Upper extremity vein graft monitoring device after surgery procedure: a preliminary study

Abstract

In most cases, surgical vein bypass or interposition vein grafting was used in both primary management of crush-avulsion amputations and on intervention for rehabilitating the patency of occluded arteries via microvascular surgery. However, surgical revascularization has significant shortcomings, principal among which is the high rate of accelerated thrombosis that develops in arterialised vein graft which renders the vein graft susceptible to acute occlusion and eventually give rise to graft failure. Evaluaion and detection of vein graft failure is essential as that will be the starting point for the clinician to make the diagnosis and safeguard patency of implanted vein graft which would otherwise fail. Unfortunately, most of the available diagnostic and monitoring tools available in the market are expensive, hence not all the hospital, private clinic and others medical centers that fully-equipped with these type of equipments. The objective of this study is to design and develop a low-cost and non-invasive vein graft monitoring prototype that able to provide high accuracy in predicting the vein graft patency and meanwhile providing the short-term monitoring on vein graft right after surgery procedure. Impedance plethysmography (IPG) was employed to measure pulsatile changes in longitudinal impedace to quantify arterial blood flow and pulsatile blood volume. Tetra-polar electrode measurement system was implemented by introduce a constant 1-mA AC current (I) at frequency of 100 kHz in the two outer electrodes. The voltage (V) is measured between the two inner electrodes, and the resulting impedance (Z) is calculated using Ohm's Law. Arterial blood flow and pulsatile blood volume can then be estimated using impedance related volume conduction equation. By measuring the changes in electrical bioimpedance which can be used to derive important hemodynamic variables, it allows the postoperative graft surveillance and early detection atherosclerosis and thrombosis as well as estimate its severity that leads to the vein graft failure.