ERGONOMICS IN DENTAL PRACTICE: MUSCULOSKELETAL DISORDERS, APPROACHES AND INTERVENTIONS

AK SHARMA
P BANSAL
SHABNAM
MANPREET KAUR

ABSTRACT

In Greek, “Ergo,” means work and, “Nomos,” means natural laws or systems. Ergonomics can be defined as ‘an applied science concerned with designing and arranging things people use so that the people and things interact most Risk efficiently and safely’. The term work-related musculoskeletal disorders (MSDs) refers to musculoskeletal disorders to which the work environment contributes significantly or to musculoskeletal disorders that are made worse or longer lasting by work conditions or workplace risk factors.

Right Ergonomics along with regular exercises, relaxation techniques and proper nutrition helps to combat stress. The successful application of ergonomics assures high productivity, avoidance of illnesses and injuries, and increased satisfaction among professionals. Practitioners should work smarter rather than harder. Unsuccessful application of ergonomics, on the other hand, can lead to work-related musculoskeletal disorders (MSDs).

This article sets forth broad important background information on ergonomics so that the dental practitioner can have a general awareness of ergonomic risk factors as well as some basis for understanding the ongoing dialogue about ergonomics, its diagnosis, treatment, and regulation. This article provides alternatives to be considered by the practitioner in light of the practitioner’s own circumstances, experiences and goals. The proposals contained in this paper are designed to make the practitioner both more comfortable and more productive.

Apart from the authors’ clinical experiences shared here, a web-based search for relevant articles in this specific area of interest was also conducted. Data searched from clinical magazine – dentistry today. The selected articles and data collected was critically reviewed and data acquired were symmetrically compiled.

Key Words: Ergonomics, Carpal tunnel syndrome, Musculoskeletal disorders.

INTRODUCTION

Anne Gopinadh et al study reported that prevalence of pain according to different specialties showed that general dental practitioners are the most affected professionals, followed by prosthodontists, oral surgeons, endodontists and periodontists. Whereas Rabiei et al found that endodontists experience more pain followed by prosthodontists, oral surgeons and periodontists.1,2

Prosthodontists are at high risk of neck and back problems. These working restrictions frequently make them assume stressful body positions to achieve good access and visibility inside the oral cavity which result in awkward positions over long periods of time; which in turn result in back problems.1

Published literature was searched in Medline using keywords ergonomics, musculoskeletal disorders, sad-
Ergonomics in dental practice

Musculoskeletal Disorders and Dental Work

Reasons for early retirement among dentists

- Musculoskeletal disorders (29.5%)
- Cardiovascular diseases (21.2%)
- Neurotic symptoms (16.5%)
- Tumors (7.6%)
- Diseases of the nervous system (6.1%).

With over 11,000 registered dental hygienists in Canada and about 100,000 in the United States, the American Dental Hygienists Association predicted a 41% growth rate in new jobs between 1992 and 2005 (Smith, 2002). Researchers have found symptoms of discomfort for dental workers occurred in the wrists/hands (69.5%), neck (68.5%), upper back (67.4%), low back (56.8%) and shoulders (60.0%). They also found that 93% of those surveyed stated that they had at least one job-related ache, pain, or discomfort in the 12 months prior to the survey (Anton, 2002).

Types of MSDs

**Back Problems — Lower back pain**

Ninety per cent of people will have back pain at some point in their lives. Low back pain is second only to the common cold as the main reason for seeking medical attention. The cause of low back pain is often multifactorial but combined motions of lumbar flexion with rotation increase risk to the lumbar disk. This is further exacerbated by inflexibilities around the hips and pelvis as well as relative weakness of the stabilizers of the lumbar spine, including the abdominal and gluteal muscles. Furthermore, back pain can exist due to abnormal postures, the symptoms include low back pain, stiffness, and sciatica with neurological features such as tingling, paresthesia, and muscle weakness and decreased endurance, and then exacerbated by a ‘specific’ injury.

**Upper Back Pain**

While not as common as lower back pain, some individuals report extensive pain in the mid and upper back. Probably, a more frequent cause of mid back pain is muscular pain from the postural muscles and scapular muscles. The contributions of abnormal posture, static postures, poor strength and endurance, and overall individual conditioning need to be taken into account.

**Hand and Wrist Problems**

In a study, the Nebraskan dentists reported that crown and bridge work was most likely to evoke altered sensations in their upper limbs. Grinding and polishing with vibrating tools are common in prosthodontic practice. The grinding tools are generally of high frequency and it can cause direct injury to the face and upper extremities. The effects of vibration on the hand can also result in vibration syndrome or vibration white finger. The main effects are narrowing of arteries in fingers and hands and damage to the ends of the nerves. Early symptoms include reduced blood circulation in the fingers, reduced sensitivity of the fingers to pain, touch, vibration and temperature, blanching of one or more finger tips.

Tendinopathies and Carpal tunnel syndrome were associated with both repetitive work and forceful work. The hand performs many complex tasks, and the tendons move inside tendon sheaths with synovial fluid. Repetitive and forceful movements and the use of vibrating tools increase fluid accumulation and inflammation.

A predominant cause of repetitive motion hand disorders is constant flexion and extension motions of the wrist and fingers. Chronic, repetitive movements of the hand and wrist, especially with the hand in...
‘pinch’ position, seem to be the most detrimental. Other common contributing factors to hand and wrist injuries include movements in which the wrist is deviated from neutral posture into an abnormal or awkward position, working for too long period without allowing rest or alternation of hand and forearm muscles; mechanical stresses to digital nerves from sustained grasps to sharp edges on instrument handles, forceful work and extended use of vibratory instruments.\textsuperscript{10}

Some of the common hand and wrist conditions are as follows:\textsuperscript{10}

- Tendinitis/tenosynovitis
- DeQuervain’s disease
- Trigger finger
- Carpal Tunnel syndrome
- Guyon’s syndrome.

**Some Signs of MSDs**\textsuperscript{13}

- Decreased range of motion
- Loss of normal sensation
- Decreased grip strength
- Loss of normal movement
- Loss of coordination

**Some Symptoms of MSDs**\textsuperscript{13}

- Excessive fatigue in the shoulders and neck
- Tingling, burning, or other pain in arms
- Weak grip, cramping of hands
- Numbness in fingers and hands
- Clumsiness and dropping of objects
- Hypersensitivity in hands and fingers

**Some Risk Factors for MSDs**\textsuperscript{14}

- Repetition
- Forceful exertions
- Awkward postures
- Contact stress
- Vibration
- Poorly designed equipment/workstation
- Improper work habits
- Genetics
- Medical conditions
- Poor fitness level
- Physical/mental stress
- Lack of rest/recovery
- Poor nutrition
- Environmental factors
- Poor lighting.

**DENTAL RISK FACTORS**

Following are recognized as important risk factors for musculoskeletal disorders among dental professionals, especially when occurring at high levels and in combination.\textsuperscript{4}

**Awkward Postures** Posture is a term used for the position of various parts of the body during an activity. For most joints, a good or “neutral” posture means that the joints are being used near the middle of their full range of motion. The further a joint moves towards either end of its range of motion, or the further away from neutral, the more awkward or poor the posture becomes and the more strain is put on the muscles, tendons and ligaments around the joint.\textsuperscript{4}

Researchers have confirmed the presence of awkward postures specifically in the neck, back, shoulders, hand and wrist for dental professionals. Awkward postures are often adopted due to improper seating, improper patient positioning and/or poor work techniques. Common awkward postures in dental practice include elbow and wrist flexion and thumb hyperextension, which have been shown to stress neurovascular structures and ligaments.\textsuperscript{4} The diagram in Fig 1 shows the reduction in strength which occurs as the wrist deviates further away from its neutral posture.

**Static Postures**

Static postures are defined by those which are held for a long period of time and may result in fatigue and injury. Oxygen is delivered to the muscles and joints
by blood. When a posture is held for a prolonged period of time there is a reduction in blood flow to the tissues. This results in a reduction of nutrient and oxygen supply with lactic acid and other metabolites accumulating, which can result in pain and tissue damage.  

Furthermore, dental practitioners have been observed statically holding postures requiring greater than 50% of the body’s musculature to contract. This
results in increased muscular effort which can lead to muscle overload, decreased blood flow and increased pressure on muscles and joints (Park 2009). Static gripping for durations exceeding 20 minutes was also noted during instrumentation tasks within dental practice (Sanders, 1997).

**Force**

Force refers to the amount of effort created by the muscles as well as the amount of pressure placed upon a body part. All tasks require workers to use their muscles to exert some level of force, however, when a task requires them to exert a level that is too high for a particular muscle, it can damage the muscle or related tendons or joints and/or other soft tissue (OHSCO, 2007).

An example of a gripping task requiring high force application could be holding small instruments for a prolonged period of time. This task is commonly performed with a pinched grip where the fingers are on one side of the object and the thumb is on the other. This form of gripping is undesirable as it requires a much greater force application than a power grip (object in the palm of the hand). Researchers have suggested that excessive use of a pinch gripping is the greatest contributing risk factor in the development of MSDs among dental hygienists.

**Repetitive Movements**

The risk of developing an MSD increases when same or similar parts of the body are used continuously, with few breaks or chances for rest. Highly repetitive tasks can lead to fatigue, tissue damage, discomfort, and, eventually injury. This can occur even if the level of force is low and the work postures are not awkward (OHSCO, 2007).

During instrumentation, there is a constant alternation between wrist flexion, extension, and forearm rotation. Repetitive gripping is experienced throughout the day in order to write, clean and hold instruments, and expose radiographs. Such high usage of wrist and forearm musculature has been linked to an increased risk of fatigue and overuse.

Three critical components to consider include:

- **Frequency**
  Repetitive wrist motions, the number of cleanings performed in a day, the number of instruments gripped by one hand

- **Duration**
  Length of time spent holding an instrument, length of time sitting in a static posture, the total length of a work day.

- **Recovery time**
  Time between clients, scheduled breaks, time spent stretching

**Vibration** Vibration exposure in dentistry may be of concern when one must grip vibratory tools for prolonged periods of time. The reason is that when holding a vibrating tool, muscles begin to tire due to over stimulation. As this occurs, the operator must squeeze harder in order to continue to operate the tool which in turn increases internal force application of the surrounding musculature.

**APPLICATION OF ERGONOMICS**

Through ergonomic advances made over the years, dental professionals have been able to modify and optimize their working environments. Ergonomic improvements in seating, instrumentation, magnification, lighting, and stretching have offered a proactive measure for ensuring a proper balance between job requirements and worker capabilities.

**The sitting postures**

The correct working postures in the dental surgery are the sitting postures that conform to the following requirements.

- Symmetrical postures
- All horizontal axes should be parallel
- Legs should be slightly apart (a 30°-45° angle)
- Shank should be perpendicular on the floor
- Upper part of the body should be perpendicular on the chair forward movements should be made without curving the spine
- Head could bend 20°-25°
- Arms should be close to the body
- Forearms should be nearly horizontal (max. 25% raised)
- Shank / thigh should be at 115°
- Soles should be on the floor

**Magnification**

Surgical telescopes comprising of multi-lens systems offer lower magnification levels (2x to 3x) which are preferred due to their portability and ease of use. These devices are commonly referred to as “surgical loupes” and can be mounted to a headband or onto the operator’s glasses. Through the use of such magnification systems dental practitioners are able to maintain a neutral working posture while increasing their visual acuity, level of motor control, and diagnostic ability (UBC, 2008).
Lighting

Light positioning is a critical factor affecting your posture during clinical operation. The goal of proper lighting is to produce even, shadow-free, colour-corrected illumination concentrated on the operating field. This not only serves to increase visibility but can also reduce awkward working postures. For optimal illumination the light-line must be as close to the sight-line as possible. The greater the deviation of the light-line from the sight-line the greater shadowing (UBC, 2008).

Typically, a single light source can provide sufficient unshadowed viewing for a supine patient. For both mandibular and maxillary treatment, the light source should be directly above and slightly behind the patient’s oral cavity. This position will insure that the light line just barely clears your head throughout a full range of o’clock positions. Once the patient has been properly situated, the light source can be positioned as far above the clinician’s head so as to just allow it to be reached. This ensures that it can still be repositioned if needed however it is out of the way from being accidentally moved.

For right-handed clinicians, working in the range from 7 to 9 o’clock is commonly associated with twisting of the trunk and neck as well as working with an elevated elbow posture in order to gain access. The mirror image (3 to 5 O’clock) is equally problematic for left-handed clinicians. In an attempt to reduce such postural deviations a conservative range from 10 o’clock to approximately 12:30 is preferred and shown below (UBC, 2008).

PREVENTION OF Musculoskeletal Disorders

Ergonomics problems in dentistry can be reduced by implementing various strategies as shown in Fig 4. Dentists should also perform specific exercises for the trunk and shoulder girdle to enhance the health and integrity of the spinal column, stretching exercises for the hands and head and neck, maintain good working posture, optimize the function of the arms and hands and prevent injuries.

Seating

Continued seating results in inactivation of upper and lower erectus spine muscle and contributes to greater lower back compressive loading in lumber spine.

Seat Angle, Depth and Style

Dental stools may have a horizontal, tilting or saddle-style seat. Horizontal seats can result in posterior rotation of the pelvis with resultant “slouching” posture. If using a tilted seat, the optimal angle is between 5 degrees and 15 degrees — a shallower incline will not optimize posture nor relieve pressure, and a steeper incline may result in the clinician sliding forward on the seat pan, thus losing contact with the backrest.

The depth of dental stools ranges from 14 inches to 18 inches. Particularly for a tilted stool, it is important that the seat’s material be textured — i.e., not slippery — so that the clinician does not slide forward during procedures, thereby disrupting an ergonomic working posture. Tilting seats and saddle-style stools open the hip angle to greater than 90 degrees and may also enable closer positioning to the patient. This will help prevent the tendency to lean forward to reach closer to patients.

Saddle style stools (Refer Fig 5) helps avoid transfer of pressure to the posterior thighs and maintains the lumbar curve of the lower back by placing pelvis in a more neutral position. Arm support during procedures helps in giving rest to wrists and arms during procedure and prevents carpel tunnel syndrome.

Stretching Frequent stretch breaks can prevent detrimental physiological changes that can develop while working in static or awkward postures. In an attempt to prevent injury from occurring to muscles and other tissues, dental professionals should allow for rest periods to replenish and nourish stressed structures. If breaks are too far apart, the rate of damage could exceed the rate of repair and eventually lead to the breakdown of tissue.

Refer figure 6,7,8

STRETCHING CAN SERVE TO:
- increase blood flow to muscles
- increase the production of joint synovial fluid
- reduce the formation of trigger points
- maintain normal joint range of motion
- increase nutrient supply to vertebral disks
- create a relaxation response in the central nervous system
- warm up the muscle before beginning to work
- identify tight structures that may be predisposed to injury.

CONCLUSION

Ergonomics have come into the profession in a big way. By practicing correct postures, the working capacity and productivity of dental professionals will enhance. They can work in a pain-free environment for quality dental care to their patients.

Right Ergonomics along with regular exercises, relaxation techniques (meditation, biofeedback &
yoga), proper nutrition helps us combat stress, thus conserving the productive energy, thereby increasing comfort, improving the quality of life, ultimately leading to extended careers.

The symptoms of MSDs increase with the number of years of practice. The prevention and reduction of MSDs among dentists should include their education in dental ergonomics and awareness regarding the importance of work-related risk factors.

REFERENCES

3. Murphy DC (NYU College of Dentistry, USA). Ergonomics and dentistry. NY State Dent J. 1997; Aug-Sep; 63(7): 30-34.