references:
Showing neuromuscular stimulation is effective in reducing stasis

collected references, June 2010

contents:

Czynny JJ, Kaplan RE, Wilding GE, Purdy CH, Hirsh J.
Department of Orthopedics, The University at Buffalo School of Medicine and Biomedical Sciences, Buffalo, NY 14215, USA.

Combined intermittent pneumatic leg compression and pharmacological prophylaxis for prevention of venous thromboembolism in high-risk patients.
Kakkos SK, Caprini JA, Geroulakos G, Nicolaides AN, Stansby GP, Reddy DJ.
Division of Vascular Surgery, Department of Surgery, Henry Ford Hospital, 2799 W. Grand Boulevard, Detroit, Michigan 28202, USA.

Effect of leg exercises on popliteal venous blood flow during prolonged immobility of seated subjects: implications for prevention of travel-related deep vein thrombosis.
Hitos K, Cannon M, Cannon S, Garth S, Fletcher JP.
Department of Surgery, University of Sydney, Westmead Hospital, Westmead, NSW, Australia.

Neuromuscular electrical stimulation and an ottoman-type seat effectively improve popliteal venous flow in a sitting position.
Morita H, Abe C, Tanaka K, Shiratori M, Oguri M, Shiga T.
Department of Physiology, Gifu University Graduate School of Medicine, Yanagido, Gifu, Japan.

Blood flow velocity of the femoral vein with foot exercise compared to pneumatic foot compression.
Yamashita K, Yokoyama T, Kitaoka N, Nishiyama T, Manabe M.
Department of Anesthesiology and Critical Care Medicine, Kochi Medical School, Kochi 783-8505, Japan.

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Electrical foot stimulation and implications for the prevention of venous thromboembolic disease.

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**J Arthroplasty. 1999 Sep;14(6):651-6.**
Thromboembolic disease prophylaxis in total knee arthroplasty using intraoperative heparin and postoperative pneumatic foot compression.

**Westrich GH, Menezes A, Sharrock N, Sculco TP.**
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The purpose of this study was to compare venous blood flow velocity of intermittent pneumatic compression to electrical stimulation of the foot. A prospective randomized controlled study of 40 healthy volunteers was conducted. Subjects were seated for 4 hours during which they received electrical stimulation of the sole of the foot or knee-high intermittent pneumatic compression. Popliteal and femoral venous blood flow velocities were measured via Doppler ultrasonography. Blood flow velocity in the nonstimulated or noncompressed lower extremity served as a simultaneous control. For both the femoral and popliteal veins, the electrical foot stimulation group exhibited a greater increase in blood flow velocity than the intermittent pneumatic compression group. Electrical foot stimulation was noninferior relative to standard intermittent pneumatic compression. Specifically, this result of a greater increase in blood flow velocity is achieved at time = 120 minutes for the femoral vein (t = 2.70; p = .005) and time = 120 (t = 2.75; p = .004) and 240 (t = 2.27; p = .014) minutes for the popliteal vein. Short-term electrical foot stimulation is at least as effective as knee-high intermittent pneumatic compression in increasing popliteal and femoral blood flow velocity. Electrical foot stimulation has the potential to be an effective method of deep venous thrombosis prophylaxis.

PMID: 20122356 [PubMed - in process]

Combined intermittent pneumatic leg compression and pharmacological prophylaxis for prevention of venous thromboembolism in high-risk patients.

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Background:
It has been suggested that combined modalities (methods of treatment) are more effective than single modalities in preventing venous thromboembolism (defined as deep vein thrombosis and pulmonary embolism, or both) in high-risk patients.

Objectives:
To assess the efficacy of intermittent pneumatic leg compression combined with pharmacological prophylaxis versus single modalities in preventing venous thromboembolism in high-risk patients.

Search strategy:
The Cochrane Peripheral Vascular Diseases (PVD) Group searched their Specialized Register (last searched 17 July 2007) and the Cochrane Central Register of Controlled Trials (CENTRAL) (last searched The Cochrane Library 2008, Issue 3). We searched the reference lists of relevant articles to identify additional trials.

Selection criteria:
Randomized controlled trials (RCTs) or controlled clinical trials (CCTs) of combined intermittent pneumatic leg compression and pharmacological interventions used to prevent venous thromboembolism in high-risk patients.

Data collection and analysis:
Data extraction was undertaken independently by two review authors using data extraction sheets.

Main results:
Eleven studies, six of them randomized controlled trials, were identified. The trials included 7431 patients, in total. Compared with compression alone, the use of combined modalities reduced significantly the incidence of both symptomatic pulmonary embolism (PE) (from about 3% to 1%; odds cont.
ratio (OR) 0.39, 95% confidence interval (CI) 0.25 to 0.63) and deep vein thrombosis (DVT) (from about 4% to 1%; OR 0.43, 95% CI 0.24 to 0.76). Compared with pharmacological prophylaxis alone, the use of combined modalities significantly reduced the incidence of DVT (from 4.21% to 0.65%; OR 0.16, 95% CI 0.07 to 0.34) but the included studies were underpowered with regard to PE. The comparison of compression plus pharmacological prophylaxis versus compression plus aspirin showed a non-significant reduction in PE and DVT in favor of the former group. Repeat analysis restricted to the RCTs confirmed the above findings.

Authors’ conclusions:

Compared with compression alone, combined prophylactic modalities decrease significantly the incidence of venous thromboembolism. Compared with pharmacological prophylaxis alone, combined modalities reduce significantly the incidence of DVT but the effect on PE is unknown. The results of the current review support, especially in high-risk patients, the use of combined modalities. More studies on their role in PE prevention, compared with pharmacological prophylaxis alone, are urgently needed.

PMID: 18843686 [PubMed - indexed for MEDLINE]


Effect of leg exercises on popliteal venous blood flow during prolonged immobility of seated subjects: implications for prevention of travel-related deep vein thrombosis.

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Background:

Venous stasis is an important contributing factor in the development of travel-related deep vein thrombosis. This study examined factors affecting popliteal venous blood flow in order to determine the most effective exercise regimen to prevent venous stasis.

Methods:

Twenty-one healthy subjects were randomly assigned to various activities over a 9-week period. Subjects remained seated throughout the investigation and 3660 duplex ultrasound examinations were performed by a single examiner using a SonoSite 180 Plus handheld ultrasound. Baseline popliteal vein blood flow velocity, cross-sectional area and volume flow in subjects sitting motionless were assessed in the first 3 weeks. The remaining 6 weeks involved subjects performing airline-recommended activities, foot exercises, foot exercises against moderate resistance and foot exercises against increased resistance in order to determine the most beneficial method for enhancing popliteal venous flow. Sitting with feet not touching the floor and the effect of sleeping were also assessed.

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**Results:**
The median age of the subjects was 22 years (range: 18-25.5 years), height 171 cm (162.5-180.5 cm) and body mass index 25.3 kg m\(^{-2}\) (23.2-26.3 kg m\(^{-2}\)). Blood volume flow in the popliteal vein was reduced by almost 40% with immobility of seated subjects and by almost 2-fold when sitting motionless with feet not touching the floor. Foot exercises against increased resistance positively enhanced volume flow (P < 0.0001).

**Conclusion:**
Leg exercise regimens enhanced popliteal venous flow during prolonged immobility of seated subjects, reinforcing the importance of regular leg movement to prevent venous stasis during prolonged sitting, such as in long-distance travel.

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Neuromuscular electrical stimulation and an ottoman-type seat effectively improve popliteal venous flow in a sitting position.

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The aim of this study was to examine the effects of the sitting posture on the lower limb venous flow and to explore the beneficial effects of neuromuscular electrical stimulation (NMES) and an ottoman-type seat on the venous flow. Healthy adult volunteers without a history of lower limb surgery or thromboembolism were recruited, and the flow velocity, cross-sectional area, and flow volume of the popliteal vein were measured using Doppler ultrasound. A posture change from the prone position to the sitting position on the ottoman-type seat decreased the flow velocity and increased the cross-sectional area of the popliteal vein, and the flow volume was not altered over 120 min. The flow velocity was further decreased, and the cross-sectional area was further increased by subjects sitting on a regular driving seat when compared with the values obtained with an ottoman-type seat. The popliteal flow velocity in the NMES leg was significantly higher than in the non-NMES leg throughout the 120-min testing in the sitting position, but no difference in the cross-sectional area was found between the NMES and the non-NMES legs. Thus lower limb venous stasis elicited by the sitting posture was improved by the ottoman-type seat and NMES.

PMID: 16839446 [PubMed - indexed for MEDLINE]

Blood flow velocity of the femoral vein with foot exercise compared to pneumatic foot compression.

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Study objective: To compare the effects of foot exercise with an intermittent pneumatic foot compression (IPC) device on blood flow velocity of the femoral veins.

Design: Prospective, controlled study.

Setting: General intensive care unit of a university hospital.

Patients: 20 patients on bed rest in the intensive care unit.

Interventions: Patients were divided into 2 groups: group A, foot exercise (n = 10); and group B, IPC device (n = 10). The foot exercise was done once by a nurse for 5 minutes with the dorsiflexion of the ankle (15 times per minute) in group A patients. The IPC device (A-V Impulse System, compression setting: 130 mm Hg for 3 seconds followed by a resting period of 60 seconds) was used for 2 hours in group B.

Measurements: Peak blood flow velocity of the femoral vein was measured using the ultrasound unit with a 7.5-MHz linear array probe (ALOKA SSD-5500) at 0, 5, 15, 30, 60, and 120 minutes.

Main results: Peak blood flow velocities in both groups increased significantly vs the control values during the study. At 5 minutes, group A showed a significant increase in the peak blood flow velocity compared with group B.

Conclusions: Foot exercise by a nurse for 5 minutes was equally or more effective compared with the IPC device in increasing peak blood flow velocity of the femoral vein. The effect of the 5-minute foot exercise lasted for 2 hours.

PMID: 15809125 [PubMed - indexed for MEDLINE]

Electrical foot stimulation and implications for the prevention of venous thromboembolic disease.

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Background:

Venous stasis caused by immobility is an important risk factor for deep vein thrombosis following surgery and lower limb trauma, in bed-ridden medical patients, and in high-risk long distance air travelers. A safe and convenient method for reducing venous stasis would be useful in patients while in hospital and after discharge during their rehabilitation.

Subjects and methods:

49 healthy subjects aged 51-76 were seated for 4 hours during which they received mild electrical stimulation of the calf, or sole of the foot (plantar muscles). Popliteal and femoral venous blood flow velocities were measured via doppler ultrasound. The non-stimulated lower extremity served as the simultaneous control. Subjects completed a questionnaire regarding their acceptance and tolerance of the electrical stimulation.

Results:

There was a significant increase in venous femoral and popliteal blood flow for both calf (p < 0.035, p < 0.003), and plantar muscles (p < 0.0001, p < 0.009) on the stimulated side compared to the unstimulated side. The magnitude of the effect was similar for calf and plantar muscle stimulation. Subjects did not find the experience uncomfortable, and would use an electrical stimulator if told by their physician that they were at risk for developing blood clots.

Conclusions:

Mild electrical stimulation of the feet, as well as the calf, is a safe effective and convenient method for counteracting venous stasis and therefore has the potential to reduce the risk of deep vein thrombosis and pulmonary embolism for subjects who are immobilized.

PMID: 12195689 [PubMed - indexed for MEDLINE]

Thromboembolic disease prophylaxis in total knee arthroplasty using intraoperative heparin and postoperative pneumatic foot compression.

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A prospective study was performed to assess the clinical efficacy of intraoperative heparin combined with postoperative pneumatic foot compression and aspirin for thromboembolic disease prophylaxis after primary total knee arthroplasty (TKA). This group of 48 patients all had a primary TKA performed under epidural anesthesia. The cohort of patients was compared with a similar cohort of patients matched for age and comorbidity. The control group consisted of 61 patients (41 unilateral patients, 20 bilateral patients) with 81 TKAs who received epidural anesthesia and postoperative pneumatic foot compression and aspirin. The same surgeon and anesthesiologist performed all cases. All patients had the pneumatic foot compression device applied in the recovery room and received 325 mg of enteric-coated aspirin twice a day beginning the night of surgery. Venography was performed on the fifth postoperative day for both groups to determine the incidence of deep vein thrombosis (DVT). In the control group with postoperative pneumatic foot compression (group 1), the overall incidence of DVT was 27% (22 of 81), with 10% (8 of 81) major calf DVT and no proximal (popliteal or femoral) DVT. In the study group with intraoperative heparin and postoperative pneumatic foot compression (group 2), the overall incidence of DVT was 25% (12 of 48), with 8% (4 of 48) major calf DVT and no proximal DVT. There was no statistically significant difference between groups 1 and 2 for the incidence of overall DVT (P > .05) or major calf DVT (P > .05). No complications were associated with the use of intraoperative heparin or the pneumatic compression device, and no patient developed a symptomatic pulmonary embolism up to 3 months postoperatively. Although this study confirms that pneumatic foot compression combined with aspirin is an effective form of DVT prophylaxis after TKA, the added benefit of intraoperative heparin was not statistically proven. Although greater statistical power is needed to determine whether intraoperative heparin provides an added benefit, this study reveals a low incidence of DVT in TKA with this protocol.

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