A NEW METHOD TO ASSESS THE SYMPATHOVAGAL BALANCE ON A BEAT-TO-BEAT BASIS

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INTRODUCTION

Heart rate variability (HRV) has become an important method to assess autonomic nervous control of the heart. Time-domain techniques and spectral analysis are fundamentally based on moment statistics and harmonics. The former essentially describes the magnitude of heart rate variability.

In recent years, analytical methods derived from non-linear dynamics based on chaos theory and fractal mathematics have been proposed to better investigate the complexity of heart rate dynamics not explored by methods based on means, variance and frequency bands.

PURPOSE OF THE STUDY

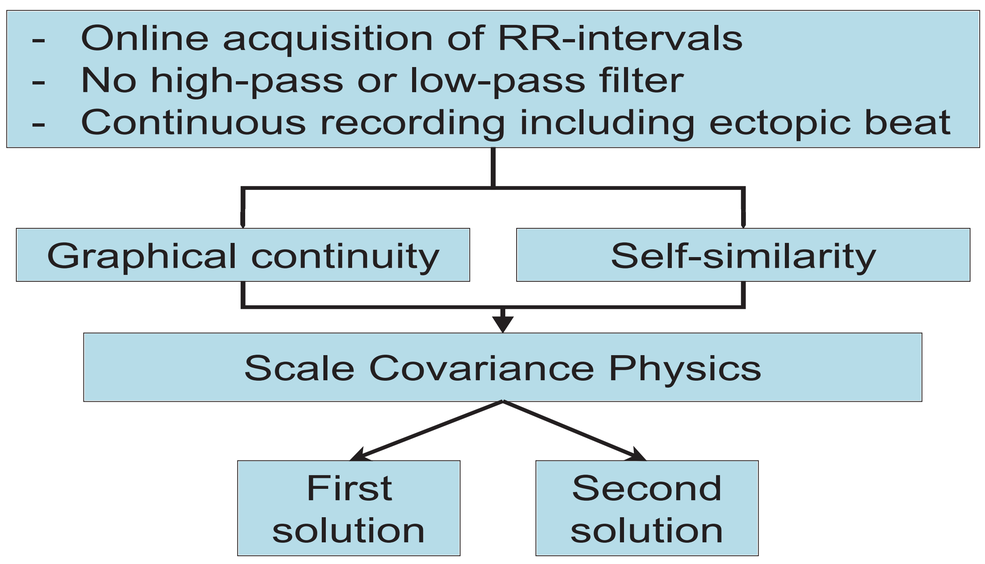
- Application of a new mathematical method based on Scale Covariance Physics to obtain a dynamic representation of the sympathovagal balance on a beat-to-beat basis.

- Validation of this method by pharmacological manœuvres :

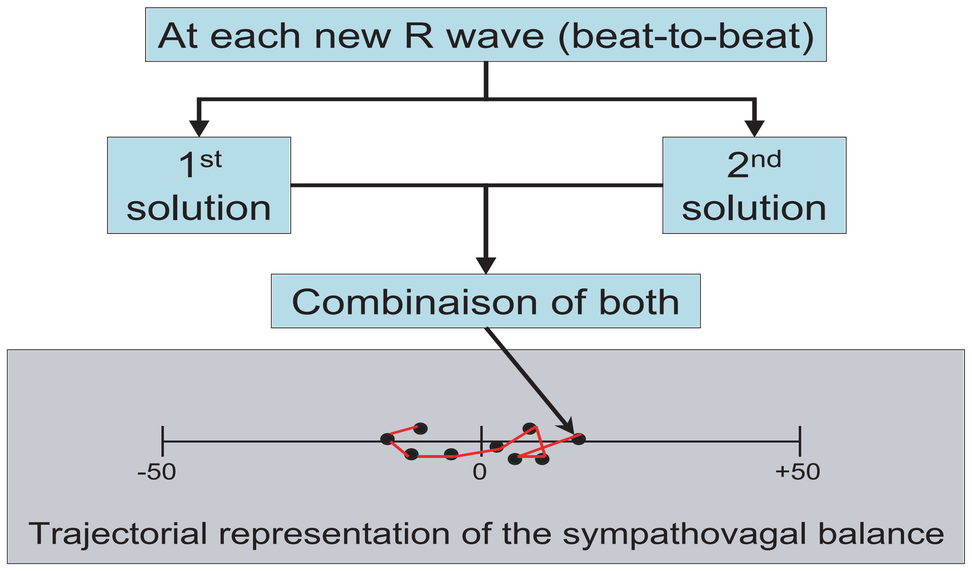
  - suppression of vagal stimulation by atropin
  - adrenergic stimulation by isoproterenol infusion

METHOD

The method can be decomposed in several steps :



The representation of the sympathovagal balance is made as follows :



METHOD (continued)

The sympathovagal balance is then portrayed as trajectories evolving under the attraction of two opposite poles.

By computing the center of gravity (CG) of the trajectories, a quantitative representation is obtained, leading to an index of the sympathovagal balance (range -50 to +50).

15 patients (13 male, 2 female)
mean age : 60 (±18) years
no structural heart disease
no antiarrhythmic drug treatment

atropin 1.0 mg intravenously
isoproterenol infusion (individual dosage to increase basic sinus rate to 110-120 bpm)
permanent recording of RR-intervals throughout the entire procedure

RESULTS

	Heart rate (bpm)	Center of gravity
BASAL	76 ± 17	-1 ± 15
ATROPIN	95 ± 18	36 ± 9
ISOPROTERENOL	121 ± 33	25 ± 13

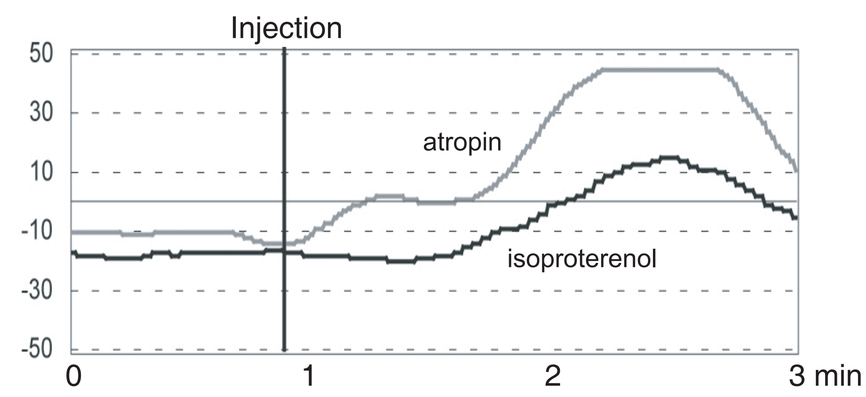


Figure 1: example of a 3 minutes evolution of the center of gravity index after injection of isoproterenol (in black) and atropin (in gray).

CONCLUSION

The selective humoral stimulation/inhibition of the autonomic nervous system by isoproterenol/atropin suggests that the trajectories obtained by the present mathematical method evolve under the attraction of the parasympathetic pole and its sympathetic opposite.

This new method allows visualisation of dynamic fluctuations of the sympathovagal balance on a beat-to-beat basis.

The center of gravity index allows quantification of the sympathovagal balance, where negative indices indicate parasympathetic predominance and positive indices, sympathetic predominance.

Trajectorial representation of the dynamical changes of the sympathovagal balance during autonomic manœuvres