

REVIEW ARTICLE

Ergonomics and Dental Concern

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ABSTRACT

Dental professionals have been reported to have an increased risk of musculoskeletal disorders and other occupational health problems. While treating patients they are concerned about their comfort and pay little attention to their own health till they begin to experience discomfort. Most of the risk factors associated with these are due to awkward postures for prolonged period. Ergonomics is an applied science concerned with designing products for maximum efficiency and safety. Its successful application in dentistry assures high productivity and avoidance of illness and injuries, and with little attention and creativity, dental professionals can improve their health and performance during the course of their career. The ergonomics and healthy workplace help the dental surgeons improve their work ability without putting at risk their own health. One of the main goals of ergonomics in dentistry is to minimize the amount of physical and mental stress that sometimes occurs in day-to-day dental practice. This study attempts to provide important recommendations for dental professionals in regard to application of ergonomics that could provide safety benefits and also improve performance objectives through greater productivity.

Keywords: Dental professionals, Ergonomics, Musculoskeletal disorders.

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INTRODUCTION

“Ergonomics” has recently become a popular term and has now been used with most professions, but increasingly in the dental profession because a healthy dentist is one of the most important requirement for a successful dental practice. In Greek, “Ergo” means work and “Nomos” means natural laws or systems.¹ Proper

ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and lead to long-term disability.² The International Ergonomics Association defines ergonomics as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principle, data, and methods to design in order to optimize human well-being and overall system performance.³

Literature suggests that the prevalence of skeletal or muscular pain in dental surgeons and dental students ranges from 64 to 93%. The most prevalent regions of pain and discomfort among dentists have been shown to be the back (36.3–60.1%) and neck (19.5–80%).² Dental professionals are amongst the most targeted group for musculoskeletal disorder (MSD) than general population because of their long procedural working hours and awkward postures.⁴ Applying ergonomics to the practice of dentistry not only could provide safety benefits but a practice might also improve performance objectives through greater productivity.⁵

Dental professionals trained in ergonomics awareness programs are able to recognize early signs of discomfort or MSDs. Training also increases awareness of ergonomic risk factors, body mechanics, and helps them to understand possible interventions to ergonomic concerns. Early reporting of symptoms gives the professionals the opportunity to respond quickly, address concerns, and alleviate potential MSDs problems. More awareness about good ergonomics is essential for the good health of dentists.³

ROLE OF ERGONOMICS

Ergonomics has much broader scope than only preventing work-related MSDs. Its successful application assures high productivity, avoidance of illness and injuries, and increased satisfaction among dentists. Unsuccessful application, on the contrary, can lead to work-related MSDs or cumulative trauma disorders.

The term work-related MSDs refers to MSDs to which the work environment contributes significantly or to MSDs that are made worse or longer lasting by work conditions or workplace risk factors.⁶ Following are recognized as important risk factors for MSDs among dental professionals, especially when occurring at high levels and in combination: Awkward postures, forceful

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exertions, repetitive motions, contact stresses, duration, and psychosocial factors.³ Goals of ergonomics in any workplace should include reducing the risk of cumulative trauma disorders, increasing productivity, increasing safety, improving the quality of work, decreasing fatigue and errors.⁷

RECOMMENDATIONS FOR THE IDEAL POSITION OF DENTAL PROFESSIONALS

A neutral working posture is defined as one which supports uncompromised musculoskeletal balance of the clinician. This consists of dynamic positioning where the clinician operates in different locations around the oral cavity, rather than static operation. Changing positions not only serves to improve vision and access into the oral cavity but also shifts work to other muscle groups. By using the clinician's stool to navigate around the patient, static and awkward postures can be avoided.⁸ Researchers have found that "currently accepted techniques" can increase the risk for MSDs as they employ same or similar patterns of muscle activity. The use of "biocentric technique" has shifted the work load from the small muscles of the hand and forearm to the larger muscle groups of the upper arm and shoulder. The four power strokes unique to this technique include rocking, power, push/pull, and swing strokes, coupled with the wrist activation and wrist rock, which are common to the currently accepted technique. Researchers believe that the biocentric technique reduces muscular fatigue by varying task performance.⁹

Theoretical "ideal position" is such that the shoulders should be in line with the ears and arms at nearly 90° (Fig. 1). The patient's mouth is positioned at elbow level, forearm angle at 0° from the horizontal axis. Neck position is reduced to 30° when raising the height of

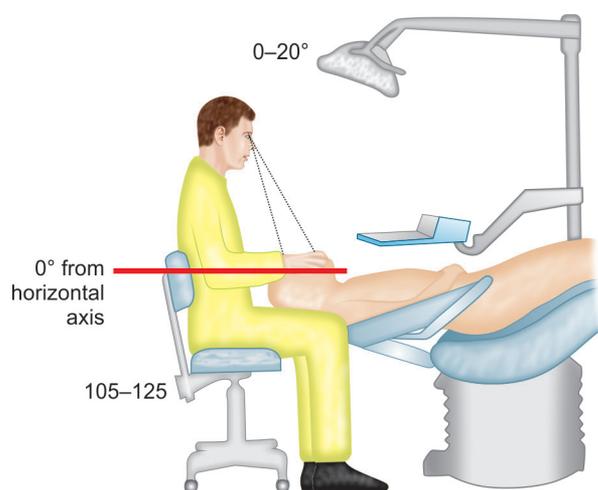


Fig. 1: Ninety degree rule; Courtesy: Prevention of work-related MSDs in dental clinic: www.asstas.qc.ca¹⁰

patient's head (Fig. 2). There is less need to bend over to see into the oral cavity. Forearms should be at 30° from the horizontal axis. By raising the level of the patient's mouth and holding the dental surgeon's arms up, the dental surgeon can straighten both neck and back. When raising the patient's head, dental surgeons often have the impression that the patient's mouth is much too close to their eyes. However, when the distance between the eye and the mouth is measured, it is found that the distance was almost the same.^{1,3}

Most of the dental work performed by dental surgeons is with the arms unsupported because the majority of stools do not have arm rests. When a person's torso is bent forward, his/her back is usually not in contact with the narrow torso support on the dental surgeon's stool, used as a lumbar support. Lack of support increases static load on the lower and upper back muscles required to maintain working positions.¹¹

RECOMMENDATIONS FOR WORKING WITH GOOD POSTURE¹²

- Maintaining an erect posture
- Use of an adjustable chair with lumbar, thoracic, and arm support
- Positioning the chair close to the patient and positioning the instrument tray close to the chair
- Minimize excessive wrist movements
- Avoiding excessive finger movements
- Alternate work positions between sitting, standing, and side of patient
- Adjusting the height of dental stool and the dental chair to a comfortable level
- Proper positioning of the adjustable light
- Check the temperature in the room

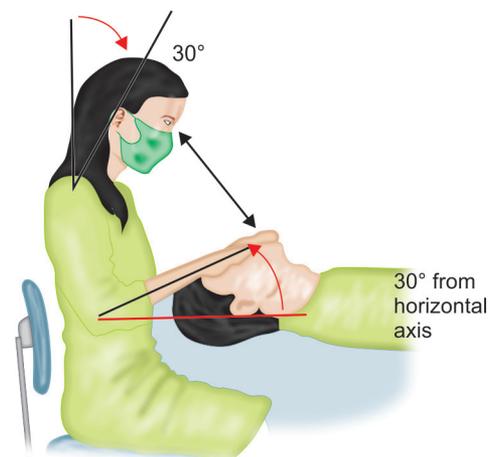


Fig. 2: Neck position is reduced to 30° when raising the height of patient's head; Courtesy: Dental ergonomics: Basic steps to enhance work efficiency³

- Alternate grip pressure and techniques used to grip items
- Use “strokes” controlled by larger muscle groups, try to maintain joint neutrality.

In addition to increasing hand stabilization, the use of two-finger rests has shown musculoskeletal advantages when performing scaling procedures. More specifically, two-finger rests always produced these reductions, as compared to not using any finger rests, while one-finger rest reduced thumb pinch force and muscle activity most of the time.¹³

MUSCULOSKELETAL DISORDERS AND RELATED RISK FACTORS

Musculoskeletal disorders are injuries and disorders of the musculoskeletal system. The musculoskeletal system includes muscles, tendons, tendon sheaths, nerves, bursa, blood vessels, joints/spinal discs, and ligaments. These disorders include upper back problems, lower back problems, hand and wrist problems like carpal tunnel syndrome, tendonitis, trigger finger, de Quervain’s disease, and Guyon’s syndrome. Since an injury can result in reducing one’s capacity and overall tissue tolerance of that area, returning to preinjury work before adequate rehabilitation could result in increased risk of developing a more severe or permanent injury.^{14,15}

A risk factor itself is not necessarily a causation factor for any particular MSD. Many times it is not simply the presence of a risk factor, but the degree to which the risk factor is expressed may lead to MSDs.¹⁴ Occupational risk factors in dentistry include:

Awkward postures: 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 toward 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.¹⁶

Static postures: Static postures are defined as those postures which are held for a long period of time and may result in pain and tissue damage. Researchers have found that even 30° of forward shoulder flexion or abduction can cause a significant impairment in blood circulation within the shoulder/neck region. Furthermore, dental practitioners have been observed statically holding postures requiring >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.¹⁷

Vibration: Vibration has been found to be an etiological factor in the work environments utilizing tools vibrating in the frequency band of 20 to 80 Hz.¹⁸ Dental handpieces

and powered automatic instruments operate at higher frequencies in the 5000 to 10,000 Hz range, and the duration of exposure to vibratory force during dental procedures is relatively short. Thus, it would appear that the exposure to this risk factor in dentistry is relatively small.¹⁹

PREVENTION OF MUSCULOSKELETAL DISORDERS

Musculoskeletal disorders can be prevented through following:

Seating: Prolonged sitting in a poorly designed chair with inadequate lumbar support or adjustability has been found to be a contributing factor to muscular fatigue and low back pain.¹⁹ Dental stool must be at correct height, offer optimum arm, and elbow support, stable base, and offer neutral back, neck, and shoulder support. Arm support during procedures helps in giving rest to wrists and arms during procedure and prevents carpal tunnel syndrome.^{20,21}

Dental chair: When seating a patient, optimal results will be achieved when their oral cavity is positioned at a height equal to the seated height of the clinician’s heart. Positioning the oral cavity above heart level will limit vantage and increase the rate of shoulder fatigue. When the patient is properly positioned, dentist’s shoulders, elbows, and wrists should be in a neutral position, meaning that upper arms are close to the body, elbow/forearm angle should be close to 90° and wrists should be in line with the forearm with no more than 20 to 30° extension.²²

Selection of instruments: The instrument must reduce exertion of force and maintain hand and wrist in neutral position. Ergonomic guidelines for instrumentation are:

For hand instruments, it should be either hollow or resin handles, round, knuckled, or compressible handle, and should have carbon steel construction.

For automatic handpieces, it should be lightweight, sufficient power, built in light source, swivel mechanisms, easy activation, and easy maintenance.^{7,23}

Equipment layout: Dental equipment should be located in a manner which allows the operator to maintain a neutral working posture. Frequently used items should be kept within a comfortable distance and not above shoulder height or below waist height. Frequently used items, such as the syringe, handpiece, saliva ejector, and high volume evacuator should be positioned so that they are within a normal horizontal reach, which is the arc created while sweeping the forearm when the upper arm is held at the side. Items that are used less frequently should be placed within the maximal horizontal reach which is created when the arm is fully extended.²⁴

Mouth mirror: Good mirrors coupled with proper use can significantly increase one’s opportunity to maintain

a neutral working posture. If the operator is unable to visualize the operating site directly while maintaining a neutral posture, one must use a mirror to prevent awkward body positioning, specifically of the neck and back. Intraoral mirrors can also be used to reflect additional light on the operating site even when a direct view is possible. It is important to remember that a mirror should be held lightly and lowered into the mouth with the handle held no more than 45° from the vertical plane.⁸

Ultrasonic tools: While ultrasonic tools can serve to reduce prolonged pinch gripping, they do expose the clinician to hand/arm vibration. Research has been controversial regarding the relationship between the use of ultrasonic scalers and the development of musculoskeletal problems. While some studies indicate that prolonged use of this equipment can be hazardous due to the negative effects associated with vibration, other researchers suggest that its use is preferable to the heavy hand forces experienced during manual scaling. As a result, educators suggest using ultrasonics for heavy calculus build-up, but limiting the overall usage of this vibrating tool.¹⁷

Lighting: Light positioning is a critical factor affecting ones posture during clinical operation. The goal of proper lighting is to produce even, shadow-free, color-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 will be the shadowing.

For both mandibular and maxillary treatment, the light source should be directly above and slightly behind the patient's oral cavity. This position will ensure 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 from being accidentally moved.⁸

Other occupational hazards: Despite various technical advancements in recent years, many occupational health problems still persist in modern dentistry. These include percutaneous exposure incidents (PEI) and exposure to infectious diseases, radiation, dental materials, and noise. As there is an almost constant risk of exposure to serious infectious agents, PEI remains to be a particular concern.²⁵

Percutaneous exposure incidents: This is a broad descriptive term that includes needlestick and sharp injuries, as well as cutaneous and mucous exposures to blood and serum. It represents the most efficient method for transmitting blood borne infections between patient and health care professionals.²⁶ Measures for the prevention of PEI, such as introduction of safety syringes have been shown to

reduce needlestick injuries in this regard. Dental surgeons should remain vigilant for these types of exposures, so that the potentially contaminated devices and instruments are not subsequently used on patients.²⁷

Infectious diseases: Various infectious diseases including viruses, such as hepatitis B virus, hepatitis C virus, herpes virus, human immunodeficiency virus, bacteria, and fungi, may potentially be transmitted during dental procedures. These agents may be present in the saliva, blood, and expired air of infected individuals.²⁶ Contaminated instruments and other infective splatters and aerosols generated during dental procedures present a cause for concern. Infection control procedures should be followed to prevent transmission of infection.²⁸

Radiation: Exposure to both ionizing and nonionizing radiation may occur in dental practice. Dental radiographic equipment is commonly used in dental practice and it is an integral part of clinical assessment. Thus good radiation protection should be employed to protect both the patient and the dental professionals. Nonionizing radiation has become an increasing concern among the dentists with the use of ultraviolet and blue light to cure or polymerize various dental materials. Exposure to these wavelengths can cause damage to various structures of eyes. Safety shield and glasses are recommended for protection to eyes.^{29,30}

General health and stress: Dentists tend to have lower mortality rate than comparable professions; however, they continue to succumb to similar causes of death, namely cardiovascular diseases, cancer, and suicide. The risk of mortality from these condition is probably higher than general population.³¹

Personal protective measures: Sterilization or high-level disinfection of equipment remains a vital part of infection control. An integral part of infection control procedures for clinicians is an adequate medical and dental history to be taken from patients. Personal protective measures, such as gloves, face mask, and eye protection, during dental procedures are essential.^{32,33}

CONCLUSION

The scope of ergonomics in dentistry is much broader than preventing work-related MSDs. Its implication in dentistry assures high productivity, avoidance of illnesses and injuries, and increased satisfaction among dental professionals. Good working ergonomics is essential so that work capability, efficiency, and high clinical level of treatment can be maintained throughout the working life of dentists. It would enable the clinicians to work in a comfortable posture, to lead a healthy life, and render appropriate care for the patients in need. Despite various

advances in modern dentistry, many risks still persist in dental practice which continue to challenge this status. Also, the integration of the ergonomic working posture into the dental curriculum should be done as early as mannequin training, as it would be easier for both students and assistants to develop further knowledge and skills. Thus “ERGONOMICS CAN ADD YEARS TO ONES CAREER.”

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