GROWING EVIDENCE IN SUPPORT OF ORTHOTIC-BASED SEATING INTERVENTIONS

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The problem

Pressure ulcers remain one of the most complex problems faced by wheelchair users with long-term spinal cord injuries (SCI). The wheelchair users interface to the wheelchair also effects postural stability which can be correlated to pressure ulcer formation at the coccyx/sacrum with a posterior pelvic tilt and the low ischial tuberosity with pelvic obliquity (1,2,3). Therefore, it is critical that the wheelchair cushion address skin integrity and postural support needs of the user.

Stage I & II pressure ulcers (superficial)

Research has identified heat and moisture at the sitter/wheelchair interface (microclimate), as an independent risk factor for sitting acquired pressure ulcer (SAPU) development, particularly Stage I and II (4). Moisture causes softening of the epidermis and weakening of the collagen in the dermis. This weaken skin increases the risk for transmission of toxins from wound drainage and incontinence as well as damage via microtaumas during transfers and wheelchair propulsion activities. Elevated heat increases metabolic needs at the tissue cell level. Research shows that every 1 degree C raises metabolic demands by 10% and that stressed tissue will cause ischemia and pressure ulcer development in a shorter period of time (5).

Stage III & IV pressure ulcers (deep)

The European Pressure Ulcer Advisory Panel (EPUAP) and recent industry research has identified deep tissue injury (DTI) as the main causative factor in Stage II and IV pressure ulcers (6,7). Deep Tissue Injury pressure ulcers do not originate at the skin surface, but at the muscle and fat layer directly under the ischial tuberosities. DTI may not be initially visible on the surface of the skin or look like a bruise, but then rapidly progresses to a full-thickness pressure ulcer.

Pressure re-distribution technology

Current pressure relieving cushions rely on pressure re-distribution principles in attempt to minimize interface pressures under focal pressure “hot spots” by distributing pressure as evenly as possible over the largest contact area possible (8). While these cushions are useful in re-distributing pressures away from the bony prominences of the buttocks, often times these areas may remain unacceptably high (9). Additionally, pressure re-distribution wheelchair cushions utilize soft, immersive materials that often do not support postural stability goals.

Orthotic technology

The orthotic approach to wheelchair cushion design intentionally loads pressure/shear forces to soft tissue areas of the buttocks (gluteus medius/maximus and proximal hamstrings) to allow off-loading of these forces at the areas of high risk ischial tuberosities (IT’s) and sacrum/coccyx. This orthotic-style approach to wheelchair seating was originally designed to address the most severe postural control needs in wheelchair users (10). The concurrent reduction of interface pressure at the sitting bony prominences has since shown a reduction in pressure ulcer risk with an orthotic approach (11,12).
Ride Designs

Orthotic-designed wheelchair seating has been commercially available since 2003 through Ride Designs, Sheridan, CO. The newly introduced Ride Java Cushion (February, 2015) is an “off-the-shelf” wheelchair cushion that has incorporated an off-loading approach into its design. The Ride Designs Java Cushion bridges the gap between the previously existing Ride Forward Cushion and the Ride Custom Cushion.

Wheelchair seating based on orthotic science has been successfully used to protect skin, improve stability, and manage heat and moisture however, these successes have been reported primarily through anecdotal experience and case studies. To provide evidence of the efficacy of the Java Cushion prior to its industry launch, Ride Designs sponsored (3) three university level, IRB approved research studies. The research included data collected and analyzed from Interface Pressure Mapping/Dispersion Index, Modified Functional Reach and MRI (magnetic resonance imaging) comparing orthotic based seating (Ride Java Cushion) to a 4” air cell immersive air floatation wheelchair cushion (Single valve, HP ROHO). A pilot research study was also conducted to exam wheelchair cushion microclimate and the heat and moisture wicking capabilities of the Java Cushion compared to ROHO. The primary investigator of the IPM and Modified Functional Reach studies is Barbara Crane, PhD, PT, ATP/SMS with the University of Hartford. The primary investigator of the MRI and microclimate studies is Evan Call, MS CSM (NRM), Weber State University, Department of Microbiology.

Interface Pressure Mapping/Dispersion Index Study

In a sample of (10) ten subjects with long-term spinal cord injury (average 20 years from onset), several IPM parameters were examined. The primary outcome assessed was dispersion index (DI) which is the percentage of the pressure being born on the IT’s/sacrum (pelvic region) compared to the pressures of the entire map. DI is calculated by taking the interface pressures under the pelvis divided by the entire contact sitting area (13). The lower the DI% the less pressure ulcer risk at the bony prominences. Secondary measures included regional pressure distributions under the ischial tuberosities and sacral regions. The results show that the dispersion index was significantly lower (p < 0.001) on the Java Cushion (11 ± 2.9%) than on the high profile ROHO Cushion (23 ± 3.0%), indicating a potentially healthier sitting environment for the high-risk bony prominences of the pelvis. All regional pressures were also significantly lower on the Java cushion than on the ROHO cushion (14).

Sitting Stability/Modified Functional Reach Study

A test of sitting stability using the modified functional reach test (15) was administered by Dr. Crane with the same 10 subjects used in the IPM study. The objective of this research was to determine any cushion related differences in seated stability between the Java and HP ROHO Cushions. Results from this testing indicated significant differences on the Java with greater functional reach in both right and left directions, however reaching in the forward direction did not demonstrate this same effect. It is hypothesized that this may have been due to an initial posterior pelvic tilt posture adopted when sitting with the ROHO cushion and a more neutral pelvic posture with the Java, basically changing the available range of movement due to a transition in pelvic posture from posterior to anterior tilt.

Deep Tissue Deformation and MRI Study

The tissue compression between the ischial tuberosity and skin was analyzed using an upright/seated MRI using the same protocol as the seminal research performed at the University of Tel Aviv (7). Data was collected from a sample of (10) subjects with SCI (average 18.4 years from onset) and compared deep tissue compression on the Ride Java and ROHO cushion (single valve, HP). The results indicated 50% less muscle and fat tissue compression than on the air cell cushion (16).
**Microclimate Study**

Preliminary microclimate research data has been collected from a single-subject human tester comparing heat and moisture on the Ride Java Cushion and a 4" air floatation cushion (ROHO). The Ride Java Cushion design includes an off-loading area at the IT’s and coccyx/sacrum as well as an air channel under the cushion base to improve air flow from the front of the cushion, under the IT’s and beyond the coccyx relief at the back of the cushion. In addition to passive air conduction of the off-loaded areas of the Java, the vertical fibers of the spacer mesh fabric cover creates a cool/dry space between the sitter and the “loaded” areas of the cushion. The results of this pilot study show the cushion/user interface on the Java Cushion being 1.6°C cooler (2.88°F) than a 4 inch air-floatation wc cushion (17).

**Conclusions**

In summary, it is essential that a wheelchair cushion prescription address the users interface pressure/dispersion index, postural stability, reduction in deep tissue deformation and reduction in heat and moisture build-up at the sitting interface. The Ride Designs Java Cushion is introduced with IRB approved, university level evidence never seen before in our industry. The Java Cushion is proven safer with pressure mapping evidence, deep tissue deformation/MRI evidence and keeps the users skin cooler and dryer (pilot study). The Java is more stable proven through modified functional reach evidence, is light weight and has no air or fluid and requires no vigilance in fit maintenance. Manufacturers of wheelchair seating should consider sponsoring independent research evidence to prove the efficacy of the products they bring to market.

**References:**


6. [http://www.epuap.org/?s=deep+tissue+injury&sfsb.x=7&sfsb.y=7](http://www.epuap.org/?s=deep+tissue+injury&sfsb.x=7&sfsb.y=7)


**Speaker Bio:**

**Tom Hetzel, PT, ATP:** Tom has been involved in virtually all levels of the seating and mobility industry for over 20 years. He supports clinical practice at the Aspen Seating clinic in Denver, CO, and leads education and product design at Ride Designs. Tom holds multiple patents in the wheelchair seating and mobility industry. He is a graduate of The Ohio State University; ATP since 1996; Clinical Practice from 1989 –1992; product and education manager for Jay Medical 1992 – 1996; Clinical consultant in private practice specific to seating and mobility 1996 – 2000; Owner/operator of Aspen Seating and Ride Designs 2000 – present.