Review Article
Decoding the ergonomics in the new normal for dentistry: A narrative review

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ABSTRACT
Focus and precision are the sine qua non of dentistry, wherein the routine tasks require a peak pinch force and results in finger fatigue and cumulative trauma disorders combined with impaired vision. Dentists’ posture is treated with great care and oft repeated in Ergonomics, studied in undergraduate courses and the continuing education courses, though many still do not know the subject well enough. The study selection was done upon selecting the dental surgeons, hygienists, assistant working on their patients and included the findings relating to practice environment. The electronically searched sources until 2021 were the MEDLINE Pub med, EMBASE, Wiley Online Library, Science direct, American Dental Association (ADA) website and Google Scholar. An additional manual search and queries with cross-reference yielded around fifty studies ultimately. The International Ergonomic Association (IEA) recognized certain domains long ago and its noteworthy application for dental office is set forth in the present review. Ergo-dentistry may come to be realized as a new essential in the new normal for our profession.

Key Messages: Evidence echoes that dentists are at risk for developing health problems, particularly the musculoskeletal disorders and impaired vision. Beyond doubt, a healthy dentist is a pre-requisite for a successful dental practice. Ergodontics is the key to keep check on the same and following its core principles is essential.

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1. Introduction

Focus and precision are the sine qua non of dentistry during routine tasks so being knackered for working with a fixed posture on a very small area, is for sure and requires obvious attention. Indubitably, a healthy dentist is a pre-requisite for a successful practice and ergonomics is its core principle.¹ The word ergonomics has a Greek origin; “ergon” which stands for work and “nomos” implying law. The products and procedures are designed contemplating the top efficiency and safety,² thanks to this science of work³.³

Evidence echoes that dentists are at risk for developing health problems, particularly the musculoskeletal disorders (MSD) and impaired vision. A comparative study reported that MSD are the most expensive form of work disability in both financial and suffering, that can also lead to surgical need in advanced stage.⁴ A global average of 1/10 and 3/10 having poor health and bodily condition have been reported for dentists respectively,⁵ besides the musculoskeletal pain upto 93%.⁶ The studies concluded a high prevalence of back pain in Australia (54%), Brazil (58%), Denmark (59%), Taiwan (66%), Saudi Arabia (79%) and neck pain in Saudi Arabia (64%), Denmark (65%), Taiwan (72%);⁷ even pain elsewhere (upper and lower extremities).⁸

Periodontists’ scaling and root planning (SRP) is one of the most routinely performed task that requires a peak pinch
force and results in finger fatigue and resultant cumulative trauma disorders (CTDs). Pinch is a prehension pattern that uses fingers to manipulate items in coordination with thumb movements, without the contact of the palm. Physiotherapist is more familiar with CTD’s, ensuing months after the repeatedly strained arms and back. The authors pondered over the seemingly inevitable travail and presented dental application of International Ergonomic Association’s (IEA) domains in the present article.

2. Materials and Methods

Study selection was conducted as per standard guidelines for transparent reporting to include the documentation relating to working in dental set-up, participants being the dental surgeons, hygienists, assistant and patients. Electronic extraction was carried out activating filters, with the choice of pertinent keywords in MEDLINE Pub med, EMBASE, Wiley Online Library, Science direct, Science and American Dental Association (ADA) website and Google Scholar, searched until 2021 present. Additionally, a manual search and queries with cross-reference was performed, (Figure 1) nonetheless forty-six studies were included in the end.

[Fig. 1: Prisma flow diagram]

2.1. Overview of the human body

Corporal frame has been studied by artists, engineers, architects and medical practitioners throughout history. A Leonardo da Vinci’s -1490 creation- “The Vitruvian man,” (Figure 2) says it all. Our body is an intricate composite assembly, comprising the nervous system – governed musculoskeletal network. All the constituents; the organs, systems, tissues and cells are highly interdependent and work together to function as a whole. Presently, diseases like obesity, diabetes, cardiovascular disease, arthritis of joints, cancer is on the rise notwithstanding our ancestors had traditionally been hunters-cum-gatherers and so the body not designed to sit in one place.

[Fig. 2: Vitruvian man -Human form represented in symmetry and proportion]

2.2. MSDs in dentistry

The hand-operated tools are indispensable but rigorously using them leads to a cumulative isometric muscular contraction and in turn, repetitive stress injuries (RSI). Beyond doubt, dentists are retiring earlier due to the following:-

Table 1: Reasons for early retirement among dentists worldwide

| S. No | Attributes                      | % age occurrence |
|-------|---------------------------------|------------------|
| 1.    | Musculoskeletal disorders       | 29.5             |
| 2.    | Cardiovascular disease          | 21.2             |
| 3.    | Neurotic symptoms               | 16.5             |
| 4.    | Tumors                          | 7.6              |
| 5.    | Diseases of the nervous system  | 6.1              |

The ’ergo-dontics’ was proposed recently to deter MSDs i.e. “work related disorders of the musculoskeletal system having chronic gradual onset involving muscles, tendons, ligaments, joints, nerves, cartilage and spinal discs”, which can lead to long term disabilities (Table 1) In the present context, pain and headache are predominant and significantly prevalent among the group who worked in direct vision, without assistant, in standing position or following none of the fitness regimen. Further based on the literature search, the risk factors for MSDs were chalked up as dental-related vs. general (Table 2). The classification was put forth by Das et al. in this regard. (Table 3)
Table 2: Risk factors for musculo-skeletal disorders

| Risk factors                     | Basis/ Origin                                                                 |
|----------------------------------|-------------------------------------------------------------------------------|
| **Dental –related**              |                                                                               |
| Repetitions                      | Scaling & polishing procedures                                               |
| Forceful exertions               | Tooth extractions, long-duration surgeries                                    |
| Static postures                  | Static neck, back & shoulders                                                |
| Awkward postures                 | Handling of objects with the back bent/twisted than straight                  |
| Contact stress                   | Repeated contact with hard or sharp objects                                   |
| Duration                         | Grasping small instruments for prolonged periods, poorly fitting surgical gloves |
| Vibration                        | Prolonged use of vibrating hand tools                                        |
| Unacceptable operatory space design | Narrow working space                                                          |
| Improper work habits             | Improper positioning and adjustment of equipment, lack of rest/ recovery      |
| Visibility                       | Poor lighting for focus and in general                                        |
| **Others**                       |                                                                               |
| Medical conditions               | Poorly controlled systemic health                                             |
| Genetics                         | Single gene or multiple gene mutations                                       |
| Fitness level                    | Poor flexibility, obesity                                                    |
| Nutrition                        | Poor diet that lacks essential nutrients, a disease or medication that impairs absorption, or both |
| Environmental & psychosocial     | Family and peer relations, mental strain                                      |

Table 3: Classification of MSD’s

| S No. | Nerve Disorders | Disorders of the neck | Disorders of the Shoulder | Disorders of the Elbow, Forearm & Wrist | Disorders of the Back |
|-------|----------------|-----------------------|---------------------------|-----------------------------------------|-----------------------|
| 1.    | Carpal tunnel syndrome | Tension neck syndrome | Trapezius myalgia | De Quervains disease | Low back pain (LBP) |
| 2.    | Ulnar neuropathy | Cervical spondylosis | Rotator cuff tendonitis | Tendonitis | Upper back pain |
| 3.    | Cervical disc disease | Rotator cuff tears | | Tenosynovitis | |
| 4.    | Brachial plexus compression. | adhesive capsulitis | | Epicondylitis | |
| 5.    | | | | Raynaud’s disease | |

2.3. **Dentists’ neutral position**

It is believed that the more a joint deviate from the neutral position, the greater the risk of injury. The neutral position is the ideal positioning of the body while performing work activities for a proper blood circulation to the clinician’s legs, thighs, wrists and feet. Accordingly, the weight is evenly balanced with forearms and thighs parallel to the floor, the hip angle is 90 degree; and operator chair is positioned low enough to be able to rest feet on the floor.

(Figure 3 a)

Neutral neck position (Figure 3 b)

1. Head tilt of 0° to 15°
2. The line from your eyes to the treatment area should be as near to vertical as possible
3. Avoid neck flexed at >20°
4. Do not tip the head too far forward or tilt the head to one side

Neutral shoulder position (Figure 3 c)

1. Shoulders in horizontal line
2. Muscles relaxed
3. Weight evenly balanced when seated
4. Avoid lateral twisting of head and neck
5. Avoid side-bending of neck
6. Do not sit with weight on one hip

Neutral back position (Figure 3d)

1. Clinician may lean forward slightly from the waist or hips
2. Trunk flexion of 0° to 20°
3. Avoid standing with back curved

Neutral upper arm position (Figure 3e)

1. Upper arms hang in a vertical line parallel to long axis of torso
2. Elbows at waist level are held slightly away from the body
3. Avoid upper arms lifted upward

Neutral forearm position (Figure 3 f)
1. Forearms has to be held parallel to the floor
2. Raised or lowered, if necessary, by pivoting at the elbow joint
3. Avoid forming an angle between forearm and upper arm $< 60^\circ$

Neutral hand & wrist position
1. Little finger should be slightly lower than the thumb
2. Wrist aligned with forearm
3. Avoid pronation (rotating the forearm and hand inward, so that the thumb and little finger are level)

Every clinician (irrespective of being right- handed or left- handed) who uses the dental chair has to adjust it in the right way - the one that will fit his own body. (Tables 4 and 5 ) When working on positions 9-12 (or 12-3 for the left- handed) split your legs apart so that the base of the seat and your legs form a tripod. That is the most balanced and stable position. (Figure 3g)

Fig. 3: Dentists’ Neutral position a: Body’s neutral; b: Neutral neck position; c: Neutral shoulder position; d: Neutral back position; e: Neutral upper arm position; f: Neutral forearm position

2.4. Education for dentists

It is no secret that ‘knowledge is power’ and a good education has the power to change a life. What is only required for this transformation is to know the time for that change. Although the theme of dentist posture is treated with great care and often presented in the undergraduate courses and the continuing education courses, many dentists do not know the subject well enough nor the theoretical issues and therefore nor the practical applicability. Aperiodic inspection of specific clinical procedures incorporating the upcoming principles should be devised for dental teachings in the modern era. A diagnostic feedback on phantom jaws should be analyzed after certain time lest the noble field of ours becomes outdated.

Ergonomics has formed an integral aspect of dental education at the University of British Columbia since the early 1980s. However, studies continued to indicate that dentists are at risk for developing musculoskeletal problems. This provided the impetus for a study of the risk factors associated with these problems. Emphasis on teaching the biomechanical principles of instrumentation, positioning simulation, appropriate relaxation techniques followed by practical application of the principles at the clinical level, may help lessen developing musculoskeletal symptoms among dental and dental hygiene students. These may include specific training on reducing peak pinch force during SRP and relaxing the pinch grip between tooth areas.9

It was necessary to have a realization of dental ergonomics in Bulgaria until 2007, when it became a section in reformed curriculum to qualify as a public dental health worker. The same was revised and has been restructured continually since then for final year students in more ways than one.9

3. Discussion

Several practices were busted in the wake of the Covid-19 crisis. Today, when the same are craving revamping and revival; Dentistry is no exception. The present state of affairs obligates the need for not only immediate safety of the healthcare professionals, but also the cognizance of practice hazards emerging from treatment delivery in disconcerting manner. Ergo-dentistry may come to be realized as a new essential in the new normal situation for our profession.

IEA categorises ergonomics into the following domains:

3.1. Physical ergonomics

The posture refers to the manner in which different parts of the body are located, meaning to appropriately use the patient and dentist chair, or establishing correct method of instrumentation. The proper workstations may include comfortable edges of work surfaces, lumbar, thoracic or arm support in dentist’s chair, (Figure 4) adequate lighting, proper ventilation, and pleasant temperature. Fromusing light weight and textured instruments to hollow handle and 3/8 inch in diameter and syringes of adequate lumen size; all are practically advantageous. Studying a lighter instrument with a wider diameter; Dong et al, said that it required the least pinch force; and Rempel et al. believed that it reduced the upper-extremity pain. The light weight vibration handpiece with swivel mechanism and built-in light source, has an edge over the conventional types.
Table 4: Positioning for the Right-handed clinician

| Operator positioning zone | Treatment area                      | Patient position                  |
|---------------------------|-------------------------------------|----------------------------------|
| Middle zone               | Maxillary right posterior, lingual  | Toward, chin-up                  |
| (side to back position)   | Maxillary left posterior, facial    | Toward, chin-up                  |
| Front zone                | Maxillary right posterior, facial   | Straight, chin-up, away, chin-up  |
| (front to side position)  | Maxillary left posterior, lingual   | Straight, or turned slightly chin-up |
| Front zone                | Maxillary anterior, surfaces toward | Straight, or turned slightly chin-up |
| (front to side position)  | Maxillary anterior, surfaces away   | Straight, or turned slightly chin-up |
| Back zone                 | Mandibular right posterior, lingual | Toward, chin-down                |
| (back to directly behind) | Mandibular left posterior, facial   | Toward, chin-down                |
| Middle zone               | Mandibular right posterior, facial  | Straight, chin-down              |
| (side to back position)   | Mandibular left posterior, lingual  | Away, chin-down                  |
| Front zone                | Mandibular anterior, surfaces toward| Straight, or turned slightly chin-down |
| (front to side position)  | Mandibular anterior, surfaces away  | Straight, or turned slightly chin-down |

Table 5: Positioning for the left-handed clinician

| Operator positioning zone | Treatment area                      | Patient position                  |
|---------------------------|-------------------------------------|----------------------------------|
| Middle zone               | Maxillary right posterior, facial   | Toward, chin-up                  |
| (side to back position)   | Maxillary left posterior, lingual   | Toward, chin-up                  |
| Front zone                | Maxillary right posterior, lingual  | Away, chin-up                    |
| (front to side position)  | Maxillary left posterior, facial    | Straight, chin-down, away, chin-up |
| Front zone                | Maxillary anterior, surfaces toward | Straight, or turned slightly chin-up |
| (front to side position)  | Maxillary anterior, surfaces away   | Straight, or turned slightly chin-up |
| Back zone                 | Mandibular left posterior, facial   | Straight, chin-down              |
| (back to directly behind) | Mandibular right posterior, lingual | Toward, chin-down                |
| Front zone                | Mandibular anterior, surfaces toward| Toward, chin-down                |
| (front to side position)  | Mandibular anterior, surfaces away  | Toward, chin-down                |
| Middle zone               | Mandibular right posterior, lingual | Straight, or turned slightly chin-down |
| (side to back position)   | Mandibular left posterior, lingual  | Toward, chin-down                |
| Front zone                | Mandibular anterior, surfaces toward| Toward, chin-down                |
| (front to side position)  | Mandibular anterior, surfaces away  | Toward, chin-down                |
| Back zone                 | Mandibular anterior, surfaces away  | Straight, or turned slightly chin-down |

3.2. Cognitive ergonomics

Dentists appreciate that human mouth is a relatively small space in which to operate. Considering the size of the available instruments (burs, handpieces, etc.), magnifiers were explored among dental hygienists. When Ludwig et al. in their study subjected twenty-seven healthy hygienists to calculus identification on chair-mounted
typhodonts, a clear majority found it worth using and modifying it further.

Next to come were the Ergonomic microscopes, which according to the oral pathologists, not only improves workability, but reduces eye and back strain; and can have reproducible results. Microscopes were repeatedly used as low (3x-8x) and medium (8x-16x) to uncover details which are otherwise impossible. However, the subtle color variance between secondary and tertiary dentin in teeth with calcific metamorphosis requires a high (16x-30x) magnification. The current trend is Four-handed dentistry (FHD) i.e., two hands each of dental assistant and dentist when integrated with these gadgets. FHD, as a whole significantly enables the operator to remain in a prolonged static posture, thereby avoiding the extreme of the ergonomic motions hypothesized by Carr et al, which involves twisting or bending.

### 3.3. Organisational ergonomics

A Tehran study revealed that the multifaceted intervention, with a focus on improving working conditions, identifying ergonomic risk factors and discussion group meetings, could decrease the prevalence of musculoskeletal disorders in dentists. The exemplar below gives a coherent explanation of ergonomics in the modern dental set-ups. (Figure 5).

### 3.4. Yoga and stretching exercises

Yoga is defined as an ascetic discipline embracing distinct bodily postures (asanas), breath control and simple meditation. The activity meant for both prevention and rehabilitation, influences pain perception and is used for relaxation. Bhujangasan, padma sanasarvangasana, matsyasana, vipareetakarani mudra and pranayama are particularly relevant. Regular body Strengthening, stretching, relaxation techniques help improve the quality of life. The unequivocal systemic reviews and meta-analyses have expressed the issue explicitly. Although, the Telephysiotherapy digital sessions and acupressure have shown promise, but exercises and chair-side stretches are imperative to prescriptions for musculoskeletal insults; the same are illustrated below. (Figure 6) Remember to hold for two to four breath cycles while performing the above all. No wonder the little change in our lifestyle can make a huge difference in the way we can escape this health hazard.
which is gulping the entire dental fraternity worldwide, like a monster.  

3.5. Risk of bias

The data from the studies of Padhye et al9 and Rempel et al32 were flawless. Whilst former reported the use of a set of Gracey curettes, the latter used custom-designed instruments for performing SRP in patients. But the fact that manual dexterity varies amongst the subjects, is a potential source of error for force and/or pain assessment. Risk of statistical bias was present in the studies of Saxena et al33 and Dehghan et al.40 The latter reported the use of randomisation techniques and stated that they used a paired t-test to compare differences in prevalence. However, in the data tables they stated that they used repeated ANOVA test. Majority of reviews and clinical demonstrations have hitherto provided definite limitations. Further studies with a larger sample size that would increase the statistical power and be representative of age, gender, ethnicity and race more realistically should be undertaken.

4. Source of Funding

None.

5. Conflict of Interest

None.

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