Plethysmography

Plethysmography is a non-invasive diagnostic treatment used for screening and patient follow-ups with various arterial and venous pathologies. This treatment is concerned with the measurement of volume and volume displacement of blood. The screening provides a circulatory assessment via a waveform representation of pulsatile peripheral blood flow. Instrumentation providing blood volume parameters exists but nothing to measure volume directly. An example of this instrumentation is the use of an ultrasound.

While ultrasound provides hemodynamic (hemodynamic refers to the forces generated by the heart and the motion of blood through the cardiovascular system) data on vein segments, plethysmography provides information that is indirectly related to venous volume changes. The data obtained is not specific to venous function because limb volume changes may be caused by several factors. Rapid changes are typically associated with changes in blood volume or movement artifact. If movement is controlled, information specific to blood volume can be obtained. Further separation of arterial and venous flow effects can be observed through electronic filtration. Venous flow changes typically involve long transient time constants with duration of seconds or minutes. Venous displacement measurements are typically associated with shifts in body position and limb compressions which allow measurements of magnitude and duration.

Four main types of plethysmography exist. They include Air-Displacement, Photoelectric, Strain gauge, and Impedance. Air-Displacement plethysmography deals with measuring the volume of an object by indirectly measuring the volume of air it displaces inside a closed chamber. The human body volume is measured when a patient sits in an enclosed chamber and displaces a volume of air equal to his or her own body volume. By subtracting the remaining volume of air inside the chamber when the patient is inside from the volume of air in the chamber empty, you get the body volume.

Photoelectric plethysmography is concerned with assessment based on cutaneous blood volume. An electrode consisting of an infrared LED and a photosensor is attached to the skin. Light transmitted into the skin is scattered and absorbed by tissue in the illuminated field. Blood attenuates the reflected light and intensity of reflected light changes with blood tissue density. The voltage signal generated by the photosensor is amplified by a DC circuit. Low frequencies are passed which produces relatively stable tracing. This corresponds to blood density in the underlying tissue.

Strain gauge plethysmography uses a transducer filled with mercury or indium-gallium metal alloy conductor. Stretching the strain gauge causes a decrease in diameter causing an increase in voltage. When wrapped around a limb segment, the gauge provides a circumferential measurement that can be used to compute area. The “slice volume” of the limb segment changes as the limb volume expands and contracts.

The final type of plethysmography is impedance plethysmography. A weak current is passed through a limb and the electrical resistance to current flow is measured. Four conductive bands are taped around the limb as outer and inner pairs of electrodes. The inner pair is then used to measure electrical resistance.

http://oac.med.jhmi.edu/res_phys/Encyclopedia/BodyPleth/BodyPleth.HTML
http://www.umm.edu/ency/article/003771.htm