

DYNAMIC COMPRESSION PRESSURES AND SKIN BLOOD PERFUSION ACCOMPANYING LEG BANDAGING AND ACTIVITY

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INTRODUCTION

BACKGROUND

Compression bandaging is a main treatment modality for lower extremity venous ulcers and is a principal component of the treatment of peripheral edema and lymphedema.

Bandaging effectiveness is in part related to the pressure it exerts, which depends on bandage type, wear-time and other factors.

Under resting conditions, sub-bandage pressures achieved and measured are "static" pressures, and previous work¹⁻⁴ has shown that these affect lower extremity blood circulation. In particular, bandaging, that achieves sub-bandage pressures of 28-42 mmHg, results in increased leg pulsatile blood flow at rest^{2,4}. However, the possible role of dynamic pressure changes that occur during normal walking and other activities has, until recently⁵, received little investigative attention.

OBJECTIVES

Static sub-bandage pressures can be very similar for quite diverse bandage material properties, but once applied, working muscle induces radial expansion that depends on the bandage elastic properties. Pressure changes accompanying normal activities will vary with bandage material, likely being greater for more inelastic materials.

The exact role of dynamic pressure changes in the therapeutic efficacy of compression bandaging is not known.

Our working hypothesis is that differences in bandage material and associated dynamic pressure differences may differentially affect blood and/or lymphatic circulations. Our initial goals were to:

1. investigate the blood circulation aspect
2. Obtain basic information on the magnitudes of static and dynamic sub-bandage pressures of two different bandaging materials and to
3. Determine if skin blood perfusion (SBF) after activity is differentially effected.

METHODS

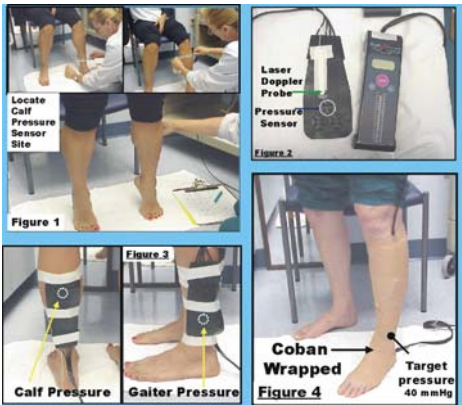
Eleven volunteer subjects were evaluated during a single test session. One leg was spirally wrapped from foot to knee with an elastic cohesive bandage (Coban, 3M Company) at full stretch extension with 50% overlap.

After a series of pressure and SBF measurements, Coban was removed and the leg was wrapped with a long-stretch (L-S) bandage (Tensor®, Kendall Health Care). Measurements were then repeated.

Leg circumferences at ankle & calf were determined (fig 1), and a standard site on the posterior calf located. With subjects seated, a pressure sensor pad (Cleveland Therapeutics), on to which a laser-Doppler probe (Vasamedics) was taped near the sensor (fig 2), was placed on the posterior calf. A 2nd sensor pad was put on the lateral gaiter area (fig 3).

Subjects then stood flat-footed while a baseline non-bandaged SBF was measured for two minutes, starting one minute after standing. Subjects then sat and one leg was wrapped with Coban. Static pressures were measured and subjects returned to a flat-footed standing position (fig 4).

Then a standardized sequential protocol (fig 5) was followed in which SBF was measured before and after two minutes of heel-up maneuvers at a rate of 15/minute and after bandage removal. The sequence was repeated with the leg bandaged with the Long-Stretch (L-S) wrap at full extension.



RESULTS

Static Sub-bandage Pressures

For Coban vs. L-S, calf pressures, [mean $\pm$ sd], during sitting (56.3 $\pm$ 13.2 vs. 36.8 $\pm$ 7.7) and standing (70.3 $\pm$ 10.9 vs. 41.9 $\pm$ 10.8) were significantly ($p < 0.01$) greater for Coban (fig 7). For Coban vs L-S, gaiter pressures during sitting (39.9 $\pm$ 6.9 vs. 31.3 $\pm$ 17.7, $p = 0.110$) and during standing (54.3 $\pm$ 12.7 vs. 42.6 $\pm$ 14.5, $p = 0.086$) were higher for Coban. All pressures were significantly greater when standing vs. sitting.

Minimum & Maximum Pressures

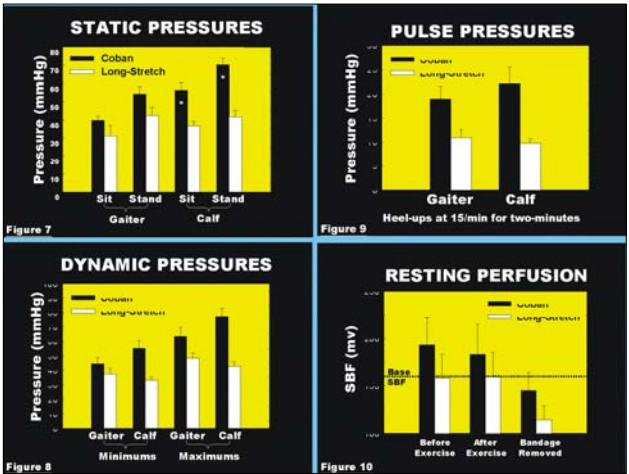
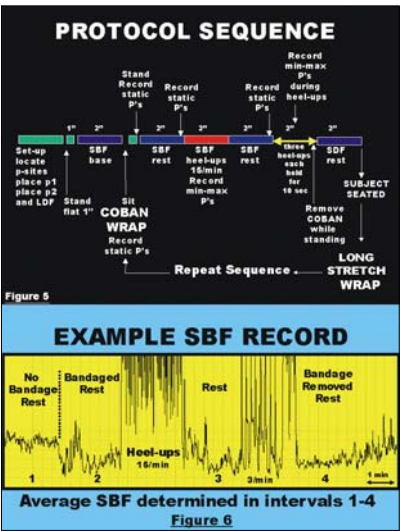
During heel-up maneuvers, maximum pressures achieved with Coban were significantly greater than achieved with L-S (fig 8)

Pulse Pressures (max-min during heel-ups)

Pulse pressures (PP) were significantly ($p = 0.001$) greater for Coban compared to L-S (fig 9). For Coban, PPs achieved were similar at gaiter and calf (19.0 $\pm$ 8.7 and 22.2 $\pm$ 11.4 mmHg). For L-S, values were 10.9 $\pm$ 6.1 and 9.8 $\pm$ 2.8 mmHg

Blood Perfusion

With Coban bandaging the baseline SBF (158 $\pm$ 58) tended to increase but the change was not statistically significant (fig 10). In contrast, L-S bandaging had no effect on base SBF. SBF tended to be greater for Coban vs. L-S bandaging, but only after exercise was the difference significant (183.3 $\pm$ 108 vs. 160.2 $\pm$ 82.1, $p < 0.05$).



CONCLUSIONS

• Sub-bandage pulse pressures achieved with an elastic cohesive bandage (Coban) during activity were about twice that achieved with a standard long-stretch bandage.

• Pressure pulse amplitudes found with Coban (~ 20 mmHg) are consistent with the notion that activity-related pulses effect underlying lymphatic vessels with the possibility of beneficial displacement of lymphatic and tissue fluids.

• But, as no direct measurements of fluid movement associated with the pulses have been made, definitive statements as to actual effects on patients with lymphedema are premature.

• On average, pressures achieved did not adversely affect sub-bandage skin blood perfusion. In fact, with the elastic cohesive bandage, SBF tended to be greater than when non-bandaged.

In a few cases, as shown by figure 6, slight reductions in SBF were observed.

• During activity-induced pressure changes, possible direct effects on SBF are masked by movement artifact. However, post-activity resting SBF was found to be insignificantly different from pre-activity values. This suggests that if pressure pulsations alter SBF, then these would be restricted to the activity interval.

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