# Electrical Stimulation And Deep Venous Thrombosus

Faghri P.D., Van Meerdervort H.F., Glaser R.M., and Figoni S.F. (1997) Electrical stimulation-induced contraction to reduce blood stasis during arthroplasty. *IEEE Trans. Rehabil. Eng* 5, 62-69.

Abstract: 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

Jonsson O., Lindstrom B. (1983) Perioperative calf-muscle stimulation for the prevention of postoperative thromboembolic complications. *Geriatric Med Today* 2:86.

Lindstrom B. (1982) Prediction and prophylaxis of postoperative thromboembolism: a comparison between perioperative calf muscle stimulation with groups of impulses and dextran 40. *Br J Surg* 69:633.

Katz R.T., Green D., Sullivan T., Yarkony G. (1987) Functional electrical stimulation to enhance systemic fibrinolytic activity in spinal cord injury patients. *Arch Phys Med Rehabil* 68:423-426.

Merli G.J., Crabbe S., Paluzzi R.G., and Fritz D. (1993) Etiology, incidence, and prevention of deep vein

thrombosis in acute spinal cord injury. *Arch. Phys. Med. Rehabil.* 74, 1199-1205.
Abstract: This article provides a critical review of the literature on the etiology, incidence, and prevention of deep-vein thrombosis in acute spinal cord injured patients. Stasis and hypercoagulability are the two major factors contributing to the development of thrombosis in this patient population. This has been supported by studies that demonstrate an impaired venous return from the lower extremities and abnormal coagulation factors, which predispose to thrombogenesis. The incidence of deep vein thrombosis secondary to the above etiologies varies from 49% to 100% in the first 12 weeks with the first 2 weeks having the highest rate following acute injury. This high rate of complication has led to numerous studies to identify the most effective regimens of prophylaxis. Studies using noninvasive testing and venography in acute spinal cord injury have supported two approaches for preventing deep- vein thrombosis. Single agent pharmacologic therapy with adjusted dose heparin is effective but does carry some risk of bleeding. Combination therapy with external pneumatic compression sleeves plus either aspirin/dipyridamole or low-dose heparin and electrical stimulation plus low-dose heparin have significantly reduced the incidence of deep vein thrombosis. The duration of prophylaxis with the above modalities has varied between 8 and 12 weeks following acute injury. Further large scale studies are required in this high-risk population to better delineate the incidence of deep vein thrombosis and pulmonary embolism, to identify the best modalities, and to define the duration of treatment for the prevention of these complications.(ABSTRACT TRUNCATED AT 250 WORDS)

Patel M.I., Hardman D.T., Nicholls D., Fisher C.M., and Appleberg M. (1996) The incidence of deep venous thrombosis after laparoscopic cholecystectomy. *Med. J. Aust.* 164, 652-4, 656 .
Abstract: OBJECTIVE: To determine the incidence of deep venous thrombosis (DVT) after laparoscopic cholecystectomy. DESIGN: Prospective cross-sectional analysis, with a one-month follow-up, conducted in 1994. SETTING: University teaching hospital. SUBJECTS: 20 patients undergoing elective or urgent laparoscopic cholecystectomy, consecutively recruited. INTERVENTIONS: Patients received thromboprophylaxis according to the normal practice of the attending surgeon and underwent laparoscopic cholecystectomy. A venous duplex scan was performed before the operation and on Day 1, 7 and 30 after the operation. MAIN OUTCOME MEASURE: The presence of postoperative DVT. RESULTS: All patients were given graduated compression stockings to wear and 16 received electrical stimulation of the calf during the operation. Only 16 patients received pharmacological thromboprophylaxis before the operation, but all patients received this after the operation. The median duration of pneumoperitoneum was 80 minutes (40-160 minutes). Eleven of 19 patients completing all the required scans developed venous thrombosis (incidence, 55%); in three the thromboses involved major axial veins. In one patient the Day 7 and Day 30 scans were not performed, but the Day 1 scan was negative. Seven of the 11 thromboses were detected on the Day 1 scan. None of the DVTs were suspected clinically. CONCLUSIONS: This extremely high

incidence of venous thrombosis correlates with the haemodynamic changes which occur in the venous system during pneumoperitoneum. Laparoscopic cholecystectomy should not be considered a procedure with a low risk of DVT, and further studies are needed to determine optimal DVT prophylaxis for laparoscopic surgery

Rosenberg I.L., Evans M., Pollack A.V. (1975) Prophylaxis of post-operative leg vein thrombosis by low dose subcutaneous heparin or perioperative calf muscle stimulation: a controlled clinical trial. *Br Med J* 1:649.