Ergonomics and its Impact on Musculoskeletal Disorder among Dental Surgeons: A Literature Review

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ABSTRACT

The word ergonomic in dentistry evolved around mid-20th century. Ergonomics is defined as an integrative knowledge in organizing the labor activity that makes up a job. Due to lack of adequate knowledge about the ergonomic importance and future health issues of poor ergonomic practice, dentistry faces a serious threat. Work-related musculoskeletal disorder (MSD) is one of the major occupational health challenges faced by industrial countries and is major cause of loss of working days and high labor cost. Ergonomics takes into consideration the type of work done and provides a healthy environment for the operator, thereby enhancing the ease of work and preventing work-related MSD. Work-related health issues due to improper posture can be combated by successful application on ergonomics. Thus, by applying the basic principle of ergonomic along with the new trends available in the field of dentistry, one can prevent the development of MSD.

Keywords: Dental surgeon, Ergonomics, Musculoskeletal disorder.

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INTRODUCTION

The word ergonomic in dentistry evolved around mid-20th century.¹ Since then various studies related to this discipline of science tried to refine the concept of ergonomics.² The word ergonomics is derived from Greek, where “Ergo” means work and “Nomos” means natural laws or system.³ Ergonomics is defined as an integrative knowledge in organizing the labor activity that makes up a job. Thus, the objective is to provide an ambience that is safe, comfortable, and healthy, thereby preventing health issues and enhancing productivity.⁴ Due to lack of adequate knowledge about the ergonomic importance and future health issues of poor ergonomic practice, dentistry faces a serious threat.²

Musculoskeletal disorders (MSDs) refer to group of disorders that affect muscles, tendons, ligaments, joints, nerves blood vessels, and all supportive structures that play a role in movements.⁵ MSD can initially begin as pain in upper limb involving forearm and wrist, further involving the upper and lower back, neck and shoulder, and finally affecting the lower extremities such as hip, thighs, knees, and ankles. If left untreated it may lead to degenerative and inflammatory changes in affected area.⁶

Apart from injuries due to sharp instruments, other occupational hazards faced by dentists includes the job-related stress, MSD, allergies, eye injury, hearing problem, and burns of which MSD accounts for about 39.8% of occupational health problems encountered among the dentists.⁷ Backache, one of the serious manifestations of MSD, is a major occupational hazard faced by dental surgeons which accounted for 47%.⁸ Around 70.51% of dental surgeons are affected by MSD.⁹

Dental surgeons are susceptible to risks of MSD more than other medical professionals, which had a significant impact on the quality of work job performance and efficiency.^{10,11} On comparison among the dental surgeons, general surgeons, and physicians, musculoskeletal pain was more prevalent among the dental surgeons (dental surgeons 61%, surgeons 37%, and physicians 20%).¹²

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WORK-RELATED MUSCULOSKELETAL DISORDERS

Work-related MSD is one of the major occupational health challenges faced by industrial countries and is major cause of loss of working days and high labor cost.¹⁰ It is estimated that musculoskeletal injury of neck, back, shoulder, elbows, wrists, and hands are more prevalent among dental surgeons.¹³ Most frequently reported disorders include lower back pain, cervical brachial pain, shoulder tendonitis, DeQuervain syndrome, Carpal tunnel syndrome, and Guyon syndrome.^{2,14–16}

Non-ergonomic behavior along with other comorbid factors such as age, sex, and physical condition can lead to lower back pain. Pain may manifest either as stiffness or as definite localized pain. Dental professionals have high risk of developing lower back pain and symptoms which increases with increase in the number of years of experience.¹⁷

Both static and dynamic overstress due to extreme and frequent vicious attitude of cervical spine throughout the dental practice causes cervical brachial pain. Routine dental practice without break can disturb the normal biomechanics of spine and deteriorate vertebral resistance.¹⁸

If the principle of ergonomics is followed properly, it can help to reduce the incidence of work-related MSD by maintaining proper posture, thereby reducing cognitive and physical stress

Fig. 1: Causes of early retirement among dentists¹

and enhancing productivity.¹⁹ MSDs are the important cause of early retirement among dentists which accounts for 29.5% of cases¹ (Fig. 1).

POSTURODONTICS

Role of improper static posture, biochemical pressure, force exertion, repetitive movement, and its ergonomic importance have been noted even before several decades.⁵ Due to enormous physical and mental pressure and prolonged working hours in dental field, dental practitioners follow awkward posture.⁶ Ergonomics takes into consideration the type of work done and provides a healthy environment for the operator, thereby enhancing the ease of work and preventing work-related MSD. Ergonomics in dentistry pose major difficulty, since the dental workplace is complicated compared to other medical field¹⁹ areas of ergonomic importance in routine dental practice^{8,9,19} (Fig. 2).

SIGNS AND SYMPTOMS OF MUSCULOSKELETAL DISORDERS (TABLE 1)²⁰

Incorrect posture will lead to MSDs that result in decreased range of motion and grip strength along with loss of normal sensation movement and co-ordination.³ Repetitive movement carried in restricted area, uncomfortable position causing muscle strain, long period of activity, lack of break during episodes of procedure causing lack of muscle relaxation, powerful movement and force exertion associated with hand grasping, uncomfortable surrounding environment, vibrations, psychosocial factors, poor lighting, poor nutrition, poor fitness, physical and mental status, medical condition, genetics, and prolonged static posture all contribute to the development of MSD's.^{5,21-27} Among various risk factors that lead to the development of MSD, sitting in same posture for a long duration is considered to be the major risk factor. Maintaining an awkward posture for a long duration and performing repeated task without intervals may also cause serious threat for developing MSDs (Fig. 3).²⁸ Lower back and neck are the most common site of prevalence of MSD, among which lower back pain was more prevalent in male, which accounted for 34.83%

Fig. 2: Area of ergonomic importance^{8,9,19}

Table 1: Signs and symptoms of musculoskeletal disorders

S. no	Diseases causing the symptoms	Signs/symptoms	Area affected
1	Carpal tunnel syndrome	Numbness, pain tingling sensation involving thumb and index finger	Finger, wrist
2	Raynaud's phenomenon	Loss of sensation, ashen skin	Finger, hands
3	deQuervain's disease	Pain in the thumb	Thumb
4	Trigger finger	Jerking movement along with difficulty in moving finger	Fingers
5	Rotator tendinitis	Stiffing of shoulder along with pain	Shoulder
6	Tenosynovitis	Pain and swelling in the upper limb	Hands, wrist
7	Back disability	Pain and numbness in the lower back and upper legs	Back

and neck pain are more prevalent in female, which accounted for 34.83% (Fig. 4).²⁹

MECHANISM OF DEVELOPMENT OF MUSCULOSKELETAL DISORDERS

Sitting posture is the body posture the dental surgeons most frequently use.³⁰ Disk pressure is found to increase during prolonged sitting, forward bending, and rotator motion which cause muscle strain and painful trigger points.^{31,32}

During dental work posture, the muscles of the shoulder, upper back, neck, and lower back are contracted to stabilize the arm to provide greater precision of movements. Keeping the head tilt on one side and holding torso in forward leaning position will impart complications on joints of neck, shoulder, upper, and lower back.³³

Prolonged static posture can lead to shortened and stressed muscle which causes ischemic pain and injury to muscle, exerting asymmetrical forces ending up in mal-aligned spinal column and career-ending MSDs.³⁴ Repetitive strenuous work can lead

Fig. 3: Risk factors associated with development of musculoskeletal disorders

Fig. 4: Common painful sites²⁹

to lower back pain, neck and shoulder injury, and increased pressure in carpal canal causing carpal tunnel syndrome.³⁵ In extreme cases, due to forward flexion and rotation, pressure in lumbar spinal disk increases causing spinal disk herniation and degeneration.³⁴

HOW TO MAINTAIN CORRECT POSTURE AND PREVENT THE DEVELOPMENT OF MUSCULOSKELETAL DISORDERS

Posture refers to the position an individual acquires in relation to space with his bone and musculoskeletal system.³⁶ Thus, maintaining a good posture reduces energy expenditure, enhances the organ function, and reduces the risk of occupational hazard.³⁷

This can be achieved by taking the following into consideration,

Posture of the Operator

Each clinician who works on the chair should adjust taking into consideration height, width, tilt, backrest, seat span, and arm rest and customize it so that the operator maintains erect neutral position with feet parallel to the floor and thighs sloping gently

downward. This prevents forward bending or excessive leaning over the patient.^{5,38} Correct operators position range for right-handed operator is 7–12.30'o clock and left-handed operator is 12.30'o clock.²⁰

Patient Positioning

Apart from providing comfort and support for the patient, patient position should help the operator maintain neutral posture while working, provide space so that thighs can freely turn beneath the patient chair, and allow clearance with unimpeded operator access with the patient headrest stabilized allowing enough movements and maximum access.³⁹ Thus, a chair that provides pivoting or drop arm rest with supplemental wrist support, thin headrest, sling or low-profile arm rest can maximize patient access, allowing closer positioning of the operator.⁴⁰ Figure 5 depicts the proper posture of the operator and the patient.

Other Factors

Hand Instrument

The hand instrument that the operator uses also has an impact on health effect of the user. Thus, the instrument with the diameter in range of 5.6–11.5 mm, light weight (15 g or less), and sharp working

Figs 5A and B: (A) Correct posture of the operator with erect neutral position; (B) Neutral zone of the operator

Fig. 7: Assistant's monitor position

end with knurled or rounded compressible handle enhances the efficiency of work.⁴¹ Hollow or resin handle with carbon steel are usually preferred.²⁰

Automatic Instruments (Handpiece)

Should have a light weight with easy activation and maintenance. It should provide sufficient power to prevent undue pressure or force that might in turn cause muscle fatigue.²⁰

Operating Light and Magnification

Use of magnification devices like dental operating microscope, magnification loupes, and magnification lenses along with proper lighting which is even, shadow-free, color corrected, and concentrated on operating field can aid in proper visibility and accessibility, thereby providing ease of the procedures.⁴² The light source must be in patients' mid-sagittal plane parallel to viewing direction of the operator with maximal deviation of approximately 15° in all direction.²⁰

Microscopic Parameters

The ideal magnification to work under dental operating microscope is 2.2x. Increasing the magnification may lower the productivity. Hence a six-step microscope can be used.

Figs 6A and B: Posture of the operator working under dental operating microscope without and with headrest

Figs 8A and B: Operator's monitor position

Patient must be kept in the Trendelenburg position, while altering the position laterally when working under a dental operating microscope.

It is preferable to use Tempur-pedic pillow for head and shoulder support with a removable headrest (Fig. 6).

Monitor

Assistant Monitor

The assistant monitor should be placed directly in front of the assistant so that the assistant does not make any undue motion while working, that is, assistant must only move his or her eyes without turning the head to view the monitor (Fig. 7).

Operators Monitor

Monitor must be placed in line of sight, and it should be large enough to view the essential details⁴³ (Fig. 8).

Chair

Patients Chair

It should be flat, stable, with proper headrest, neck/wrist, and forearm support to provide comfort for the patient and maximize the patient access. The swivel chair offers a highly flexible working method with patients (Fig. 9).

Operating Stool

It should provide seat height adjustment and wrap around body support with lumbar support and foot rest²⁰ (Fig. 10).

Fig 9A and B: Ergonomically designed chair

Fig. 11: Operating instrument with movable footrest

Foot Control Positioning

Alternating the foot control position from side to side 2–3 times a day, and keeping it close to the operators' knee at about 90–100° angle can reduce the load on the back thereby reducing the risk of lower back pain⁴⁰ (Fig. 11).

NEW TRENDS IN ERGONOMICS TO COMBAT MUSCULOSKELETAL DISORDERS?

Various new means of ergonomic support are being practiced to prevent MSDs which includes, four-handed dentistry, alternating sitting and standing position, using Matt surfaces, proper cord management, maintenance of proper temperature around 25° or 77°F, having rest period, and scheduling the appointment.²⁰

STRETCHES

Prolonged working hours results in muscle tightness which can be relieved by stretches. In cases of established pain, these stretches which are depicted in Table 2 can be done which is a cumulative information obtained various studies in the literature.^{44–47}

CONCLUSION

A dental surgeon spends most of his lifetime in tense position, where he is subjected to work-related health problems. Work-related health issues due to improper posture can be combated by successful application on ergonomics. Ergonomics not only provides a balanced musculoskeletal health but also enhances the efficiency and productivity of work. Thus, ergonomics plays

Fig. 10: Operating stool

Table 2: Stretching exercise

Exercise	Procedure
Untwister exercise	Keep the legs in tripod with left side knee bend and left arm should rest on it. Right arm is stretched over head looking upward.
Trunk rotation exercise	While sitting erect the trunk is oriented right side and cross the right leg over the left leg.
Reversal exercise	Extend backwards by supporting the wrist with the hip.
Tucked chin	While tipping the head forward occipital pressure is applied with the chin tucked.
Scalene stretch	Sit and bend the neck to one side with chin tucked. Same side hand is used to pressurize the head in the direction of the stretch.
Upper trapezius stretch	Scalene stretch done in opposite side.
Pectoralis major stretch	While standing at the corner of the wall both the hand are supported on the wall. On pushing the entire body forward a stretch is felt.
Hand stretch	While extending the elbow and wrist of one hand widely spread the fingers of the same and pressurize it in more extended position with the other hand.
Upper thoracic extension exercise	While sitting erect keep both the hand on the occiput with elbows backwards.
Lateral trunk stretching	While sitting bend on one side and hands of opposite side raised upward.
Hip flexor stretching	Stretch both the legs with the front leg bend at the knee and supporting the body weight. Back leg is extended at the knee.
Calf stretch	While standing on a slope, bend forward with a straight spine.
Hamstring stretching	While sitting extend the leg which has to be stretched on another chair and bend toward the knee.

a pivotal role in one's health during practice and increases the duration of healthy practice during lifetime.

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