IMPEDANCE PLETHYSMOGRAPHY

Plethysmography

- Instruments measuring volume changes are called plethysmographs
- Plethysmography is the method for recording volume changes of an organ or
- a body part that results from pulsations of blood occuring with each heart beat.
- Useful in detecting
  1. arterial obstructions
  2. Pulse wave - velocity measurements

Plethysmography measurement techniques

1. Using pressure transducer
2. capacitive transducer
3. Strain Gage
4. Photoelectric Method
5. Impedance Plethysmography

Introduction

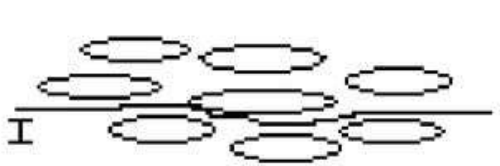
- **Impedance PlethysmoGraphy** (IPG), is a non - invasive medical test that measures small changes in *electrical resistance* of the chest, calf or other regions of the body.
- These measurements reflect *blood volume* changes, and can indirectly indicate the presence or absence of *Cardiac, Venous or Arterial pathology*.
- This procedure provides an alternative to *venography or arteriography*, which is invasive.

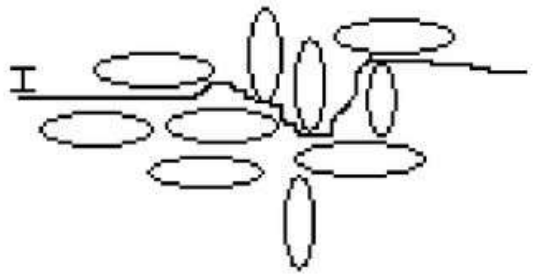
Principle

- In this technique, the ELECTRICAL IMPEDANCE of any part of the body is measured by **constant current** method & variations in the impedance are recorded as a function of time.
- Since blood is a good conductor of electricity, the amount of blood in a given body segment is reflected inversely in the electrical impedance of the body segment.

Principle

- Pulsatile blood volume by heart , that is systemic blood circulation causes proportional decrease in the electrical impedance.
- Variation in the electrical impedance thus gives adequate information about the blood circulation.





5. Impedance Plethysmography

- Volume changes in blood are measured using change in impedance.
- Done by changes in conductivity of current path with each pulsation of blood.

1. Two electrode system

- Electrodes are either conductive bands wrapped around the limb

<u>or</u>

- Simple conductive strips of tape attached to the skin using jelly or electrolyte paste to reduce skin resistance
- A constant current is forced through the tissue, between the 2 electrodes
- Resulting voltage changes are measured and recorded

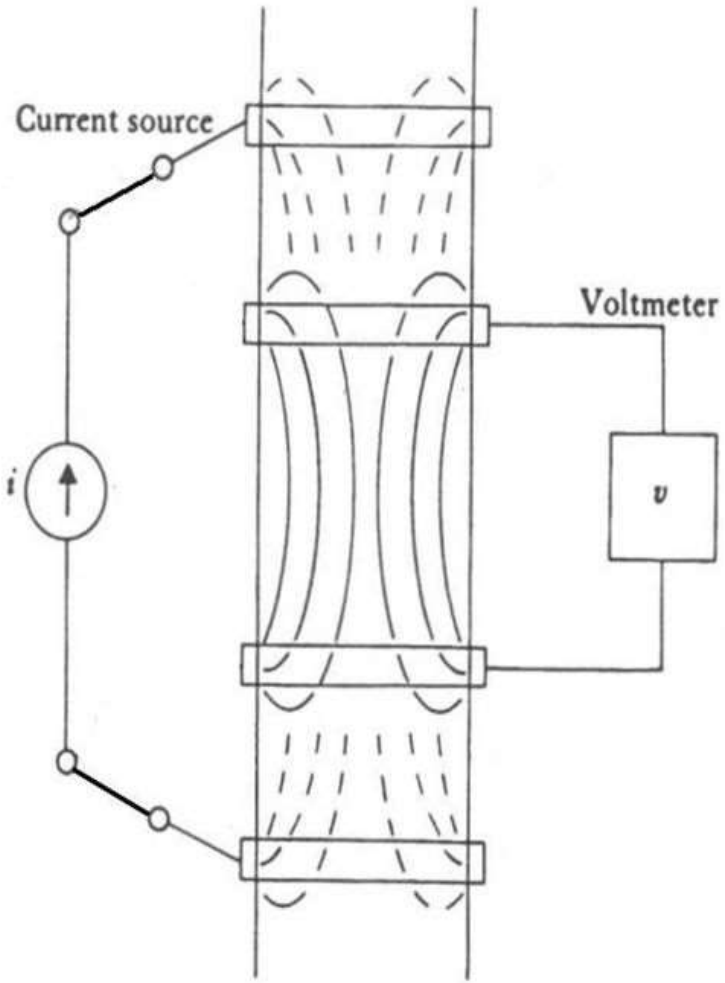
2. Four electrode system

- Constant current is forced through 2 outer electrodes (current electrodes)
- The voltage between the 2 inner or measurement electrodes is measured
- The internal body resistance between the electrodes form a physiological voltage divider.
- Advantage: low amount of current.
- Ac microamp range, 10KHz or higher
- Square wave shape.

Technique

- Constant current is passed through the body segment of interest with the help of 2 surface electrodes.
- Voltage signal devloped along the current path is sensed with the help of another pair of electrodes.
- The amplitude of the signal sensed is directly propotional to the elecrical impedance of the body segment.
- Amplification & detection of this signal gives instantaneous electrical impedance Z of the body segment.

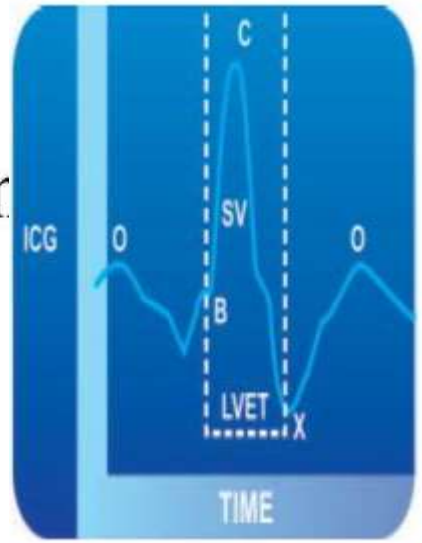
Technique



Technique

- Difference between the instantaneous electrical impedance & initial value of electrical impedance (Zo) gives variation in the impedance as a function of time, called the $\Delta Z(t)$ waveform.
- First time derivative of the impedance (dZ / dt) is obtained to give the rate of change of impedance.
- With the help of this dZ / dt, used in different equation, peripheral arterial - venous blood flow & stroke volume can be measured.

- Stroke volume is then estimated using the Kubicek formula
- Stroke volume = k p (L / Zo)² [LVET (dZ / dt) max]
- where k is a constant which accounts for variation in body composition based on age, gender, relative fat content, chest circumference;
- L is the inter - electrode distance;
- p is the blood specific resistivity computed using hematocrit as [13.5 + (4.29 Hematocrit)].



Left ventricular ejection time (LVET) is a useful measure of ventricular performance and preload.

Example

Impedance Arteriography