Intermittent mechanical compression for prevention of travellers' thrombosis

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Disclosure of Conflict of Interests

The authors state that they have no conflict of interest.

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Intermittent mechanical compression for prevention of travellers' thrombosis

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Long-haul air travel is associated with coagulation activation and an increased risk of deep vein thrombosis and pulmonary embolism. The overall risk of developing thrombosis is approximately one per 5000 flights lasting more than 4 h [1,2]. This risk is further increased in people with additional risk factors such as inherited thrombophilia, recent surgery and oral

contraceptive use [2,3]. Whether this risk warrants pharmacological prophylaxis in high-risk travellers is controversial, partly due to the concomitant risk of bleeding associated with anticoagulants. Intermittent pneumatic compression devices have been shown to increase venous outflow and to safely reduce the risk of postoperative venous thrombosis with no effect on bleeding [4]. Besides the effects on venous outflow, intermittent compression has also been shown to increase fibrinolytic activity, which may contribute to the antithrombotic effect [5].

In the present crossover study, we evaluated the effects of intermittent mechanical compression in six volunteers (four men, mean age 59 years, range 55–64), of whom none had a history of venous thromboembolism or heart failure. Intermittent mechanical compression was exerted by a lightweight novel device (AviaFit^{TM}, FlowMedic Ltd, Caesarea, Israel), placed on both calves, and which generates 1 pulse min^{-1} with a pressure of 45 mmHg during 7 s. The volunteers were exposed to 4 h of strict seated immobilization on two separate occasions. Half of the group had the devices placed the first day, the others on the second day of investigation, 1 week later.

Effects of intermittent compression were assessed by measurement of venous flow velocity, both proximally and distally of the device, changes of lower extremity volume and by markers of coagulation and fibrinolysis. All measurements were performed, and blood samples taken, immediately prior to, and at the end of, the seated immobilization. Both peak flow velocity and mean flow velocity over a 7.2-s interval in the popliteal vein were measured using duplex ultrasonography. Direction of flow during compression distally from the device was measured in the posterior tibial vein. The increase in lower extremity volume was calculated by measuring the volume immediately before and after immobilization at 30 cm from the ground using a water bath. Prothrombin fragments 1 + 2, tissue type plasminogen activator antigen, D-dimer and von Willebrand factor antigen were determined with standard laboratory assays. Global fibrinolytic capacity, as described by Giddings *et al.* [6] was measured as a marker of overall activity.

The mean flow velocity in the popliteal vein after 4 h of seated immobilization with intermittent compression was increased almost twofold, as compared to seated immobilization without the device. After adjustment for flow velocity at baseline, the absolute increase was 1.0 cm s^{-1} [95% confidence interval (CI%95) −1.1 to 3.1; Table 1]. The contraction of the device induced a flow pulse in the popliteal vein with a peak flow velocity measured at the end of the 4-h observation period of 33.6 cm s^{-1}, which was much higher than the peak flow velocity induced by normal inspiration and expiration (5.3 cm s^{-1}; Table 1). For comparison, mean peak flow velocity during maximal inspiration without the device is approximately 9 cm s^{-1}. Flow direction in the posterior tibial vein during compression was upwards in all subjects. The mean increase in lower-extremity volume induced by seated immobilization was 91 mL without intermittent compression, as compared to 73 mL with intermittent compression respectively. Adjusted for values at baseline, the absolute difference was −20 mL (CI%95 −77 to 36). With regard to laboratory markers of coagulation and fibrinolysis, the mean global fibrinolytic capacity was higher with intermittent compression, as compared to without intermittent compression, with wide confidence limits (adjusted absolute difference 2.5 μg mL^{-1}, CI%95 −2.7 to 7.8; Table 1). Other markers of fibrinolysis and coagulation did not show an effect of intermittent compression.

Our objective in this pilot experiment was to assess the potential of the novel device on flow, lower extremity volume, and hemostasis. The findings suggest that this device increases peak flow velocity in the popliteal vein to an extent which cannot be achieved by maximal inspiration. In fact, the device induced a peak flow that was approximately 3-fold higher. Furthermore, the increase in mean flow velocity in between compressions suggested that these pulses may have a carry-over effect that stimulates venous outflow of the lower extremity. There was no indication that the device induced backward

Table 1 Effects on intermittent mechanical compression on venous flow, lower-extremity volume and coagulation/fibrinolysis after 4 h of seated immobilization without or with intermittent mechanical compression

	Mean		
	Without IMC	With IMC	Adjusted absolute difference (95%CI)*
Venous flow			
Flow velocity popliteal vein (cm s^{-1})	1.4	2.6	1.0 (−1.1 to +3.1)
Peak flow (cm s^{-1})	5.3	33.6	28.3† (11.7 to +44.8)
Lower-extremity volume/venous stasis			
Volume increase (mL)	91	73	−20 (−77 to +36)
Coagulation/fibrinolysis			
Prothrombin fragments 1 + 2 (nmol L^{-1})	0.6	0.5	−0.1 (−0.4 to +0.2)
Global fibrinolytic capacity (μg mL^{-1})	4.0	6.1	2.5 (−2.7 to +7.8)
Tissue plasminogen activator antigen (ng mL^{-1})	4.7	5.3	0.6 (−0.6 to +1.7)
D-dimer (μg mL^{-1})	0.3	0.2	−0.1 (−0.3 to +0.1)
von Willebrand factor antigen (%)	129	125	−7 (−15 to +1)

IMC, intermittent mechanical compression.
*Adjusted for values at baseline. †Unadjusted absolute difference. IMC, intermittent mechanical compression.

flow. Lower extremity volume measurement after immobilization suggested a beneficial effect of the device. Finally, with the possible exception of the global fibrinolytic capacity, we could not detect any effect on systemic hemostasis.

Our findings warrant further experimental and clinical evaluation as to whether this device may be useful in the setting of prevention of air travel-related thrombosis.

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Thromboprophylaxis with graduated compression stockings for elderly inpatients: more evidence is needed

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Graduated compression stockings are used to prevent deep vein thrombosis (DVT) in elderly patients [1], a setting in which physicians are often reluctant to order anticoagulant-based prophylaxis for fear of bleeding complications. Although their mechanism of action is probably multifactorial, graduated compression stockings exert graded circumferential pressure from distal to proximal segments of the lower limbs, increasing venous outflow and reducing stasis within the leg veins [2]. Their use is recommended only in patients at high risk for bleeding complications or as an adjunct to anticoagulant-based prophylaxis [3]. The aim of this study was to identify baseline characteristics and treatments associated with the use of graduated compression stockings in elderly patients with restricted mobility.

We analyzed the individual data for 1664 patients, 65 years of age or older, who were enrolled in two cross-sectional studies conducted at 50 hospital-based postacute care facilities in France in 2001 and 2003. Postacute care departments receive patients who typically have complicated conditions and who require specialized care, rehabilitation services, or other services associated with the transition between short-stay hospital care and home. Risk factors and prophylaxis for venous thromboembolism were collected by physicians, using a case report form. Graduated compression stocking users were defined as patients who wore below-knee or thigh-length graduated compression stockings for daytime hours or longer. Given the observational nature of this study, physicians in charge of

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