

# Dental Ergonomics-Musculoskeletal Disorders (MSDs) & Workplace Factors : A Critical Review

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## Abstract

Ergonomics is the science of fitting the task to human capabilities and limitation in order to improve work place safety and productivity. Dental profession is not immune from MSDs or cumulative trauma disorders (CTD). Risk factors for work related MSDs with specific reference to dentistry include stress, poor flexibility, improper positioning, infrequent breaks, repetitive movements, weak postural muscles, prolonged awkward postures and improper adjustment of equipment. Proper ergonomic design is necessary to prevent repetitive strain injuries (RSI), which can develop over time and can lead to long term disability. This article discusses the important issues of postures and offers different methods to ergonomize the dental operator so as to work with comfort, efficiency and ease.

**Keywords:** Ergonomics, MSD, RSI, CTD, Prolonged static postures (PSP).

## Introduction

Pain of dentistry is a common fear that keeps patients away from the dental office. Pain in dentistry is common, but has nothing to do with the patient. The individuals having pain in dentistry are the practitioners. It is estimated that more than half of practitioners have some kind of painful musculoskeletal disorder that is work related.

The word 'Ergonomics' was derived from the Greek words: 'Ergon' which means work; and 'nomos' meaning natural laws. It is the science of fitting the job settings conducive to the worker. In simple terminology, Ergonomics is a way to work smarter- not harder, by designing tools, equipment, work stations and tasks to fit the job to the worker- NOT the worker to the job. Proper ergonomic design is necessary to prevent repetitive strain injuries (RSI), which can develop over time and can lead to long term disability.<sup>[1]</sup>

Literature suggests that the prevalence of musculoskeletal pain in dentists, dental hygienists and dental students ranges between 64% to 93%. The most prevalent regions for pain in dentists have been shown to be the back (36.3-60.1%) and neck (19.8-85%).<sup>[9]</sup>

## Musculoskeletal Disorders

The world health organization defines MSD as "a disorder of the muscles, tendons, joints, intervertebral discs, peripheral nerves and vascular system, not directly resulting from an acute or instantaneous event but installing gradually and chronically." Cumulative trauma disorders (CTDs) are

health disorders arising from repeated biomechanical stress to the hands, wrist, elbows, shoulders, neck and back. Most common CTDs are carpal tunnel syndrome and Low back pain.<sup>[11]</sup>

The common signs and symptoms of MSD are presented in Table 1

**Table 1. Some Symptoms of MSDs**

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

## Signs

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

## Ergonomic Risk Factors<sup>[4]</sup>

Table [2] Definitions of various work place risk factors contributing to CTD.

Ergonomic Risk Factors	Definition
Repetition	Performing repeated motions in the same way with the same body part often observed when the job had a repeated sequence of steps
Awkward posture	Placing a joint towards its extreme end of movement in any direction away from its neutral, centered position
Force	Performing an activity with excessive muscular exertion, estimated as percentage of maximal voluntary contraction
Static Exertion	Holding an object or a body position in a still, fixed manner
Contact stress	Direct pressure on nerves or tendons due to resting the body part against a hard and possibly angled surface
Age related changes	Decreases work load capacity, visual capabilities decreases and reaction time lengthens

Hence with specific reference to dentistry, the risk factors include: stress, poor flexibility, improper positioning, infrequent breaks, repetitive movements, weak postural muscles, prolonged awkward postures and improper adjustment of equipment.

## Sitting Posture

Human spine has four natural curves; cervical lordosis, thoracic kyphosis, lumbar lordosis and sacral kyphosis (Fig: 2). When sitting unsupported frequent posture in dentistry the lumbar lordosis flattens. The bony infrastructure provides little support to the spine, which now is hanging on the muscles, ligaments and connective tissue at the back of the spine, causing tension in these

structures. Ischemia can ensue, leading to low back strain and trigger points. Maintaining the cervical lordosis in the proper position is equally important (Fig. 3). Forward-head postures are common among dentists, due to years of poor posture involving holding the neck and head in an unbalanced forward position to gain better visibility during treatment. In this posture, the vertebrae no longer can support the spine properly, and the muscles of the cervical and upper thoracic spine must contract constantly to support the weight of the head in the forward posture. This can result in a pain pattern, which often is referred to as tension neck syndrome. This syndrome can cause headaches and chronic pain in the neck, shoulders and interscapular muscles, and it occasionally can radiate pain into the arms.<sup>[15]</sup>

The best way to reduce pressure in the back is to be in a standing position. However, there are times when the dentist needs to sit. When sitting the main part of the body weight is transferred to the seat. Some weight is also transferred to the floor, back rest and arm rests. Where the weight is transferred is the key to a good seat design.<sup>[3]</sup>

When working in sitting postures a chair is required to support the seat and back. In this situation one should alternate active and passive sitting postures. The active posture could be defined as the correct body posture that is maintained by the muscles of the back, the back being leaned forward. This posture can not be maintained for a very long time. The passive posture is the one in which the back is sustained by the dentists' back of the chair.<sup>[3]</sup>

## Parameters of the correct working postures<sup>[12]</sup> (Fig:1A,1B)

1. The sitting posture is upright and symmetrical.
2. The shoulders hanging down relaxed with the upper arms beside the upper body.
3. The forearms have been lightly elevated.
4. The angle between lower and upper legs is approx. 105-110.
5. The legs are slightly apart, making an angle of between 30-45°.
6. The patient's head is appropriately rotated in 3 directions.
7. The light beam of the dental operating light is as parallel as possible to the viewing.
8. The sitting location, between 09.00-12.00 o'clock, for left-handed people 03.00- 12.00.
9. The soles should be on the floor.

10. The patient's head is rotated and the sitting location adjusted.
11. Instruments held in 3 supporting points.
12. The upper part of the body should be perpendicular on the chair forward movements should be made without curving the spine.
13. The head could bend 20°-25°.
14. The arms should be close to the body.

#### Postural Awareness Techniques<sup>[3,9]</sup>

Maintain the low back curve- This facilitates proper posture and reduces pressure on disks and muscles (Fig:3).

The following practices can help maintain the low back curve:

**Tilted Seat Plan :** It opens the hip angle by 110 degrees. Retrofit a non tilting seat such as commercially available Fit-sit ergonomic cushion for accomplishing this.

**Saddle Stools :** Consider using saddle-style operator stool that promotes the natural low back curve by increasing the hip angle to approximately 130 degree. It is ideal for confined operatory spaces. The doctor is now halfway between standing and sitting, so low back pressure is even less than when seated in traditional operator chairs.

**Lumbar Support of the Chair:** Must be used as much as possible by adjusting it forward to contact your back.

**Avoid Static Postures:** Dentists should vary their work positions as often as possible to shift the workload from one group of muscles to another.

#### Alternate Between Standing and Sitting

Standing uses different muscle groups than does sitting; therefore, alternating between the two positions lets one group of muscles rest, while the workload is shifted to another group of muscles. Alternating between standing and sitting also can be an effective tool in preventing injuries.

**Reposition the Feet :** Subtle 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.

**Position Patients at the Proper Height:** A common mistake among dentists is positioning patients too high. This causes elevation of the shoulders and abduction of the arms, leading to prolonged static muscular tension in the neck and shoulders. Operators should take the time to position their patients properly for mandibular and maxillary procedures. Generally, patients should be placed in a semisupine position for mandibular procedures and a supine position for maxillary procedures.

**Sit Close to the Patient :** And position knees under the patient's chair if possible. This can be facilitated by tilting the seat and using patient chairs that have thin upper backs and headrests.

**Adjust the Chair :** So your hips are slightly higher than your knees and distribute your weight evenly by placing your feet firmly on the floor. The forward edge of the

chair should not compress the backs of your thighs. Sit close to the patient and position knees under the patient's chair if possible. This can be facilitated by tilting the seat and using patient chairs that have thin upper backs and headrests.

**Adjust Armrests :** Which are designed to decrease neck and shoulder fatigue and strain, to support elbows in the neutral shoulder position.

**Avoid Twisting :** When possible, dentists should position instruments within easy reach. Repeated unilateral twisting in one direction may result in muscle imbalances or structural tissue damage, leading to low back pain.<sup>[4,5]</sup>

#### MSD Prevention Strategies<sup>[10]</sup>

##### Use Magnification

Magnification enables operators to maintain a greater working distance and position patients at the proper height, with the shoulders relaxed and the forearms approximately parallel with the floor. Operating telescopes or loupes are available with flip-up or through-the-lens designs. Working in postures with greater than 20 degrees of neck flexion have been associated with increased neck pain. The declination angle of the scopes should allow you to maintain less than 20 degrees of neck flexion

##### Selection of Instruments<sup>[7]</sup>

Tool/instrument design should be such that it reduces forceful exertion and maintains hand/wrist in neutral posture.

While using hand instruments look for:

1. Hollow or resin handles.
2. Round, knurled or compressible handles.
3. Carbon steel construction (for instruments with sharp edges).

While using automated instruments look for:

1. Light weight, balanced models(cordless preferred).
2. Sufficient power.
3. Built in light sources.
4. Angled vs straight shank.
5. Pliable, light weight hoses.
6. Easy activation.
7. Swivel mechanisms.

**Exercise:** It is important to stabilize the low back curve by contracting the transverse abdominal muscles. To do this while sitting, sit tall with a slight curve in the low back, exhale, pull your navel toward the spine without letting the curve flatten. Continue breathing while holding the contraction for one breath cycle. Repeat five times. Strive to maintain this stabilization regularly throughout the workday.<sup>[10]</sup>

##### Chairside Directional Stretching

Having operators take frequent breaks and reverse their positions is integral in an effective injury prevention program. Directional stretches can be performed in or out of the operatory and can be incorporated into a daily routine that facilitates balanced musculoskeletal health.

Directional stretching involves a rotation, sidebending or extension component that

generally is in the opposite direction of that in which the operator frequently works (Fig. 4A-4D). Figure-6 shows various hand exercises to be performed to reduce carpal tunnel syndrome. This strategy addresses the muscle imbalances that tend to develop. Frequent stretching breaks address the detrimental physiological changes that can develop while working in optimal or awkward prolonged static postures.

**Microbreaks :** To prevent injury from occurring to muscles and other tissues, the operator should allow for rest periods to replenish and nourish the stressed structures. In a study on the efficacy of microbreaks during the workday, Morris and colleague found that by complying with regularly scheduled microbreaks, the subjects had less discomfort and that the addition of 30-second microbreaks showed no detrimental effect on worker productivity.<sup>[10,13]</sup>

##### Weight Control

For each additional 10 pounds of weight you carry, 100 pounds of force is generated to the low back.

**Scheduling:** Goal would be to provide sufficient recovery time for the doctor and the staff to avoid chronic muscle fatigue.

##### Potential Strategies

- Vary procedures within the same appointment.
- Alternate tough and easy patients.
- Shorten patient's recall interval.<sup>[1]</sup>

##### Goals of ergonomics in any work place should include<sup>[13]</sup>

1. Reducing the risk of CTD.
2. Increasing productivity.
3. Increasing safety.
4. Improving the quality of work.
5. Decreasing fatigue and errors.

##### MSD Prevention Methods<sup>[14]</sup>

1. Adopting a correct working posture.
2. Use of adequate light.
3. Good planning of dental care sessions.
4. Alternative planning of long and short sessions.
5. Alternating the body postures sitting and upright.
6. Having short breaks after each care session and long coffee or lunch breaks, the sink should be installed at distance.
7. The working day should not be longer than 7 hours.
8. Every 6 weeks a journey should be planned.
9. Sports activities should be practised for about 45 minutes three times a week.

##### Conclusion

Work-related pain is common among dental professionals. The development of four-handed operatory techniques has made delivery of dental care more efficient and productive; however, it also has contributed to an increase in Prolonged static postures among operators. Because this problem is multifactorial, any possible solution should be multifactorial as well. Available research supports the idea that this problem can be

managed or alleviated effectively using a multifaceted approach that includes preventive education, postural and positioning strategies, proper selection and use of ergonomic equipment and frequent breaks with stretching and postural strengthening techniques. This represents a paradigm shift for daily dental practice. It is important that dentistry incorporate these strategies into practice to facilitate balanced musculoskeletal health that will enable longer, healthier careers; increase productivity; provide safer workplaces and prevent MSDs.

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Fig. 1A : Symmetrical Postures



Fig. 1B : Ergonomics- Evaluation of static working posture

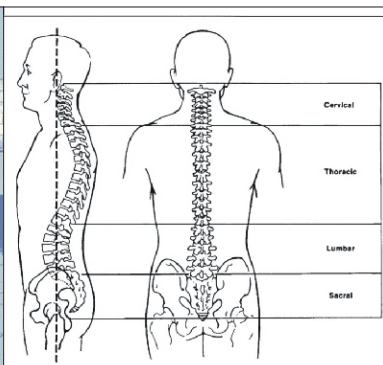


Fig 2 : The four primary curves of the spine  
Cervical Lordosis, Thoracic Kyphosis  
Lumbar Lordosis, Sacral Kyphosis

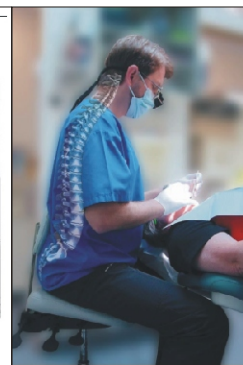


Fig 3 : Maintaining the Low Back Curve  
Facilitates Proper Posture & Reduces  
Pressure on Disks & Muscles

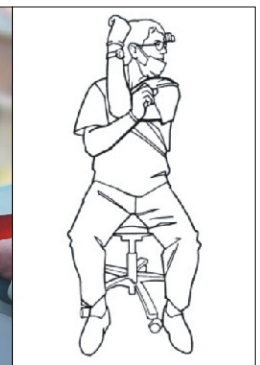


Fig.4A: Examples of Chairside Directional Stretches- Neck and shoulder stretches. Neck and shoulder height and at a 90-degree angle, gently pull the arm across the front of body with opposite arm. Look over the shoulder being stretched and hold for two to four breathing cycles.



Fig.4B: The untwister. With the knees wider than shoulder width, bend to the left side, resting the full body weight through the left elbow on the left knee. Stretch the right arm overhead and look toward the ceiling. Hold for two to four breathing cycles



Fig.4C: Upper trapezius stretch. Anchor the right hand behind the seat of the chair. Gently bring the left ear toward the left armpit. Hold for two to four breathing cycles

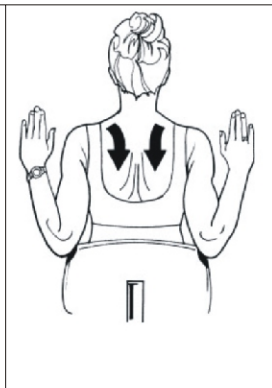


Fig.4D: Downward squeeze. Assume a neutral head posture (ears over the shoulders) and do not let the head move forward throughout the exercise. Lift the chest upward, position the arms at the sides with fingers pointing upward and palms facing forward. Roll the shoulders back and down, squeezing the shoulder blades downward and together. Hold for one long breath cycle.

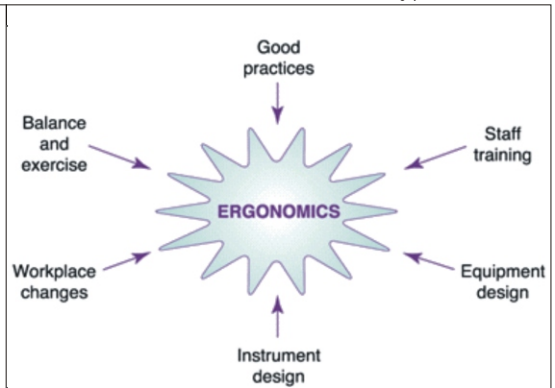


Fig-5 : Ergonomic Balance



Fig 6 : Different Hand Exercises.