

## Musculoskeletal Disorders and Ergonomic Risk Factors in Dental Practice

### Abstract

Ergonomics is the science of fitting the task to human capabilities and limitation in order to improve work place health safety and productivity. Manual work often imposes extensive strain on musculoskeletal system that culminates into musculoskeletal disorders (MSD) owing to poor ergonomics of the workplace. Modernization and automation in industries and offices has introduced a myriad of dexterous hand intensive work processes that are contributing to soft tissue injuries of upper extremities often termed as cumulative trauma disorders (CTD) which is a new age health issue affecting millions worldwide.

Dental profession is not immune from MSD or CTD. Reports of musculoskeletal symptoms among dental professionals are conspicuously high and manifested mainly as neck, shoulder, hand, arm wrist and low back pain.

Ergonomic characterization of dental work methods has revealed various occupational risk factors inherent in dental procedures and their contribution to a high degree of MSD observed among dentists. In addition, studies have also indicated a significant amount of contribution from non-occupational factors as causative agent for MSDs.

Well planned ergonomic intervention program can reduce the overall burden of this problem. Ergonomic training and awareness among dental professionals and students is therefore highly recommended.

### Key Words

Musculoskeletal disorders, Cumulative trauma disorders, Dentistry, Ergonomic risks

### Introduction

The word 'Ergonomics' was derived from the Greek words: 'Ergon' which means work; and 'nomos' meaning natural laws. The very root of this comparatively young branch of science goes back to the early 1900s, but it appeared as an identifiable profession in late 1940 after world war –II. An insight into the accidents of bomber pilots of similar nature revealed a mismatch between cockpit design (controls and displays) and the limitation of the capabilities of the pilots. It was emphasized that in all working conditions, the human limits and capabilities should be studied prior to job or machine design. Thus 'Ergonomics' emerges as a technique that brings together several disciplines to solve problems arising from the incompatibility of man, machine and work environment. The international Labor Organization (ILO) defines ergonomics as 'the application of human biological sciences in conjunction with the engineering sciences to achieve the optimal mutual adjustment of man and his work, the benefits being measured in terms of human efficiency and well being. In simpler terms, it can be defined as a science of fitting the physical, physiological and psychological requirement of a job to the

capabilities of the workers with the goal of making the workplace more comfortable in order to improve health, safety and productivity. The principles of ergonomics touch all aspects of our life and can be applied in work place, at home and even in recreational and leisure activities.

### Musculoskeletal Disorders (MSD)

According to World Health Organization about 58% of the world's population over the age of 10 years spend one third of their time at work and about 30 – 50% of the workers are exposed to significant physical occupational hazards [1].

The manual exertions required for performing a task is one of the major areas of ergonomic consideration. This is often described in terms of cardio respiratory or musculoskeletal workload. As regards to the musculoskeletal workload, the work always brings with it an inevitable risk of mismatch between the mechanical capabilities of the worker and job demand in conjunction with improper work process, hand tool use and ambient conditions. Thus manual work often imposes strain on our musculoskeletal system that culminates into work related mechanical trauma often described as musculoskeletal disorders (MSD).

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MSDs were recognized as having occupational etiologic factors as early as the beginning of the 18th century. Italian physician Bernardino Ramazzini in his famous publication, *De Morbis Artificum* (Diseases of worker) first pointed out a definite relation between the manual work and the strain imposed on the musculoskeletal systems of our body which result in work related injuries.

After 1970's various occupational factors leading to MSD were examined using epidemiologic methods, and the work-relatedness of these conditions began appearing regularly in different scientific literatures which indicated that there exists a strong and consistent relationship between work exposure and MSDs [2-5]. Today MSDs appear to be the most common cause of severe long term pain and physical disability and account for 23% of total cost of illness. It has been estimated that between 50 – 70% of workforce in developing countries is at a risk of developing musculoskeletal disorder owing to the various ergonomic risks factors present in their workplace [6]. Studies have shown that these disorders can affect any part of the body, but the most affected areas are low back [7] neck, shoulder, elbow and wrist [8].

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

**Table 1 Signs and Symptoms of MSDs**

<p><b>Signs</b></p> <ul style="list-style-type: none"> <li>• Decreased range of motion</li> <li>• Loss of normal sensation</li> <li>• Decreased grip strength</li> <li>• Loss of normal movement</li> <li>• Loss of coordination</li> </ul> <p><b>Some Symptoms of MSDs</b></p> <ul style="list-style-type: none"> <li>• Excessive fatigue in the shoulders and neck</li> <li>• Tingling, burning, or other pain in arms</li> <li>• Weak grip, cramping of hands</li> <li>• Numbness in fingers and hands</li> <li>• Clumsiness and dropping of objects</li> <li>• Hypersensitivity in hands and fingers</li> </ul>
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**Cumulative Trauma Disorder (CTD) and Ergonomic risks factors**

The modern era has observed a radical change in both office and industrial work environment. The advent of automation and mechanization has introduced a myriad of dexterous hand-intensive work processes. Although these work methods are not very arduous in nature but involve various ergonomic risks factors that contribute to different soft tissue injuries and disorders of the nerve, tendons, tendon sheaths and muscles of the upper extremities, which are collectively referred to as Repetitive Strain Injury - RSI or Cumulative Trauma Disorders- CTD [8, 9, 10]. Today this is considered as a new age health issue that is affecting millions worldwide.

A number of ergonomic risk factors are responsible for this kind of injuries and can also precipitate and aggravate the condition. These factors include repetition, awkward posture, force, static exertion, and contact stress. **Table 2** provides a definition for these risks factors.

**Prevalence of MSD's among Dental Professionals**

Like all other occupations, the dental profession is also burdened with occupational health problems and hazards of various kinds among which the musculoskeletal disorder is a major one [11].

Although modern dentistry although considered as a least hazardous occupation [12] but still the risks of musculoskeletal disorders in dental practice remains conspicuously high. In the last two decades a considerable interest has grown in ergonomics and work related musculoskeletal disorders associated with dental practice. The prevalence of musculoskeletal disorders among dentists and other dental professionals is manifested mainly as neck shoulder hand wrist pain (also classified as upper extremity musculoskeletal disorder) and low back pain.

**Prevalence of Upper Extremity Musculoskeletal Disorder (UEMSD)**

High rates of occurrence of UEMSD in dental professionals are well documented, including regional neck and shoulder pain, shoulder tendonitis, neuropathy, tension neck syndrome and trapezius myalgia and carpal tunnel syndrome [13-18] A recent updated review on the prevalence of for neck symptoms has reported a rate of varying between 17-73% for dentists, 54-83% for dental hygienists and 38-62% for dental assistants. For shoulder symptoms, ranges were 20-65% for dentists, 27-76% for dental hygienists and 62% for dental assistants [19].

**Prevalence of low back pain**

A persistence low back pain has been defined as a pain in the lower back occurring for most of the time during last 12 months [20]. This is also considered as the annual prevalence of low back pain. Literatures revealed that annual prevalence rates for low

back pain are quite high in dental profession. A self reported annual prevalence of LBP was found to be 50% and 55% for Danish and Israel dentist [21,22]. Similar reports of 54% prevalence of LBP were obtained for Australian (Queensland) [23] and Flemish dentists in Belgium [24]. However some higher rates of LBP of 64% and 74% was reported among dentists of New South Wales , Australia and Saudi Arabia respectively [25, 16]. A lower rate of 43% was reported among Hong Kong dentists [26].

**Ergonomic risk factors in dental procedures.**

In conjunction with the prevalence study of MSDs among the dentists, researches have also focused on ergonomic characterization of dentists work. These studies have revealed various ergonomic risks factors associated with dental procedures contributing to MSDs.

Awkward postures have been identified as the major etiologic factor for upper extremity musculoskeletal disorders. The range of awkward occupational postures may include pinch grips, wrists deviations, ulnar /radial bending forearm pronation/ supination, shoulder elevation / abduction, neck rotation and flexion. All these postures are associated with a variety of upper extremity CTDs [27] and are influenced by the interaction of many occupational and individual factors including work station layout, equipment and tool features and workers anthropometry [28].

Modern seated dentistry is more ergonomically designed than the old standing procedures. Research suggested that this transition from a standing to seated posture, has not reduced the prevalence rate of MSD [25] but part of body affected has moved from the lower back to the neck, shoulders, and arms [29].

The work of a dentist is conducted in a small 2/ 2½ inch workplace which represents the

**Table 2. Definitions Of Various Workplace Risk Factors Contributing To CTS**

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, centred position.
Force	Performing an activity with excessive muscular exertion, estimated as percentage of maximal voluntary contraction (% MVC).
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.

patient's mouth. The work procedures are extremely precise and require steady hands and often require repeated or sustained muscular exertions with limited range of motion. Moreover, improper positioning of both patient and dental worker often increases the static work load and awkwardness of their postures particularly in relation to neck and shoulder conditions. There is a well -documented relationship that these types of work characteristics is a major etiologic factor for upper extremity musculoskeletal discomfort for dentists [30, 31]. Problems such as rotator cuff syndrome, tension neck syndrome (TNS), involving painful neck spasms and trigger points, have also been found to be associated dental hygiene work [31].

Observational studies on dental procedures have revealed a high frequency of neck bending [16] and neck flexion [21] during work period which was found to be well correlated occurrence of cervicobrachial disorders among the dentists [32]. Along with awkward head and neck postures the work also required to hold the upper arm to be elevated for a prolonged period of time. Studies have revealed that these create a high static muscle load in the neck and shoulder regions particularly in the trapezius [29] and supraspinatus muscle [21, 33].

Dental procedures are also visually demanding. Difficulties in direct visualization inside the mouth also cause awkward posture. Dentists often rotate their necks to the left with the side bend to the right for better visibility. In a study it was noted that 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 [32]. 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 [29].

Studies have also indicated that handedness was a clear determinant of whether dentists left or right sided pain [18]. Forward leaning postures are also common in dentistry which was also found to be a significant contributor in increasing the neck and shoulder pain of dentists [34].

Various endodontic and surgical procedures require long time. Forceful clinical tasks such as scaling requires wrist flexion for grasping small vibrating tools in extremely awkward wrist postures with repetitive movements. These are identified as the causative occupational factors for carpal

tunnel syndrome [10]. Various studies have corroborated these factors with the occurrence of carpal tunnel syndrome, median nerve dysfunction and reduced tactile perception among dentists [35–40].

#### **Non - occupational risks factors**

The prevalence of MSD among dental practitioners appeared to be multifactorial; with a significant contribution from various confounding variables that include demographic and psychosocial and anthropometric factors. Working hours, work habits, gender, perceived level of stress, experience and personal characteristics [15, 23, 25, 41-43] all are found to be associated with MSD. There are also studies which report a high association of MSD with less work satisfaction, poor quality of health and more anxiety among dentists [44,45]. Besides there are various pre existing medical conditions that can acts as potential non- occupational risks factors for CTD observed among dental practitioners.

#### **Application of Ergonomic principles can help in reducing MSD**

In spite of various positive epidemiological findings there is still an ongoing debate on the potentiality of various risk factors of dental procedures in causing MSD among dentists [46, 47]. These studies have indicated that establishing a relationship between the dental tasks and ergonomically related disorders remains speculative. Quantification of the exposure to ergonomic risk factors in dental practice appears to be the most important fact in order to gain a much detail insight on the potentiality of the dental procedures on the causation of MSD. Thus a need for more systematic ergonomic studies aiming at analyzing various dental tasks both qualitatively and quantitatively has been indicated.

Ergonomic studies have indicated that regular periodic rest periods and job rotation can be used effectively to reduce the incidence of CTD in different group of workers [48]. This can also be introduced in dental practices to reduce the overall job stain and occurrence of MSD among dental practitioners. Improvement of hand tool design is also effective in reducing the ergonomic risk factors for CTD [49]. Majority of the dental instruments are held in pinch grip. Therefore changing the handle design may offer an inexpensive opportunity for reducing hand wrist stress during dental practice [47].

#### **Conclusion and Recommendation**

Musculoskeletal disorders are high among dentists. Pain in low back, neck, shoulder , hand and wrist and some associated musculoskeletal disorders and injuries are a major health problem for dental practitioners. These disorders and injuries may result in absence from work for extended periods away from work that may decrease work performance, job satisfaction and can also increase anxiety and stress.

It seems that there is a wide scope of reducing various problems arising out of dental practices. Principles of design ergonomics can be applied for redesigning of work station and work tools to promote more neutral working postures. Well organized job rotation and tasks planning can be introduced to reduce the cumulative musculoskeletal stress that may appear from prolonged work exposure. Furthermore, dentists could be trained for increasing the awareness of various ergonomic issues. These sorts of training can encourage them in adapting micro breaks during their jobs and to practice some regime of flexibility and strengthening exercises. This can be a great help in reducing the overall burden of musculoskeletal work load among dentists.

In spite of a multitude of overseas literatures available on MSD among dentists, studies among Indian dentist on similar issues are conspicuously low. This may be due to the fact that Ergonomics as a subject is still not that popular and has been not added in regular curriculum of different Varsities. Therefore it seems natural that awareness about good ergonomic practices is lacking among general population and the dentists are also no exception. In this context it therefore appears that the Dental Council of India should take interest in ergonomic issues as these concepts are extremely important for dental offices. Initiative should also be taken to include the subject as a part of dental curriculum particularly in bachelor level. This will not only help to build ergonomic awareness among dental students but will also widen the scope of ergonomic research in the context of dental practices.

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