

REVIEW ARTICLE

Musculoskeletal Disorders in Clinical Dentistry and Their Prevention

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ABSTRACT

In the dental profession, dental professionals spend their work days in an awkward, static position performing extremely precise procedures. Maintaining the steady hand and posture comes at a cost to the back, neck and shoulder area of the dental professional. Occasional pains from irregular stances or positions are to be expected while they are performing static work. However, when the pain becomes a regular occurrence, cumulative damage could arise leading to debilitating injuries. Work-related musculoskeletal disorders are a common complaint of practicing dentists and dental hygienists. This article provides a brief review of literature on musculoskeletal disorders in clinical dentistry and various strategies of their prevention with a special emphasis on the neutral position for the clinicians and dental operators with an aim that it should help the dental operators to prevent these injuries and to work effectively and efficiently.

Keywords: Musculoskeletal disorders, Occupational injuries, Static postures, Optimal seated positions, Neutral positions, Dental professionals.

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INTRODUCTION

In the dental profession, dental professionals spend their work days in an awkward, static position performing extremely precise procedures in a 2" × 2½" workspace—the patient's mouth. Because there is no room for error, a steady hand and a steady, awkward posture must be assumed and maintained. However, maintaining the steady hand and posture comes at a cost to the back, neck and shoulder area of the dentist. Occasional pains from irregular stances or positions are to be expected while they are performing static work. However, when the pain becomes a regular occurrence, cumulative damage could arise leading to debilitating injuries.

A work-related musculoskeletal disorder is an injury affecting the musculoskeletal, peripheral nervous and neurovascular systems, that is caused or aggravated by prolonged repetitive forceful or awkward movements, poor posture, ill fitting chairs and equipments, or a fast paced workload.¹ Musculoskeletal disorders result in more than 60% of all newly reported occupational injuries.¹ The result is injury to the muscles, nerves, and tendon sheaths of the back, shoulders, neck, arms, elbows, wrists and hands that

can cause loss of strength, impairment of motor control, tingling, numbness or pain. Work-related musculoskeletal disorders are a common complaint of practicing dentists and dental hygienists.²⁻⁸

The human body is not designed to maintain the same body position or engage in fine hand movements hour after hour, day after day. BA Silverstein, in an article defined a repetitive task as a task that involves the same fundamental movement for more than 50% of the work cycle.⁹ Periodontal instrumentation requires excessive upper body immobility while the tendons and muscles of the forearms, hands and fingers overwork. Dental operators often cannot avoid prolonged static postures.¹⁰ Even in optimal seated postures, more than one half of the body muscles are contracted statically, and there is little movement of the vertebral joints. This may result in damaging physiological changes that can lead to back, neck or shoulders pain or musculoskeletal disorders.¹¹

This article provides a brief review of literature on musculoskeletal disorders in clinical dentistry and various strategies of their prevention with a special emphasis on the neutral position for the clinicians and dental operators with an aim that it should help the dental operators to prevent these injuries and to work effectively and efficiently.

Prevalence of Musculoskeletal Disorders in Dentistry

There are many studies regarding musculoskeletal disorders experienced by persons working in the dental field that have used surveys to assess pain perception. Although they vary in scope and objective, a targeted look at the upper back, neck, shoulders and wrists is common in all of the studies.

Several studies have indicated that back, neck and shoulder pain are a major problem among dentists. Six studies, in particular, polled respondents over a period of 1 to 5 years and reported that over half of the participating dentists experienced musculoskeletal pain.¹²⁻¹⁴ However, all of these studies focused primarily on the physiological effects of prolonged postures occurring in the neck and shoulder region.

When dentistry changed from a standing job to a sit down task, musculoskeletal pain in the neck and shoulder region became more prevalent. This may explain the eventual focus on these areas. However, musculoskeletal pain in the lower back, regardless of occupation, remains a constant cause of

loss of work for dentists and should be equally examined. Because dentists spend long hours hunched over their patients with their arms raised and their hands positioned relative to their patients' mouths, unsupported stress is placed on the muscles of the lower back. A study by McGill et al explains how prolonged static contractions of the lumbar erector spine decreases oxygenation levels in the muscle. When this happens, lactic acid and metabolites accumulate and causes the pain that one feels.¹⁵

The pain suffered by dentists may lead to reduced productivity in terms of missed time from work or reduced work hours and may also lead to inefficient movements while working, causing an increase in time spent per patient. Incidentally, Shugars et al report that dental professionals lose in excess of \$41 million annually because of musculoskeletal pain.¹² The rescheduling and/or cancelling of appointments of 1.3 million patients were also due to pain and discomfort suffered by their dentist. Therefore, not only will those engaged in dentistry benefit from a reduction of the chronic trauma often associated with the profession, but society as a whole will reap benefits in terms of efficiency and reliability of dentists and their practices.

In a study comparing Swedish and Australian dentists regarding working conditions and their mental well being, 376 dentists were polled with a response rate of 86% in Sweden and 71% in Australia.¹⁶ Correlations were made based on age, number of years working and residence. Work-family overload, scaling procedures, work relations, practicing in Australia, and being under 42 years of age were associated with more musculoskeletal disorders. The percentage of the total sample that reported the following complaints were: Physical fatigue: 18%, mental fatigue: 15%, headaches: 16% and anxiety: 13%.

Another study used telephone interviews to determine the prevalence of neck, shoulder, arm and hand discomfort in dentists and pharmacists.¹⁷ Fifty-one percent of dentists compared to 23% of pharmacists reported shoulder symptoms, and 44% of dentists and 26% of pharmacists suffered from neck pain. This indicates that shoulder-neck discomfort is more of a problem among dentists than pharmacists. These results lend support for further research regarding the postures commonly assumed by those working in the field of dentistry.

It is certainly plausible that the difficult work positions demand of dentists, including large cervical flexion and rotation, abducted arms, and repetitive precision-demanding handgrips, in comparison to pharmacists, could lead to the high levels of shoulder-neck discomfort reported.

Conventional wisdom suggests that by switching from standup dentistry to a seated practice with an assistant, one

would experience fewer incidences of lower back pain and more occurrences of neck and shoulder discomfort. Thus, the focus of most studies seemed to concentrate on the upper trapezius area when lower back pain and discomfort were prevalent. In a study by Biller, 65% of dentists surveyed experienced and complained of back pain.¹⁸ A study by McGill et al reported that 81% of dentists surveyed experienced and complained of neck, shoulder, wrist and back pain.¹⁵ These examples show how switching to a seated position has made little to no difference in the frequency of pain experienced by dentists in the lower back region.

In a study by Basset,¹⁹ 465 Canadian dentists were surveyed and 62% of the respondents reported lower back pain. Seventy percent of those reporting lower back pain/sought professional treatment for their discomfort, and 50% used exercise as a preventative tool and a means of relief. Thirty percent of those reporting lower back pain had missed days from work due to pain and discomfort. Diakow and Cassidy²⁰ found that 57% of their surveyed dentists suffered from back pain and this pain may be more prolonged than that experienced by the general population. They also indicated that the highest frequency of lower back pain was experienced by the 30- to 40-year-old age group.

Finally, an electromyographic study by Milerad et al,²¹ identifies the muscles placed under the most stress by routine dental work to be the shoulder, neck and arm muscles. Of these muscles investigated in the study, the trapezius muscles on each side of the body had the highest mean amplitude (expressed in % maximal reference contraction). The right trapezius mean was 9.0%, while the left was 7.6%.

Musculoskeletal Disorders seen in Dental Health Care Providers²²

Carpal Tunnel Syndrome

It is a painful disorder of the wrist and hand caused by compression of the median nerve within the carpal tunnel of the wrist. As the nerve fibers of the median nerve originate in the spinal cord in the neck; therefore poor posture can cause symptoms of CTs. Other causes include repeatedly bending the hand up, down, or from side to side at the wrist and continuously pinch-gripping an instrument without resting the muscles. It is characterized by numbness, pain, tingling in the thumb, index and middle fingers.²²

Ulnar Nerve Entrapment

It is a painful disorder of the lower arm and wrist caused by compression of the ulnar nerve of the arm as it passes through the wrist. It is caused by bending the hand up, down or from side to side at the wrist and holding the little finger

a full span away from the hand. It is characterized by numbness, tingling and/or loss of strength in the lower arm or wrist.²²

Pronator Syndrome

It is a painful disorder of the wrist and hand caused by compression of the median nerve between the two heads of the pronator teres muscle. It is caused by holding the arms away from the body. Symptoms are similar to carpal tunnel syndrome.²²

Tendinitis

A painful inflammation of the tendons of the wrist resulting from strain. It is caused by repeatedly extending the hand up or down at the wrist. It is characterized by pain in the wrist, especially on the outer edges of the hand, rather than the centre of the wrist.²²

Tenosynovitis

A painful inflammation of the tendons on the side of the wrist and at the base of the thumb. It is caused by hand twisting, forceful gripping, bending the hand back or to the side. It is characterized by pain on the side of the wrist and the base of the thumb, sometimes the movements of the wrist yields a crackling noise.²²

Extensor Wad Strain

A painful disorder of the fingers as a result of injury of the extensor muscles of the thumb and fingers. It is caused by extending the fingers independently of each other. It is characterized by numbness, pain and loss of strength in the fingers.²²

Thoracic Outlet Syndrome

A painful disorder of the fingers, hands and/or wrist as a result of the compression of the brachial nerve plexus and vessels between the neck and shoulders. It is caused by tilting the head forward, hunching the shoulders forward and continuously reaching overhead. It is characterized by numbness, tingling and/or pain in the fingers, hand or wrist.²²

Rotator Cuff Tendinitis

It is a painful inflammation of the muscle tendons in the shoulder region. It is caused by holding the elbow above waist level and holding the upper arm away from the body. It is characterized by severe pain and impaired function of the shoulder joint.²²

The Natural Spinal Curves

In standing postures, the spine has four natural curves when viewed from the side: cervical lordosis, thoracic kyphosis, lumbar lordosis and sacral kyphosis.²³ These curves are interdependent; a change in one curve will result in a change in the curve above or below it.²⁴ Because the sacral curve is composed of five fused vertebrae, its movement is extremely limited. However, the remaining curves—especially the lumbar and cervical curves—are more mobile and can be influenced more easily. When the curves of the spine are present and balanced against the center of gravity, the spine is supported mostly by the bony structures of the vertebrae resting on the top of one another. When these curves become either exaggerated or flattened, the spine increasingly depends on muscles, ligaments and soft tissues to maintain erect.

When sitting unsupported—a frequent posture in dentistry—the lumbar lordosis flattens. The bony infrastructure provides little support to the spine, which is now 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. This flattening of the lumbar curve also causes 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 occur.

Maintaining the cervical lordosis in the proper position is equally important. Forward-head postures are common among dentists. Holding the neck and head in unbalanced forward position to gain better visibility during treatment, 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.²⁵ This can result in pain patterns, which often is referred to as tension neck syndrome. This syndrome is characterized by headaches and chronic pain in the neck, shoulders and interscapular muscles. Sustained contraction of the cervical muscles also cause weakening of the spinal disks, with possible disk degeneration or herniation.²⁶ Therefore, frequent relaxing and stretching of the neck muscles, strengthening of the deep postural cervical lordosis in proper posture with all activities is essential for optimal musculoskeletal health of the neck.

A forward-head posture also can lead to muscle imbalances, contributing to a rounded shoulder posture. This posture can predispose the operator to impingement of the supraspinatus tendon in the shoulder (rotator cuff impingement) when reaching for items. Additionally, static posture of the arms in an elevated or abducted state of more than 30° impedes the blood flow to the supraspinatus muscle

and tendon. Prolonged arm abduction also can lead to trapezius myalgia—chronic pain and trigger points in the upper trapezius muscle.

To effectively prevent injuries in dentistry, prevention strategies and ergonomic techniques must address these postural and positioning difficulties, as well as subsequent detrimental physiological changes: muscle imbalances, stiff joints, muscle necrosis and spinal disk degeneration.

Concept of Neutral Position for the Clinician

Research indicates that over 80% of dental hygienists complain of pain in the upper body and back. This musculoskeletal pain is often the direct result of the body positioning and movements made by dental hygienists in their daily work. Neutral position is the ideal positioning of the body while performing work activities and is associated with decreased risk of musculoskeletal injury. It is generally believed that the more a joint deviates from neutral position, the greater the risk of injury.²²

Neutral seated position: Features are: forearms parallel to the floor, weight evenly balanced, thighs parallel to the floor, hip angle of 90°, seat height positioned low enough so that you are able to rest the heels of your feet on the floor (Figs 1 and 2).

Neutral neck position: The position that allow head tilt of 0 to 15° and to keep eye line as near to the vertical as possible. Head tipping to forward and tilting to one side should be avoided.

Neutral back position: The goal of neutral back position is to lean forward slightly from the waist or hips and trunk flexion of 0 to 20°. Overflexion of the spine should be avoided (Figs 1 and 3).

Neutral shoulder position: The aim of this position is to maintain the shoulders in a horizontal line and to evenly

balance the weight when seated. Shoulders should not be lifted toward ears or hunched forward (Figs 4 and 5).

Neutral upper arm position: The goal is to maintain upper arms parallel to the long axis of torso and elbows at waist level. One should avoid greater than 20° abduction away from the body (Figs 6 and 7).

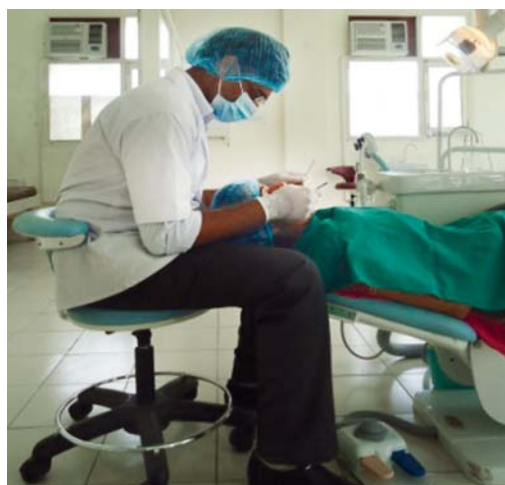


Fig. 2: Incorrect seated position



Fig. 3: Correct back position



Fig. 1: Neutral seated position



Fig. 4: Correct shoulder position

Neutral forearm position: Forearm should be kept parallel to the floor and can be raised or lowered accordingly by pivoting at the elbow joint. Angle between upper arm and forearm should be less than 60° (Figs 8 and 9).

Neutral hand position: Keep little finger side of palm slightly lower than thumbside of palm. The wrist should be aligned

with the forearm. Avoid bending of hand up and down²² (Figs 10 and 11).

Postural Awareness Techniques

Maintaining the low back curve: When sitting maintaining low back curve can reduce or prevent low back pain.^{27,28}



Fig. 5: Incorrect shoulder position



Fig. 8: Correct forearm position



Fig. 6: Correct upper arm position



Fig. 9: Incorrect forearm position



Fig. 7: Incorrect upper arm position



Fig. 10: Correct hand position

The best way to achieve low back curve is by tilting seat angle slightly forward 5 to 15° to increase the low back curve.²⁹ It increases hip angle to greater than 90°, which may allow for closer positioning to the patient.

A saddle-style operator stool should be taken in consideration as it promotes the natural low back curve by increasing hip angle to approximately 130°. Proper adjustment of chair to distribute the body weight evenly is required. The forward edge of the chair should not compress operator's thighs. Use lumbar support of the chair to support your back.

Use magnification systems: Use of magnification systems have been associated with decreased neck and low back pain as they allow operators to maintain healthier postures³⁰ (Fig. 12). Declination angle of the scopes should allow the operator to maintain less than 20° of neck flexion. Working in postures with greater than 20° of neck flexion have been associated with increased neck pain.³¹ One should try various telescopic models to determine which unit suits best to the operator.



Fig. 11: Incorrect hand position



Fig. 12: Use of magnification system

Adjust operator chair properly: Operators need to know, how to adjust their chairs to obtain maximal ergonomic benefits. A common mistake operator make is positioning the patient first and then adjusting their chairs to accommodate the patients. Allowances can be made when working with elderly or disabled patients. Operators should always sit in a neutral position.

There are many ergonomically, designed operator chairs available. Because of varied operator body sizes and needs, one should always try to use chair, which one is selecting for one's clinic or workplace. Many manufacturers and dealers should also allow for in-office trial periods enabling operators to evaluate best model, which suits their needs.

Positioning Strategies

Avoid static postures: As human body is made for movement and ever changing postures, the concept of a single correct work posture may be physiologically invalid.³² Some dental schools and educational programs stress the importance of using one 'home position while working' while it is important to use ergonomically correct positions and postures, some studies suggest that several home positions may be better than one.³³ Static postures can increase susceptibility to injury.¹

Operators should vary their work positions as often as possible to shift workload from one group of muscles to another.³⁴ Alternate between standing and sitting is also an effective alternative. One study revealed that dentist who worked solely in a seated position had more severe low back pain than did those who alternated between standing and sitting.³⁵

Repositioning the feet: Subtle changes in foot position can shift workload from one group of muscles to other, allow overloaded tissues to be replenished with nutrients.

Avoid twisting: Dentist should position the instruments within easy reach, so that repeated unilateral twisting can be avoided, which prevent the structural tissue damage and low back pain.^{36,37}

Periodic Breaks and Stretching

Studies suggest that the increase in operator pain since the 1960s may be due to longer work periods without breaks, due in part to the use of four handed dentistry techniques.^{19,26} Having operators take frequent breaks and reverse their positions is an integral in an effective injury prevention program.³⁸

Directional stretching can be done in or out of the operatory and can be incorporated in to a daily routine that facilitates balanced musculoskeletal health. Directional



Fig. 13: Stretching exercise for shoulders



Fig. 14: Stretching exercise for back and shoulders

stretching involves a rotation, side bending or extension component that generally is in the opposite direction of that in which the operator frequently works (Fig. 13).

Stretching increases blood flow to muscles, increases production of joint synovial fluid, reduces formation of trigger points, maintains normal joint range of motion, increases nutrient supply to vertebral disks, creates a relaxation response in the central nervous system, warms up the muscle before beginning to work, identifies tight structures that may be predisposed to injury.

Stretching during Microbreaks

To prevent injury to the muscles and other tissues, the operator should allow for rest periods to replenish and nourish the stressed structures. If these breaks are too far apart, the rate of damage will exceed the rate of repair, ultimately resulting in breakdown of the tissues (Figs 14 and 15).

Efficacy of microbreaks was evaluated by Mclean et al.³⁹ He reported that by complying with regularly scheduled microbreaks, the subjects had less discomfort and that the addition of 30 seconds microbreaks showed no detrimental effect on worker productivity. Other authors have pointed out to the efficacy of using micropauses and stretching during dental procedure.^{40,41}

Trigger points: These are tight bands of muscle, which feels like a small hard knot.⁴² When firm pressure is applied the trigger points are painful and may refer pain to another area. Self-administering trigger point therapy using a tennis ball or other small ball between the back and a wall or using a trigger point self-massage tool can be helpful.

Strengthening exercises: Specific strengthening exercises for the trunk and shoulder girdle should be performed to enhance the health and integrity of the spinal column,



Fig. 15: Stretching exercise for back and shoulders

maintain good working posture, optimize the function of the arms and hands and prevent injury.

Aerobic exercise: It should be performed three to four times a week for atleast 20 minutes. One major factor contributing to musculoskeletal disorder is decreased flow of nutrients and oxygen to the muscles.¹ Aerobic exercise increases blood flow to all the tissues and improves their ability to use oxygen. It also improves cardiovascular and cardiorespiratory function, lowers heart rate and blood pressure, reduces body fat, improves stress tolerance and increases mental acuity.⁴³

Stress management: It generally is accepted that dentistry can be a stressful occupation. Stress can elicit muscular contraction and pain especially in the trapezius muscle.⁴⁴ Various stress-reduction techniques can be employed by the operators.

Education: Injury prevention and dental ergonomics education still is in infancy.⁴⁵ Most dental practitioners have not been trained in these areas, and they have not developed

the skills and knowledge necessary to practice in a manner that is ergonomically correct. This lack of training is due in part to the need for more research and for better teaching tools and better informed and trained teachers. Dental operators can be taught to manage and prevent injuries effectively.

CONCLUSION

Available research supports the idea that musculoskeletal problems can be managed or alleviated effectively using a multifaceted approach that includes preventive strategies, proper selection and use of positioning techniques and frequent breaks with stretching and postural strengthening techniques. It is important that dentistry incorporate these strategies in to practice to facilitate balanced musculoskeletal health that will enable longer, healthier carriers, increase productivity, provide safer workplaces and prevent musculoskeletal disorders.

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