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Dynamic Seating – providing movement and why

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Introduction

Dynamic seating provides movement, which occurs within the seat and/or wheelchair frame in response to force from the client. Dynamic components absorb force, which in turn, assist the client back to a starting position. Most wheelchair seating systems are static. If the client is able to move, this movement is independent of the seating system. Providing movement within the seating system and/or wheelchair frame allows the client to move while maintaining contact with support surfaces to provide stability and reduce shear forces. Dynamic seating should not be mistaken for adjustability. Dynamic seating has many applications. For clients with increased muscle tone, dynamic components absorb and diffuse this force, increasing seating tolerance, reducing extensor posturing and maintaining the client's overall position. By absorbing force, dynamic components also reduce wear and tear on the seating system and wheelchair. Movement provides sensory input and many clients seek this out. Movement is critical. By intentional movement the brain is developing through neuroplasticity (Rossini & DalForno, (2004). This occurs through experience dependent activity that increases the amount of brain derived neurotrophic hormone, which is critical in developing new axon and dendrite connections (Wittenberg, 2009). Movement also supports an enriched environment that is also needed for improved brain function (Morgan, Novak & Badawi, 2013). Dynamic seating may be integrated within a wheelchair and typically includes more than one area of movement. Other dynamic seating options are modular, can be placed on a variety of wheelchair frames and capture one specific area of movement. Common modular options capture movement at the pelvis, knee and head (Eason, 2011, 2015; Freney & Schwartz, 2015; Lange, 2013; Presperin-Pedersen & Eason, 2015).

Definitions

Dynamic, in the context of physics, is defined as "of or relating to force or power" and "of or relating to force related to motion" (Dictionary.com, 2016). In wheelchair seating, dynamic refers to components which translate force into motion of a portion of the seating system and/or wheelchair frame and, as a result, motion of the client (Lange, 2016).

Terminology is a challenge in the field of wheelchair seating and mobility. In a recent literature review, the term dynamic seating was used in several distinct ways. This term is sometimes used to describe wheelchair cushions, which alternate pressure under the client, similar to an alternating pressure air mattress (Burns & Betz, 1999). Other articles used the term dynamic seating to refer to changes in pressure between the client and a cushion that occur during self-propulsion of a manual wheelchair (Kernozek & Lewin, 1998). Still others use this term to describe a client moving in relation to a static seating system, rather than being in a constant relation to the support surfaces (Aissaoui, et al., 2001).

We are defining dynamic seating as movement which occurs within the seat system and/or wheelchair frame in response to intentional or unintentional force from the client. Dynamic components absorb force, which in turn assists the client back to a starting position.

Clinical Applications

Dynamic seating can be used in numerous clinical applications:

- To protect wheelchair and seating hardware from breakage
- To increase sitting tolerance and compliance
- To provide vestibular input
- To provide active range of motion
- To increase alertness
- To decrease agitation

  To decrease fatigue
- To increase function
- To increase strength and postural control
- To reduce active extension
- To reduce energy exertion (Lange, 2013; Presperin-Pedersen & Eason, 2015).

Dynamic seating is used in two main clinical scenarios. First, for clients with increased muscle tone, dynamic components absorb extensor forces that could otherwise lead to equipment breakage, decreased sitting tolerance, increased agitation, decreased function, further increases in extension, and quite a bit of energy exertion. Second, for clients who seek out movement, dynamic components provide vestibular input, increased alertness, decreased agitation, increased range for voluntary control of trunk or extremity, and sometimes increased strength and postural control.

Preventing Equipment Breakage

Dynamic seating is often used to prevent/decrease equipment breakage. Some clients who use wheelchair seating exhibit increased or fluctuating muscle tone. This is common in clients with diagnoses such as cerebral palsy, traumatic brain injury and Huntington's disease. Increased muscle tone or spasticity is caused by an imbalance of

signals between the central nervous system and the muscles. In addition to increased muscle tone, primitive reflexes and involuntary movements may also be present.

Muscle tone is not a constant state. Many clients may appear to be quite relaxed while sitting in their wheelchair seating system. However, a number of factors can lead to sudden and forceful extension, particularly at the hips, knees, and neck. This extension is often maintained for a short period of time and then subsides. The forces from this extension on a static wheelchair seat and frame can be so strong as to cause damage over time. Hardware used to mount the seating system and components (such as a head support), are particularly susceptible to damage. Breakage frequently occurs at the footplates, footrest hangers, back support mounting hardware and head support hardware. These forces are not entirely dependent on the client's size. Even very lightweight clients can exert enough repeated force over a period of time to cause breakage.

Dynamic seating is designed to absorb these extreme forces, which in turn, protects the wheelchair seating and frame from wear and tear and even breakage. Less breakage means clients can use their equipment with fewer repairs, less interruption to life, and less funding and documentation requirements.

Many clients with a variety of intellectual disabilities tend move a lot and frequently rock in their wheelchair seating system. This rocking movement may be so strong as to literally "bounce" a manual wheelchair across the room and can lead to the wheelchair tipping over. These clients may be seeking vestibular input and often demonstrate reduced rocking movements when other sensory stimulation is provided. Continuous rocking, as well as forceful rocking, can lead to damage of the wheelchair seating system and frame.

Providing dynamic seating, particularly at the hips, allows the client to rock and move while absorbing these forces. This is typically addressed with a dynamic back support. Absorbing the force protects the wheelchair and seating system from damage.

Reducing Extension

Many clients using wheelchair seating have increased muscle tone. This can lead to active extension, particularly at the hips, knees and neck. When a client extends against a static seating system, the forces exerted against the footplates, seat, back, and head support have nowhere to go and this can lead to an actual increase in client extension. As a result, the client may have difficulty tolerating the seating system for a reasonable amount of time (sitting tolerance), and may experience discomfort and even pain. Dynamic seating absorbs and diffuses these extensor forces and this can lead to an actual reduction in extensor tone.

Providing Vestibular Input

Many clients move, not due to increased extensor tone, but rather for the intentional purpose of moving. People tend to seek out movement. We are wired to move

and movement has so many benefits. Intentional movement helps us to understand our world and our relationship to the world. It is the building block of perception and learning (Ferre & Harris, 2015). Movement can calm, arouse, work muscles, enhance visual control and provide comfort by varying our position. From a sensory standpoint, movement provides vestibular input. The vestibular system is responsible for processing movement, changes in head position, and direction and speed of movement. The vestibular system is in the inner ear. When the vestibular system is activated, the brain can be either calmed or aroused. An agitated client may calm when the vestibular system is activated and a sub-aroused client may become more alert. One study showed that clients with dementia, who were agitated, calmed in response to rocking. Other clients with dementia who were sub-aroused became more alert and responsive after rocking (Watson, et al, 1998).

Integrated and Modular Dynamic Seating

Some dynamic systems are integrated into the mobility base, meaning that the entire system must be purchased as a unit and cannot be retrofitted to other mobility bases. These integrated systems often provide movement at more than one joint/location of the body, such as the hips, knees, and cervical spine/head. Other dynamic systems are modular. These modular components can typically be used on a number of different mobility bases. Movement can be provided at one joint/location, such as the hips, or several modular components can be combined to provide movement in more than one area/segment of the body. Most of these systems have ways of adjusting or grading the amount of force and movement excursion.

Providing Movement at the Pelvis

Dynamic movement can be provided at various areas of the body where movement is possible from a seated posture. The dynamic component allows movement beyond the usual seated posture, such as into increased pelvic and trunk extension, and then assists with the client returning to upright. Ideally, the return to upright does not lead to a loss of position, such as a posterior pelvic tilt. It is important that we think clinically about where movement is actually occurring and where we want movement to occur, for example at the thigh –pelvis intersection (the hip joints) and /or at the lumbar/thoracic intersection which is an important consideration for maintaining thoracic extension.

Most frequently, movement is allowed posteriorly, opening the seat to back angle (which is usually aligned with the client's hip joints). Upon return to upright, the pelvis is at risk of falling into a posterior tilt and being pushed forward. The pivot point of the dynamic component is critical to the client returning to upright with a neutral pelvic position and should be as close to the natural pivot point, as possible. Some components only allow very small movement and are designed primarily to protect seating hardware

from breakage. These components are less likely to lead to a loss of client position as so little movement occurs.

Providing Movement at the Trunk

If the pelvis moves posteriorly, the trunk will move posteriorly, as well. So if posterior movement of the trunk is desired, dynamic components which allow posterior movement of the pelvis are provided, namely a dynamic back. Posterior movement of the pelvis and trunk opens the seat to back angle in response to client movement and force. This movement may be utilized to protect back mounting hardware, absorb extensor forces and simply provide active movement. If the client experiences a loss of trunk position upon return to upright, it is important to ensure that adequate posterior, lateral, and anterior trunk support is used.

Opening the seat to back angle can lead to shear forces between the client's trunk and the back of the seating system. One result of this shear is that the client may move in relationship to the back of the seating system, affecting the relative position of supports attached to the back, such as lateral trunk supports. Typically, the amount of movement is not significant and so the client is not significantly out of alignment with these supports, but the lateral supports could end up in the client's axilla during extension. It is important to consider the pivot points of the dynamic back. Just as the optimal pivot point facilitates the pelvis returning to neutral after extending, the optimal pivot point also reduces shear in the back (Dawley & Julian, 2003).

Providing Movement above the Pelvis

Spinal extension may be desired in the mid thoracic area above the pelvis to allow specific spinal extension to occur for a functional task while stabilizing the pelvis. This active movement might be needed to enhance a desired functional activity such as throwing a ball or reaching backward to grab an object behind the wheelchair.

Providing Movement at the Knees

Another common area of dynamic movement is at the knees. Dynamic movement may allow knee extension, as well as a telescoping or lengthening movement. In combination, the dynamic component can capture the arc of movement that occurs at the knee. If the dynamic component only captures one plane of movement, it may be ineffective and, at times, detrimental.

Providing Movement at the Head

Finally, dynamic movement may be provided behind the head as a part of the head support. Some dynamic components only allow a small amount of movement to absorb forces and protect hardware, but do not move enough to trigger startle, postural insecurity, or reflexive responses. Other dynamic components allow greater movement in

one or more planes to capture posterior and rotational movements. Dynamic headrest hardware might enhance the functional goal of neck extension for individuals with spinal cord injury, multiple sclerosis, muscular dystrophy, or other diagnoses. As always, when considering head supports, dynamic or otherwise, it is critical that we consider where the support is consistently being provided.

Conclusion

Dynamic seating has many applications that can benefit clients using wheelchair technologies. Education is needed to increase awareness of the benefits of dynamic seating. Product options continue to expand and improve to better match these needs, as well. Finally, more research is required to validate clinical benefits and improve funding for this technology.

References

Aissaoui, R., Boucher, C., Bourbonnais, D., Lacoste, M., & Dansereau, J. (2001). Effect of seat cushion on dynamic stability in sitting during a reaching task in wheelchair users with paraplegia. Archives of physical medicine and rehabilitation, 82(2), 274-281.

Burns, S. P., & Betz, K. L. (1999). Seating pressures with conventional and dynamic wheelchair cushions in tetraplegia. Archives of physical medicine and rehabilitation, 80(5), 566-571.

Campbell, G. (2009, February 13). Michael Merzenich on Neuroplasticity. *Brain Science Podcast, 54* Retrieved from http://www.brainsciencepodcast.com/storage/transcripts/bsp-year-3/54-brainscience-Merzenich.pdf.

Dawley, J., & Julian, R. (2003). Purpose use and fabrication of a custom made dynamic seat back. In *Proceedings of the 19th International Seating Symposium,* Pittsburgh, PA: University of Pittsburgh.

Dictionary.com. Retrieved October 1, 2016, from http://www.dictionary.com/browse/dynamic.

Eason, S. (2011). Dynamic seating: Why, who, how? In *Proceedings of the 27th International Seating Symposium: The Next Chapter*, Pittsburgh, PA: University of Pittsburgh.

Eason, S. (2015). Enhancing development with dynamic wheelchair components. *Directions, 4,* 50-52.

Ferre, E. R. & Harris, L. R. (2015). Introduction to vestibular cognition special issue: progress in vestibular cognition. *Multisensory Research 28,* 393-396. doi: 10.1163/22134808-00002508

Freney, D., & Schwartz, K. (2015). Dynamic seating. *Directions, 4*, 44-48.

Kernozek, T. W., & Lewin, J. E. (1998). Seat interface pressures of individuals with paraplegia: influence of dynamic wheelchair locomotion compared with static seated measurements. Archives of physical medicine and rehabilitation, 79(3), 313-316.

Lange, M. (2016, April 20). What is Dynamic Seating? A definition. Retrieved from http://www.seatingdynamics.com/2016/04/20/dynamic-seating-definition/.

Lange, M. (2013). Dynamic Seating Webinar *National Seating and Mobility.* Retrieved from https://vimeo.com/100236246

Morgan, C. B., Novak, I., & Badawi, N. (2013). Enriched environments and motor outcomes in cerebral palsy: systematic review and meta-analysis. *Pediatrics*, 132(3), e735-e746. doi: 10.1542/peds.2012-3985

Presperin Pedersen, J., & Eason, S. (2015). Using seating to enhance movement of the body in a wheelchair. In *Proceedings of the 31st International Seating Symposium: The Next Chapter*, Pittsburgh, PA: University of Pittsburgh. Retrieved from http://www.iss.pitt.edu/ISS_Pre/Iss_Pre_Doc/ISS_2015.pdf

Rossini, P. M., Dal Forno, G. (2004). Integrated technology for evaluation of brain function and neural plasticity. *Physical Medicine Rehabilitation Clinics of North America, 15*(1):263-306.

Watson, N. M., Wells, T. J., & Cox, C. (1998). Rocking chair therapy for dementia patients: Its effect on psychosocial well-being and balance. *American Journal of Alzheimer's Disease and Other Dementias, 13*(6), 296-308.

Wittenberg, G. F. (2009). Neural plasticity and treatment across the lifespan for motor deficits in cerebral palsy. [Supplement] *Developmental Medicine Child Neurololgy, 51* (Suppl 4) 130-133.