Heart Rate Variability (HRV)

Performing and Understanding HRV Measurements

The AtCor Medical ***HRV*** software is able to assess sympathetic / para-sympathetic autonomic function. Patient studies can be performed in three modes:

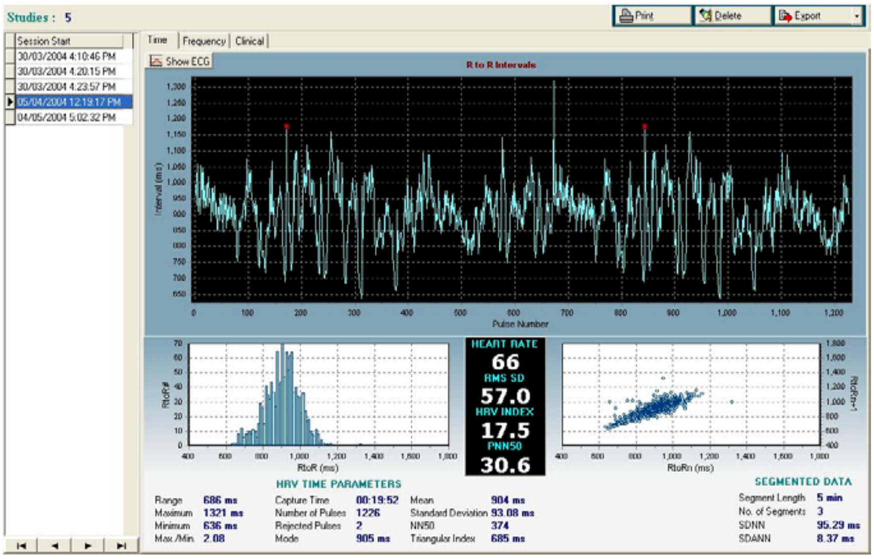
- During stable supine resting (baseline) – providing HRV time and frequency domain parameters
- After Valsalva maneuver – providing the Valsalva ratio
- After Standing maneuver – providing the 30:15 ratio

MODE 1: HRV Measurement in Supine Resting State

It is recommended that a standard 5 minute ECG recording is performed with patient in a supine position, with a regular and calm breathing pattern (5 minute resting study). Patients should remain awake.

[Note: 1. A second measurement performed for 5 minutes with the patient standing can provide additional information when the changes between supine and standing are assessed.
2. Heart rate response to deep breathing may be recorded in this mode, however breathing cues are not provided automatically by the *HRV* system.]

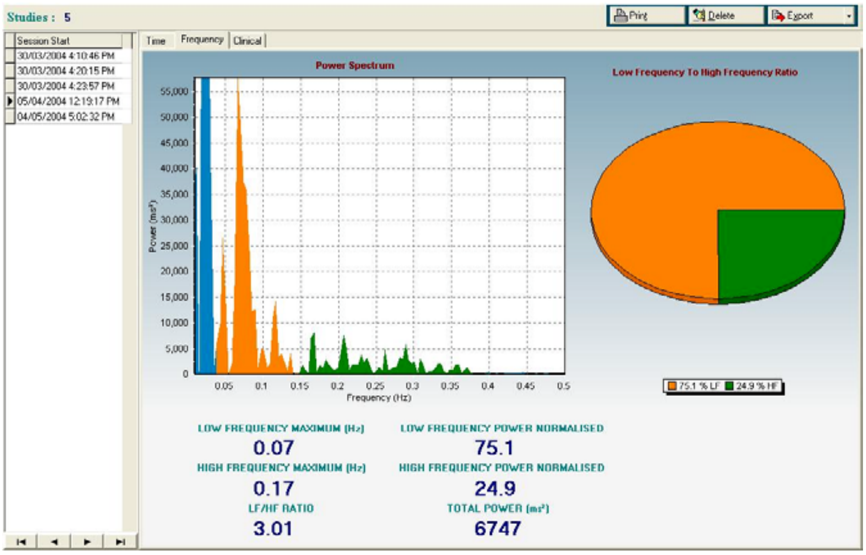
Time Domain Analysis



Time domain measures are the means and standard deviations of R-R intervals recorded by the continuous ECG, where NN (normal-to-normal) intervals represents all the R-R intervals. The variables of time domain measures are shown in the following table.

Variable	Description	Relevance
SDNN (ms)	Standard deviation of the all NN interval. Reflects all the cyclic components responsible for variability in the period of the recording.	Estimate of overall HRV. A decrease in SDNN has been associated with sudden cardiac death.
SDANN (ms)	Standard deviation of the averages NN intervals calculated over short periods, usually 5 min. An estimation of the changes in heart rate due to cycles longer than 5 mins.	Reflects circadian rhythmicity of autonomic function.
pNN50 (%)	The proportion of RR intervals having a difference of >50 msec.	Is virtually independent of circadian rhythms. Reflects alterations in autonomic function that are primarily vagally mediated.
Triangular Index (ms)	The integral of the density distribution (ie number of all NN intervals plotted in a histogram) divided by the maximum of the density distribution.	Estimate of overall HRV
RMSSD (m/s)	The square root of the mean squared differences of successive NN intervals.	Estimate of the short-term components of HRV. Provides Vagal Index.

Frequency Domain Analysis

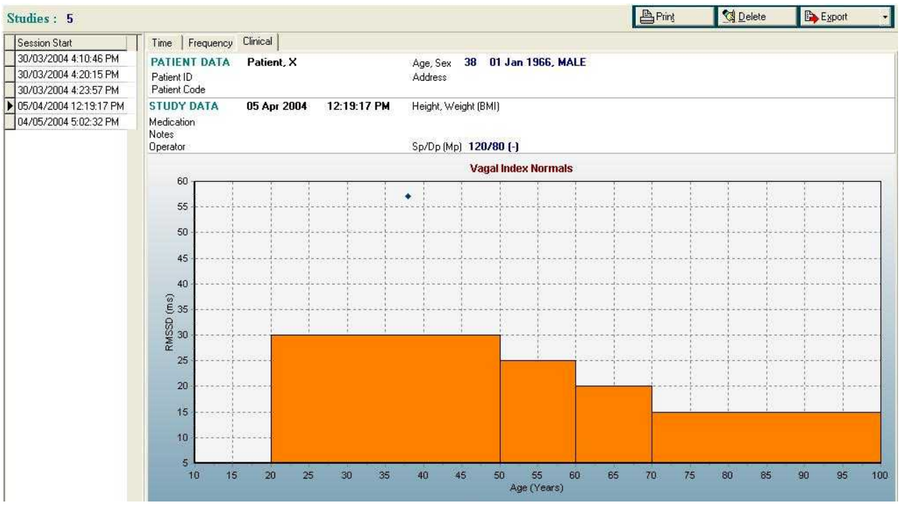


Spectral analysis of a series of successive R-R intervals provides the frequency domain analysis. This technique separates the heart rate spectrum into various components and quantifies sympathetic and vagal influences on the heart.

- Total Power (ms^2) reflects all cyclic components of HR variability.
- High Frequency (HF) generally represents parasympathetic activity and is therefore generally considered to be a marker of vagal activity.
- Low frequency (LF) is influenced by both sympathetic and parasympathetic activity.

The ratio of HF:LF represents the balance of parasympathetic and sympathetic activity.

Clinical Report



The patient's results for Vagal Index (RMSSD vs age) is displayed with respect to the normal ranges[1].

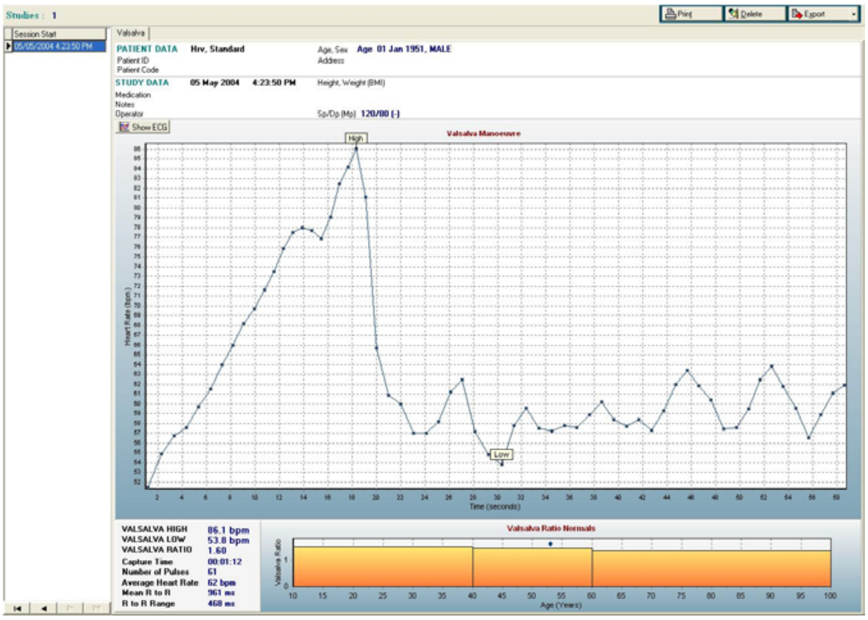
MODE 2: HRV Measurement after Valsalva Maneuver

The Valsalva Maneuver represents a more complex reflex arc involving both sympathetic and parasympathetic pathways to the heart, sympathetic pathways to the vascular tree, and baroreceptors to the chest and lungs.

The reflex response to the Valsalva Maneuver includes tachycardia and peripheral vasoconstriction during strain, followed by an overshoot of blood pressure and bradycahardia after release of strain. The response is mediated through the alternating activation of parasympathetic and sympathetic nerve fibres. In patients with autonomic damage the reflex pathways are damaged. This is seen as a blunted heart rate response.

In the standard Valsalva Maneuver the supine patient, connected to the ECG, blows into an open manometer and maintains a pressure of 40 mm Hg for 15 seconds, followed by a period of relaxation and breathing at a normal rate (45 seconds).

Valsalva Maneuver Report



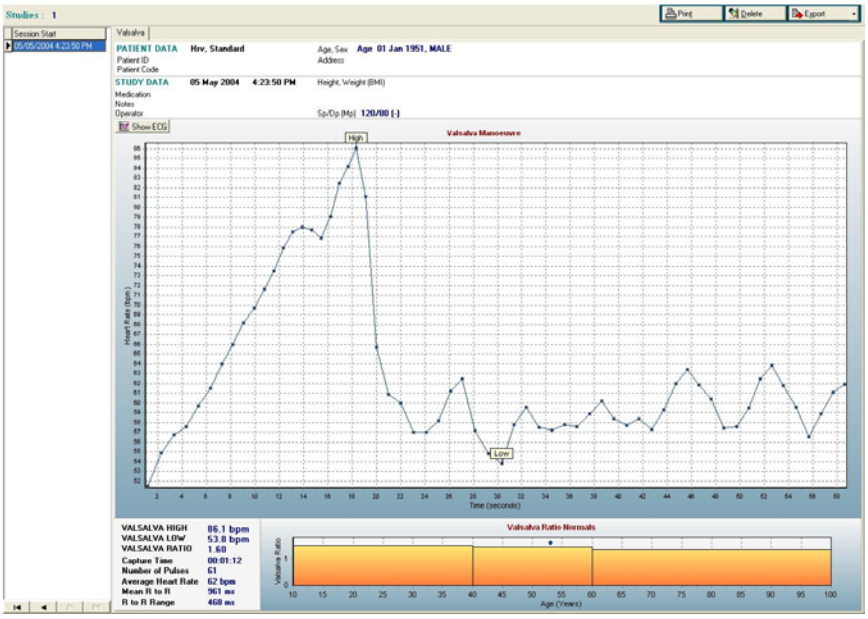
The Valsalva Ratio is the ratio between the slowest heart rate after the maneuver (reflecting the bradycardia response to overshoot) to the highest heart rate after the maneuver (reflecting the result of strain). This Valsalva Ratio is also plotted against a normal population for age[2]. Results in the white area are normal, while the shaded area is below normal. Patients displaying a progression of autonomic dysfunction, deterioration in the Valsalva Ratio would be seen.

MODE 3: HRV Measurement after Standing Maneuver

The heart rate response to standing evaluates the cardiovascular response elicited by a change from horizontal to a vertical position. The typical heart rate response to standing is largely attenuated by a parasympathetic blockade. In healthy subjects, there is a characteristic and rapid response to standing that is maximal at approximately the 15th beat after standing. This is followed by a relaxation bracycardia that is maximal at approximately the 30th beat after standing.

The patient should be in rested prior to commencing the measurement. The patient starts in a supine position, then stands to a full upright position. The ECG trace is recorded for a minimum of 1 minute to ensure enough beats are captured.

Standing Maneuver Report



The Stand Ratio (also known as the 30:15 ratio) is calculated as the ratio of the slowest heart rate (found around beat 30) and the quickest heart rate (found around beat 15). The Stand Ratio is also plotted against a normal population for age[1]. Results in the white area are normal, while the shaded area is below normal.

References:

1. Agelink MW, Malessa R, Baumann B, et al. Standardised tests of heart rate variability: normal ranges from 309 healthy humans, and effects of age, gender, and heart rate. Clin Auton Res 2001;11:99-108.
2. Risk M, Bril V, Broadbridge C, Cohen A. Heart rate variability measurement in diabetic neuropathy: review of mehtods. Diabetes Technol Ther 2001;3:63-70.

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