Ergonomics in Periodontics

Abstract: Ergonomics is one of the most important and crucial aspects in dental profession. Its goal being connecting most efficiently and securely people and things at the workplace. In dentistry the postures assumed by dental surgeons during their professional work has an enormous effect on their body. And they are becoming more prone to musculoskeletal disorders. The successful application of ergonomics assures high productivity, avoidance of illnesses and injuries, and increased satisfaction among workers. The branch of Periodontics in particular is the one where time consuming ultrasonic scaling and extensively long surgical procedures are performed. Owing to this, the muscles used for this purpose are at risk of becoming fatigued causing discomfort to the practitioner. Thus this review article focuses on the possible ill effects of incorrect postures and various methods to stabilize the dental operator to allow the operator to work with comfort, efficiency, and ease.

Keywords: Ergonomics, Musculoskeletal disorders, Operator position, Delivery systems, Postures, Magnification, Instrumentation.

INTRODUCTION

“Take care of your body. It's the only place you have to live” - Jim Rohn.

Dentistry is a social interaction between helper and recipient in their limited job setting and with personal characteristics (Sarkar et al., 2012). A fit dentist is one of the most significant constituents in an efficacious dental practice. It is vitally important for each dental practitioner to till in correct stance and form in order to maintain an upright function & health. It is estimated that more than half of practitioners have some kind of painful musculoskeletal disorder that is work related. 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. Studies by Gorter et al., in 2000 show that one out of ten dentist’s reports having poor general health and three out of ten dentists report having poor physical state (Gorter et al., 2000). Literature suggests that the prevalence of skeletal or muscular pain in dentists, dental hygienists and dental students ranges from 93% to 64%. The most prevalent regions for pain in dentists have been shown to be the back (36.3% - 60.1%) and neck (19.5 - 80%) (Biswas et al., 2012). Dentists and dental hygienists are at risk for work related musculoskeletal disorders compared to the general population. The most frequent injuries occur in the spine (neck and back), shoulders, elbows and hands. Although the causes of any particular case of a MSD are exceedingly difficult to identify with complete accuracy, certain risk factors are typically discussed in the field of ergonomic studies (Fish et al., 1998). Burke et al., found that 29.5% of dentists suffer from musculoskeletal disorders which lead to early retirement of dental practitioners (Hayes et al., 2010). Thus it is necessary to know seriousness of effective & proper ergonomic design in dental practice in order to prevent from musculoskeletal disorders (MSDs) another posture related injuries that develops over time & can later lead to long-term disability (Das et al., 2018). To overcome this kind of health hazards, dentists and their team should work in an ergonomic environment (Sakweski et al., 2014).

Ergonomics

Ergonomics can be defined as an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely” (Gupta et al., 2014). The term ergonomics is derived from “Greek” words “ergon” and “nomos” in which “ergon” means work and “nomos” means natural laws. Thus Ergonomics is a study of how the human body can be best used for maximum comfort, efficiency, safety, and productivity (Supe et al., 2010). Ergonomics, as a discipline, has its formal beginnings immediately after the Second World War. During this time, the focus of concern expanded to include worker safety, as well as productivity. The studies of efficiency carried out by psychologists on Pilots, Radar, and Sonar operators in Great Britain during the war and immediately after it, showed the importance of designing technologies that should adapt sizably, statically, and dynamically to the human body and that should stimulate the physical and mental status of the human beings (Waterson P, 2011).
International Ergonomic Association defines Ergonomics (or human factors) as “the scientific discipline concerned with the understanding of the interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to design, in order to optimize human well-being and overall system”. The goal is to allow people to perform work and other activities safely and efficiently. The basic principle in ergonomics is to match tools, equipment, and work methods to the needs of the worker in order to enable him/her perform comfortably to his/her best. Thus, the need is to recognize conditions that lead to discomfort and implement changes to minimize or eliminate those conditions (Shaik A R., 2015). Modern ergonomics is an interdisciplinary applied science that studies the optimization possibilities of the man machine system design by knowing the human’s physical and mental possibilities and limits, his/her capacity to learn, the factors generating errors, the work, the physiology, the human behavior as an individual and within a team, the managerial possibilities, the organizational culture (interdisciplinary study of anatomy, physiology, psychology, management), and the technical and designing possibilities (engineering, design) (International Ergonomic Association, 2000).

Contribution and Evolution of dental chairs in dental ergonomics

Dentist getting a good look inside the patient’s mouth requires the patient to be lower than the doctor. Thus mankind has tinkered for centuries with the optimum dental chair design. Dental chairs have become a testing ground for high tech wizardry and ergonomics, evolving from decorative Victorian models to space-age pods with insect-like composite limb attachments.

The foreground for the improvement in providing proper treatment lead to the alteration in the design of the dental chair. The first chair to be used specifically in the dental office was designed by Josiah Flagg in 1790 when he added a headrest to an armchair and can be said that this was done not keeping in mind about the ergonomics associated with it. Innovations in dental chair design improved and multiplied, and by the late 1800s, over eighty different chair designs could be found on the market which came with forward and backward tilt and vertical adjustments. In the 1940s the dental chairs came up with working hydraulics that improved the workability and adjustability of the chairs.

In the 21st Century dentist chair upholstered in vinyl material and semi-automatic to fully adjustable chairs with foot control were made available. Ergonomic chairs are available in market which reduces the amount of stress and fatigue caused to dentist during treatment. As an experienced manufacturer of dental chairs, such as Pelton & Crane has combined critical elements to create the ergonomic chairs. Sleek lines and quiet movements contribute to a stylish aesthetic and relaxing environment, while ergonomic design and massage technology put the patient at ease. Designed with efficiency in mind, the dentist chair offers ergonomically-positioned touchpads to control motion, and is available in a narrow back and traditional back versions.(Fig 1).
Goals of Ergonomics (Pendyala S et al., 2014)
- Prevention of work related musculoskeletal disorders and conditions which might lead to it
- Increasing safety and productivity
- Enhanced performance by eliminating unnecessary effort
- Improving the standard of care to the patient

Ergonomics in periodontics
Periodontics is an integral part of dentistry and one of the branches of dentistry where time consuming ultrasonic scaling and extensively long surgical procedures are performed. These procedures increase the exposure of the periodontist to work related musculoskeletal disorders. The unremitting vibration of the rotary and ultrasonic tools, the grasp of the hand instruments which are long and thin with deficient lightning of the work area and the extensive stressful hours make life difficult for a periodontist. What do these difficulties if not dealt with are going to cause? And how these can be managed? We will answer these questions in the upcoming paragraphs.

Musculoskeletal disorders
The world health organization defines MSD as “a disorder of the muscles, tendons, joints, intervertebral discs, peripheral nerves and vascular system, not directly resulting from an acute or instantaneous event but installing gradually and chronically.” Cumulative trauma disorders (CTDs) are health disorders arising from repeated biomechanical stress to the hands, wrist, elbows, shoulders, neck and back (Kaur M et al., 2019).

Periodontists at risk for musculoskeletal disorders
Awkward postures or positions of the body that significantly deviate from neutral position while performing different scaling and root planning strokes as shown in the figure 2.

Fig 2
Static postures are again the risk factors those which if held for a long period of time during the mucogingival or the periodontal pocket therapy procedures and may result in fatigue and injury.

Force is another factor which is the amount of physical effort required to maintain control of equipment or tools, or to perform a task. As in cases of hand scaling and root planning

Repetitive movements can result in the risk of developing an MSD increases when same parts of body are used continuously with few breaks, like scaling, root planning.

Contact stress is one more factor that results from occasional, repeated, or continuous contact between sensitive body tissues and hard or sharp objects like resting the wrist on the edge of a desk, or tool handles of periodontal instruments pressing into palms.

Classification of MSDs
- Nerve Disorders: Carpal tunnel syndrome, Ulnar neuropathy.
- Disorders of the Shoulder: Trapezius myalgia, Rotator cuff tendinitis, Rotator cuff tears, & adhesive capsulitis.
- Disorders of the Elbow, Forearm & Wrist: deQuervains disease, Tendonitis, Tenosynovitis, Epicondylitis.
- Disorders of the Back: Low back pain (LBP), Upper back pain

Mechanisms MSDs in Periodontics
Prolonged Static Postures (PSPs): When the human body is subjected repeatedly to PSPs, as you can notice in majority of the periodontal procedures it can initiate a series of events that may result in pain, injury or a career-ending MSD.

Muscle Ischemia/Necrosis and Imbalances: During the periodontal treatment, operators strive to maintain a neutral, balanced posture and find themselves in sustained awkward postures. These postures often lead to stressed and shortened muscles which can become ischemic and painful, exerting asymmetrical forces that can cause misalignment of the spinal column.

Hypomobile Joints: During periods of PSPs or when joints are restricted due to muscle contractions, synovial fluid production is reduced and joint hypo mobility may result.

Spinal Disc Herniation and Degeneration: In unsupported sitting, pressure in the lumbar spinal discs increases. During forward flexion and rotation, the pressure increases further and makes the spine & disc vulnerable to injury

Neck and Shoulder Injury: Repetitive neck movements and continuous arm and hand movements as in scaling and root planning affect the neck and shoulder and demonstrate significant associations with neck MSDs.
Carpal-Tunnel Syndrome (CTS): Repetitive wrist motions, especially while a pinch pressure is exerted by the fingers, have been linked to an increased incidence in developing CTS (Huntley, 1988). Symptoms can appear from any activity causing prolonged and increased pressure (passive or active) in the carpal canal. Researchers have highlighted that one of the predictors for the high prevalence of CTS among dental hygienists were their longer clinical period of repetitive movements when work was done on parts of the mouth that were difficult to access and required precise movement and control (Mangharam, 1998).

Low Back Pain: Low back discomfort has been associated with dental work in numerous studies.

Psychosocial Factors: Dentists with work related MSDs show a significant tendency to be more dissatisfied at work. They are burdened by anxiety, poor psychosomatic health and thus feel less confident with their future Table 1.

Table 1

<table>
<thead>
<tr>
<th>Body Parts Affected</th>
<th>Symptoms</th>
<th>Possible causes</th>
<th>Disease name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fingers</td>
<td>Pain at the base of the thumbs</td>
<td>Twisting &amp; gripping</td>
<td>De Quervain’s disease</td>
</tr>
<tr>
<td>Shoulders</td>
<td>Pain, stiffness</td>
<td>Working with hands above the head</td>
<td>Trigger finger</td>
</tr>
<tr>
<td>Hands, Wrist</td>
<td>Pain, swelling</td>
<td>Repetitive or forceful hand &amp; wrist motions</td>
<td>Tenosynovitis</td>
</tr>
<tr>
<td>Fingers, Hands</td>
<td>Tingling, numbness, severe pain; loss of feeling &amp; control</td>
<td>Exposure to vibration</td>
<td>Raynaud’s syndrome(white finger)</td>
</tr>
<tr>
<td>Fingers, Wrist</td>
<td>Tingling, numbness, severe pain; loss of strength, sensation in the thumbs, index, or middle half of the ring fingers</td>
<td>Repetitive &amp; forceful manual tasks without time to recover</td>
<td>Carpal tunnel syndrome(CTS)</td>
</tr>
<tr>
<td>Back</td>
<td>Low back pain, shooting pain or numbness in the upper legs</td>
<td>Inflexibilities around the hips &amp; pelvis; weakness of the stabilizers of the lumbar spine</td>
<td>Back disability</td>
</tr>
</tbody>
</table>

For prevention of musculoskeletal disorders in a periodontal setup these following points need to be considered:
- Handling of instruments
- Handling of equipments
- Work postures

Guidelines to prevent musculoskeletal disorders in the periodontal setup

Operator Position (Sanders M A et al., 2002)
- Always try to maintain an erect posture during all the periodontal procedures
- Use an adjustable chair with lumbar, thoracic and arm support in the periodontal setup
- Seat should be adjusted so that the operator knee is slightly below the hip level and thighs are 100-110 degree to the trunk with feet resting flat on the floor
- Always work close to your body
- The distance between the working field and eye should be 35–40 cm
- Minimize excessive wrist movements
- Avoid excessive finger movements
- Alternate work positions between sitting, standing and side of patient
- Adjust the height of your chair and the patient’s chair to a comfortable level
- Consider horizontal patient positioning
- Check the placement of the adjustable light.
- The instrument tray should be positioned below the treatment point so that instrument can be picked only by moving the forearm
- Patient should be positioned so that the operator achieves neutral posture
- Elbow forearm angle is close to 90 degree
- Bending body forward to 10 degree at hip joint (Sanders & Michalak-Turcotte, 2004). (Fig 3).

![Diagram of Operator Position](image-url)
Patient positioning (Kawaldeep K S et al., 2020)
- Supine position of patient is usually the effective way by which operator achieves neutral posture.
- Patient should be positioned in such a way that the patient’s mouth should be only slightly above the dentist’s elbow level.
- Shifting the positions of patients to supine, semi supine and trendelenburg helps to avoid any problems associated with circulation, cardiovascular and vertigo.
- There should be supplemental wrist/forearm support for operator.
- Articulating head rests should be provided.
- Swivel feature allows chair to rotate in the operatory.

Rheostat Positioning
Rheostat is a very important aspect of the periodontal setup and should be positioned so that the operator knee is about 90–100 degree angle (Alexopoulus, Staathi, & Charizani, 2004)

Light Illumination (Pendyala S et al., 2014)
The main goal of overhead lighting is to provide an even, shadow free, colour-corrected illumination that concentrates on the operating field. Another key point to be taken into consideration is the intensity ratio between task lighting (the dental operating light) and ambient room lighting which should not be greater than 3 to 1.6. Furthermore, the light source should be in the patient’s mid-sagittal plane; directly above and slightly behind the patient’s oral cavity, and 5° toward the head of the operator in the 12 o’clock position. Once the patient and operator are ergonomically positioned, the light source can be left far above the heads of both the operator and assistant which will not require adjustment during the procedure.

Proper Temperatures
Within the work environment, low room temperatures, manipulation of cold materials or instruments and exposure to cold air exhaust can contribute to low finger temperature. There are no standards for finger temperatures, but it is recommended that hands and fingers be kept above 25°C or 77°F to avoid detrimental effects on dexterity and grip strength.

Delivery Systems
Various delivery systems have advantages and disadvantages. When working in four-handed dentistry the dentist maintains a position around the operating field with limited hand, arm and body movement, and should best confine eye focus to the working field. Additionally, the dental equipment and instruments should be centered on the dental assistant. From an ergonomic viewpoint, over-the-head and over-the-patient delivery systems better allow the dental assistant to access the handpieces for bur changes or other operations.

Magnification (Pendyala S et al., 2014)
Dentist posture is ergonomically better while using magnification lenses compared to their posture while using regular safety glasses.

Use of normal safety glasses necessitates 20 degree forward head bending which leads to flattening of low back curve; in contrast, use of magnification scope utilizes zero degree forward head bending, hence better results are provided. Dentists should select the magnification that will support their position.

Factors considered include; working distance, depth of field, declination angle, convergence angle, magnification factor, lighting needs.

There are three basic magnification systems available:
- Single lens Loupes
- Galilean Loupes
- Prismatic Loupes

‘Magnification Continum’ is the term given to the growing number of magnification users (Sunnell, & Rucker, 2004) (Initially through naked eye progressing to the operating microscope).

The dental operating microscope is different from that of loupes in that it offers stereoscopic vision compared to loupes with its convergent vision. The operating microscope has multiple levels of magnification from low (2.1, 3.2x) to high levels (13-19x). Shadow free lighting is provided.
Other advantages include—improvement in precision of treatment, communication with patient (through live video), improved ergonomics, and increase ease of documentation.

Other newest technologies in the field of magnification include heads up display that involves a camera that is placed over patient and projects image to a monitor.

Other newer technological advances like CEREC helps the dentists to design and create all ceramic inlays, inlays, crowns, veneers for all teeth in one visit, by utilising digital impression technique there by eliminating the need for time consuming procedures.

**Instrumentation (Pendyala S et al., 2014)**

- Use Larger Diameter, balanced Instruments with hollow or resin handles: They increase tactile sensitivity and reduce clinician fatigue. Thin instruments are difficult to grasp and increase the chance of muscle cramping.
- Instrument sharpness: An instrument with a sharp blade will be less fatiguing to the clinician and contribute to the efficacy of work. Dull instruments require more force to be exerted.
- Handles should be textured to reduce slippage, but should not be contoured. Round, knurled handles are preferred.
- Grip design: Grip span should be curved and comfortably fit the palm of the hand (4”-5”) (Osuna, RDH, BS, & FAADH, 2006).
- Automatic Hand pieces: Lightweight, balanced models (cordless preferred), sufficient power, built-in light sources, easy activation and maintenance. Introduction of rotary instrument also lead to improved speed, efficiency and productivity.

**Gloves**

Each dental healthcare worker must have gloves of proper size and fit. Although the influence of gloves on hand discomfort has yet to be explored, they have been cited indirectly as a potential contributor to carpal tunnel syndrome.

**Body stretching exercises to prevent MSD’s:**

*Hand exercises to prevent the MSD’s*
CONCLUSION

A dentist can spend up to 60,000 hours in a lifetime working in tense and distorted positions, with consequent musculoskeletal problems. Dentistry does not lend itself to good posture; however, it is possible with instruction and practice to correct the harmful postural habits that may be the cause of such stress and pain.

Along with that, dental professionals are prone to unique muscle imbalances and require special exercise and ergonomic interventions to maintain optimal health during the course of their career. It is important to not only know what the effective interventions are, but also in what sequence to implement them. And also the faculty in the institutions are required to teach these principles on ‘need for dentist’s health’ basis rather than just as a curriculum since BDS first year so that prevention of MSDs can be implemented at primary level.

REFERENCES