



WHITE PAPER

Dental Professional Use of Ergonomically Designed Seating



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Figure 1

The majority of dental health professionals have reported at least one MSD over the past year, with lower back pain being the most prevalent disorder among dentists.

HISTORY OF DENTAL SEATING

Sit down dentistry was introduced in the late 1950s and has been the predominant method for delivering dental care since the 1980s. The benefits of accuracy, efficiency and lower fatigue are well established, but to minimize the negative effects of sitting requires a close examination of the stools available.

Dental seating is simultaneously the most often used and least appreciated equipment in the operatory. Conventional wisdom is that dental seating needs are similar to desktop computer seating. Examining the working positions, motions and frequent entries and exits required by the dental profession show that the needs are different. For example, a typical healthy dentist's working positing has his/her torso leaning forward 10 - 20 degrees, and head leaning forward an additional 10 - 20 degrees to see into and reach the oral cavity. This is true even when using loupes. This is unlike the slight torso recline often used to comfortably view a desktop computer monitor and reach a keyboard and mouse. Therefore, a different seating solution is required.

A vast majority of dental professionals sacrifice their own health to increase comfort and reduce anxiety of their patients (*see figure 1*). This is observed in many practices in the first five minutes of treatment, when the doctor bends and twists at the trunk and neck. The focus on patient comfort has led to diminished dental team health.

MUSCULOSKELETAL DISORDERS AMONG DENTAL HEALTH PROFESSIONALS

Prevalence

Musculoskeletal disorders (MSDs) among dental health professionals have been a topic of concern for decades. This has been attributed to several factors including static positioning, use of vibrating instruments, and repetitive motions. The majority of dental health professionals have reported at least one MSD over the past year, with lower back pain being the most prevalent disorder among dentists (up to 60%) (*Hays 2009*).

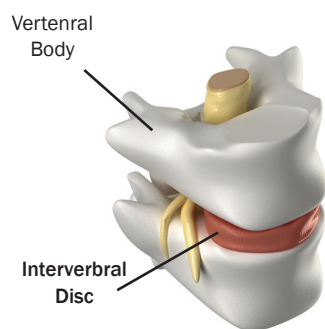


Figure 2

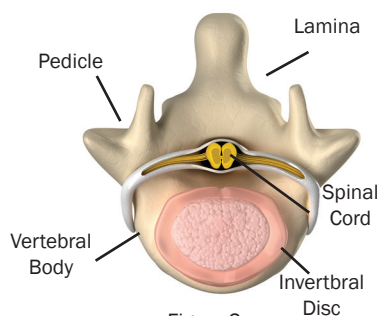


Figure 3

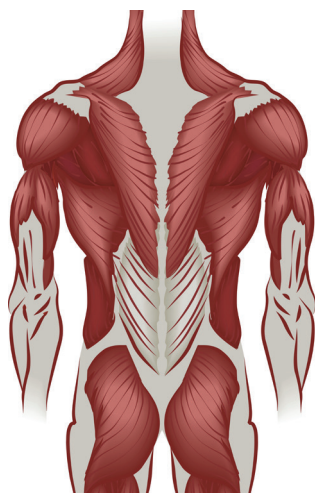


Figure 4

Neck and shoulder pain has also been reported as significantly prevalent with up to 85% of dentists in Sweden and 68% of dental hygienists in the United States reporting the problem (Hays 2009). Early retirement or changes in profession have been reported as common reactions to cope with chronic and severe MSDs.

PERTINENT ANATOMY AND DEFINITIONS

The Vertebral Column

Main structures of the vertebral column include the vertebrae, intervertebral discs (IVDs) (see figure 2), spinal ligaments, muscles and tendons. The contractile structures include muscles and their respective tendons. Non-contractile elements are passive structures of the spine that cannot move on their own; they require the force from muscles to change position. Non-contractile structures (see figure 3) include vertebrae and IVDs. Most of the force transferred down from one vertebrae to another is borne through the flexible IVD.

Muscles of the Trunk

There are many different muscles that attach to the spinal column, ribs, pelvis, and cranium. They can be divided into two basic groups: global muscles and local muscles. Global muscles are larger, have higher force-generating capacities, and are responsible for performing large movements of the trunk and limbs. Examples of global muscles include the rectus abdominus, latissimus dorsi, upper trapezius, and erector spinae (see figure 4). Conversely, the local muscles of the spine are generally smaller, and are generally used to control the fine motions of each individual segment.

Neutral Spine

In its most basic sense, having a neutral spine involves positioning the pelvis and vertebrae in such a way that joint and soft tissue mechanical stresses are at their lowest, allowing the muscular system to maintain that position with the least amount of energy. This is often associated with the appearance of a spine shaped like the letter 'S' when observed from the side of the body, similar to a standing posture.

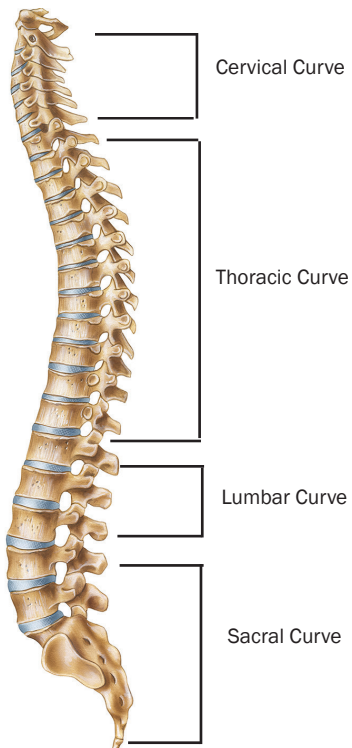


Figure 5

Spinal Motions and Positions

Flexion is the term used when the spine bends forward. This occurs when you look down toward the floor (cervical flexion) or bend over to touch your toes (thoracic and lumbar flexion). The opposite of flexion is termed extension, as in when you bend your head back to look toward the sky (cervical extension) (see figure 5). Lordosis can be thought of as a backward curvature and is normally found in the cervical and lumbar spines. Kyphosis bends in the opposite direction as the lordotic curve. It is typically found in the thoracic spine and can be imagined as a forward curvature. A normal, healthy spine contains both lordotic and kyphotic curvatures (see Figure 6).

BENEFITS OF A 'NEUTRAL SPINE'

Lumbar Spine Structures

The non-contractile structures that are placed under the most strain during static and dynamic postures are the intervertebral discs (IVDs), and the various lumbar ligaments. Each of them endures increases in stress with different motions or positions, thus having a neutral spine balances forces among these structures.

The internal pressure of IVDs changes based upon the position of the spine relative to gravity. As seen in (figure 9), assuming a flexed or rounded spinal position dramatically increases the pressures inside the lumbar IVDs (Nachemson 1966), which can lead to disk injury, disk herniations, and/or generalized lower back pain. Therefore, minimizing these internal pressures via a neutral spinal position can reduce the incidence of painful and disabling disc injuries (Casey 2011, Kang 2014, Beattie 2008).

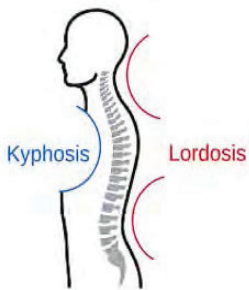


Figure 6

Muscles of the Lumbar Spine and Trunk

Achieving a neutral spine minimizes the muscular effort required to maintain the desired position and reduces the feeling of muscular fatigue (O'Sullivan 2006). This involves reducing the activity of the larger global muscles and utilizing the smaller local muscles to a greater extent. Individuals with lower back pain overuse their global muscles and demonstrate inactivity or even atrophy of their local muscles (Richardson 2002). When trained to activate their smaller local muscles more often and with greater success, lower back pain decreases (Hides 2001). Fatigue of the lumbar musculature causes a decrease in the information feedback system that ultimately provides protection to the spine (Fallentin 2012). Simply stated, you are at a higher risk for lumbar injury if your muscles are fatigued.

Posture of the Cervical and Thoracic Spine

The position of the pelvis has a significant influence on the postures of the lumbar, thoracic, and cervical spine. If the pelvis isn't in a stable and neutral position tilted forward, everything that it supports will likely be in a non-ideal position and will not be able to withstand the same amount of stress.

As in the lumbar spine, the cervical spinal structures (discs, joints, ligaments) are under the least amount of mechanical stress when in a neutral, lordotic position. When the lumbar spine demonstrates less of a lordosis curvature, the thoracic spine displays more of a kyphosis curvature. Continuing up the spine, the neck compensates by losing its normal lordotic curve (see figure 7).

The effects of poor posturing is most prominently seen by IVD injuries when observing the lumbar spine. The cervical spine, however, is more prone to dysfunctions in muscle activation and shortening. Analogous to the lumbar spine, the cervical spine has its own set of global and local muscles and can be compared similarly in regards to muscle dysfunction. Individuals with neck pain overutilize their global muscles (upper trapezius, levator scapula, etc.) and demonstrate decreased activity and atrophy of their local muscles (Falla 2012). Assuming a forward-head position dictates greater effort from the superficial global muscles and lengthens the deeper cervical-stabilizing local muscles, decreasing their strength and mechanical advantage.

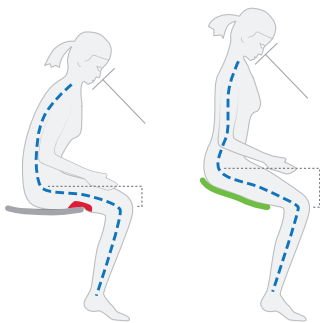


Figure 7

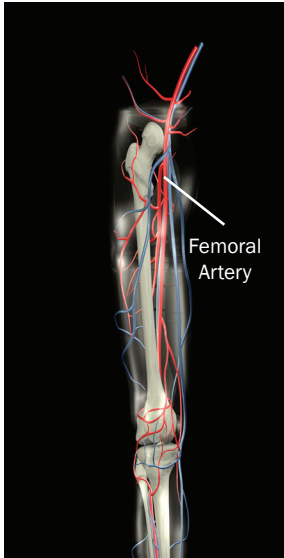


Figure 8

The femoral artery is the main artery that provides oxygenated blood to the tissues of the leg (InnerBody 2015).

Dynamic Sitting

The profession of dentistry requires the doctor or hygienist to remain at one location from several minutes up to a few hours at one time. The majority of dentists sit down, which gives rise to its own specific set of challenges. A lack of movement has been linked to health problems including cardiovascular disease, higher blood glucose levels, some cancers, and localized musculoskeletal disorders (Goodman 2003).

All tissues of the body require a means of delivery for nutrients and energy, as well as transportation of metabolic waste products to be excreted from the body. The main delivery system is the circulatory system and blood (see figure 8). The higher the rate of blood flowing to an area equates to a greater delivery of nutrients and greater disposal of waste products.

Some tissues in the body receive nutrients not through blood, but rather via diffusion. This process takes much longer and typically is aided by the movement of fluid (water) and tissue. The inner parts of a spinal IVD receive nutrients via diffusion and thus are relatively healthier when the spine is routinely and gently loaded and unloaded. Gentle, oscillatory mobilization (flexion, extension and other movements) has been found to increase the rate of diffusion into and out of these structures (Beattie 2009). This phenomenon of water diffusion is also the reason why humans are actually about 1-2 cm taller in the morning than in the evening – because throughout the day, gravity applies pressure to all of our discs, pushing out some of their fluid.

In regards to tissue health, the more movement we get throughout the day, the greater potential we have to distribute nutrients to the areas of the body that do not receive direct circulation (i.e. IVDs and ligaments). Decreasing diffusion of nutrients into the IVD causes degenerative changes (Beattie 2008).

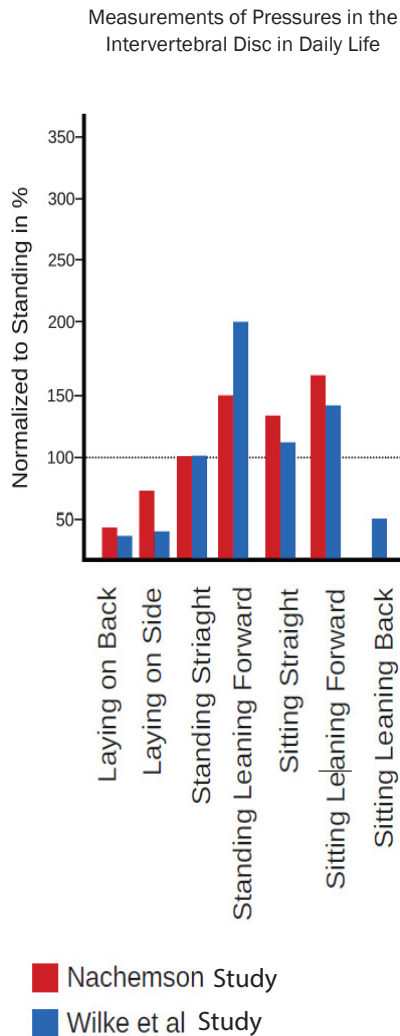


Figure 9

The sitting position places differing amounts of pressure on the back, buttocks, thighs and feet, depending upon the posture adopted and the seating surface (see figure 9). Modern technology allows a way to quantify these forces using pressure mapping. These pressure maps also inversely correlate to the amount of blood perfusion at the local tissues. Therefore, designing a seating surface that reduces the pressure at unwanted “hot spots” by distributing load or allowing pressure relief through movement is crucial to the overall health of the tissues in the lower extremities. Movement and pressure relief have been a staple of reducing tissue fatigue and pain for people who are not freely able to move out of the seated position (ie. frail, elderly, and spinal cord injury patients) (Makhsous 2007).

The amount of forward seat tilt has been shown to alter not only the resting position and biomechanics of the spine, but also the contact pressures exerted through the sitting surface and the pressures transferred to the feet (Pynt 2001). When there is an inclination that places the hips and pelvis above the knees, the pelvis is free to rotate forward, causing more of a natural lumbar lordotic curve, as well as ultimately influencing structures that are positioned above. Therefore, having a hips-above-knees position influences the posture of the entire spinal column and positively affects the mechanics of the neck, shoulder and back. An increase in body weight is transferred to the feet, decreasing the total pressure on the seating surface. The advantages of this type of seating in dentistry is two-fold:

- Reduces the overall strain on spinal tissues, which is imperative for health and well-being given the amount of sitting that is performed over a professional’s lifetime.
- Places the dentist in a more forward-leaning position to improve access and visibility to the patient’s oral cavity, enhancing performance and precision.



Figure 10

The option for movement with a dynamic sitting surface and a neutral spine may improve the overall health of tissues, decrease tissue degeneration, reduce muscular fatigue, reduce the incidence of injury and MSDs, decrease pain, and prolong the working careers of those who utilize them (*see figure 10*).

Optimal Seating for Dentistry

The unique physical requirements of dentistry pose several challenges to manufacturers who strive to provide optimal seating solutions. A chair that best meets the needs for dentists and hygienist will excel in the following ways:

- **Adjustability:** Easy seat and back height and tilt to enable and encourage custom adjustments. If these adjustments are not easy or the ranges of motion do not match the user's needs, the user will not be able to position properly to access the oral cavity with minimal stress on the musculoskeletal system.
- **Back support:** Enable and encourage a neutral, S-shaped spine by providing low lumbar support and the right height, angle and forward position compared to the seat pocket. This is very different than the needs of computer desk seating.
- **Seat support:** Comfort and security at a slight forward tilt. Support where it is needed (sit bones), relief where it is not (thighs.) Hips positioned above the knees to pivot the pelvis forward and position the user for a low stress, S-shaped spine.
- **Dynamic performance:** The seat armature should be flexible to move as the user moves. Encourages slight adjustments to minimize repetitive stress. Seat and thigh pockets are the most important areas to have dynamic support instead of rigid support to not inhibit blood flow through the femoral arteries.

A good set of core equipment (patient chair, dental light, delivery system and dental team seating) will enable and encourage comfortable patient positioning and also provide excellent access to the patient oral cavity. This combination completes an ergonomic solution that benefits the dental staff's health and well-being.

There are three areas required to achieve the most benefit from proper dental seating. The first is the ability to easily get into an athletic stance with hips above knees. This sets up the low stress, healthy, S-shaped spine. The second is a comfortable seat armature with different zones to maximize comfort and support. The last is a flexible seat area under each thigh to minimize blood flow restrictions to the lower extremities.

The time spent to make sure dental seating includes adjustability, back support, seat support and dynamic performance can pay off in increased comfort, but more importantly, the reduction of injury and the ability to continue a long and healthy career as a dental professional.

BIBLIOGRAPHY

1. Beattie, P. (2008). Current Understanding of Lumbar Intervertebral Disc Degeneration: A Review With Emphasis Upon Etiology, Pathophysiology, and Lumbar Magnetic Resonance Imaging Findings. *J Orthop Sports Phys Ther Journal of Orthopaedic & Sports Physical Therapy*, 38(6), 329-340.
2. Casey, E. (2011). Natural History of Radiculopathy. *Physical Medicine and Rehabilitation Clinics of North America*, 22(1), 1-5.
3. Falla, D., O'Leary, S., Farina, D., & Jull, G. (2012). The Change in Deep Cervical Flexor Activity After Training Is Associated With the Degree of Pain Reduction in Patients With Chronic Neck Pain. *The Clinical Journal OF Pain*, 28(7), 628-634.
3. Falla, D., O'Leary, S., Farina, D., & Jull, G. (2012). The Change in Deep Cervical Flexor Activity After Training Is Associated With the Degree of Pain Reduction in Patients With Chronic Neck Pain. *The Clinical Journal OF Pain*, 28(7), 628-634.
4. Fallentin N., Maikala R., Banks J., O'Brien N., & Rivard A. (2012). Specificity of Back Muscle Response to Submaximal Fatiguing Contractions.
5. Goodman CC, Fuller KS, Boissonnault WG. (2003). *Pathology: Implications for the Physical Therapist*. (2nd ed). Saunders, Philadelphia.
5. Goodman CC, Fuller KS, Boissonnault WG. (2003). *Pathology: Implications for the Physical Therapist*. (2nd ed). Saunders, Philadelphia.
6. Hayes, M., Cockrell, D., & Smith. (009). A systematic review of musculoskeletal disorders among dental professionals. *International Journal of Dental Hygiene*, 7(3), 159-165.
7. Hides, J. A., Jull, G. A., & Richardson, C. A. (2001). Long-Term Effects of Specific Stabilizing Exercises for First-Episode Low Back Pain. *Spine*, 26(11).
8. Kang, R., Li, H., Ringgaard, S., Rickers, K., Sun, H., Chen, M., Bünger, C. (2014). Interference in the endplate nutritional pathway causes intervertebral disc degeneration in an immature porcine model. *International Orthopaedics (SICOT) International Orthopaedics*, 38(5), 1011-1017.
9. Makhssous M., Priebe M., Bankard J., Rowles D., Zeigler M., Chen D., & Lin F. (2007). Measuring Tissue Perfusion During Pressure Relief Maneuvers: Insights Into Preventing Pressure Ulcers. *J Spinal Cord*.
10. Nachemson, A. (1966). The Load on Lumbar Disks in Different Positions of the Body. *Clinical Orthopaedics and Related Research*, 45(1).
11. O'Sullivan PB., Dankaerts W., Burnett AF., Farrell GT., Jefford E., Naylor CS., & O'Sullivan KJ. (2006) Effect of Different Upright Sitting Postures on Spinal-Pelvic Curvature and Trunk Muscle Activation in a Pain-Free Population. *Spine*.
12. Pynt, J., Higgs, J., & Mackey, M. (2001). Seeking the optimal posture of the seated lumbar spine. *Physiotherapy Theory and Practice Physiother Theory Pract*, 17(1), 5-21.
13. Richardson, C. A., Snijders, C. J., Hides, J. A., Damen, L., Pas, M. S., & Storm, J. (2002). The Relation Between the Transversus Abdominis Muscles, Sacroiliac Joint Mechanics, and Low Back Pain. *Spine*, 27(4), 399-405.

