterdam, Netherlands). Best linear fit to time course data was analyzed with rms error which followed a fractional power law, or fractal dimension, with respect to scale. A multivariate statistical analysis with significance $p<.05$ was performed to determine the presence of association between average dp/dt and variability of heart rate and systolic blood pressure.

Results: Reduced ventricular contractility is associated with reduced fractal geometry in heart rate.

Conclusion: The presence of multiple, oscillating feedback loops is responsible for the fractal patterns found in cardiovascular parameters. Our study identified such a pattern in HRV and dP/dt under general anesthesia. This retrospective study suffers significant limitations in that this data was collected from human subjects under general anesthesia which is known to blunt the autonomic nervous system, an important feedback loop responsible for fractal patterns in heart rate. Given that we have established fractal analysis under anesthesia, it will be important to collect data on non-anesthetized patients across different ages and comorbidities using hemodynamic parameters measured by the Nexfin.