

## Short Communication

### Optimizing human factors in dentistry

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#### ABSTRACT

Occupational health hazards among dental professionals are on a continuous rise and they have a significant negative overall impact on daily life. This review is intended to provide the information regarding risk factors and to highlight the prevention strategies for optimizing human factors in dentistry. Risk factors among dentists are multifactorial, which can be categorized into biomechanical and psychosocial. To achieve a realistic target of safety and health at work, prevention is clearly the best approach; therefore, musculoskeletal disorders can be reduced through proper positioning of dental worker and patient, regular rest breaks, general good health, using ergonomic equipment, and exercises designed to counteract the particular risk factors for the dental occupation. However, substantial evidences are still required to elucidate the potential risk factors and to formulate effective prevention programs.

**Key Words:** Dental ergonomics, ergonomic culture, musculoskeletal disorders, occupational hazards, prevention strategies, risk factors

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## INTRODUCTION

Dentistry faces a serious threat because of the poor ergonomic practices. Occupational health hazards among dental professionals are on a continuous rise. Owing to a mismatch between the physical requirements of the job and the physical capacity of the human body, work-related musculoskeletal disorders (MSDs) are now increasingly common.

When applied to dentistry, ergonomics seeks to reduce cognitive and physical stress, prevent occupational diseases related to the practice of dentistry, and improve productivity, with better quality and greater comfort for both the professional and the patient.

## THE PRESENT SCENARIO

The concept of ergonomics in dentistry can be traced

back to 1950s when the first journal articles pertaining to dental ergonomics was published.<sup>[1]</sup> Since then, various studies have tried to refine the concept.

It has been observed among dentists worldwide that low back problems are the most common, followed by problems of the hand and wrist, neck and shoulders with more than one-third requiring medical care for MSDs and also requiring extended leave from their practice.<sup>[2,3]</sup> Moreover, hand paresthesia is now becoming increasingly common.<sup>[4]</sup>

Although dentists are reporting higher levels of psychosocial and physical work demand than dental hygienist and dental assistants, these factors are less associated with pain intensity or location. The overall pattern suggests somewhat parallel level of symptoms in dentists across various national systems, but different patterns of work culture.<sup>[5]</sup>

Significantly, more females are reporting neck symptoms and upper back symptoms are reported with higher rates for older and more experienced dentists.<sup>[3]</sup>

Consistently, high frequencies for neck and shoulder pain across the globe causing both discomfort and difficulty with daily functional activities, indicates a high level of severity.<sup>[2]</sup>

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Even the dental practitioner students are not an unexposed or symptom-free population. The prevalence of chronic MSD is reported to be high among them.<sup>[6]</sup> Female students report higher level of pain and also the neck and shoulders as the most affected regions, whereas back complaints are more commonly reported in male students.<sup>[7]</sup> Pain is generally related both to fatigue and to stress.

Although a number of these symptoms are not currently disabling, they have quite a high level of impact on chronic health, missed days and reduced income, early burn out and premature retirement, and also a significant negative overall impact on daily life.<sup>[2]</sup>

### WHY ARE DENTISTS AT RISK?

Risk factors among dentists are multifactorial, which can be categorized into biomechanical and psychosocial. Various risk factors include static and awkward postures (particularly in relation to neck and shoulder conditions), repetition and force (more commonly related to hand and arm conditions), poor lighting (both intensity and positioning), improper positioning of both patient and dental worker, poor working conditions and instrument designs, individual characteristics (physical conditioning, height, weight, general health, gender, and age), and stress.<sup>[2,8]</sup>

Dentists are bound to limited range of motion (constrained postures) resulting in isometric muscle contractions, difficulties in direct visualization (which causes awkward posture), visual demands requiring static postures, repetitive tasks for long periods including scaling and endodontic procedures, long surgical procedures, forceful clinical tasks

such as scaling, and high precision, and flexion for instrumentation.<sup>[9]</sup>

In dentists, head rotation, neck flexion, and the necessity of upper arm abduction for mirror usage are common risk factors for upper extremity disorders. Cervicobrachial disorders are more common among dentists who keep their head bent to the side and rotated. Risk for trapezius pain may also be heightened from holding the arm elevated for long periods, such as holding a mirror for indirect visualization. However, general practitioners tend to be susceptible to lower back and neck injuries due to prolonged static postures, but have relatively fewer repetitive-motion injuries.<sup>[10]</sup> It is also noted that dentists often rotate their necks to the left with side bending to the right for better visibility and this is likely to strengthen the muscles on one side while weakening the opposing muscles, thus resulting in the inability to rotate the neck to the right with side bending to the left. Similarly, the forward viewing posture frequently used by dental workers can lead to weakening of the stabilizer muscles of the shoulder blades, leading to rounded shoulder posture [Figures 1 and 2]. Association of headaches with neck and shoulder pain is also significant.<sup>[11]</sup>

The historic change in dental workers from standing posture to typically seated posture has not reduced the rate of MSD, but that the part of body affected has moved from the back to the neck, shoulders, and arms largely due to static postures combined with forceful, repetitive movements. Nowadays, dentists experience less varicosities of the legs, but more breakdowns of the upper back and extremities.<sup>[12]</sup>



**Figure 1:** Poor posture with curved back and forward head position leading to musculoskeletal disorders



**Figure 2:** Proper posture with straight back to avoid musculoskeletal disorders

Dental students work alone without assistants so they may be at a particular risk as they move into clinical practice. Left-handed students had shown to have higher MSD. Moreover, postural risk factors appear to be widely present in all dental occupations and also appear to be related to MSD symptoms, and these appear to increase cumulatively as students move into practice.<sup>[2]</sup>

Biomechanical risk factors are not the only risk factors that should be considered when examining MSDs in the dental population. Psychosocial factors include issues such as the organization of the job, job demands (number of workers seen and the hours worked), job control, style of supervision, and support among co-workers and others. Work - home conflicts have also been studied in relation to stress and related musculoskeletal pain.<sup>[2]</sup>

Exertion of force (extraction of teeth) and duration of force (injection of anesthetic/scaling) are also contributory to the MSDs. Risk factors are also related to “ergonomic causes” such as work station design (operator), tool design, work object (patient), work techniques, work organization (case load), and work environment (lighting).<sup>[1]</sup>

Historic trends toward higher efficiency (such as increased patient visits) also have increased MSD risks. In addition, there is also a relationship to personal characteristics (such as height), high visual demands, workplace organization, and lack of recovery time that adds to the risk of developing a MSD. Active leisure decreases the risk for upper extremity MSD, and work (including hours worked) and family overload increases the odds.<sup>[13]</sup>



**Figure 3:** Poor posture

## PREVENTION STRATEGIES

To achieve a realistic target of safety and health at work, prevention is clearly the best approach; hence, the preventive philosophy deserves considerable attention. MSDs can be reduced through proper positioning of dental worker and patient, regular rest breaks, general good health, and exercises designed to counteract the particular risk factors for the dental occupation. Postures to avoid include head forward, rounded shoulders, and bent back. Based on the available literature,<sup>[8,9,11,14-16]</sup> a few Prevention Guidelines can be summed up:

1. An adjustable ergonomic stool with lumbar and arm support and capability to rotate.
2. Dentists sitting with feet flat on floor and thighs parallel to the floor and dental assistants 4-6” higher and using a footrest on the stool [Figures 3 and 4].
3. Patients reclined fully with mouth at the dentist’s elbow height for maxillary arch tasks and lowered with a 20° incline (still with mouth at dentist’s elbow height) for mandibular arch tasks.
4. Proper lighting (such as for maxillary treatment, having the overhead light close to the operator’s line of vision) and indirect mirror viewing.
5. Using ×2 magnification, properly selected and positioned magnification systems can help reduce forward posture, including keeping forward flexion of the neck below 20°.
6. Regular resting from static postures particularly for the trapezius and forearm muscles, and from repetitive motions of the forearm and hand (minimum of 6 min per h and 10-15 min every 2-3 h).



**Figure 4:** Improved posture and body position: Straight back, thighs parallel to the floor, and full planter aspect of sole on the floor

7. Exercises during those breaks, such as relaxing the arms at the side and shaking, or moving limbs and muscles in the opposite direction of repetitive or static postures between patients (such as bending the neck backwards after prolonged forward tilt).
8. Alternating sitting and standing, and using properly adjusted armrests to reduce shoulder fatigue and allow reduced force due to more stable positioning of instruments.
9. Observing recommended practices for nutrition and regular leisure exercise, and using shoulder blade repositioning and chin tuck exercises for neck pain.
10. Choosing ergonomic dental instruments that are lighter weight to reduce shoulder and neck fatigue and effects from holding static postures.
11. Using dental instruments with appropriate design and with better handle sizes and shapes, to reduce the hand force.
12. Overall, wellbeing by promoting daily exercises, proper diet, and nutrition. There are Yoga Poses which can help to achieve toned Neck and Back Muscles, making them less susceptible to injuries. These poses also help in the rehabilitation of chronic neck and upper back pain. Few of such poses include easy pose (Sukhasana), single leg raises, shoulder

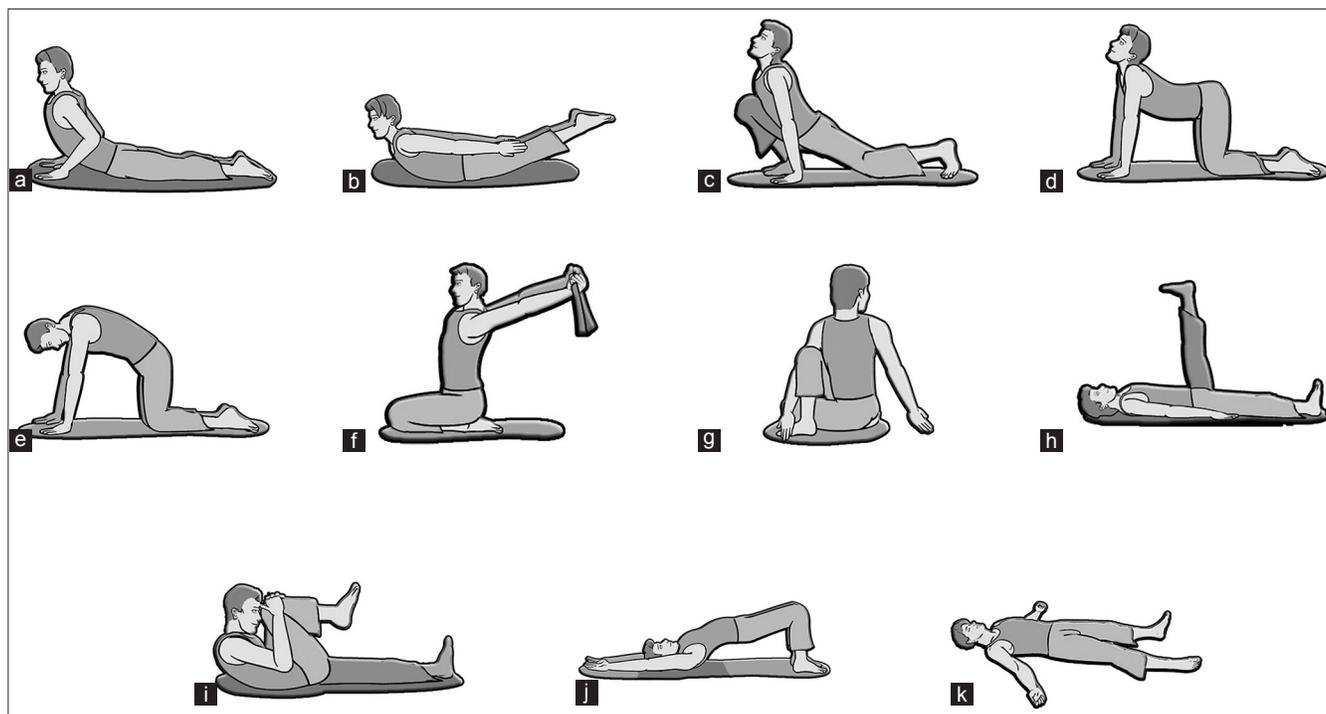
stretches, sun salutation (Surya Namaskar), half spinal twist (Ardha Matsyendrasana), wind relieving pose (Pavanmuktasana), relaxation pose (Savasana), Setu Bandhasana, Salabhasana, Bhujangasana, Adho Mukha Svanasana, and Bidalasana [Figure 5].

Qualitative responses suggest ergonomic design characteristics include patient chairs able to go sufficiently low (particularly for smaller stature dentists), adequate space in the room for moving the stool around easily, dental instruments that are sized properly for smaller hands and are lightweight, sufficient lighting, magnifying loupes available, and also addressing psychosocial issues such as control over scheduling, social isolation (hygienists tend to work alone, in contrast to dental assistants), inadequate recognition, and professional satisfaction.<sup>[17]</sup>

Such approaches can be developed for individual situations by evaluating individual characteristics and symptoms, postures, instrumentation, environmental, and organizational factors in relation to workplace improvements.

## DISCUSSION

There have been a number of general alarms that the practice of dentistry carries high risks of disabling



**Figure 5:** Yoga poses helpful to prevent neck, back, and shoulder disorders. (a) Bhujangasana, (b) Salabhasana, (c) Surya Namaskar, (d) Adho Mukha Svanasana, (e) Bidalasana, (f) shoulder stretches, (g) Ardha Matsyendrasana, (h) single leg raises, (i) Pavanmuktasana, (j) Setu Bandhasana, and (k) Savasana

disease and injury and potential premature career loss. MSD has significant social and economic consequences, including quitting the profession or significantly reducing working hours. Although ergonomic improvements in the dental setting have improved risk factors, they may be exacerbated by higher productivity demands in the profession generally and psychosocial considerations including social isolation. The literature presents with numerous studies but substantial evidence is still required to link the risk factors and to establish the effectiveness of the preventive measures.<sup>[15]</sup> Therefore, to elucidate the potential risk factors and to formulate effective prevention programs, interventional studies are the need for the hour. Moreover, the available data are concentrated around developed countries; therefore, in order to assess the risk factors in different working cultures, researches on this vital subject should be encouraged globally.

In the modern era, the concept of active ergonomics as well as combining health promotion concepts with ergonomics is gaining widespread support. It is based on theoretical models, general physical therapy and ergonomic principles.<sup>[2]</sup> Both these approaches suggest regular movement as important in reducing the impact, particularly of static postures. This includes regular movement and changing of postures over the work day, as well as integrating exercise, stretching (particularly in the opposite direction of static and repetitive workplace postures), yoga, and/or relaxation exercises.<sup>[18]</sup> Exercise and stretching also make sense from a biomechanical standpoint, but interventional studies are required to substantiate this view.

Moreover, a few recommendations can be made:

1. Formulating a prevention strategy by promoting training on both ergonomics practices (biomechanics) and stress (psychosocial and physical) reduction in dental schools. Also, including a separate course on ergonomics in the dentistry curriculum and periodically evaluating the ergonomic practices by students.
2. Promoting Continuing Dental Education programs on Dental ergonomics for the clinicians and also periodic Screening for MSDs-related symptoms to diagnose it early and treat promptly.
3. Formulating global guidelines for designing and developing ergonomic dental equipment and also setting up an international monitoring agency to prevent manufacturing and sale of non-ergonomic dental equipment.
4. Promoting the development of standards for interoperability and adoption of dental technology products.
5. Promoting high quality researches on this vital subject, globally. A useful first step would be to integrate and adopt user-centered design principles into research and development processes.
6. Welcoming collaborations among all healthcare professionals (dentistry, medicine, physiotherapy, etc.) and combined effort of personals from various disciplines (biomechanics, instrument designing and manufacturing industries, etc.) to prevent MSDs with focus upon examining the broad social and cultural contexts of disability for dental professionals, the prevalence and risk factors for MSDs, and unique solutions for MSD prevention.
7. Combining ergonomic interventions (chair redesigns, magnification and lighting, activity breaks, organizational changes, and creative use of part-time or rotating work) with health promotion activities (stretching that targets the under-utilized muscles, leisure exercise, and work-family conflicts) and evaluating the outcomes.
8. Promoting technology integration in the dental office as an essential measure for increasing the efficiency and efficacy of the dental care system. Moreover, successful integration requires the cooperation of many stakeholders, including the dental industry, academia, and the practicing community.

## CONCLUSION

Hence to conclude, there is a need of continuing interdisciplinary efforts to discover innovative prevention strategies, understand the larger systems issues, and appreciate the very damaging nature of poor ergonomic practices on the lives of dental practitioners.

Therefore, there is a call to make our contribution to this vital issue and to promote human factors in order to help the practitioners adopt the so called “ergonomic culture.”

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