

Introduction

The conductance-volume method employs a multi-electrode catheter to measure intracavitary electrical conductance from which ventricular volume is calculated by taking into account several calibration factors.

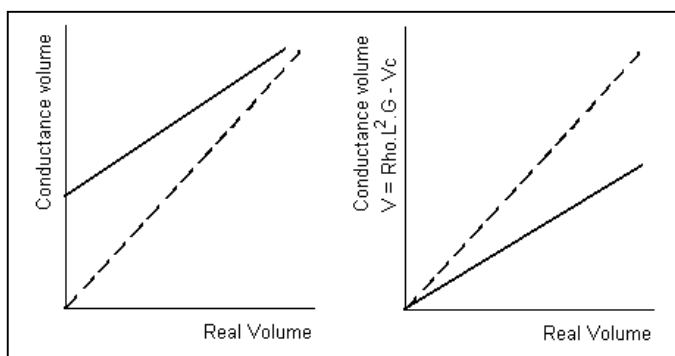
Conversion to volume

The measured conductance is converted to a continuous volume signal by taking into account the specific resistivity of blood and the spacing between the sensing electrodes. The electrode spacing (L) can be entered in 'Catheter settings' in the settings menu. Blood resistivity (Rho) is measured by connecting the Rho-cuvette filled with 5 ml blood to the CFL-512. Pushing the red button next to the rho-display transfers the measured value to the console and activates the rho measurement dialogue. The total volume is calculated as: $V(t) = \rho \cdot L^2 \cdot G(t)$ where G(t) is the sum of the segmental conductances.

Calibration for absolute volume

The uncalibrated conductance-volume signal

If the raw signal is plotted against real volume a typical relation as shown in the left figure is obtained.



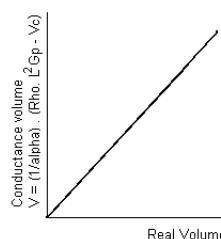
Parallel conductance

The offset in the relation is related to the so-called parallel conductance (G_p). Because the myocardial wall is conductive (although less than blood) the electric current is not confined to the ventricular cavity but the wall and surrounding structures contribute to the measured conductance.

The offset, or correction volume: $V_c = \rho \cdot L^2 \cdot G_p$. Once parallel conductance (or better the corresponding correction volume) is determined (usually by the saline dilution method as described below) it may be subtracted from the raw volume signal ($V = \rho \cdot L^2 \cdot G - V_c$) to obtain a relation as shown in right figure.

Slope factor alpha

After correction for parallel conductance, conductance-derived volume is directly proportional to real volume, but in general underestimation by a fixed percentage remains. This result from the fact the equipotential planes are not exactly parallel, indicating an inhomogeneous intracavitary current distribution. In addition, it may be partly due to a mismatch between the electrode distances and the ventricular long axis.



To amend this, the slope factor alpha was introduced. Alpha is usually obtained by comparing SV obtained by the conductance catheter with 'real' SV (e.g. by thermodilution):

$$\alpha = \frac{[SV \text{ by conductance}]}{[SV \text{ by thermodilution}]}$$

After correction for both parallel conductance and alpha a calibrated LV volume signal is obtained as shown in figure. $V_{LV} = \left(\frac{1}{\alpha}\right) \cdot (\rho \cdot L^2 \cdot G_p - V_c)$

Practice

The Conduct NT software enables determination of the parallel conductance correction from signals acquired during the saline injection. The hypertonic saline is best injected into the pulmonary artery (typically using the distal port of a thermodilution catheter) because this way the blood in the right ventricle, which is part of parallel conductance, is not affected. The passage through the lung circulation will enable sufficient mixing of blood and saline before entrance into the left ventricle.

To obtain a reliable estimate of correction volume, hemodynamics should be stable during the data-acquisition. Therefore data are best obtained during breath holding. Furthermore, the injected volume should be limited as much as possible to avoid direct myocardial or vascular effects or a volume loading effect. On the other hand, the amount should be sufficient to obtain a clear alteration of conductivity. Typically, in humans 5-10 ml of 5% saline is used. In a 30 kg animal 2-3 ml of 10% saline, and in a small animal (3-5 kg) less than 1 ml 10% should be sufficient.

It is recommended to perform 2-3 injections and average the results under each experimental condition. Assessments should be repeated after substantial hemodynamic changes, changes in catheter position and when changes in parallel conductance are anticipated e.g. due to fluid infusion.