# Textile Composition, Not Number of Layers, Impact Interphase Pressure (IP): A Pragmatic, Comparative Analysis of the *In Vivo* IP of Seven Different Two Layer Cohesive Bandage Kits in Healthy Volunteers

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INTRODUCTION: Compression is an integral part of the conventional management of chronic venous disease (CVD), venous leg ulcers (VLUsa) and edema of any origin.[1-4] Although there is a plethora of evidence touting the benefits of compression,[1-9] there has yet to be identified a universal dosage or a specific textile combination that is superior.[9]

The routine use of disposable, pre-packaged compression bandage sets is customary in the standard of care (SOC) management of VLUs and edema of the lower extremity. There is an absence of *in vivo* data reported in the literature which is necessary to not only better understand the dynamic performance of these textiles, but to also discriminate between compression applications based on the compression profile created by the textile composition, rather than by current convention of number of layers.

The interchangeable use of generic descriptions of these compression kits (i.e. 2-layer, short stretch, elastic) that is pervasive in consensus statements, Cochrane reviews, clinical practice guidelines and clinical studies documenting the efficacy of compression disregards the unique technical characteristics of one compression bandage kit over another.

## AIMS

- Compare IP of seven, 2-layer cohesive bandage kits immediately after application in two positions, supine and standing, when applied on healthy volunteers
- Compare static stiffness index (SSI) of seven, 2-layer cohesive bandage kits measured immediately after application in healthy volunteers

## MATERIALS AND METHODS

A sample of convenience was utilized (n=10). Bandages were applied in random order, on non-consecutive days by a single experienced clinician over a 4-wk period. A Pico Press® was used to measure the IP on the right lower limb of 10 healthy volunteers. Measurements were captured at two different locations, B1 and C. The measurements were made at the time of application in supine and standing. This procedure was repeated twice on the same volunteer, for each compression bandage kit.

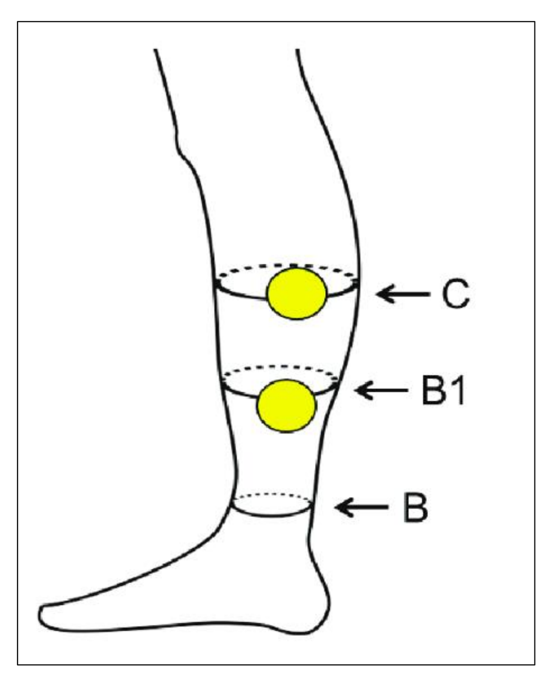


Figure 1- IP measurements at B1 and C

Statistical analysis of the outcome data was performed utilizing a repeated measures analysis of variance (ANOVA) to determine the effects of the bandage type on IP and SSI for each of the measurement points and according to the subject's position.

The SSI was calculated by subtracting the standing pressure from the supine pressure for both the B1 and C locations. ($SSI = IP_{standing} - IP_{supine}$) Post hoc analyses were performed by Tukey and Bonferroni test to identify significant differences. A regression model including the main effect of the wrap and the subject was performed for the supine measurements at B1 and C. The dispersion of the recorded pressures within the study population (dispersion between subjects) was assessed by the coefficient of variations.

## RESULTS

The *in vivo* IP measured at B1 and C in the supine and standing position outlined below:

| | B1 Supine | | B1 Standing | | C Supine | | C Standing | |
|---|---|---|---|---|---|---|---|---|
| Wrap | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| (1) | 73.7 | 13.4 | 85.0 | 14.0 | 69.3 | 10.6 | 77.3 | 12.6 |
| (2) | 50.1 | 5.3 | 57.1 | 6.6 | 53.2 | 7.6 | 59.1 | 7.9 |
| (3) | 52.8 | 7.6 | 61.1 | 9.0 | 55.0 | 6.4 | 51.7 | 7.9 |
| (4) | 58.4 | 8.7 | 69.9 | 9.6 | 59.3 | 8.2 | 68.1 | 10.9 |
| (5) | 61.7 | 10.6 | 68.4 | 10.1 | 60.0 | 6.8 | 66.4 | 6.3 |
| (6) | 51.7 | 7.1 | 59.1 | 9.4 | 54.1 | 9.1 | 59.3 | 10.7 |
| (7) | 66.4 | 6.1 | 74.6 | 6.1 | 66.3 | 7.8 | 72.9 | 8.2 |

Bonferroni post hoc analyses, with 95% Confidence Interval, found significant differences between wraps and placed them into 5 groups for IP at B1 outlined below:

| IP B1 - Supine | | | Bonferroni Grouping | | | | |
|---|---|---|---|---|---|---|---|
| Wrap | Average | Std Dev | | | | | |
| 1 | 73.70 | 13.44 | A | | | | |
| 7 | 66.40 | 6.06 | | B | | | |
| 5 | 61.70 | 10.55 | | B | C | | |
| 4 | 58.40 | 8.68 | | | C | D | |
| 3 | 52.75 | 7.59 | | | | D | E |
| 6 | 51.65 | 7.11 | | | | | E |
| 2 | 50.10 | 5.33 | | | | | E |

Bonferroni post hoc analyses, with 95% Confidence Interval found significant differences between wraps and placed them into 3 groups for SSI as measured at B1 outlined below:

| SSI measured at B1 | | | | Bonferroni Grouping | | |
|---|---|---|---|---|---|---|
| Wrap | Average | Std Dev | Observations | A | B | C |
| 1 | 11.95 | 5.36 | 19 | A | | |
| 4 | 11.45 | 5.44 | 20 | A | B | |
| 7 | 9.00 | 4.55 | 19 | A | B | C |
| 3 | 8.30 | 4.55 | 20 | A | B | C |
| 6 | 7.45 | 4.15 | 20 | A | B | C |
| 2 | 7.00 | 3.63 | 20 | | | C |
| 5 | 6.65 | 4.36 | 20 | | | C |

A regression model including the main effects of wrap and subject with their interaction had an $R^2=0.881$.

## CONCLUSIONS

Hemodynamic efficacy of a compression application is determined by IP and SSI.[5] The definition of 'therapeutic dosage' for a compression application varies based on both underlying etiology and patient presentation.[9,10] As such, compression prescription requires knowledge of both IP and SSI to guide selection of a compression textile or product.

The observed differences between the seven, 2-layer bandage kits tested are potentially important in that it may give rise to differences in both benefits and risks of utilization of a particular compression application according to patient presentation and underlying etiology. Furthermore, there are educational implications, elevating the conversation of compression beyond the number of layers and beyond dosage.

Future research should include documentation of *in vivo* comprehensive compression profile of IP, SSI, and the distribution of the pressure across the tissue vertically and horizontally to better understand the effect of compression on the vascular systems and the impact of varying textile composition has on tissue and cellular deformation and remodeling.

## REFERENCES

1. Shi C, Dumville JC, Cullum N, Connaughton E, Norman G. Compression bandages or stockings versus no compression for treating venous leg ulcers. Cochrane Database Syst Rev. Jul 26 2021;7(7):Cd013397. doi:10.1002/14651858.CD013397.pub2
2. Dissemond J, Assenheimer B, Bültemann A, et al. Compression therapy in patients with venous leg ulcers. JDDG: Journal der Deutschen Dermatologischen Gesellschaft. 2016;14(11):1072-1087. doi:https://doi.org/10.1111/ddg.13091
3. Stout N, Partsch H, Szolnoky G, et al. Chronic edema of the lower extremities: international consensus recommendations for compression therapy clinical research trials. Int Angiol. Aug 2012;31(4):316-29.
4. Gianesini S, Obi A, Onida S, et al. Global guidelines trends and controversies in lower limb venous and lymphatic disease: Narrative literature revision and experts' opinions following the vWINter international meeting in Phlebology, Lymphology & Aesthetics, 23-25 January 2019. Phlebology. Sep 2019;34(1 Suppl):4-66. doi:10.1177/0268355519870690
5. Partsch H. Compression heals leg ulcers due to abolishment of venous reflux. *J Wound Care*. Jul 2 2019;28(7):427. doi:10.12968/jowc.2019.28.7.427
6. Beidler SK, Douillet CD, Berndt DF, Keagy BA, Rich PB, Marston WA. Inflammatory cytokine levels in chronic venous insufficiency ulcer tissue before and after compression therapy. *J Vasc Surg*. Apr 2009;49(4):1013-20. doi:10.1016/j.jvs.2008.11.049
7. Beidler SK, Douillet CD, Berndt DF, Keagy BA, Rich PB, Marston WA. Multiplexed analysis of matrix metalloproteinases in leg ulcer tissue of patients with chronic venous insufficiency before and after compression therapy. *Wound Repair Regen*. Sep-Oct 2008;16(5):642-8. doi:10.1111/j.1524-475X.2008.00415.x
8. Bojesen S, Midttun M, Wiese L. Compression bandaging does not compromise peripheral microcirculation in patients with cellulitis of the lower leg. *Eur J Dermatol*. Aug 1 2019;29(4):396-400. doi:10.1684/ejd.2019.3606
9. Vowden P KA, Mosti G. Demystifying mild, moderate and high compression systems - when and how to introduce "lighter" compression. *Wounds International*. 2020
10. Bjork R, Ehmann S. S.T.R.I.D.E. Professional Guide to Compression Garment Selection for the Lower Extremity. *J Wound Care*. Jun 1 2019;28(Sup6a):1-44. doi:10.12968/jowc.2019.28.Sup6a.S1

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