

PRESSURES PRODUCED BY TWO TYPES OF LYMPHEDEMA TREATMENT DEVICES

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BACKGROUND & GOALS

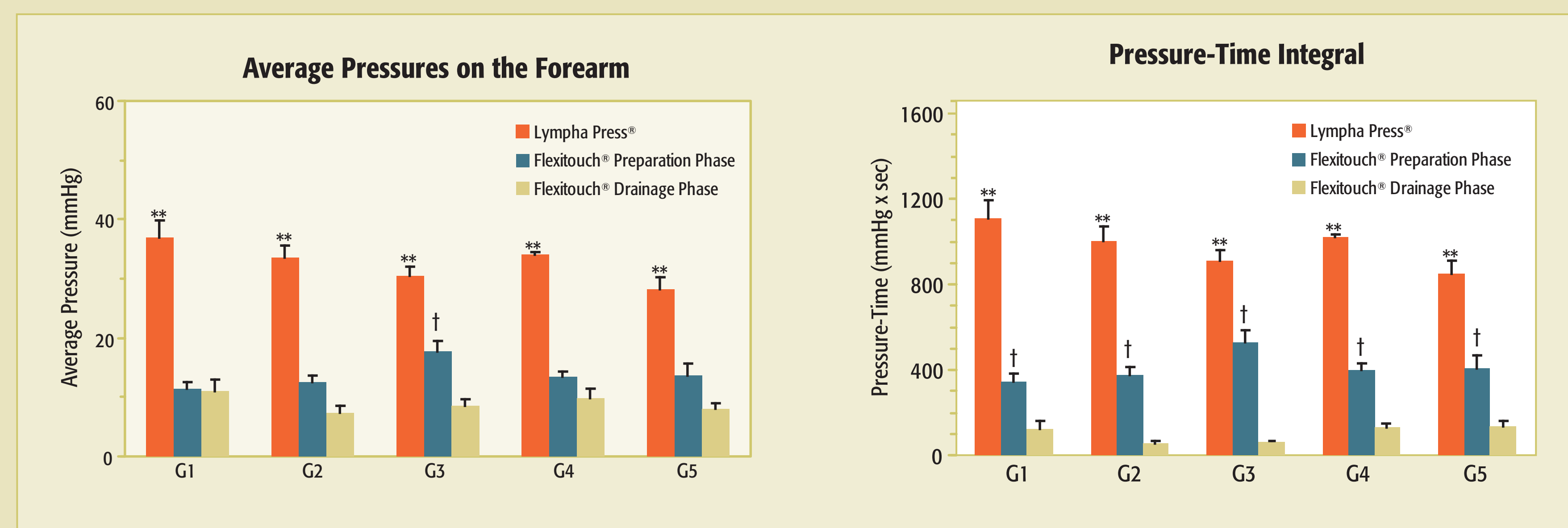
Automated sequential compression devices of different types have been reported to provide benefit in treating persons with limb lymphedema¹⁻⁷. These devices have been used in conjunction with complete decongestive physiotherapy (CDP)^{2,8}, and compared to the effectiveness of CDP¹. Most devices consist of multiple contiguous chambers that encircle the limb with the chambers sequentially inflated and then deflated simultaneously. Newer promising approaches involve sequential compression patterns that emulate manual lymph drainage⁶ and provide both preparation and drainage cycles. Although a common feature among these devices is their ability to deliver sequential pressures to assist lymphatic drainage, the nature of the pressures may be different in magnitude, pattern and timing. Such differences may have important implications.

It has been reported that even with manual massage, lymphatic vessels can be damaged if too high pressures are used⁹. Measurements of pressures actually applied to limb models showed that pressures experienced with sequential compression pumps can far exceed those pressures indicated by the device settings¹⁰. Similar measurements have not been reported with devices that were applied to human arms. Thus, our goal was to investigate pressure magnitudes and patterns produced on the arms of persons by two devices, a traditional sequential compression pump (Lympha Press[®] [LP]), and a new compression device technology designed to simulate manual lymphatic drainage (Flexitouch[®] System [FT]), both of which have shown efficacy in treating lymphedema^{6,7}.

METHODS

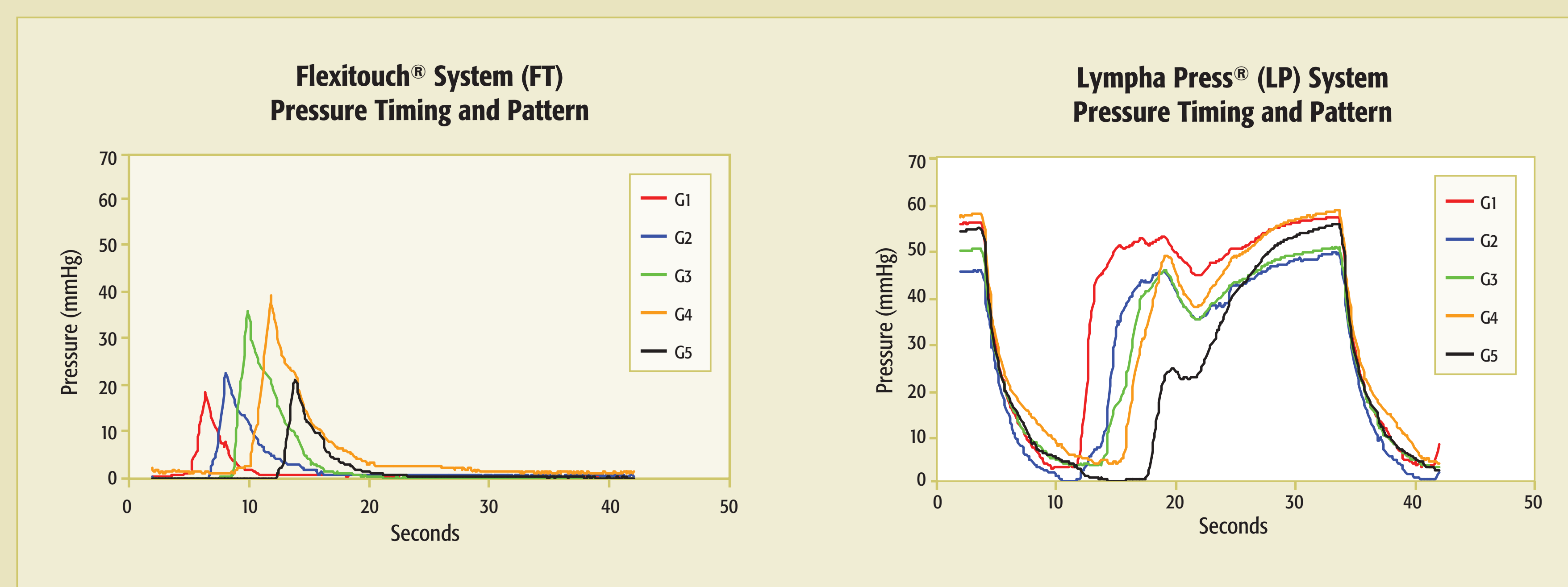
Ten volunteer subjects were evaluated with devices applied to the left arm as shown in the photos. Evaluation order was random with at least 48 hours between evaluations on the same individual. A pressure sensor array was affixed to the left arm to measure interface pressures along the forearm as described under Experimental Setup. Garments were then applied to subjects according to manufacturers' directions. The FT or LP device was then activated and pressures were recorded for at least two full cycles of each device. A general linear model for repeated measures was used to test for overall differences between pressures. In this analysis, site (G1 through G5) was used as the within-factor, and LP pressures, FT preparation phase pressures (FT-P) and drainage phase pressures (FT-D) were used as independent between-factors. Post-hoc tests of pressure differences at each site were tested using a one-way analysis of variance (ANOVA) among the LP pressures and the FT-P and the FT-D pressures.

MAIN RESEARCH FINDINGS



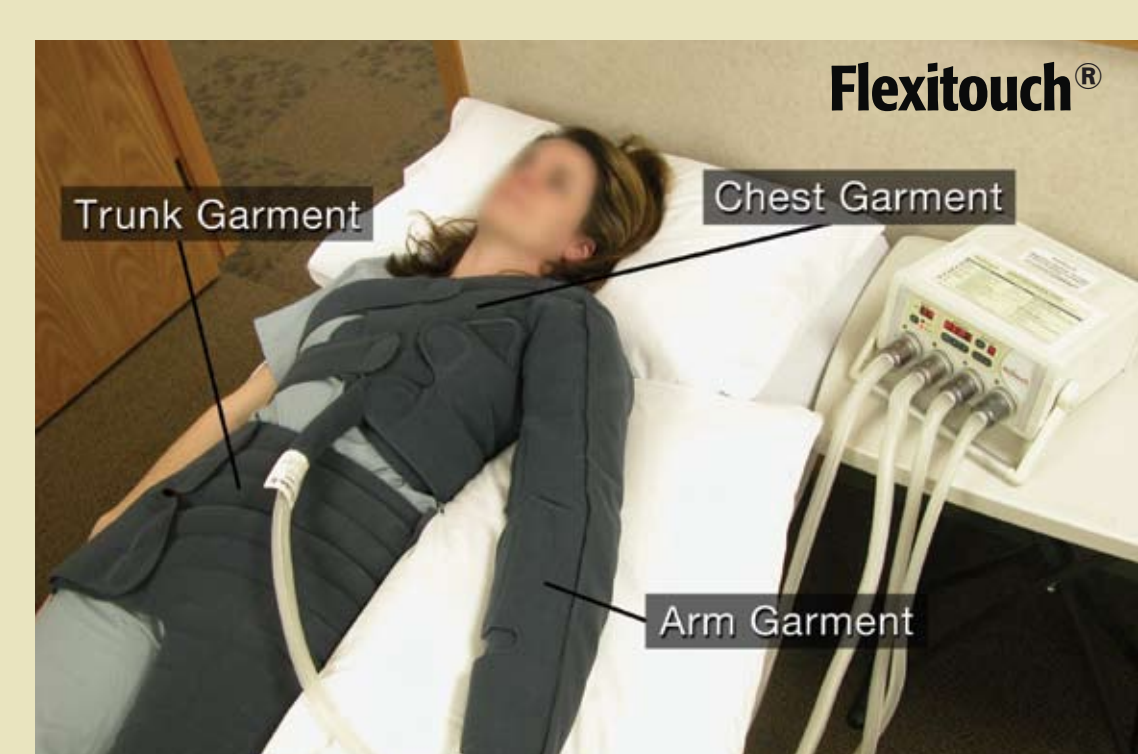
** Lympha Press[®] pressures greater than for the Flexitouch[®] preparation and drainage phase pressures, $p < 0.001$;

† Flexitouch[®] preparation phase pressure greater than for the Flexitouch[®] drainage phase, $p < 0.01$.



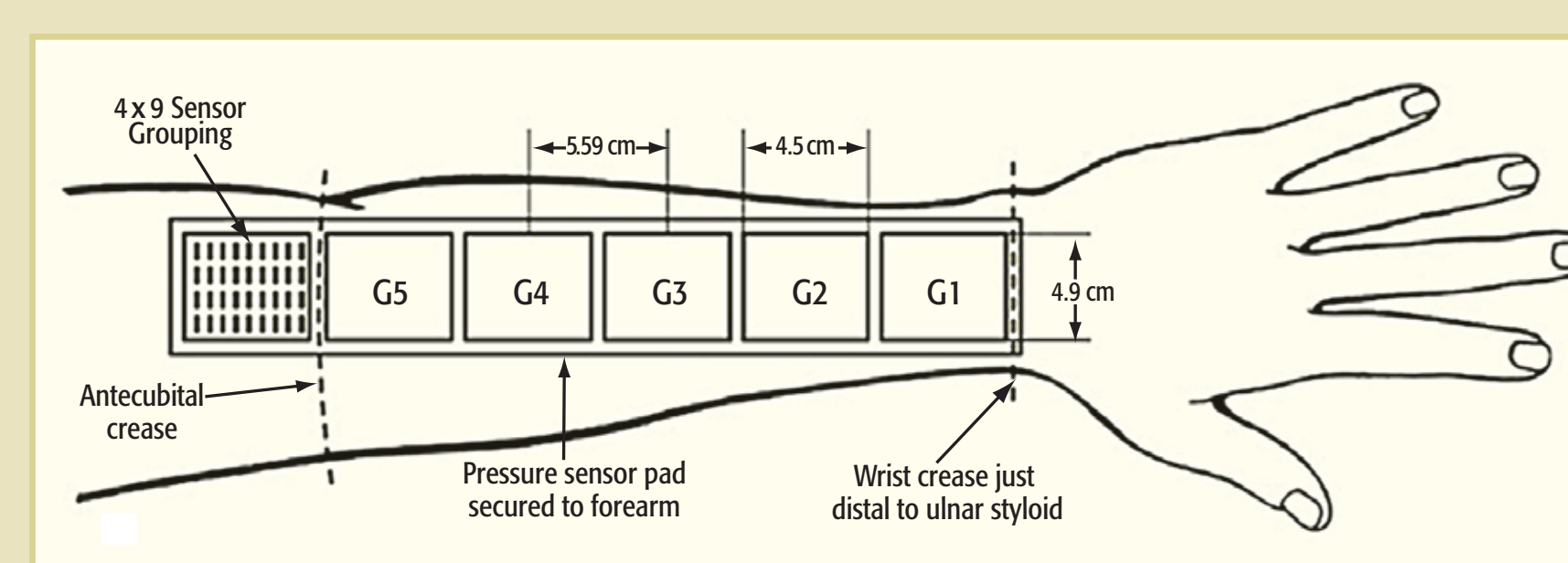
Example of temporal pressure patterns developed by the two devices. FT is crisper with a smaller peak pressure and shorter duration.

EXPERIMENTAL SETUP



Pressure Measurement Method

Pressures along the left posterior forearm were measured using a 256 pressure sensor array with the sensors imbedded in a 33 cm x 4.9 cm cloth strip. Each rectangular sensor was 1.1 cm x 0.4 cm with the long dimension oriented across the arm. The full array consisted of 64 sets of four sensors with each set of four sensors monitoring an arm width of 4.9 cm and length of 0.4 cm. Spacing between adjacent sensors up the arm was 0.10 cm and spacing between sensors across the arm was 0.16 cm. To determine the pressure profile along the forearm, five standardized areas were defined with each area corresponding to a group of 4 x 9 sensors encompassing an arm surface area of about 22 cm². These groups are designated as G1 through G5. Pressures measured by all sensors were automatically sampled and recorded at 0.1 sec. intervals over at least two full inflation cycles of each device. The stored pressure data was subsequently processed with dedicated software provided with the sensor array system (Xsensor[®]).



RESULTS

Pressure Pattern Comparisons

The initial pressure rise during inflation of both devices to a peak for the FT device or to a plateau for the LP device is rapid, but occurs significantly more rapidly with the FT device (1.48 ± 0.31 vs. 4.12 ± 1.66 sec., $p < 0.001$). Also, the FT device starts its pressure release immediately after peak inflation but the LP device maintains inflation pressures for the remaining part of its cycle. Thus the inflation duration of the FT device at all arm sites is significantly shorter being about 1.5 seconds compared to up to 22 seconds for the LP device.

Average Pressure Magnitude Comparisons

Mean overall pressures were: for LP 32.6 ± 6.5 mmHg; for FT-P 13.7 ± 4.9 mmHg; and for FT-D 9.0 ± 4.2 mmHg. These LP pressures were significantly ($p < 0.001$) greater than FT-P and FT-D pressures. Site-by-site comparisons showed that LP pressures were greater than FT-P and FT-D pressures at every site ($p < 0.001$). FT-P and FT-D pressure differences were not significant ($p > 0.05$) except at site G3 (mid forearm) where FT-P pressure were significantly ($p < 0.001$) greater than FT-D pressures.

Pressure-Time Comparisons

Mean pressure-time integral values were for LP 978 ± 197 mmHg x sec.; for FT-P 411 ± 146 mmHg x sec.; and for FT-D 99 ± 74 mmHg x sec. At all sites, the LP pressure-time integral was significantly ($p < 0.001$) greater than for FT-P and FT-D values.

Conclusions

Major differences in pattern, timing and magnitude of pressures experienced by treated limbs can be expected depending on the device used. These factors may be significant and it may be prudent to consider them prior to selecting a given device for any specific patient.

References

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