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Electrical stimulation-induced contraction to reduce blood stasis during arthroplasty.

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Deep venous thrombosis and subsequent pulmonary embolism due to venous pooling/stasis commonly occur in patients during hip and/or knee arthroplasty (i.e., replacement). This problem may be alleviated by using techniques to promote lower limb blood flow. Electrical stimulation-induced contractions have been shown to activate the skeletal muscle pump, promote limb blood flow, and may be effective for reducing venous pooling/stasis and edema. Therefore, electrical stimulation may reduce the incidence of deep venous thrombosis (DVT) and pulmonary embolism (PE) during and following surgery. The overall goal of this project was to evaluate the clinical efficacy of sequential electrical stimulation-induced leg muscle contractions on the venous blood flow during surgery. The degree of venous pooling/stasis was monitored via electrical impedance changes in the thorax. The changes in the patient's central hemodynamics were then calculated. Thirty patients were recruited and randomly assigned to either a control group (n = 15, mean age = 66.4 +/- 7.3) or experimental group (n = 15, age = 60.7 +/- 9.7). Both groups received the standard medical treatment for prevention of DVT (i.e., coumadin, heparin, etc.) and compression stockings (TED, Kendall). The control group used the sequential compression device (SCD + TED) and the experimental group used electrical stimulation (ES + TED). Electrical stimulation was applied via surface electrodes to the lower-limb muscles (tibialis anterior and gastrocnemius) and upper limb muscles (quadriceps femoris and hamstrings). These muscles contracted sequentially, using an eight-channel electrical stimulator. Four seconds of calf (contraction/compression) were followed by 7-s of calf and thigh (contraction/compression) interspersed by 60-s rest period during both electrical stimulation or sequential compression device. This cycle continued throughout the surgery (60-75 min) for both groups. At 15 min intervals, venous return was monitored by impedance cardiograph. Physiologic responses including ventricular stroke volume (SV), cardiac output (CO), heart rate (HR), total peripheral resistance (TPR), as well as mean arterial pressure (MAP) were monitored. These responses were statistically analyzed and compared throughout the surgery within each group and between the two groups. The results show stroke volume and cardiac output to be higher throughout surgery in the electrical stimulation group as compared with the sequential compression device group. The heart rate was consistently lower during electrical stimulation for both groups. Total peripheral resistance did not change in the electrical stimulation group; but increased in the sequential compression device group. The data suggest that

continuous electrical stimulation-induced contractions could improve lower leg circulation by eliciting the physiologic muscle pump. This will lead to improved venous circulation and reduction of blood stasis during total hip and/or knee surgery. This technique may offer greater protection against DVT and PE during surgery than the commonly used sequential compression device.

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