ASSESSMENT OF STATIC AND DYNAMIC ARM PRESSURES ACHIEVED WITH A THERAPEUTIC COMPRESSION GARMENT AND A SHORT STRETCH BANDAGE

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INTRODUCTION

BACKGROUND: Many compression bandages and devices are available to treat lymphedema. Since the pressures achieved by these play a role in their therapeutic usefulness it is instructive to examine some of these pressure features under different conditions. Of particular interest is the pressure measured between the bandage or device and the limb. This interface pressure (IP) is variously called interface, surface, contact or sub-bandage pressure. When a compression bandage or device is applied to a limb and the limb is at rest, measured pressure is a resting or static pressure. When the limb is moving and/or its muscles are contracting, then pressure changes are called dynamic or working pressure. Each pressure has its own specific role in therapeutic processes. We believe that dynamic pressures provide therapeutic effects that depend on their ability to stimulate movement of fluids (lymph, interstitial and blood) and their repetitive impact that favorably alters tissue properties [1-2].

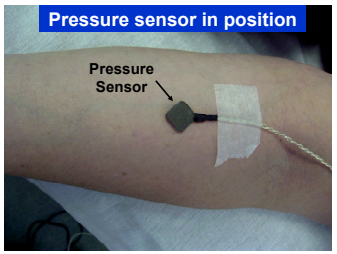
Previous work has examined IP features associated with various bandages and devices when applied to the leg. Although the need for adequate compression to manage arm lymphedema is well known, there are surprisingly few quantitative data describing these features for arm ompression.

GOALS: Thus our goal was to characterize arm IP achieved with a commonly used short stretch bandage and a new type of compression garment (FarrowWrap Lite™, Farrow Medical). Our main purpose was to investigate relevant pressures achievable with two different modalities and to provide examples of their features. Comparative data is provided to illustrate these features but this is not a product-comparison study. This would require a much larger undertaking for such comparisons to be scientifically meaningful. However, the basic results obtained are indicative of the main features.

***Pressure Measurement*:** Accurate and reliable measurement of IP, especially on a limb, requires a sensor that is sufficiently thin and small so its presence has an acceptably small effect on true pressure. We used a thin (1 mm) square (10 mm^2) capacitive-based sensor that produces an output voltage related to the integrated pressure over the sensor area (Figure 1). Most, if not all, sensors available for measuring interface pressure are nonlinear, so it is necessary to calibrate and correct for such nonlinearity. Our approach is to calibrate the sensor *in situ* using a calibrated vascular cuff–sphygmomanometer combination (Figure 2) and then to use a software-based least-squares optimization procedure to relate measured sensor voltage to actual pressure in mmHg.

***Protocol*:** Six female volunteers had one arm wrapped with FarrowWrap™ (Figure 3) and then with a short stretch bandage (Figure 4) by an experienced lymphedema therapist. Prior to wrapping, the pressure sensor was placed on the volar forearm 7 cm distal to the antecubital crease. A thin sleeve that extended from wrist to axilla was then fitted onto the arm. With the subject supine, pressures were recorded continuously after wrapping the arm with either FarrowWrap™ or short stretch. The short stretch bandage was applied over cotton padding as is standard. Both FarrowWrap™ and short stretch were applied at "100%" stretch. Average pressure recorded while subjects were resting is the static pressure. After recording the static pressure, the subject squeezed and released a ball to simulate standard MLD-like exercise. This test segment consisted of about 10 cycles. The difference between the maximum and minimum pressures during this exercise is the dynamic pressure.

PROCEDURES AND EXAMPLES OF PRESSURE FEATURES



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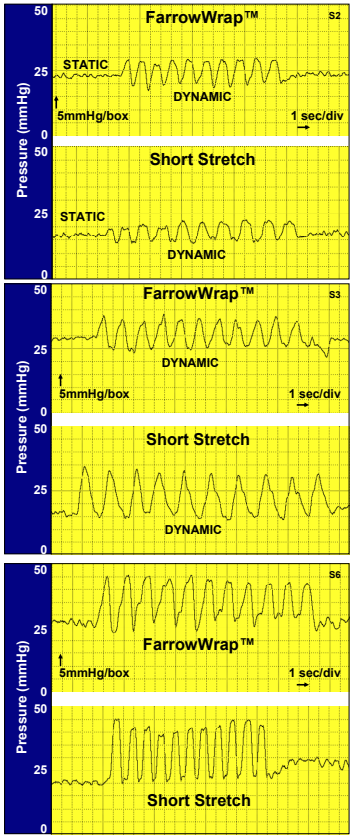

Examples of static and dynamic pressures achieved by three subjects are shown above. Subject #1 was unable to squeeze the ball with short stretch applied so is not included in the dynamic pressure listing. A noteworthy feature of the ball squeezing exercise is that dynamic pressures may oscillate around the static pressure level as shown in S2 above, or may increase above it as shown in S6 above. This differential result is not yet fully explained and the possible clinical significance of these different patterns is as yet undetermined.

RESULTS

STATIC PRESSURES (mmHg)		
Subject	FarrowWrap	ShortStretch
1	21.0	28.2
2	19.3	19.6
3	24.6	18.9
4	26.5	15.8
5	23.0	34.1
6	23.4	22.5
Avg	23.0	23.2
SD	2.6	6.8

DYNAMIC PRESSURES (mmHg)						
	FarrowWrap			Short Stretch		
Subject	Max	Min	Dynamic	Max	Min	Dynamic
2	28.4	19.2	9.2	22.2	14.3	7.9
3	36.0	24.9	11.1	33.1	15.1	18.0
4	43.7	25.7	18.0	20.3	12.7	7.6
5	29.0	20.8	8.2	56.4	35.1	21.3
6	44.6	24.2	20.4	43.6	23.1	20.5
Avg	36.3	22.9	13.4	35.1	20.1	15.1
SD	7.7	2.8	5.5	15.1	9.3	6.8

CONCLUSION

Compression therapy is one of the most important aspects for treating lymphedema and for maintaining gains achieved during acute therapy. We know that it works, but there are many details of the mechanisms and processes that are not yet fully understood. This means that it is not always clear as to which bandage or device features are optimum for a given condition or patient.

In this study, the short stretch bandage and the compression garment, when applied by an experienced therapist, both achieved static and dynamic pressures within commonly accepted therapeutic ranges. The smaller standard deviation of static pressures achieved by FarrowWrap™ suggest it may be capable of a greater application uniformity among subjects, but this needs confirmation. Other "pros" of the garment include a soft and comfortable feel, not too difficult to move in, not cumbersome and less time to apply and remove.

We believe that more expansive studies along the lines outlined here should be done using patients with arm lymphedema to determine if these results for normals fully apply to the intended target population.

REFERENCES

[1] Mayrovitz HN , Larsen PB(1997) Effects of compression bandaging on leg pulsatile blood flow. Clinical Physiology 17:105-117

[2] Mayrovitz HN and Sims N (2005) Compression Therapy. In: *Wound Healing* Ed. Falabella, AF and Kirsner, RS Chapter 33 pp 409-421 Taylor & Francis, Boca Raton FL