

# Musculoskeletal Disorders in Dental Practitioners and Ergonomic Strategies

Mahboobeh Abdolizadeh<sup>1</sup>, Fatemeh Jahanimoghadam<sup>2\*</sup>

1. Department of Physiotherapy, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.

2. Department of Pediatric Dentistry, School of Dentistry, Oral & Dental Research Center, Kerman University of Medical Sciences, Kerman, Iran.



Fatemeh Jahanimoghadam is assistant professor of Pediatric Dentistry. She teaches Pediatric Dentistry at Dental School, University of Medical Sciences of Kerman, Iran. Her research interests are preventive dentistry and microbiology.

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## ABSTRACT

**Introduction:** In different professions, including dentistry, work-related musculoskeletal disorders (MSDs) are the main reason of loss of working period, increasing labor costs, human injuries, and absence from work. Improper posture while working is the main cause of these disorders among dentists. In this regard, identifying the risk factors and its potential harms are absolutely necessary. However, dentists are not usually informed of the role of ergonomics in the health of their musculoskeletal system. The aim of this study was to evaluate body posture in dentists' profession.

**Methods:** Through search in PubMed, Google, Scopus, and Medline, a total of 23 original research papers were found with the keywords such as musculoskeletal disorders, dentists and ergonomics. Then, the main factors responsible for MSDs among dentists and the ways to prevent them were identified and presented.

**Results:** Dentists working in an asymmetric and static position. Usually their head is forward and often rotates in one direction and hands are away from the body. Furthermore, dentists need eye-hand coordination to work. Maintaining this posture for a long period causes stress in the joints, muscles and tendons, especially in the neck, back, shoulder, and wrist body parts. Work equipment is not often designed ergonomically. These factors lead to musculoskeletal disorders like thoracic kyphosis, lumbar lordosis, rounded shoulders, forward head posture, supraspinatus tendinitis, and trigger points in muscles like trapezius.

**Conclusion:** The work conditions and postures of dentists need to be improved. Furthermore, the level of dental professional education regarding the risk factors of MSDs as well as correct working conditions and postures should be increased.

### Key Words:

Musculoskeletal disease,  
Dentist, Ergonomics

### \* Corresponding Author:

Fatemeh Jahanimoghadam, PhD

Address: Department of Pediatric Dentistry, School of Dentistry, Oral & Dental Research Center, Kerman University of Medical Sciences, Shafa St., Kerman, Iran.

Tel: +98 (913) 3431507

Fax: +98 (34) 32118071

E-mail: fatemehjahani4@gmail.com

## 1. Introduction

**M**usculoskeletal disorders (MSDs) have become increasingly prevalent in the world during the past decades. It is a common reason of work-related disabilities in workers with substantial financial consequences due to workers' compensation and medical expenses [1]. MSDs are identified as damages to the human support system of muscles, ligaments, tendons, nerves, blood vessels, bones, and joints, and can occur from a single event or cumulative trauma [2]. These disorders are identified by pain and dysfunction of the neck, back, hands, and fingers [3]. Musculoskeletal symptoms are significant; serious workplace problems affect occupational health, causing pain, weakness and paresthesia, muscle ischemia, imbalances, necrosis, reduced range of joint mobility, spinal disk herniation or degeneration as well as other associated symptoms. They occur in a wide range of professionals, including dentists [4, 5]. Dental practitioners often cannot avoid prolonged static postures. Even in optimal seated postures, more than one-half of the body's muscles are contracted statically, and vertebral joints are in movement too [6]. Dentistry is acknowledged as a difficult and demanding profession. Dental operators describe their profession as a job requiring more endurance and physical self-sacrifice [7].

## 2. Materials and Methods

A search was performed through PubMed, Google Scholar, Scopus and Medline for body postures and musculoskeletal disorders in dental practitioners. A total of 23 original research papers that have been published from 1990 to 2014, with keywords such as musculoskeletal disorders, dentists, and ergonomics were selected. Information from selected articles was extracted and classified to assess the predisposing and risk factors of musculoskeletal disorders.

## 3. Results

### Causes of musculoskeletal disorders in dentists

Dentists apply accurate motor skills with concentrated hand-eye coordination to perform dental procedures in a dynamic setting. Dental practitioners often choose uncomfortable and asymmetric positions while balancing the head forward and rotated to the side with the arms held out from the body. These positions, if held for prolonged period time, might overstress muscles and joints, particularly those of the neck, shoulder, and back, lead-

ing to musculoskeletal symptoms [7]. Some predisposing risk factors for musculoskeletal disorders are as follows [3]

- Frequent movements
- Inappropriate postures
- Standing or sitting in one posture for long periods
- Weak posture
- Poor positional muscle strength
- Poor flexibility
- Stress
- Infrequent break times
- Improper design of dental chair and magnification tools
- Contact stress
- Inappropriate work habits
- Genetics
- Poor nutrition
- Environmental factors
- Improper lighting
- Vibration
- Medical conditions

When sitting unsupported -a common posture in dentistry- the lumbar lordosis flattens. The bony infrastructure provides little support to the spine, which is hanging on the muscles, ligaments, and connective tissue at the back of the spine, causing tension in these structures. Ischemia can ensue, causing low back strain and trigger points. This flattening of the lumbar curve also leads to the nucleus in the spinal disk to migrate posteriorly toward the spinal cord. Over time, the posterior wall of the disk becomes weak, and disk herniation can happen [6].

Forward-head postures are common in dentists, holding the neck and head in an unbalanced forward position to gain better visibility during treatment. In this poor posture, the vertebrae cannot support the spine properly,

and the muscles of the cervical and upper thoracic spine must contract frequently to support the weight of the head in the forward posture. This posture can lead to a pain pattern, which is often referred to as tension neck syndrome, which can cause headaches and chronic pain in the neck, shoulders, and interscapular muscles, and sometimes pain radiates into the arms. Constant contraction of cervical muscles also causes weakening of the spinal disks, with possible disk degeneration or herniation. Therefore, frequent relaxing and stretching of the neck muscles, strengthening of the deep postural cervical muscles, and preservation of the cervical lordosis in correct posture in all activities, including sleeping and driving, is important [6].

A forward-head posture also can cause muscle imbalance, contributing to a rounded shoulder posture. This posture can predispose the practitioner to impingement of the supraspinatus tendon in the shoulder (rotator cuff impingement) when reaching for items. Furthermore, static posture of the arms in an elevated state of more than 30 degrees impedes the blood flow to the supraspinatus muscle and tendon. Prolonged arm abduction can lead to trapezius myalgia chronic pain and trigger points in the upper trapezius muscle [6].

#### The following positions are the main sources of deviation from the balanced position

- Excessive bending of the operator's head and the extent of neck, rotation, and tilting of the head;
- Tilting and the rotation of the trunk on one side;
- Lifted arms (dominant, non-dominant or both) without enough support on the trunk or on the arm support;
- Lifting one shoulder or both;
- An increase in thoracic curvature and the lumbar curvature reduction;
- The angle between thighs and shanks below 90° [8].

Among the most common practices performed by dental professionals are using vibratory tools, excessive repetition of movements, and the static balance of incorrect posture for long period. "Vibration" may play a role in the long-term development of carpal tunnel syndrome and decreased tactile sensitivity. Researchers have detected abnormalities in temperature and vibration recognition after using high-frequency hand-held instruments. Prolonged use of these instruments may be associated with damage to nerve fibers. Additionally, tight

wrist watches and tight-fitting gloves may also constrict structures at the carpal tunnel and fingers [5, 9]. A right handed practitioner often sits at 11 o'clock from the patient's head. The over-the-patient delivery system has a tray suspended over the patient's chest, to carry the instruments closer to the patient's mouth. The dental practitioner is mainly seated at 9 o'clock. These positions entail scapulohumeral flexion to reach the instruments when the operator is at 12 o'clock and scapulohumeral lateral rotation when the dentist is at 9 o'clock [10].

Musculoskeletal pain rate in the lower extremities of Polish dentists was 47.8%; however, the most percentage of these dentists work in a standing position [2].

### 3.2. Prevention of musculoskeletal disorders in dentists

#### Ergonomic strategies

Awareness of interventions or prevention strategies is needed to effectively manage and prevent injuries. Applying ergonomics to the practice of dentistry provides safety benefits and also meliorate performance objectives through greater productivity [3].

A good posture provides the dentist more working energy, lower stress level, increased comfort, lack of pain and muscular tension, and a lower risk for therapeutic errors [11]. The balanced or neutral posture is the reference point for the proper working posture and encouraged to be kept within the limits imposed by the practice conditions, throughout all stages of the clinical acts. This is a seated posture, which is natural, unforced, stress free, and symmetrical that takes into account the loco motor system of the human body [8].

The balanced posture does not need a rigid body attitude. The dentist has the freedom to move within some limits so that no damaging positions result. The active balanced posture includes the dentist supporting the back straight (the physiological spine curvatures and the "S" spine form) only by means of paravertebral muscles tonicity. The passive balanced posture is identified by the use of lumbar support provided by the seat back [5].

#### Operator position

The position of the dental practitioner is described in reference to a clock, where the patient's head is positioned at 12 o'clock and the dental practitioner is positioned to the side of the client according to the task being performed. Right handed dental operators usually work from 7 to 12 o'clock (or 8 to 2); left handed dental opera-

tors work from 12 to 5 o'clock. Dental practitioners sit about 14-16 degrees from the patient's head in order to prevent excessive reaching or flexing forward to reach the mouth. Dental operators should move the patient from upright to reclined positions as necessary to access specific mouth areas [12].

Use the lumbar support of the chair by adjusting the lumbar support forward to contact your back.

### Position patients at the proper height

An obvious mistake among dentists is positioning patients too high. This causes elevation of the shoulders and abduction of the arms, leading to prolonged constant muscular tension in the neck and shoulders [3].

### Avoid twisting

Operatory design plays a key part on how often dentist performs detrimental twisting movements during the work time. Rear delivery systems encourage extensive trunk twisting and shift of vision to recover instruments, and side delivery systems require moderate twisting. Trans-thorax (or over-the-patient) delivery systems decreases twisting and shift of vision and dentist should position instruments within easy reach [13]

### Alternate between standing and sitting

Standing uses different muscle groups compare to sitting; therefore, alternating between the two positions let one group of muscles rest, while the workload is changed to another group of muscles. In order to compensate the effects of a static work and postural demands, many authors suggested a dynamic way of working. These methods are as follows:

- Employing the active balanced posture and the passive proper posture alternatively;
- Using the short break time between the patients in order to leave the stool and walk;
- A working program with long requesting treatment sessions alternating to short and easier ones;
- Performing easy exercises between patients and at the end of the treatments [14].

### Reposition the feet

Precise changes in foot position can shift the workload from one group of low back muscles to another, allowing the overworked tissues to be replenished with nutrients.

Stabilize the low back by contracting the transverse abdominal muscles. While sitting, sit straight with a slight curve in the low back, exhale, and pull your navel toward the spine without letting the curve flatten. Continue breathing while holding the contraction for one breath period [3].

### Trigger points

To relieve trigger points, dentists can use a physical therapist trained in trigger point therapy, contract and relax method, or muscle energy technique, or use self-administering trigger point therapy using a small ball between the back and a wall or using a trigger point self-massage tool [15].

### Workstation

The following equipment can be characterized among the spatial elements of the dentist's workstation: the dentist's stool, the patient lying in the anatomical chair, the components of the dental unit (the dentist's cart, the lamp, the vacuum system and the control pedal), the fixed elements around the working area including the fixed furniture, the mobile case and all the tools and equipment placed on it [8].

According to the International Standards Organization, there are some core interventions applicable to every workplace:

- Adjust work area and equipment to account for operator and work being performed with preferred body postures;
- Provide enough space in clinics for body movements;
- Provide variety in tasks and movements to prevent static muscle tension caused by postural constraints;
- Design work to allow machinery to assist highly repetitive tasks [3].

In an ideal condition, the surface of the treated teeth should be parallel to the front of the dentist and his or her view is oriented perpendicular to the working field. It is suggested that the distance between the working field and the dentist's eyes be 35-40 cm or slightly higher for very tall dentist. When this relationship is not appointed or lost during the clinical act, the dentist's eyes will look for it and the dentist will depart instinctively from the correct posture [3].

The properly chosen and adjusted magnification system can avoid the bending of the dentist's head and the development of the musculoskeletal disorders. Additionally, its misuse could have adverse effects, increasing the risk of musculoskeletal damages, or aggravating them. Operating telescopes are available with flip-up or through-the-lens designs. The declination angle of the loupes should allow you to maintain less than 20 degrees of neck flexion. Working in postures with greater than 20 degrees of neck flexion are associated with increased neck pain [16].

The stool height adjustment is important for the correct orientation of the thighs to the floor and a minimum angle of 105-110 degrees between the thighs and the shanks. A too high position of the stool needs sitting on the edge, losing the weight distribution on the stool axis and the contact of the dentist's back with the stool back. So, the risk of slipping off the stool increases. When the stool is too low, the lumbar curvature of the spine decreases through posterior rotation of the pelvis [17].

Shift the seat angle slightly forward 5 to 15 degrees to increase the low back curve. This will place your hips slightly higher than your knees and increase the hip angle to greater than 90 degrees, may allow for closer positioning to the patient. Sit close to the patient and position knees under the patient's chair if it is possible. This can be facilitated by shifting the seat and using patient's chair that has thin upper back and headrest.

Consider using a saddle-style dentist stool that promotes the natural low back curve by increasing the hip angle to approximately 130 degrees. Using this type of stool may allow you to be closer to the patient when the patient's chair has thick back and headrest.

Adjust the chair so your hips be slightly higher than your knees and distribute your weight equally by placing your feet firmly on the floor. The forward edge of the chair should not compact the backs of your thighs. The size of the dental practitioner must be matched with seat height and instrument handles. Instrumentation through a low seat may cause excess wrist flexion, shoulder abduction, and neck extension, while instrumentation performed from a high seat may lead to excessive neck and low back flexion. Instrument handle sizes should be compatible with the hand size of the operator [18].

The dentist's orthostatic posture is an asymmetrical posture with the body support essentially on the right foot and the internal organ compression on the right side due to bending towards the patient. Only specific short clinical

acts should be done in this posture (e.g. the bite records, the impressions, extractions, the aesthetic evaluations) [8].

### Patient scheduling

Ideally, dental practitioners should schedule patients according to the needs of the patient (longer sessions or several shorter sessions) and the tolerances of the practitioner (alternate patients with varying degrees of calculus).

### Handle design

Dental practitioners should select handle sizes that are appropriate for their hand size and the task being performed. Use of instruments with small diameter handles (1/4 or less) necessitates higher hand forces to hold and operate them. Use of instruments with large diameters may limit accessibility to posterior areas of the mouth.

### Ultrasonic scalers

Ultrasonic scalers are vibrating hand pieces with a thin tip that are used to remove calculus from the teeth with only a little force required of hand scaling. However, it has been controversial regarding the relationship between the use of ultrasonic scalers and the development of musculoskeletal problems. Some studies indicate that cumulative use of ultrasonic equipment is dangerous due to the vibration effects. The tips are thinner recently, which produces a smoother root surface than hand scaling. Some vibrating components can be also dampened [19].

### Periodic breaks and stretching, Chair side directional stretching

Having operators take frequent break time and change their positions is crucial in an effective injury prevention program. Stretches performed in the opposite direction of incorrect poor static postures may avoid muscle imbalances that can lead to pain and MSDs. Directional stretching includes a rotation, side bending, or extension component that usually is in the opposite direction of that in which the operator frequently works [5].

### Strengthening exercises

As the muscles get weak, practitioners tend to slump into poor posture, setting the stage for injuries. Dentists should perform specific strengthening exercises for the trunk and shoulder girdle to improve the health and integrity of the spinal column, maintain good working posture, optimize the function of the arms and hands, and prevent injuries.

Areas to strengthen include the trunk stabilization muscles, basically the transverse and oblique abdominal muscles and multifidus muscles; the stabilizing muscles of the shoulder girdle, mainly the middle and lower trapezius muscles; and the downward gliding muscles of the rotator cuff, the infraspinatus, subscapular and teres minor muscles. Dentists should avoid over strengthening the chest and anterior neck musculature, deltoid muscles, and upper trapezius muscles, as this may aggravate muscle imbalances to which they are prone.

Parts to stretch include the chest musculature, hamstring muscles, low back muscles, buttock (piriformis) muscles and hip flexor (iliopsoas) muscles [5].

#### Aerobic exercise

Aerobic exercise must be performed 3-4 times a week for at least 20 minutes. Aerobic exercise increases blood flow to all tissues and improves their ability to use oxygen.

#### Education

To protect their own health, dentists should seek out and receive education regarding musculoskeletal health, injury prevention, and dental ergonomics [17].

#### 4. Discussion

Prevention of chronic pain requires dentists to gain more knowledge, change their habits, select appropriate ergonomic equipment, and have a break period after each operation with stretching exercise. Additionally, exercise plays an important role in their career to be healthy, safe, and longer practice years. Further studies are required to provide new dental instruments compatible with ergonomics, which reduce musculoskeletal disorders.

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