



Review Article

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

Sumit Munjal^{1,*}, Seema Munjal²

¹Dept. of Periodontics, ITS Dental College, Greater Noida, Uttar Pradesh, India

²Dept. of Prosthodontics, ITS Dental College, Greater Noida, Uttar Pradesh, India



ARTICLE INFO

Article history:

Received 13-05-2021

Accepted 03-08-2021

Available online 28-08-2021

Keywords:

Dentistry

Ergonomics

Musculoskeletal disorders

Pinch force

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 work”.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

* Corresponding author.

E-mail address: ssmunjal1@gmail.com (S. Munjal).

force and results in finger fatigue⁹ and resultant cumulative trauma disorders (CTDs). Pinch is a prehension pattern that using fingers to manipulate items in coordination with thumb movements, without the contact of the palm.¹⁰ Physiotherapist is more familiar with CTD's, ensuing months after the repeatedly strained arms and back.¹¹ 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^{12,13} 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.

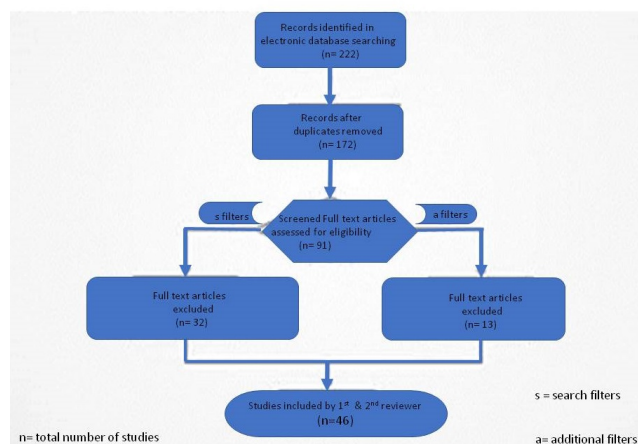


Fig. 1: Prisma flow diagram

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,"¹⁴ (Figure 2) says it all. Our body is an intricate composite assembly, comprising the nervous system – governed musculoskeletal network.¹⁵ 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 rise¹⁶ notwithstanding our ancestors had

traditionally been hunters -cum- gatherers and so the body not designed to sit in one place.

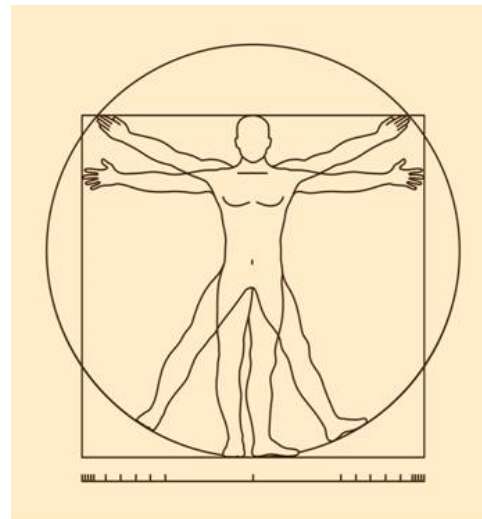


Fig. 2: Vitruvian man -Human form represented in symmetry and proportion

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 worldwide¹⁷

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 recently¹⁸ 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",¹⁹ which can lead to long term disabilities²⁰ (Table 1) In the present context, pain and headache are predominant^{6,18,19,21,22} and significantly prevalent among the group who worked in direct vision, without assistant, in standing position or following none of the fitness regimen.²³ 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,²² 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 activities²⁴ 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)

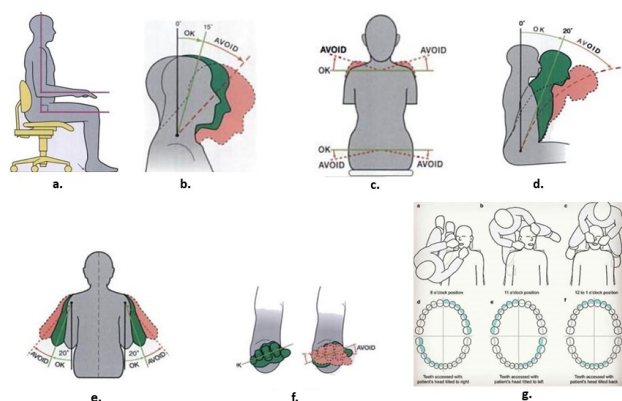


Fig. 3: Dentists' Neutral position **a:** Body's neutral; **b:** Neutral neck position; **c:** Neutral shoulder position; **d:** Neutral back position; **e:** Neutral upper arm position; **f:** Neutral forearm position

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.²⁵ A periodic 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.²⁶ 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.²⁷ 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.

IEA²⁸ 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,²⁵ 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,²⁹ and pleasant temperature.³⁰ From using light weight and textured instruments to hollow handle and 3/8 inch in diameter²⁴ and syringes of adequate lumen size;²² all are practically advantageous. Studying a lighter instrument with a wider diameter; Dong et al,³¹ said that it required the least pinch force; and Rempel et al.³² 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 (side to back position)	Maxillary right posterior, lingual Maxillary left posterior, facial	Toward, chin-up Toward, chin-up
Front zone (front to side position)	Maxillary right posterior, facial Maxillary left posterior, lingual	Straight, chin-up away, chin-up
Front zone (front to side position)	Maxillary anterior, surfaces toward	Straight, or turned slightly chin-up
Back zone (back to directly behind)	Maxillary anterior, surfaces away	Straight, or turned slightly chin-up
Middle zone (side to back position)	Mandibular right posterior, lingual Maxillary left posterior, facial	Toward, chin-down Toward, chin-down
Front zone (front to side position)	Mandibular right posterior, facial Mandibular left posterior, lingual	Straight, chin-down Away, chin-down
Front zone (front to side position)	Mandibular anterior, surfaces toward	Straight, or turned slightly chin-down
Back zone (back to directly behind)	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 (side to back Position)	Maxillary right posterior, facial Maxillary left posterior, lingual	Toward, chin-up Toward, chin-up
Front zone (front to side position)	Maxillary right posterior, lingual Maxillary left posterior, facial	Away, chin-up straight, chin-up
Front zone (front to side position)	Maxillary anterior, surfaces toward	Straight, or turned slightly chin-up
Back zone (back to directly behind)	Maxillary anterior, surfaces away	Straight, or turned slightly chin-up
Front zone (front to side position)	Mandibular left posterior, facial Mandibular right posterior, lingual	Straight, chin-down away, chin-down
Middle zone (side to back position)	Mandibular left posterior, lingual Mandibular right posterior, facial	Toward, chin-down Toward, chin-down
Front zone (front to side position)	Mandibular anterior, surfaces toward	Straight, or turned slightly chin-down
Back zone (back to directly behind)	Mandibular anterior, surfaces away	Straight or turned slightly chin-down



Fig. 4: Ergonomic chair models

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.^{33,34} When Ludwig et al,³³ in their study subjected twenty-seven healthy hygienists to calculus identification on chair-mounted

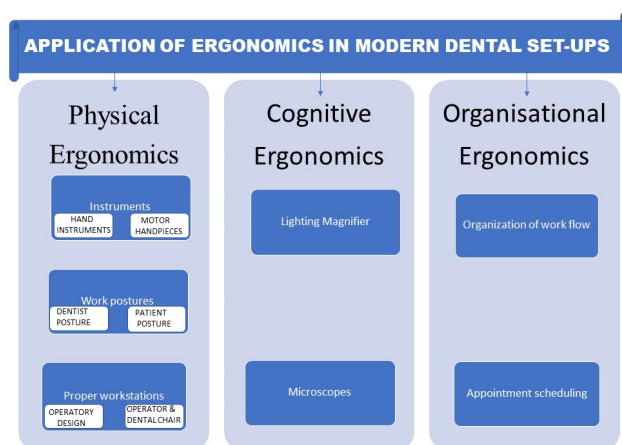


Fig. 5: Application of Ergonomics in the modern dental set-ups

**Fig 6a** Reversal

Support wrist on hips and lean backward. Don't overextend the head

**Fig 6b** Un-twister

Legs in tripod, bend to your left with left elbow on left knee. Stretch right arm

**Fig 6c** Chin nod

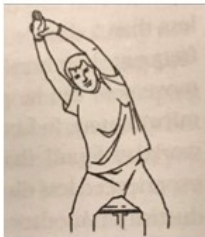
Lift chest & shoulders nod the head, dipping the chin slightly downward. Repeat 5 times

**Fig 6d** Scalene stretch

Anchor right hand behind back, slowly bring left ear to left shoulder.

**Fig 6e** Trapezius stretch

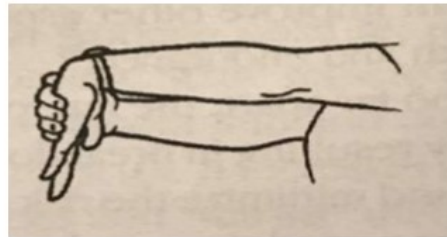
Anchor right hand behind back, slowly bring left ear to left armpit.

**Fig 6f** Overhead stretches

Sit, clasp hands up with palms up, bend trunk to side.

**Fig 6g** Thoracic stretch

closed fingers behind head, extend upper back, look up and press elbows outwards

**Fig 6h** Wrist extensor stretch

With straight elbow, pointing fingers downward and gently pull fingers and hand towards the body.

**Fig 6i** Carpel tunnel stretch

Turn palm upward & hold, slowly extend the elbow until straight.

Fig. 6: Chair- side stretches; **a:** Reversal; **b:** Un- twister; **c:** Chin nod; **d:** Scalene stretch; **e:** Trapezius stretch; **f:** Overhead stretches; **g:** Thoracic stretch; **h:** Carpel tunnel stretch

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.³⁵ Microscopes were repeatedly used as low (3x-8x) and medium (8x-16x)^{36,37} 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,³⁸ thereby avoiding the extreme of the ergonomic motions hypothesized by Carr et al,³⁹ 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.⁴⁰ 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.⁴¹ Bhujangasana, padma sanasarvangasana, matsyasana, vipareetakarani mudra and pranayama are particularly relevant. Regular body Strengthening, stretching, relaxation techniques help improve the quality of life.⁴² The unequivocal systemic reviews⁴³ and meta-analyses⁴⁴ have expressed the issue explicitly. Although, the Telephysiotherapy digital sessions⁸ and acupressure⁴⁵ have shown promise, but exercises and chair-side stretches are imperative to prescriptions for musculoskeletal insults;⁴⁶ 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.⁴¹

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 al²³ 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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Author biography

Sumit Munjal, Reader

Seema Munjal, Reader

Cite this article: Munjal S, Munjal S. Decoding the ergonomics in the new normal for dentistry: A narrative review . *J Educ Technol Health Sci* 2021;8(2):40-47.