

# Posture, Precision, and Prevention: A Comprehensive Review of Dental Ergonomics

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## Abstract

Ergonomics is an interdisciplinary field that studies the relationship between people and various systems, aiming to improve human welfare and optimize system efficiency. In dentistry, ergonomics plays a critical role in sustaining clinicians' competence, efficiency, and ability to deliver high-quality treatment throughout their careers. Given the confined working field of the oral cavity, which demands precision within mere millimetres and careful force application, dental professionals are required to maintain static postures that involve prolonged muscle contraction, often engaging nearly 50% of their musculature. This physical strain, if unmanaged, can lead to various musculoskeletal disorders (MSDs), compromising both practitioner health and patient care. This review aims to consolidate current literature on dental ergonomics, risk factors, the development of MSDs and techniques to improve ergonomics.

**Keywords:** Dentistry, Dental Ergonomics, Musculoskeletal disorders.

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## INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are a group of health conditions that affect the musculoskeletal system, including bones, muscles, tendons, ligaments, cartilage, blood vessels, and nerves, arising specifically from occupational activities. In their initial stages, these disorders often manifest as mild discomfort, pain, or localized fatigue, which can usually be managed through rest, ergonomic adjustments, or physical therapy. However, in the absence of timely intervention, ongoing exposure to ergonomic risk factors can result in chronic ailments like tendinitis, carpal tunnel syndrome, and disc degeneration, which may persist throughout a clinician's professional life, adversely affecting their productivity and overall well-being (Figure 1) [1,2].

In 1857, Polish scientist Wojciech Jastrzębowski introduced the term 'ergonomics,'

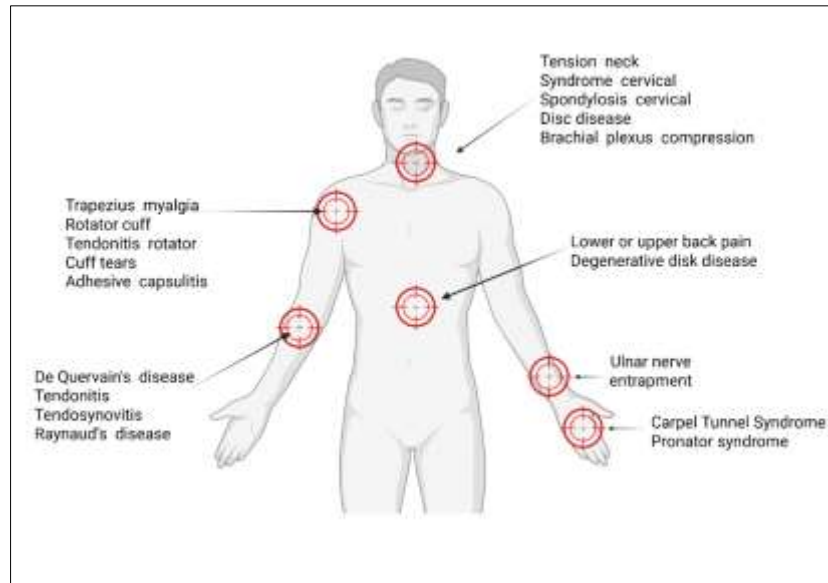
combining the Greek words 'ergo' meaning work and 'nomos' meaning law, to describe the study of human labor, its underlying principles, and efficiency [3]. Common occupational conditions that may contribute to WMSDs include repetitive lifting of heavy items, prolonged exposure to full-body vibration, working with the neck constantly flexed, performing overhead tasks, or engaging in forceful repetitive activities [4].

In dental practice, WMSDs are predominantly the result of cumulative trauma and are often classified as repetitive strain injuries. Dentists face significant risks due to the continuous use of fine instruments in repetitive actions, such as scaling or cavity preparation, as well as the use of vibrating tools like handpieces and ultrasonic scalers [5]. Additionally, the dental workspace requires practitioners to maintain awkward postures and non-neutral wrist positions for extended periods, further increasing the risk of developing WMSDs. Psychological and social factors such as job satisfaction,

workplace support, and work-life balance have also been linked to the onset of these disorders [6].

Lower back pain is reported in approximately one-third to one-half of all dental professionals [7,8]. Studies show a particularly high prevalence of WMSDs among dental hygienists (64%–93%) and dental students (48.5%–95%) [9]. Interestingly, recent research

indicates that the prevalence and severity of musculoskeletal issues are not significantly influenced by the dental specialty [10]. In another study, about 70% of dental healthcare workers reported having experienced musculoskeletal discomfort, underscoring the critical importance of promoting ergonomic awareness and practice early in a dental professional's career [11].



**Figure 1: Common musculoskeletal disorders related to dentistry**

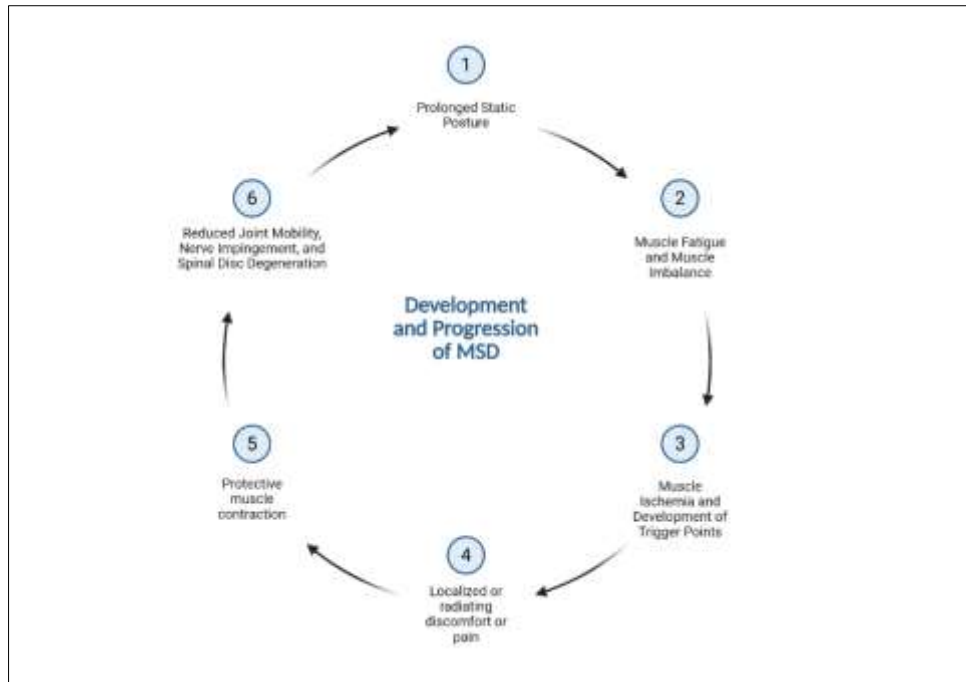
### Risk Factors

Prolonged periods of work combined with insufficient rest, along with repetitive movements of specific body parts, place continuous static pressure on certain regions. This often leads to symptoms such as discomfort, muscle spasms, tingling sensations, and joint stiffness. Consequently, a dentist's daily activities can be significantly affected over time, sometimes even resulting in premature retirement. Caballero *et al*.

conducted a study on ergonomic factors involving 83 dental students from the University of Colombia. Their findings revealed that 80% of the students experienced muscular discomfort related to clinical practice, 55% believed that minimizing unnecessary hand movements improved efficiency, and only 13% engaged in regular exercise during their education. Notably, surgical and periodontal specialties were associated with higher levels of occupational stress (Figures 2, 3) [12].



**Figure 2: Risk factors for musculoskeletal disorders**



**Figure 3: Development of musculoskeletal disorders**

### Ideal Ergonomic Posture in Dentistry

Ergonomics is a method of working smarter by providing tools, equipment, and workstations that allow practitioners to operate as efficiently and safely as possible. The utilization of appropriate ergonomic design is crucial for dental professionals to enhance efficiency, minimize injuries, and promote job satisfaction.

### Operator/Patient Positioning [13]

- Position yourself upright and sit back fully in the chair to achieve a stable and balanced posture.
- Keep the upper arms close to the sides of the body to provide support while performing procedures.
- Adjust the working height appropriately, allowing the forearms to be slightly elevated, ideally between 10° and 25°.
- Maintain an angle of approximately 110° or slightly more between the thighs and calves, with the legs slightly apart for stability.
- Maintain a working distance of approximately 35 to 40 cm between the dentist's eyes and the patient's mouth.
- Dentists should have the freedom to move within the 8:30 to 12:30 clock position for right-handed operators and from 3:30 to 11:30 for left-handed operators, positioning their legs comfortably beneath the patient's chair back.

### Four-handed dentistry

The vital role of dental assistants in enhancing dental practice is well established. Research has shown that their involvement not only decreases physical stress on the clinician but also improves procedural efficiency

by 16% to 70% [14, 15]. In four-handed dentistry, a properly trained dental assistant is responsible for managing and transferring instruments and equipment positioned within a short horizontal reach, typically between 14 and 25 inches. This setup ensures efficient and seamless instrument transfer to the operator. The collaborative nature of the four-handed technique promotes optimal working posture for both the dentist and the assistant while minimizing unnecessary movements [16].

### Six-handed dentistry

A high-powered microscope is essential for performing advanced surgical procedures. Tasks such as isolation, retraction, and material preparation can often require the assistance of an additional set of hands. In such settings, the first assistant works closely with the surgeon at the operative site, while the second assistant anticipates and supports the needs of both the primary assistant and the surgeon, ensuring smooth workflow and efficiency [17].

### Ergonomic office design and tools

Workstation layout focuses on positioning work objects in the most effective locations according to their intended function. Since every item cannot share the same space, applying basic ergonomic principles helps determine the most suitable placement. These principles address both the overall organization of the workspace and the specific arrangement of individual items within it [18,19].

1. **Importance Principle:** Objects that are most critical to the task should be positioned within the easiest reach.

2. **Frequency-of-Use Principle:** Items that are used most often should be placed in readily accessible locations.
3. **Function Principle:** Objects with similar functions should be organized together within the workspace.
4. **Sequence-of-Use Principle:** Tools and materials should be arranged in the order they are used during the procedure.

The dental operating light should be positioned near the dentist's head, slightly in front and to the side, ensuring that the light beam aligns parallel to the line of sight, with a maximum deviation of approximately 15°. Balanced Instruments with hollow or resin handles enhance tactile sensitivity and help minimize clinician fatigue. In contrast, thin-handled instruments can be harder to hold securely, raising the risk of muscle strain and cramping. Using a sharp instrument reduces the effort required by the clinician, improving efficiency and decreasing fatigue during procedures [20].

### Benefits of Indirect Vision and Magnification

In clinical practice, relying solely on direct vision during a full day of dental procedures leads to greater strain on the neck, causing increased head and neck flexion and elevated levels of discomfort compared to techniques that utilize indirect viewing [21]. The use of a dental mirror not only assists in retracting the lips and cheeks but also improves the visibility of surgical sites; by providing indirect vision through reflection, it helps dentists maintain better posture and avoid harmful ergonomic habits [22]. Dental headlights offer superior coaxial illumination, helping to enhance practitioner posture during procedures and minimize the need for frequent light adjustments [23]. Several studies have demonstrated that the use of magnification loupes combined with indirect vision techniques can reduce musculoskeletal discomfort by promoting better working postures and decreasing ergonomic risk scores [24]. However, visual misalignment issues may extend the adaptation period and lead to symptoms such as eye strain, headaches, and dizziness among dentists [25].



**Figure 4: Ideal ergonomic posture**

According to Hokwerda and Shaw, dentists are encouraged to adopt a more dynamic approach to their work posture. They argue that one of dentistry's key challenges is the work's static nature. Since the human body is designed for continuous motion, dynamic movement helps muscles act as pumps, supporting circulation and preventing stagnation. Frequent movement is essential for muscle recovery to counteract the effects of prolonged static posture [26].

Dentists can incorporate more motion into their routines through several strategies: [27,28]

1. Alternate between active and passive forms of sitting to promote dynamic seating.

2. Frequently shift working positions throughout the day.
3. Personally welcome patients in the waiting area to encourage movement.
4. Switch between standing and sitting during procedures, which requires adjustable chairs and equipment. Additionally, patients can be instructed to change their positioning when needed. Proper setup can also allow computer tasks to be performed while standing.
5. Install washbasins at a distance that requires getting up and walking, promoting brief physical activity.



6. Alternate between short and long procedures to vary physical demands.
7. Incorporate brief exercises such as finger flexion, deep breathing, and stretching during treatments.
8. Take short breaks between patient sessions to perform stretching exercises.
9. Schedule regular coffee, tea, or lunch breaks, ensuring a 10-minute break after every two hours of continuous work.
10. Engage in physical exercise at least twice a week to maintain muscle strength and flexibility.
11. Plan occasional getaways, such as short trips or educational courses, roughly every year to provide mental and physical relief.
12. Limit daily work hours to no more than eight hours to prevent fatigue and promote overall well-being.

### Physical exercises

Stretching exercises help relieve musculoskeletal pain, particularly in muscles like the iliocostalis lumborum, rhomboids, and upper trapezius [28,29]. Yoga also plays a major role in preventing and managing WMSDs, especially for dental professionals [30]. Frequent short stretches during chair-side breaks are more effective than longer, infrequent sessions. Stretching is most beneficial when combined with other pain management strategies [31]. Strengthening exercises alongside stretching can reduce WMSD risks, especially in the neck, shoulders, and lower back. Hand-strengthening activities, like using elastic putty, improve finger strength and coordination, enhancing periodontal skills. Resistance training programs over ten weeks have been shown to lower pain levels and increase neck and back strength, boosting overall muscular endurance and flexibility [32].

### Design of Dental Offices

Dental clinics are typically designed around patient-centred zones, placing reception and service areas near the entrance and separating them from workspaces. This layout reduces hallway congestion and patient confusion. Patient chairs are positioned close to the dental professional to minimize movement, improving efficiency and reducing strain [33].

Dental professionals often receive minimal training in creating ergonomic workspaces. Experts recommend the following for better posture and injury prevention: [34,35]

1. Sit at a proper height with stable body support; adjust the patient's mouth level near the operator's elbow to limit trunk bending.
2. Use adjustable clinician chairs offering back support, height control, and seat tilt.
3. Position client chairs to allow close access; adjust the patient's head position for optimal clinician posture.

4. Ensure the dental light is easily reachable.
5. Arrange the delivery system (tray) within 18-20 inches to avoid excessive reaching and promote efficient four-handed dentistry.

### Future Interventions

Advances in technology are offering new ways to help dentists prevent and manage WMSDs, improving both health and clinical performance. Promising innovations include: [36-38]

- Artificial intelligence: Monitors posture and health data, offering personalized preventive advice.
- Wearable devices and biomechanical monitoring: Detects poor posture and suggests immediate corrections.
- Robotic-assisted technology: Handles repetitive tasks, reducing physical strain.
- Virtual and augmented reality: Enhances training and surgical posture through immersive tools.
- 3D printing: Enables the creation of ergonomic, custom-designed instruments.
- Smart rehabilitation devices and biotechnology: Help reduce muscle fatigue and promote recovery.
- Virtual health assistants and digital education: Improve awareness about occupational health and preventive care.

Integrating these technologies aims to create safer, healthier workplaces for dentist, extending their careers and advancing the field.

### CONCLUSION

Maintaining good posture in dentistry is not a luxury; it is a necessity that requires a conscious rethinking of work habits rather than major investments. Adopting proper posture and ergonomics significantly enhances comfort, health, morale, productivity, and the overall readiness of dental professionals. Prompt recognition of ergonomic stress symptoms and early intervention can prevent long-term musculoskeletal damage. By minimizing fatigue and pain, clinicians can sustain the high-quality care that both they and their patients expect.

The prevention of WMSDs hinges on simple but crucial strategies. The organised operatory layouts, use of ergonomic equipment, regular stretching breaks, and correct body positioning are key steps. It is vital to remember that the human body is not designed to endure prolonged hours of static sitting. Visual demands in dentistry often lead to posture compromises; thus, magnification tools and coaxial lighting should be widely adopted. Moreover, dental schools must prioritize teaching ergonomic practices, including the correct use of microscopes, adjustable stools, and four-handed

dentistry techniques to streamline workflows and reduce physical strain.

An ergonomic approach benefits not only the physical but also the mental well-being of the dental team, ultimately leading to reduced stress, improved focus, and longer career longevity. Offices that integrate these principles will foster healthier work environments, promote better mental health, and ensure a sustainable future for the profession. In a field where precision and endurance are paramount, investing in ergonomic awareness and practices is a wise and necessary commitment not just for today's performance, but for the health and success of the dental team over the long term.

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