COMFORT COMPANY

WHEELCHAIR CUSHION INTERFACE PRESSURE COMPARISONS

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Cushion Testing Report: Prepared for the Comfort Company

BACKGROUND

This study measured the interface pressure characteristics of seven commercially available wheelchair seat cushions. The objective of this study was to determine if there was a measurable difference in interface pressure readings between cushions using different material and construction types.

History of Pressure Ulcers

Skin ulcers in the buttocks area are prevalent among wheelchair users that have limited mobility, decreased sensation or both. Many wheelchair users tend to sit on their cushions for extended periods of time. Previously, high pressures have been identified as one of the principle contributing factors in causing skin ulcers. As a result, cushion selection criteria continues to focus on decreasing overall and peak pressures while seated.

This study is designed to establish the characteristics of pressure distribution while using cushions from The Comfort Company line of products and to compare their cushions with commercially available cushions commonly used in clinical practice.

Test Procedures

Five pressure zones on the buttocks (left and right trochanters, left and right ischial tuberosities and sacrum) were examined during this study. The analysis is based on previous buttocks to cushion interface pressure studies (Siekman, 2002).

RESEARCH QUESTIONS / OBJECTIVES

This research sought to answer the following question: Do different cushion types affect the buttocks to seat cushion interface pressures while seated?

The objectives of this research were to determine if there is a measurable difference in interface pressure readings between different cushions.

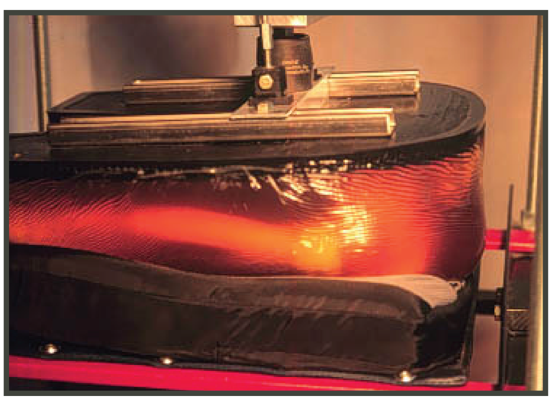
METHOD

Test Dummy

In an effort to eliminate uncontrolled variability of human test subjects, a surrogate test fixture was used to apply load to the test cushions. The surrogate indenter consists of the pelvis and femur sections of a skeleton model that is molded into a gel polymer in the shape of a human buttocks and thighs. This adult male test dummy, Skeletal Embedded Loading Indentor (SKELI), was developed by the International Organization for Standardization (ISO) and is currently used by laboratories in the US and other countries as a research tool. Use of the SKELI assures consistency between tests with accurate and repeatable loads on all cushions tested (Figure 1). The SKELI used for testing represents the 50th percentile adult male for weight (174 pounds), thus matching normal load supported by cushions during sitting (approximately 65% of the body weight is supported by the buttocks and thigh (Kroemer, 1997)).

By using the fixture and indenter, it is possible to expose all of the test cushions to the same load, shape and location. This procedure assures consistency at a much higher level than can be achieved using human subjects and is repeatable over time. The use of human test subjects for pressure mapping research can provide inconsistent data due to subtle changes in posture and movement. It is difficult to assure that the human test subjects are placed in exactly the same position between pressure readings.

Figure 1. Surrogate Test Fixture (SKELI)



Test Equipment / Test Fixture / Seat Cushion

Interface pressure measurements were made using an FSA pressure measurement system, an ultra-thin sensor mat and type IV data interface. The FSA system was calibrated prior to testing following the manufacturers instructions (FSA Force Sensitive Applications, Winnipeg, Canada). The accuracy of the FSA system is reported to be within 10%.

Load was applied to the test cushion using a Load Deflection Test Fixture as described in ISO 16840-2. Test trials consisted of seven wheelchair cushions (see Table 1).

Table 1. Wheelchair Cushions

CUSHION #	MANUFACTURER/MODEL	SIZE
1	Comfort Company - Adjuster	16 x 18
2	Comfort Company - Vector	16 x 18
3	ROHO - High Profile Quadtro Select	16 x 18
4	Sunrise Medical - Jay 2 Deep Contour	16 x 18
5	Sunrise Medical - Jay 2	16 x 18
6	Varilite - Evolution	16 x 18

Test Procedure / Protocol

The test cushions were placed on the load deflection test fixture in a position that would allow alignment of the cushion support to the appropriate section of the surrogate soft tissue indenter.

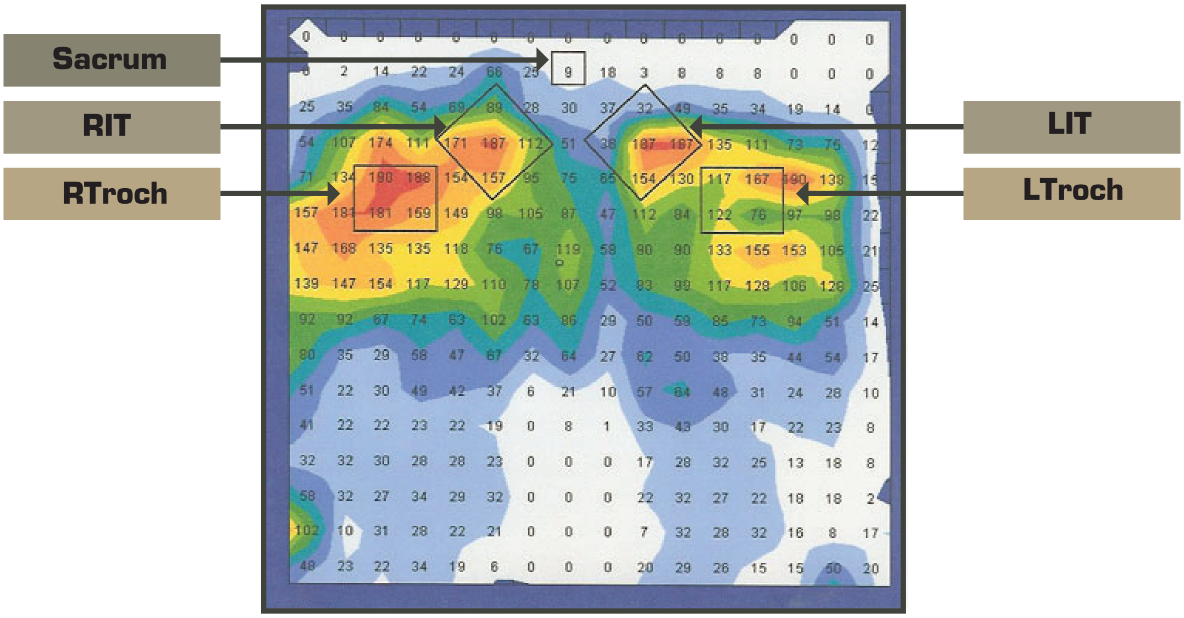
The SKELI was positioned onto the pressure-sensing mat that was placed on top of each cushion. A 500 N (112 pound) load was applied to each cushion for 120 seconds and then pressure readings were recorded. For cushions requiring a longer time to allow for adjustment and stabilization, load was applied without the pressure mat for 10 minutes and then the load was removed and reapplied with the pressure map in place. For each cushion, three trials were recorded. The load was completely removed for a minimum of 120 seconds between each trial. Cushion test order was randomized.

All cushions were kept in a temperature and humidity controlled environment (72° F (+/-2°), 50% (+/-5%) RH) for a minimum of 12 hours prior to testing. All cushions were adjusted to manufactures' specifications at test load prior to testing.

Data Analysis

The interface pressure distribution characteristics of each cushion were calculated and compared. For each trial, zones were identified based upon peak pressure readings and anatomical dimensions. The five zones were: the right and left ischial tuberosities (RIT and LIT; 5 readings each), the right and left greater trochanters (Rtroch and Ltroch; 4 readings each), and the sacrum (1-2 readings). For each cushion, the average pressure reading for each zone across the three trials was calculated (Figure 2).

Figure 2. Sample Interface Pressure Reading Zones.



Readings within 10mm Hg were considered within the measurement tolerance of the equipment and therefore set as the standard for measurements that are considered comparable. Measurement differences higher than 10mm Hg were considered significant differences.

RESULTS

Data demonstrated that pressure readings averaged across all five zones compared to the Jay 2 were lower using the Vector (60%) and Adjuster (38%) (Table 1).

Table 1. Differences between cushion pressures (bold equals significant difference).

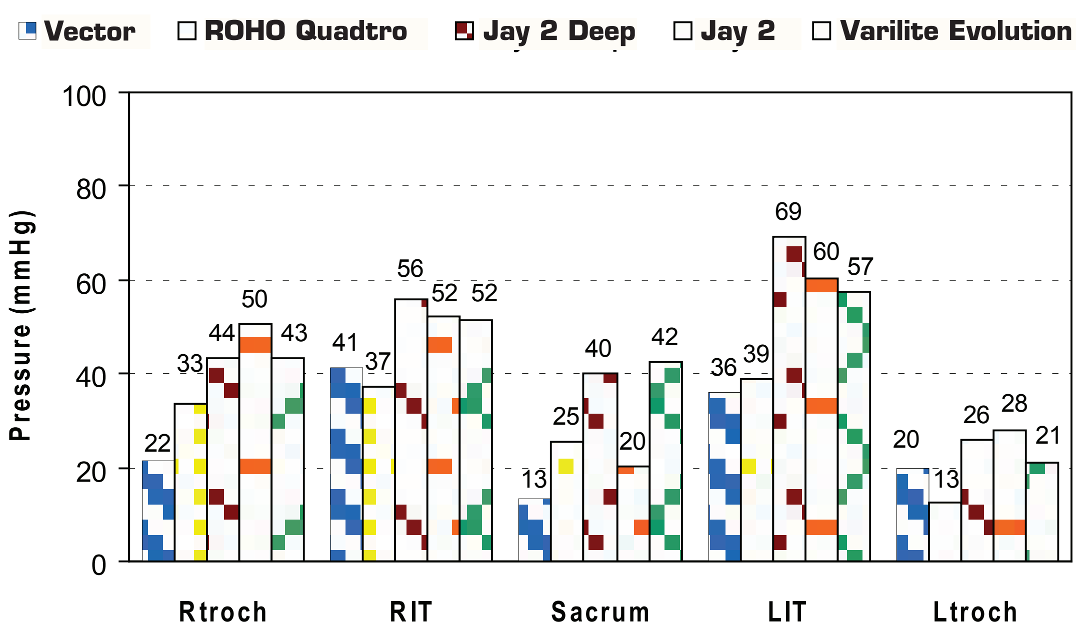
		ROHO Quadtro	Jay 2 Deep	Jay 2	Varilite Evolution
	mmHg	**29.5**	**47**	**42.3**	**43.2**
Vector	**26.4**	-3.1	**-20.6**	**-15.9**	**-16.8**
Adjuster	**30.7**	1.3	**-16.2**	**-11.5**	**-12.4**

*Note that all numbers are rounded to the tenth place; therefore differences may not be exactly as calculated from the table.

Pressures compared to the Jay 2 Deep were lower using the Vector (78%) and Adjuster (53%). Pressures compared to the Varilite were lower using the Vector (64%) and Adjuster (40%). In addition, the Vector and Adjuster both had comparable pressures compared to the ROHO Quadtro.

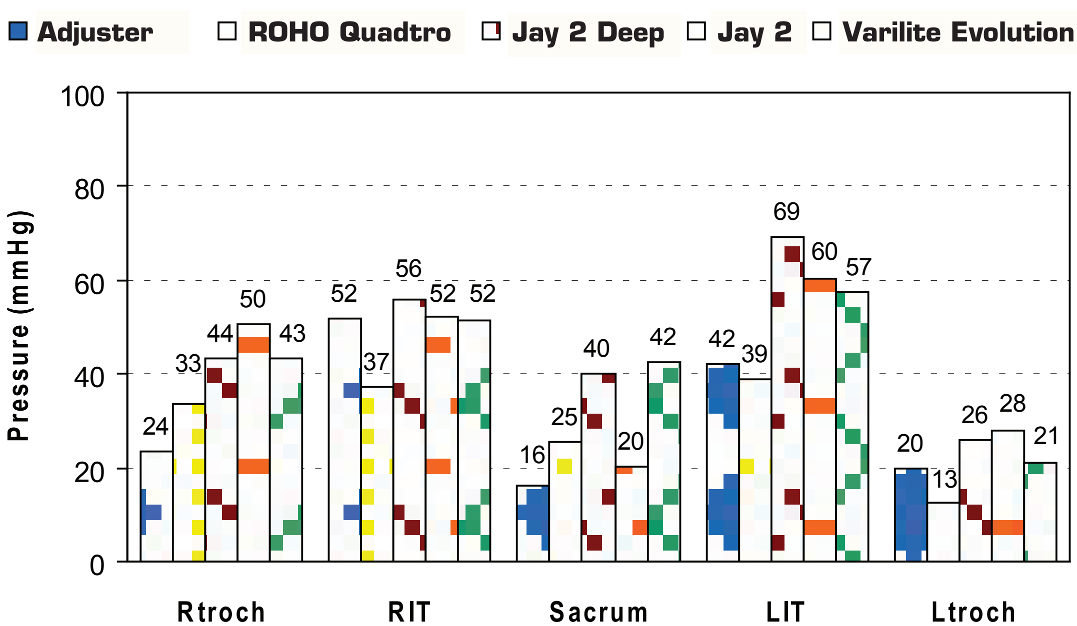
Lower or comparable pressures were obtained using the Vector compared to the ROHO Quadtro, Jay 2 Deep, Jay 2, and Varilite Evolution for the Right Troch, RIT, Sacrum, LIT, and Left Troch (Figure 3). Lower pressures were obtained using the Vector compared to the Jay 2 Deep, Jay 2 and Varilite for the Left and Right ITs. Lower pressures were obtained using the Vector compared to the ROHO, Jay 2 and Varilite for the Sacrum. *(See Figure 3 Below)*

Figure 3. Vector- Average Interface Pressure Readings.



Lower or comparable pressures were obtained using the Adjuster compared to the ROHO Quadtro, Jay 2, Jay 2 Deep and Varilite Evolution for the Right Troch, Sacrum and Left Troch (Figure 4). Lower or comparable pressures were also obtained using the Adjuster compared to the Jay 2, Jay 2 Deep and Varilite for the Left and Right ITs. Lower pressures were obtained using the Adjuster compared to the Jay 2 and Varilite for the Sacrum. *(See Figure 4 Below)*

Figure 4. Adjuster - Average Interface Pressure Readings.



DISCUSSION

Preliminary data suggests that the Vector performed better for pressure relief or was comparable to the ROHO Quadtro, Jay 2, Jay 2 Deep and Varilite across all 5 zones. In addition, the Adjuster performed better or was comparable to the ROHO Quadtro, Jay 2, Jay 2 Deep and Varilite for both the Right and Left Trochanters and Sacrum. The Adjuster performed better or was comparable to the Jay 2, Jay 2 Deep and Varilite for both the Right and Left Ischial Tuberosities.

CONCLUSIONS

This study demonstrated that the Vector and Adjuster are a comparable option for pressure management compared to other commercially available "high-end" cushions commonly used in clinical practice. In fact, the data shows that in some cases the Vector and Adjuster perform better than the other tested cushions. These data suggests that the best cushion for pressure relief varies across zones and the Vector and Adjuster cushions are viable options for pressure management. The pressure distribution characteristics of the Vector and Adjuster cushions make them an excellent candidate for people that are at high risk of skin ulcers.

REFERENCES

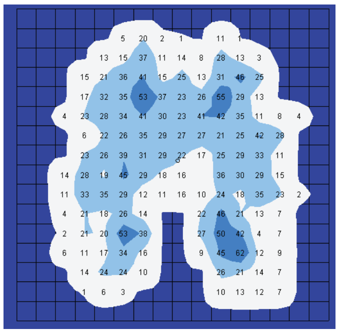
Axelson, P.W., Siekman, A.R., Hurley, S.L. & Yamada, D.A. (2002). Measurement of cushion interface pressures using the proposed new wheelchair seating standard.*Proceedings of the Eighteenth International Seating Symposium* (pp. 253-255). Vancouver, Canada

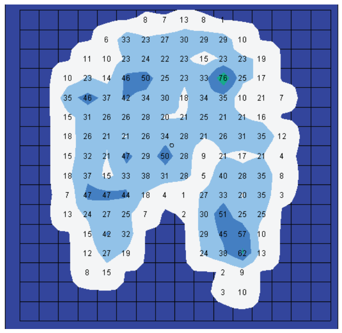
Kroemer, K. H. E., Kroemer, H.J. & Kroemer-Elbert, K. E. (1997). *Engineering Physiology: Bases of Human Factors/Ergonomics* (pg158). Hoboken: Wiley and Sons.

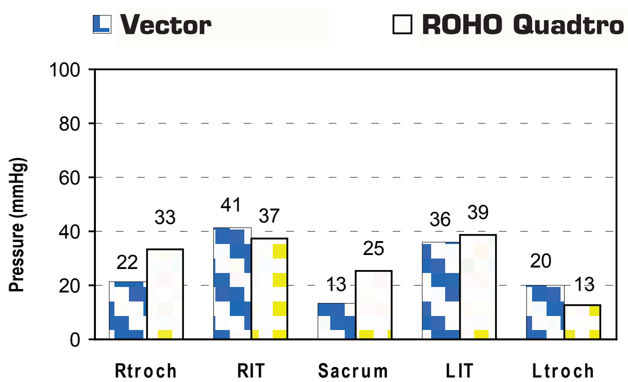
APPENDIX A

SAMPLE PRESSURE GRAPHS: VECTOR

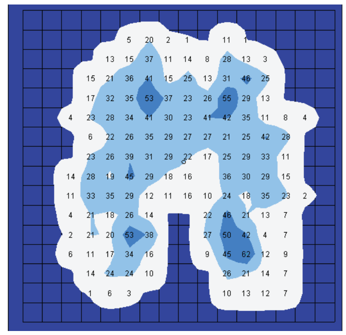
Vector | **ROHO Quadtro**

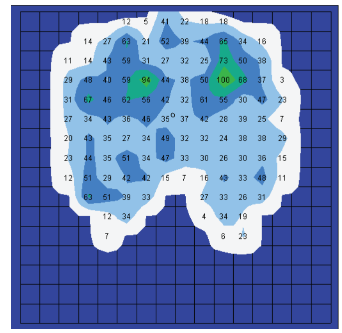


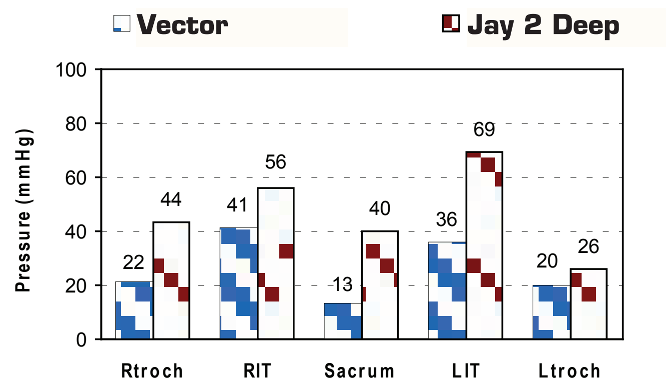




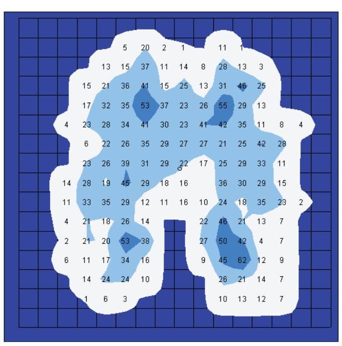
Vector | **Jay 2 Deep**

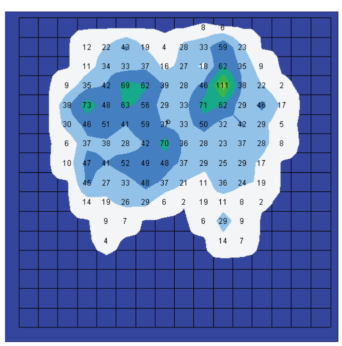


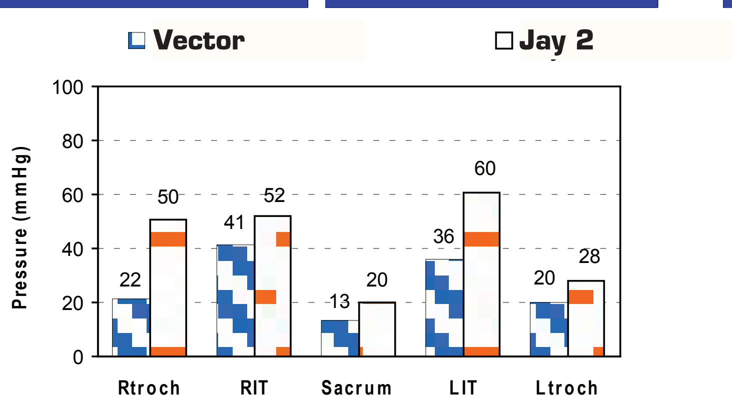




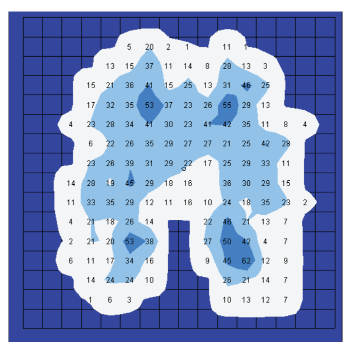
Vector | **Jay 2**

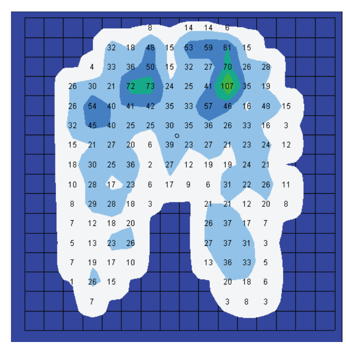


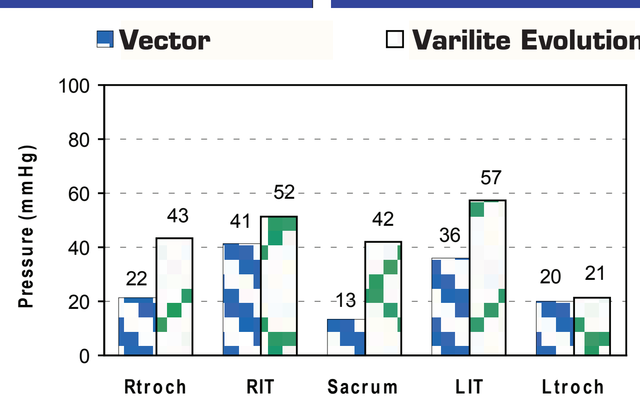




Vector | **Varilite Evolution**







APPENDIX A (CONTINUED)

SAMPLE PRESSURE GRAPHS: ADJUSTER