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Ergonomics in dentistry: Narrative review

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Abstract
The prevalence of work-related Musculoskeletal disorders (MSDs) in Dentists is increasing day by day. Dental practitioners have to work with instruments, equipments& working postures that does not fit the required way of working and/or individual characteristics. The ergonomic limitations play a distinct role in such musculoskeletal injuries. Application of Ergonomic principles in the design of work systems is the key to prevent occupational injury. Ergonomics draws on a number of scientific disciplines, including physiology, biomechanics, psychology, anthropometry & kinesiology. This review article includes Musculoskeletal disorders(MSDs), their types, clinical features, risk factors and steps to prevent MSDs through various applications of ergonomics in dentistry.

Keywords: musculoskeletal disorders (MSDs), ergonomics, dentist

Introduction
" Take care of your body. It's the only place you have to live''- Jim Rohn. It is paramount important for every dental practitioner to work in right posture and shape in order to maintain a good form, function & health. Dental work require enormous physical and mental concentration and prolonged working hours make dental practitioners to follow improper working posture [1]. These conditions predispose dental practitioners to diverse occupation related diseases & disorders, and most common of them are Musculoskeletal Disorders (MSDs) which can even lead to irreversible injuries [2]. Research had shown that most common injuries occur in wrists, elbows, shoulders, neck and back & spine [3]. Complex conditions like Carpel tunnel syndrome, Sciatica, Tendinitis & Tension neck syndrome are now often associated with dental workers & dentists [4]. Burke *et al* found that 29.5% of dentists suffer from musculoskeletal disorders which lead to early retirement of dental practitioners [5]. Thus it is necessary to know seriousness of effective & proper ergonomic design in dental practice in order to prevent from musculoskeletal disorders (MSDs) &other posture related injuries that develops over time & can later lead to long-term disability.
Ergonomics is derived from Greek words: Ergon meaning 'work' & Nomos meaning 'principles or laws [6]. It is an approach to work smarter by designing tools, equipments, work stations which can allow practitioners to work with maximum efficiency and safety. Proper ergonomic design leads to enhanced productivity, minimizes injuries & maximize worker satisfaction. Therefore, it is crucial for upcoming dental practitioners to adopt proper ergonomic design while practising dentistry. This article review about various musculoskeletal disorders and its management.

Musculoskeletal disorders (MSDs) – definition and prevalence
MSDs are "work related disorders of the musculoskeletal system having chronic gradual onset involving muscles, tendons, ligaments, joints, nerves, cartilage and spinal discs" [7]. They are also known as Cumulative Trauma Disorders (CTDs) or Repetitive Motion Injuries (RMI).
MSDs are an increasing healthcare issue globally, being the second leading cause of disability [8]. Since, dental treatment is performed in extremely narrow working area with a very inflexible work posture, the prevalence of MSDs exceeds over other disorders. A review of the International dental literature states that approximately 65% of dentists reports of musculoskeletal complaints of pain, discomfort, impediment in functioning & increased working time [9]. In 1998 Bramson *et al* found that back, neck, shoulder or arm pain is present in up to 81% of dental operators [10]. According to an evaluation from the Bureau of Labour

Statistics (2002), dental hygienists ranked 1st above all occupations in the proportion of cases of carpal tunnel syndrome per 1,000 employees.

Researchers have found symptoms of discomfort for dental workers occurred in the (Anton, 2002)

- Wrists/hands (69.5%)
- Neck (68.5%)
- Upper back (67.4%)
- Low back (56.8%)
- Shoulders (60%)

Classification of MSDs

(A) Nerve Disorders: Carpal tunnel syndrome, Ulnar neuropathy.

(B) Disorders of the neck: Tension neck syndrome, Cervical spondylosis, Cervical disc disease, Brachial plexus compression.

(C) Disorders of the Shoulder: Trapezius myalgia, Rotator cuff tendonitis, Rotator cuff tears, & adhesive capsulitis.

(D) Disorders of the Elbow, Forearm & Wrist: deQuervains disease, Tendonitis, Tenosynovitis, Epicondylitis.

(E) Hand-Arm Vibration Syndrome: Raynaud's disease.

(F) Disorders of the Back: Low back pain (LBP), Upper back pain

Examples of Musculoskeletal Disorders (MSDs)

Body Parts Affected	Symptoms	Possible causes	Disease name
Thumbs	Pain at the base of the thumbs	Twisting & gripping	De Quervain's disease
Fingers	Difficulty moving finger; snapping & jerking movements	Repeatedly using the index fingers	Trigger finger
Shoulders	Pain, stiffness	Working with hands above the head	Rotar cuff tendinitis
Hands, Wrists	Pain, swelling	Repetitive or forceful hand & wrist motions	Tenosynovitis
Fingers, Hands	Numbness, tingling; ashen skin; loss of feeling & control	Exposure to vibration	Raynaud's syndrome(white finger)
Fingers, Wrists	Tingling, numbness, severe pain; loss of strength, sensation in the thumbs, index, or middle or half of the ring fingers	Repetitive & forceful manual tasks without time to recover	Carpal tunnel syndrome(CTS)
Back	Low back pain, shooting pain or numbness in the upper legs	Inflexibilities around the hips & pelvis; weakness of the stabilizers of the lumbar spine	Back disability

Risk factors for MSDs

Based on various studies made, the following are the variety of risk factors for musculoskeletal disorders (MSDs) that are encountered in dental practice [11].

Risk Factors for MSDs	Dental Procedures
Repititive motions	Scaling, polishing
Awkward postures	Handling of objects with the back bent/twisted than straight
Static postures	Static neck, back & shoulders
Forceful exertions	Tooth extraction
Duration	Grasping small instruments for prolonged periods
Contact stresses	Repeated contact with hard or sharp objects
Vibration	Prolonged use of vibrating hand tools

Other risk factors for MSDs are

- Poorly designed equipment workstation eg-narrow working space
- Improper work habits
- Genetics
- Medical conditions
- Poor fitness level
- Physical/mental stress
- Lack of rest/recovery
- Poor nutrition
- Poor lighting
- Environmental & psychosocial factors

Clinical features of musculoskeletal disorders (MSDs)

Signs	Symptoms
Decreased range of motion	Excessive fatigue in the shoulders & neck
Loss of normal sensation	Tingling, burning sensation in arms
Decreased grip strength	Weak grip, cramping of hands
Loss of normal movement	Numbness in fingers & hands
Loss of co-ordination.	Clumsiness & dropping of objects
	Hypersensitivity in hands & fingers

Mechanisms causing musculoskeletal disorders (MSDs) in dentistry

- Prolonged static postures(PSPs)
- Muscle imbalances
- Muscle ischemia & necrosis
- Hypomobile joints
- Spinal disc herniation & degeneration
- Neck & shoulder injury
- Carpal-tunnel syndrome(CTS)
- Low back pain

Goals of Ergonomics

- Reducing the risks of musculoskeletal disorders (MSDs).
- Improving worker safety.
- Increasing worker comfort.
- Minimize worker fatigue.
- Improving the quality of work.

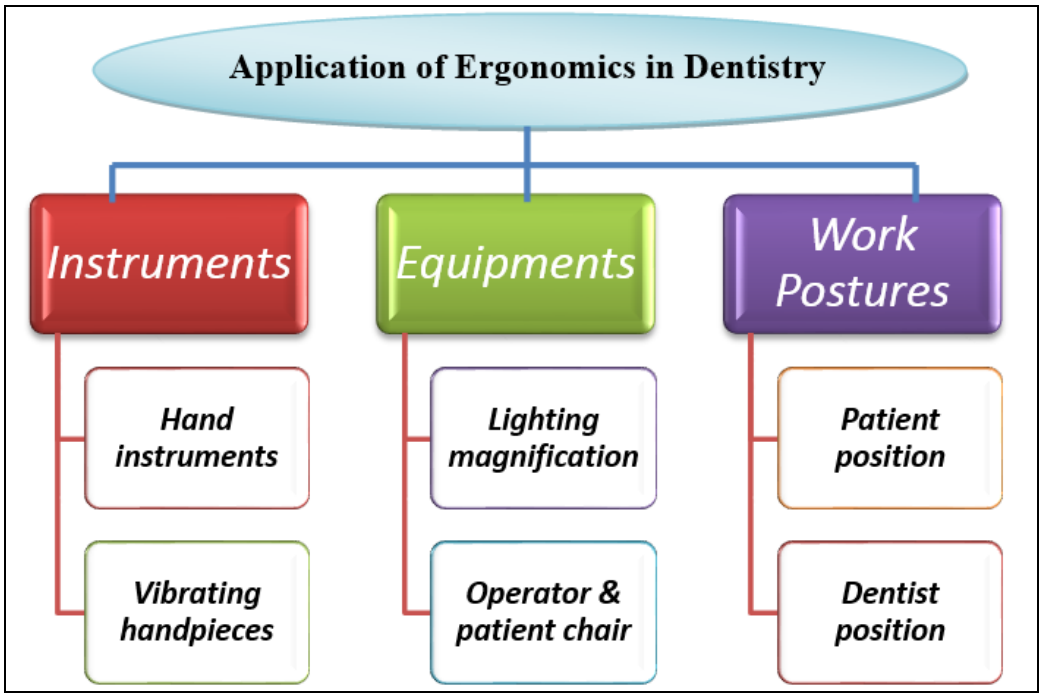
Prevention & Intervention

"Prevention is better than cure". Prevention of any disease saves time, money & pain. The problem (disease) prevailing amongst dentists is Musculoskeletal disorders (MSDs) and the solution to the problem is Ergonomics. More awareness about

good ergonomics is necessary for better health of dentists. Design of the work system based on ergonomic principles in relation to body posture, body movement, muscular strength & body dimensions is the secret to a healthy practice through various ergonomic applications in dentistry.

For prevention of musculoskeletal disorders following points need to be considered

a) Handling of instruments
b) Handing of equipments
c) Work postures



Some elements of an improper workstation setup (Sadig, 2000)

- Dentist's or patient's chair is too high/low.
- Dentist's chair has no lumbar, thoracic, or arm support.
- Instrument table is not positioned properly.
- Lighting is inadequate for the task.
- Edges of tables/work surfaces are sharp/uncomfortable.
- Ventilation makes workspace cold.
- Work environment is damp & cold.

Work Posture

1. Importance of posture

Human spine has four natural curves; cervical lordosis, thoracic kyphosis, lumbar lordosis & sacral kyphosis. The lumbar lordosis flattens when sitting in an awkward unsupported posture frequently for a long time. The bony infrastructure provides little support to the spine causing tension, strain & trigger points. Therefore, proper working posture is important in maintaining the cervical lordosis in stable position.

2. Ergonomics principle for working posture

Maintain neutral posture

Supports uncompromised musculoskeletal balance of the clinician

3. Correct working postures: (Yamalik, 2007)

- Maintain an erect position.
- Use an adjustable chair with lumbar, thoracic & arm support.
- Work close to your body.
- Minimize excessive wrist movements.
- Avoid excessive finger movements.
- Alternate work positions between sitting, standing & side of patient.
- Adjust the height of your chair & the patient's chair to a comfortable level.
- Consider horizontal patient positioning.
- Check the placement of the adjustable light.
- Check the temperature in the room.

Patient positioning

Supine positioning of the patient in the chair is usually the most effective way to help to maintain neutral posture. The patient must lie comfortably without feeling pressure from the back.

Operator position

The clinician's access to the oral cavity should be truly unimpeded. The operator should be able to move freely the legs beneath the patient's head & headrest to avoid twisting or forward bending of the torso. 7 to 12:30 o' clock position is preferred for the right handed operator, & 12:30 to 5 o' clock for the left handed operator.

Dental operating light

Lighting provides good shadow free, even, color-corrected illumination to the operating field leading to increased visibility & accessibility to the operator. The light source should be in the patient's mid-sagittal plane. The dental operating light must be able to be positioned around the head of the dentist, before & sideward so that the light beam is running parallel to the viewing direction, with a maximal deviation of approximately 15°, in all positions around the

patient chair from which a dentist treats patient.

Magnification

Magnification allows to maintain a greater working distance, improve neck posture by helping the clinician prevent leaning forward towards the patient & provides clearer vision. Dental loupes, operating telescopes & microscopes are available for magnification systems. Using such equipments lets the dentist focus the eyes specifically on operating field. There is no need to flex the neck, upper spine, and lower back to improve visibility.

Patient chair

The goal is to promote patient comfort; maximize patient access.

Look for:

1. Chair with a flat surface.
2. Stability.
3. Pivoting or drop-down arm rests.
4. Headrest & neck support.
5. Wrist/forearm support.

Operator stool

The goal is to promote mobility and patient access; accommodate different body sizes.

Look for:

1. Adjustable lumbar support.
2. Seat height adjustment.
3. Adjustable foot rests.
4. Wrap around body support
5. Seamless upholstery

Types of operator stool: Saddle stools, Brewer operator stool, Posiflex stool, Kobo chair.

Saddle style stools maintains the lumbar curve of the lower back by increasing the hip angle to 130° and placing the pelvis in a more neutral position. It is ideal for confined operatory spaces.

Ergonomic Specifications of Instruments

Hand instruments	Automatic instruments (Handpieces)	Syringes & Dispensers
Hollow or resin handles	Light weight.	Adequate lumen size.
Rounded, knuckled, or compressible handles.	Sufficient power.	Ease in cleaning.
Carbon steel construction.	Built in light source.	Knurled handles.
	Swivel mechanisms.	Easy activation & placement.
	Easy activation.	
	Easy maintenance.	

Recent trends & strategies in Ergonomics in Dentistry

- **Four handed dentistry**

Akesson *et al*. in their study noted that practice of four handed dentistry proved to be significant in reducing stress. When working in four-handed dentistry the dentist maintains a position around the operating field with limited hand, arm & body movement, and should best confine eye focus to the working field. The dental equipment & instruments should be centred on the dental assistant promoting over-the head & over-the patient delivery system that allow better access during procedures.

- **Alternate between standing & sitting**

Standing allows reducing the pressure in the back. However, there are times when the dentist needs to sit. When sitting, the main part of the body weight is transferred to the scat. Alternating between the two positions lets one group of muscles rest, while the workload is shifted to another group of muscles. Alternating between standing & sitting can be an effective tool in preventing injuries.

- **Foot control dental unit**

A foot control can be designed with a pedal on which the foot is placed either entirely, or partly. Placing the whole foot on the pedal causes an unfavourable load which results in the unequal position of the right & left foot which in turn causes an asymmetrical, harmful strain on pelvis & vertebral column. Therefore, it is necessary to place the heel on the floor so that it can support the foot, while the front part of the shoe is placed on the pedal.

- **Using matt surfaces**

The surfaces of dental equipment & instruments have to be matt, to avoid fatiguing glittering effects on the eyes of the dentist. The colours used for dental equipment should be light for an optimal contrast to avoid more adaptation of the eyes than necessary & so prevent eye fatigue.

- **Cord management**

The added weight of cords can often influence the level of muscle fatigue experienced by the clinician. The dentist may wrap the cord around their arm or try to pinch it between the ring finger & the smallest finger in order to support the weight.

- **Proper size & fit of gloves**

Gloves must be of proper size, lightweight, and pliable. Poor fitting gloves can cause pain in the hands, particularly at the base of the thumb & is a potential contributor to carpal tunnel syndrome.

- **Proper temperature**

It is recommended that hands & fingers be kept above 25°C or 77°F to avoid detrimental effects on dexterity & grip strength. However there are no standards for temperatures.

- **Ambidexterity**

The majority of people prefer the use of their dominant hand when performing manual operations. While this can improve efficiency, it can also result in muscular overload of the dominant hand/arm. It is recommended that individuals attempt to alternate hands throughout the workday, whenever possible. However, this may not be practical.

- **Micro breaks**

The operator can take a break to prevent injury to the muscles & allow rest periods to replenish & nourish the stressed structures. A 30 seconds micro break may help the dentist to work effectively & efficiently.

- **Scheduling**

Scheduling provides sufficient recovery time to avoid chronic

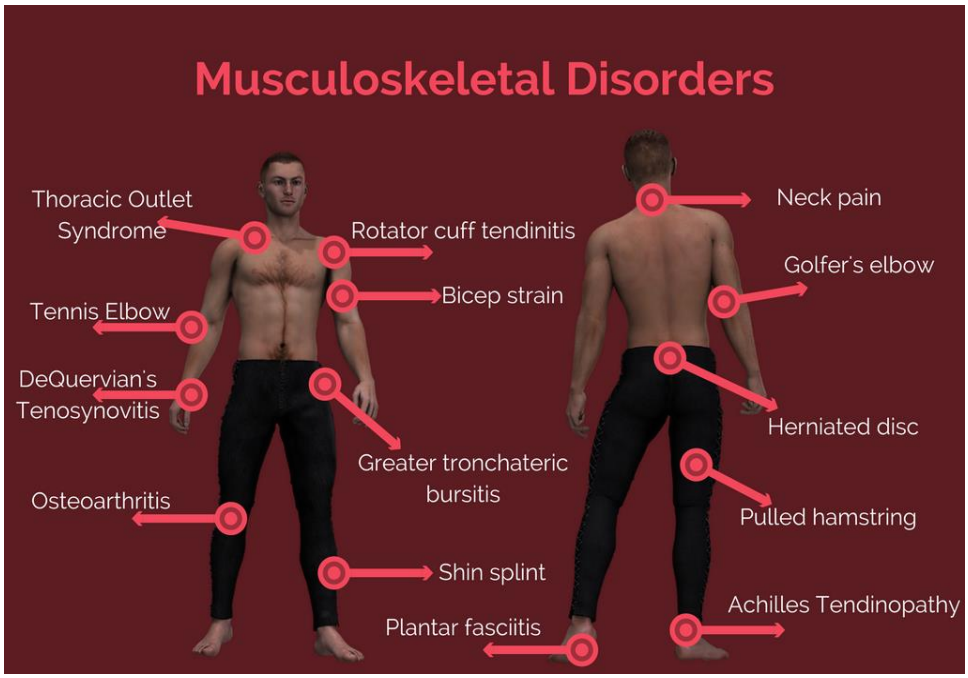
muscular fatigue. Potential strategies include flexible scheduling systems, vary procedures within the same appointment, shorten patient's recall interval.

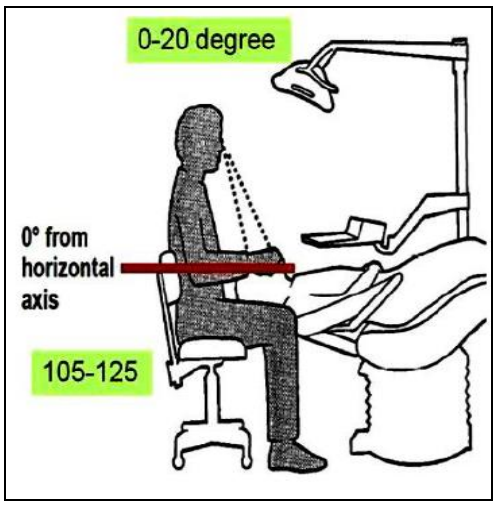
- **Stretching & exercises**

Regular exercises, stretching, relaxation techniques (meditation, biofeedback & yoga) helps prevent injuries & combat stress thereby improving the quality of life.

Body Strengthening Exercises (Valachi & Valachi, 2003) [12]

A. Stretching & strengthening the muscles that support the back & neck and those used in the forearm, wrist, and hand will help them remain strong & healthy.
B. Periodic stretching throughout the workday.
C. Resting hands frequently is believed to be one of the most important factors in preventing CTS.
D. To relieve eyestrain caused by focusing intensely at one depth of vision for long periods, look up from the task & focus eyes at a distance for approximately 20 seconds.
E. Move the head down slowly & allow the arms & head to fall between the knees; hold for a few seconds; raise slowly by contracting the stomach muscles & rolling up, bringing the head up last.
F. Try head rotation for neck stiffness. Head rotation involves tilting the head from right to left, as well as forward & backwards without forcing the motion beyond a range of comfort.
G. Shoulder shrugging can be used to stretch the shoulder muscles that may be stressed from holding oral evacuator, instruments and telephone handset. Pull the shoulders up towards the ears, roll them backward & then forward in a circular motion.





Conclusion

The successful application of ergonomics assures high productivity & avoidance of illness & injuries. It is crucial to detect the risk factors & implement the ergonomic strategies. A balanced musculoskeletal health will enable the dentist for a longer, healthier careers, safer workplaces & prevent MSDs.

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