

# Ergonomics in Dentistry–Designing Your Work

Sowmya Pendyala<sup>1\*</sup> and P. Karunakar<sup>2</sup>

<sup>1</sup>Internee, Panineeya Mahavidhyalaya Institute of Dental Sciences and Research Centre, Hyderabad, India; sowmyastar111@gmail.com

<sup>2</sup>Principal and Head of Department of Conservative and Endodontics, Panineeya Mahavidhyalaya Institute of Dental Sciences and Research Centre, Hyderabad, India; drpkk@gmail.com

## Abstract

In recent years, there is a reported increase in the number of people suffering from work related musculoskeletal disorders; though all the people related to medical profession are included, there has been an increase incidence in dentists, dental hygienists, dental assistants. Maintaining one's own health is important for overall performance and understanding the principles of ergonomics helps to achieve this goal. Ergonomics is the science of designing jobs, equipments and work-places to fit workers. Proper ergonomic design is necessary to prevent work related musculoskeletal disorders and the conditions which might lead to it, thereby increasing the performance of the dentist.

**Keywords:** Dentistry, Ergonomics, Musculoskeletal Disorders, Work Practices

## 1. Introduction

In Greek, “ergo” means work and “nomos” means natural laws or systems. Ergonomics is an applied science concerned with designing products which are comfortable and provide safety (ADA). Ergonomics modifies work to meet the needs of people, rather than forcing people to accommodate the work. The international ergonomic association defines ergonomics as, the scientific disciplines concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human wellbeing and overall system performance. (International Ergonomic Association <http://www.iea.cc>)

The term ergonomics was coined by British psychologist Hywel murrell, at the 1949 meeting at the United Kingdom admiralty, which later led to the foundation of the ergonomic society.

## 2. Implications in Dentistry

Though the musculoskeletal disorders are common among medical professionals, it is more common among dentists and dental hygienists, because of

prevalence of different postures in dental procedures, repeated work, prolonged stature, unsupported sitting and grasping smaller and thin instruments for longer time (Alexopoulos, Staathi, & Charizani, 2004; Finsen, Christensen, & Bakke, 1998). Limited access during dental procedures is also known to be the one of the reasons for causing musculoskeletal disorders.

## 3. Goals of Ergonomics Include

- Prevention of work related musculoskeletal disorders and conditions which might lead to it
- Increasing safety and productivity
- Enhanced performance by eliminating unnecessary effort
- Improving the standard of care to the patient

## 4. Musculoskeletal Disorders in Dentistry

Literature suggests that the incidence of the musculoskeletal pain in dentists, dental hygienist & dental students range from 64 to 93% (Gross & Fuchs, 1990). The most common work related musculoskeletal disorders are low back pain,

\*Author for correspondence

tendonitis, epicondylitis, bursitis, carpal tunnel syndrome. Cumulative Trauma Disorders (CTD'S) are health disorders arising from repeated biomechanical stress to the hands, wrist, elbows, shoulders, neck and back. Most common CTD'S are carpal tunnel syndrome and low back pain (Shugars, Miller, Williams, Fishburne & Srickland, 1987). Carpal tunnel syndrome has been associated with repetitive and forceful work (Liss, Jesin, Kusiak, & White, 1995).

Work related musculoskeletal disorders affect soft tissues of the body in areas like the neck, back, shoulders, elbow, hands, wrist, and fingers. Symptoms of work related musculoskeletal disorders may progress in stages from mild to severe.

**Early Stage:** aching and tiredness of the affected limb occur during the work shift but disappears at night and during day off work. No reduction and tiredness in work performance.

**Intermediate Stage:** aching and tiredness occurs early in the work shift & persists at night. Reduced capacity for repetitive work.

**Late Stage:** aching, fatigue and weakness persists at rest. Inability to sleep.

## 5. Application of Ergonomics in Dentistry

### 5.1 Risk Factors in Dentistry Leading to Work related Musculoskeletal Disorders

- Fixed body position during work
- Repetition of movements during work
- Forced concentration on small parts of body
- Continuous work that does not allow sufficient recovery between movements
- Grasping smaller and thin instruments for longer periods
- Prolonged use of vibrating hand tools
- Suboptimal lighting
- Mental stress
- Prolonged static position (Yamalick, 2007)

### 5.2 Guidelines to Prevent Work Related Musculoskeletal Disorders

#### 5.2.1 Work Station

##### 5.2.1.1 Workstation Layout

The Ergonomic Standard mandated by the Occupational Safety and Health Administration (OSHA) recommended

that the most efficient and effective way to remedy “ergonomic hazards” causing musculoskeletal strain should be through engineering improvements in the workstation. (Liss, Jesin, Kusiak, & White, 1995; Gopikrishna, 2006).

Guidelines to be followed are:

- Instruments, medications, materials should be placed so that they are easily accessible to the dentists
- Easily adjustable chairs should be placed
- The temperature of the room should be checked
- Audio analgesia can be incorporated in the workplace
- The distance between the dental chairs should be sufficient enough so that the operators can move easily (Sanders & Michalak-Turcotte, 2004).
- Hoses should be positioned away from the body

#### 5.2.1.2 Operator Position

The main goal is to provide good access, support and mobility

- The operator stool should have a broad base pan
- Adjustable seat should be selected
- Seat should be adjusted so that the operator knee is slightly below the hip level and thighs are 100-110 degree to the trunk with feet resting flat on the floor
- Back rest height should be adjusted. The operator should sit back to take maximum lumbar support
- Foot rests should be adjusted
- Good hydraulic controls should be provided
- The distance between the working field and eye should be 35–40 cm
- The instrument tray should be positioned below the treatment point so that instrument can be picked only by moving the forearm
- Patient should be positioned so that the operator achieves neutral posture
- Elbow forearm angle is close to 90 degree
- Bending body forward to 10 degree at hip joint (Sanders & Michalak-Turcotte, 2004)

#### 5.2.1.3 Patient Position

- Supine position of patient is usually the effective way by which operator achieves neutral posture
- Stability should be looked for
- Drop down arm rests
- Patient should be positioned in such a way that the patient's mouth should be only slightly above the dentists elbow level

- There should be supplemental wrist/forearm support for operator
- Articulating head rests should be provided
- Hands free operation
- Swivel feature—allows chair to rotate in the operatory
- Large knobs should be eliminated as they, disturb the position of operator by hitting the dental chair (Osuna, RDH, BS, & FAADH, 2006).

#### 5.2.1.4 Rheostat Positioning

- Rheostat should be positioned so that the operator knee is about 90–100 degree angle (Alexopoulos, Staathi, & Charizani, 2004) (Figure 1).

#### 5.2.1.5 Light Illumination

- Main aim is to provide shadow free ,even operating field
- Light source placed directly above or slightly behind the patients head to provide ood illumination
- The intensity ratio between the dental operatory light and room lighting should be no greater than 3–4.6

#### 5.2.1.6 Magnification

- It has been noted that the dentist posture is ergonomically better while using magnification lenses compared to their posture while using regular safety glasses
- Use of normal safety glasses necessitates 20 degree forward head bending which leads to flattening of low back curve; in contrast, use of magnification scope utilizes zero degree forward head bending, hence better results are provided



**Figure 1.** Rheostat position.

- Dentists should select the magnification that will support their position
- Factors considered include; working distance, depth of field, declination angle, convergence angle, magnification factor, lighting needs

There are three basic magnification systems available:

1. Single lens Loupes
2. Galilean Loupes
3. Prismatic Loupes

‘Magnification Continuum’ is the term given to the growing number of magnification users (Sunnell, & Rucker, 2004) (Initially through naked eye progressing to the operating microscope).

#### 5.2.1.7 Operating Microscopes

- The dental operating microscope is different from that of loupes in that it offers stereoscopic vision compared to loupes with its convergent vision
- The operating microscope has multiple levels of magnification from low(2.1, 3.2x)to high levels (13-19x)
- Shadow free lighting is provided
- Other advantages include—improvement in precision of treatment, communication with patient (through live video), improved ergonomics, and increase ease of documentation

Other newest technologies in the field of magnification include heads up display that involves a camera that is placed over patient and projects image to a monitor.

Other newer technological advances like CEREC helps the dentists to design and create all ceramic inlays, inlays, crowns, veneers for all teeth in one visit, by utilizing digital impression technique there by eliminating the need for time consuming procedures.

## 5.3 Instrumentation

### 5.3.1 Hand Instruments

- Use Larger Diameter, balanced Instruments with hollow or resin handles: They increase tactile sensitivity and reduce clinician fatigue. Thin instruments are difficult to grasp and increase the chance of muscle cramping.
- Instrument sharpness: An instrument with a sharp blade will be less fatiguing to the clinician and

contribute to the efficacy of work. Dull instruments require more force to be exerted.

- Handles should be textured to reduce slippage, but should not be contoured. Round, knurled handles are preferred.
- Grip design: Grip span should be curved and comfortably fit the palm of the hand (4"–5") (Osuna, RDH, BS, & FAADH, 2006).

### 5.3.2 Automatic Handpieces

- Lightweight, balanced models (cordless preferred)
- Sufficient power
- Built-in light sources
- Easy activation and maintenance

Introduction of rotary instrument also lead to improved speed, efficiency and productivity.

## 5.4 Work Practices/Methods

### 5.4.1 Four Handed Dentistry

Method of practicing dentistry ergonomically by combing the skills of dental assistant with other work practices.

The work area around the patient is divided into four zones of activity. Zones of activity are identified using the patient's face compared to face of a clock. The four zones are: the operator's zone, assistant's zone, transfer zone, and static zone. (Finkbeiner, 2001)

The operator's zone for a right-handed operator extends from 7 to 12 o'clock, the assistant's zone from 2 to 4 o'clock, the instrument transfer zone from 4 to 7 o'clock, and the static zone from 12 to 2 o'clock.

## 5.5 Instrument Transfer and Exchange

### 5.5.1 Benefits

- Standardized operating sequence
- Reduces the amount of time in the dental chair for the patient
- Increased productivity
- Less fatigue and stress

### 5.5.2 Principles of Instrument Transfer

- The assistant must understand the sequence of the treatment procedure and anticipate when an instrument transfer will be required

- The transfer of instruments should be accomplished with a minimum of motion involving only the fingers, wrist, and elbow
- Instruments are transferred in the position of use
- An instrument is transferred so the dentist can grasp the instrument for its appropriate use
- The instrument being transferred must be positioned in the dentist's hand firmly
- The assistant will transfer dental instruments and dental materials with his or her left hand (Banerjee, 2013).

## 5.6 The Expanded-function Dental Assistant

Expanded function refers to specific intraoral tasks that are completed as a procedure or part of a procedure by the clinical dental assistant that have been delegated by the dentist.

- Increased productivity
- Less stress on dentist
- More patients seen
- Increased job satisfaction

## 6. Quadrant Dentistry

- Doctor time is maximized. Completing multiple restorations on one patient takes less time than doing the same number on multiple patients
- It minimizes cost. There is less paid in non-productive employee wages, fewer disposable goods, and less impression material, etc., which leads to huge savings
- It reduces office and doctor stress. Fewer patients equals less scheduling headaches, no-shows, and cancellations
- It increases the quality of care. Managing interproximal contacts, balancing aberrant occlusal forces, fine tuning occlusion, and delivering equally aesthetic restorations can be more predictably delivered in quadrants rather than one tooth at a time
- It increases revenue. Maximizing time, decreasing cost, less stress, and more dentistry significantly raises your bottom line

## 7. Scheduling

- Schedule Rest Breaks Between Patients
- Rotate Between Tasks

- Schedule Enough Time for Each Patient
- Switch Between Positions Throughout the Day

## 8. Training of Dental Personnel

The main goal of training dental personnel is to identify and avoid conditions which might lead to WMSD.

## 9. Stretches

Apart from different ways of practicing work, performing specific exercises for trunk, shoulder, hands, head and neck should be performed on regular basis to prevent these disorders (Nutralapati, Gaddipati, Chitta, Pinninti, & Boyapati, 2010).

## 10. Scope of Ergonomics

Advanced working techniques with magnification devices, visualization aids and dental equipment have all helped improve the ergonomics of working as a dental clinician (Hokwerda, 2008; Murphy, 1998). Awareness about the operating positions should be done to eliminate work related disorders. Four handed dentistry is ergonomically known to be the best way to reduce WMSD. Dentists' knowledge and attitudes towards ergonomics should be improved and updated by educational programmes in order to increase awareness, reduce the incidence of occupational pathology and improve the quality of the dental health-care (Rundcrantz, 1991; Valachi & Valachi, 2003). Legal responsibility for protecting the health of dental personnel and patients should be stressed upon.

## 11. Conclusion

Though the reasons for work related musculoskeletal disorders are numerous among dentists, the main contributing factor is poor posture. Working ergonomically helps prevent work-related injuries. The clinician must optimize working environment to help eliminate awkward postures, physical wear and tear, and fatigue. By combining ergonomic magnification with postural strengthening, positioning techniques, working practices, chair side stretching, the multifactorial problem of work-related pain in dentistry can most effectively be addressed.

Thus, successful application of ergonomics not only helps the dentists to improve their health, it also increases satisfaction as well as quality of work.

## 12. References

1. American Dental Association INFOpak (ADA INFOpak). (2011). Ergonomics for dental students. 1–4.
2. Alexopoulos, E. C., Staathi, I. C., & Charizani, F. (2004). Prevalence of musculoskeletal disorders among dentists. *BMC Musculoskeletal Disorders*, 5, 16.
3. Finsen, L., Christensen, H., & Bakke, M. (1998). Musculoskeletal disorders among dentists and variation in dental work. *Applied Ergonomics*, 29(2), 119–25.
4. Gross, C. M., & Fuchs, A. (1990). Reduce musculoskeletal injuries with corporate ergonomics program. *Occupational Health and Safety*, 59(1), 28–33.
5. Shugars, D., Miller, D., Williams, D., Fishburne, C., & Srickland, D. (1987). Musculoskeletal pain among general dentists. *General Dentistry*, 35(4), 272–76.
6. Liss, G. M., Jesin, E., Kusiak, R. A., & White, P. (1995). Musculoskeletal problems among Ontario dental hygienists. *Am J Ind Med*, 28, 521–40.
7. Yamalik, N. A. (2007). Musculoskeletal Disorders (MSDs) and Dental Practice part 2. Risk Factors for dentistry Magnitude of the problem, prevention, and dental ergonomics. *International Dental Journal*, 57(1), 45–54.
8. Gopikrishna, V. *Sturdevants-art and science of operative dentistry*. 5<sup>th</sup> South Asian ed. MOSBY INC, St. Louis: Missouri, Elsevier India pvt ltd; 2006.
9. Sanders, M., & Michalak-Turcotte, C. (2004). Preventing work related MSDs in dental hygienists. In M. Sanders (Ed.), *Ergonomics and the management of musculoskeletal disorder*, (2nd ed.) (pp. 448–469). St. Louis, MO: Butterworth Heinemann.
10. Osuna, T., RDH, BS. (2006). Ergonomics: investing in yourself/CDHA.21.2:18–26.
11. Sunnell, S., Rucker, L. (2004). Surgical magnification in dental hygiene practice. *International Journal of Dental Hygiene*, 2(1), 26–35.
12. Banerjee, S., Satyabrat, J., Himesh, D., & Anil. (2013). Dental ergonomics: your path to peak performance. *Guident*, 6(5), 36–42.
13. Nutralapati, R., Gaddipati, R., Chitta, H., Pinninti, M., Boyapati, R. (2010). Ergonomics in dentistry and the prevention of musculoskeletal disorders in dentists. *The Internet Journal of Occupational Health*. 1(1).
14. Hokwerda, O. (2008). Vision of the future of ergonomics in dentistry. *Ned Tijdschr Tandheelkd*, 115(8), 429–34.
15. Murphy, D. C. (1998). Ergonomics and the dental care worker. American Public Health Association. pp. 219.

16. Rundcrantz, B. L. (1991). Pain and discomfort in the musculoskeletal system among dentists. *Swed Dent J Suppl.* 76, 1–102.
17. Valachi, B., Valachi, K. (2003). Preventing musculoskeletal disorders in clinic dentistry: strategies to address the mechanisms leading to musculoskeletal disorders. *Am Dent Assoc.* 134(12), 1604–12.
18. International Ergonomic Association. Retrieved from <http://www.iea.cc>
19. Finkbeiner, B. L. (2001). Selecting equipment for the ergonomic four-handed dental practice. *The Journal of Contemporary Dental Practice*, 1(4).