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Insights of Ergonomics in Dentistry

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ABSTRACT:Dentistry is a profession in which the clinical performance is restricted to an area covering only a few tens of millimeters (the mouth), and it requires precise force applications. Practicing dentistry cannot be considered easy as operators strive to maintain a balance posture while 50% of their body's muscles are made to contract to hold the body motionless.

The aim of this scientific literature was to review existing literature on ergonomics so that dentist can gain knowledge about ergonomic posture, role of instruments in general dentistry, help dentist to self-assess the posture and pain site.

Identification and selection of articles were performed by searching core databases such as PubMed, PubMed Central, EMBASE, Cochrane library, and Google Scholar; using the combination of both key words and MeSH headings. The Original research articles, reviews were included in the study. The studies published in languages other than English, were excluded from this review.

Good posture improves personnel comfort, health, morale, productivity. It is critical to seek prompt medical aid for symptoms of ergonomic stress/detect risk factors. We can find that we have less fatigue at the end of the day, and will be able to provide the quality of service.

I. INTRODUCTION:

[1,2,3].An occupational health hazard is common in the dental sector and is on a continuous rise. According to The National Institute for Occupational Safety and Health (NIOSH), work-related musculoskeletal disorders (WMSDs) includes not only workplace conditions i.e. a mismatch between the physical requirements and the physical capacity of the human body but also organizational, psychosocial, sociocultural, mental stress and age.

[1,4-7].Practising dentistry cannot be considered as an easy job as dentist work is restricted to an area covering only a few tens of millimetres, for around 6 hours. During which, operators strive to maintain a balance posture while 50% of their body's muscles are made to contract to hold the body motionless, resulting in prolonged contraction of the upper trapezius, which causes compression of blood vessels and nerves making the upper extremity susceptible to temporary ischemia.

II. AIM AND OBJECTIVES:

Aim:

This scientific literature aimed to review existing literature on ergonomics so that dentist can have a sound knowledge about ideal ergonomic posture and role of instruments in general dentistry, help dentist to self-assess the posture and pain site.

Objectives:

1. To identify and describe various epidemiological studies on Ergonomics in Dentistry encompassing the private and public practitioners, undergraduate and postgraduate students.
2. To provide a narrative explanation of key concepts and findings of the previous studies.
3. Emphasizing on the importance of Ergonomics in Dentistry.

Definition And Types Of Ergonomics:

[8].International Ergonomics Association Executive Council, August 2000 defines Ergonomics as:

"Ergonomics (or human factors) is the scientific discipline concerned with the understanding of the interactions among human and other elements of a system, and the profession that applies theory, principles, data and methods to design to optimize human well-being and overall system performance."

HISTORY OF ERGONOMICS:

[9,10].History dates back to millions of years ago:

1. **Early Human Tool Use:** Millions of years ago.

The first known use of human tools dates back perhaps as far as 2.6 million years ago.

2. **Ancient Civilizations:** Thousands of years ago.

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Some extracts from Hippocrates dated back to 460 - 370 BC in his work "Kat' Ihtreion" (About the hospital) which stated that:

"For surgery that occurs in a hospital, the following is required: patient, surgeon, assistants, tools, and lighting; the surgeon must attend to all of the above, as regards their positioning, their use and their number; he should also attend to the patient's position and the surgical instruments; finally, attention should be paid to the time, the method and the place".

3. **Industrial Revolution:** Hundreds of years ago.

This era, from the mid-1700s to the mid-1800s, was a time of great industrial change for many countries and societies. It's characterized by people shifting from rural, predominantly agricultural activities to one dominated by advancements in machines, mass industrial production techniques.

TYPES OF ERGONOMICS:

[8,11].Types of ergonomics includes the following:

Physical ergonomics:

It includes working postures, work-related musculoskeletal disorders, workplace layout, safety, health and how the human body's responses to physiological workloads.

Cognitive ergonomics:

It includes mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design.

Organizational ergonomics:

It includes communication, crew resource management, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, virtual organizations, telework, and quality management.

III. MATERIALS AND METHODS:

Identification and selection of articles were performed by searching core databases such as PubMed, PubMed Central, EMBASE, Cochrane library, and Google Scholar; using the combination of both keywords and MeSH headings. Websites (World Health Organization, ergoweb, Centers for Disease Control and Prevention) were also searched. A hand search of the journals was also performed in the central library of the college.

Inclusion Criteria:

- Original research articles (analytical and experimental), reviews, which reported ergonomics in the workplace.
- The studies which were conducted across the globe, particularly Indian studies which were based on ergonomics were included.

Exclusion Criteria:

- The studies published in languages other than English,
- Articles with only abstracts were excluded from this review.
- Unpublished articles in the press and personal communications.

PREVALENCE OF WMSD:

[1, 13-24].WMSD has a high prevalence among dentist across the globe. This condition is found to increase with age and number of years of experience this is shown below:

WORK-RELATED MUSCULOSKELETAL DISORDERS: (WMSD)

Definitions Of WMSD:

[12].According to The World Health Organization (2007):

Work-related musculoskeletal disorders (WMSDs) are conditions in which the work environment and performance of work contribute significantly to the condition; and/or the condition is made worse or persists longer due to work conditions.

Classification Of WMSD:

[12].International Classification Of Diseases Codes– 10th REVISION by WHO

Vascular effects

- I73.0 Raynaud´s syndrome

Neuropathies

- G56.0 Carpal tunnel syndrome
- G56.1 Other lesions of the median nerve
- G56.2 Lesion of the ulnar nerve
- G56.3 Lesion of radial nerve
- G56.9 Mononeuropathy of the upper limb, unspecified

Arthrosis of the carpal region

- M19.2 Secondary arthrosis of other joints.

The above syndromes may not appear immediately because they develop over weeks, months, or years. By then, the damage may be serious. The cost of an injury can be high, especially if the injury prevents us from doing our jobs.

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Sl No.	Author	Year	Place	Prevalence of WMSD among dentist
1.	Chowanadisai S et al. [13]	2000	Thailand	78%
2.	Rising et al. [14]	2005	California at San Francisco	70%
3.	Leggat P A et al. [15]	2006	Queensland, Australia	87.2%
4.	Abduljabbar TA et al. [16]	2008	Saudi Arabia	83%
5.	Hayes M et al. [17]	2009	Ourimbah, Australia.	64%-93%
6.	Niu et al. [18]	2010	Geneva, Switzerland	78%
7.	Madaan and Chaudhari et al. [19]	2012	Navi Mumbai, India	78% - 84% third year and interns
8.	K Reheman et al. [20]	2013	Khyber Pakhtunkhwa, Pakistan	58% - Lower back 38% - neck 30% - shoulder
9.	Gupta A et al. [21]	2013	KLE, Belgum, India	65%
10.	H.S Bedi et al. [1]	2015	Northern India	68.3%
11.	Roshene.R et al. [22]	2017	Chennai, Tamil Nadu, India.	85% - neck 10% - wrist
12.	Yemineni B C et al. [23]	2018	Andra Pradesh	36.3-60.1% -back 19.8-85% - neck 60-69.5% - wrist
13.	Golchha V et al. [24]	2019	New Delhi/NCR	56.2% -shoulder 42.6% - cervical

The Deviations from The Balanced Posture:

[25].The deviations from the balanced posture during the clinical act may be because:

- Incorrect positioning of dentist around the patient concerning the working area;
- Improper working level
- Incorrect positioning of the patient's head

As a means of deviation from the balanced position, the following can be seen most often

- The excessive bending of the dentist's head and the extent of the neck, the rotation and the tilting of the head;
- Lifted arms (dominant, non-dominant or both) without adequate support on the trunk or the arm support of the stool;
- Increased thoracic curvature of the lumbar curvature reduction;
- The angle between thighs and shanks below 90°.

Ideal Ergonomic Posture In Dentistry:

[26].The main aim of ergonomics for dentists is to allow achieve optimum access, visibility, comfort and control in clinical work. (fig no. 1)

- Sitting as upright and back as possible in the seat to obtain a stable posture, i.e symmetrically upright.
- Upper arms along the upper body to support the arms whilst carrying out treatment.
- Working height regulated properly, with the lower arms lifted a little from about 10° to a maximum of 25°.
- The angle between thigh and calf muscles legs of about 110° or a little more, with the legs, slightly spread.
- Distance between the mouth and eyes or spectacles normally between 35 –40 cm.
- The dentist should be able to move freely from 8.30 - 12.30 o'clock (right-handed), from 3.30 – 11.30 o'clock (left-handed), with the legs beneath the back of the patient chair.

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The patient's head must be moved in three planes to achieve the correct position of the working field [3,26]

First:

a) forward with occlusal surface of the lower jaw horizontally, about 00

b) Or turning backwards with occlusal surface upper jaw 200-250

Second:

a) latero-flexion to the left

b) or to the right, about 300

Third:

a) around the long axis of the head of the patient to the left

b) or to the right minimally 450

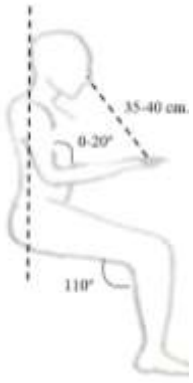

Fig no. 1

Requirements Of Dental Equipment:

[25,26].Role of dental equipment in maintaining ideal posture:

Studies have demonstrated that the musculoskeletal problems and disability experienced by dentists in which ergonomic limitations of dental equipment played a distinct role.

Patient chair:

- The patient must lie comfortably without feeling pressure from the form of the back. Curvatures support can be uncomfortable because they frequently, and mostly unintentionally, interfere with the anatomical characteristics of the patient.

Working stool dentist:

- The seat is divided into 2 parts for obtaining a balanced sitting posture: a horizontal part at the rear for supporting the buttocks, and an oblique front part declining 20° for equal support of the thighs (fig no.2).
- While sitting in a working posture, there should be no contact between the pelvic support and the back musculature on either side of this pelvic support.

Foot control:

- A foot control, attached to the basis of the patient chair such that, no accidental chair movements occur. The dentist need not slide away from his operating posture, to adjust controls with a "stretched" leg.
- A foot control can also be designed, such that the heel rests on the floor and only small movements of maximally 15°, which require little strength.

Dental operating light:

- A dental operating light should be positioned around the head of the dentist, before and sideward so that the light beam is running parallel to the viewing direction, with a maximal deviation of around 15°.

Hand Instruments:

- 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.

Instruments with tubing (dynamic instruments):

Dynamic instruments should be positioned within:

- The field of vision, the instrument console needs to have an adequate reach so that it is possible to place the tubing with the attached instruments within the direction of grasp, to prevent traction.
- Dynamic instruments should be placed in the field of vision, 30° right or left of the mid-sagittal or symmetrical plane of the dentist, a reach of 30-40 cm from the dentist, the console should hang down with an angle of 45° about a vertical plane. (fig no.3)

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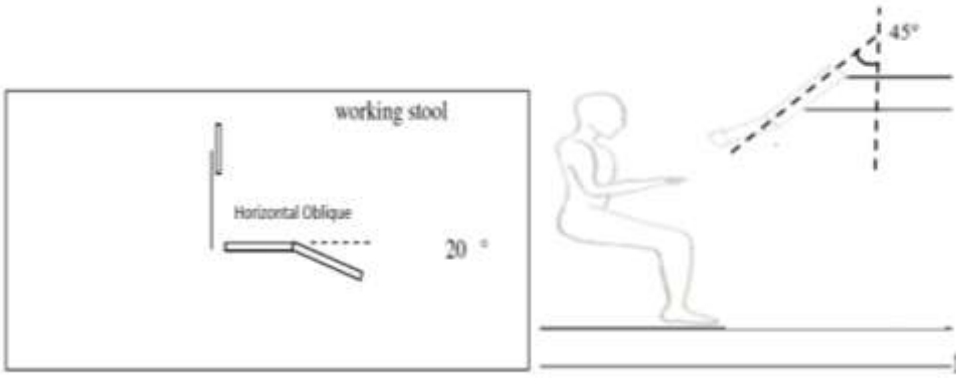

Fig no. 2Fig no. 3

SCALES USED TO ASSESS THE WORKING POSTURE:

[12,27-29].Dental students tend to overlook the hazards and consequences of poor postures, due to the multifaceted complexities of patient care. By improving awareness through measurement scales, the intent is to improve postures and the accuracy of their ergonomic evaluation.

Assessment scales used in dental ergonomics:

1. Posture assessment instrument - PAI
2. Modified – Dental operator posture assessment instrument - M- DOPAI
3. Rapid upper limb assessment - RULA
4. Test of visual perception- TVP
5. Video Technique for Analysing Postures and Movements-VIRA
6. Method for the Identification of Musculoskeletal Stress Factors-PLIBEL
7. Portable ergonomic observation-PEO
8. Postural and Repetitive Risk-Factors Index-PRRI
9. Ovako Working Posture Analysing System-OWAS
10. Occupational Repetitive Action Index-OCRA

SCALES USED TO ASSESS PAIN SITES IN MSD:

[30-35].Musculoskeletal pain is one of the most common reasons that people seek medical help, at least one contact with their general practitioner due to musculoskeletal pain conditions over 18 months. Many individuals report pain in multiple sites. Assessment of such pain usually based on a patient-administered questionnaire.

Pain site can be assessed using the following questionnaire:

1. Standard evaluation questionnaire - SEQ
2. Standardised Nordic questionnaires - SNQ
3. The Nordic Musculoskeletal Questionnaire - NMQ
4. The Extended Nordic Musculoskeletal Questionnaire - NMQ-E

WMSD PREVENTION STRATEGIES:

[14,36-41].**Postural Awareness.**

- Maintaining a low back curve
- Adjusting the operator chair properly
- Alternating between standing and sitting

Magnification loupes:

- Magnification enables operators to maintain a greater working distance and position patients at the proper height, with the shoulders relaxed and the forearms approximately parallel with the floor.
- There are three basic magnification systems available:

1. Single-lens Loupes
2. Galilean Loupes
3.Prismatic Loupes

Operating Microscopes:

- 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

Work Practices.

- Four-Handed Dentistry Method:
- Four-Handed Dentistry Method of practising dentistry ergonomically by combing the skills of a dental assistant with other work practices.
- Zones of activity are identified using the patient's face compared to the face of a clock.
- The four zones are:
  - the operator's zone - 7 to 12 o'clock
  - assistant's zone - 2 to 4 o'clock

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- transfer zone - 4 to 7 o'clock
- static zone - 12 to 2 o'clock

- The Expanded–function Dental Assistant:
- Expanded function refers to specific intraoral tasks that are completed as a procedure or part of a procedure by the clinical dental assistant that has been delegated by the dentist.
- Increased productivity of the dentist
- Less stress on the dentist
- More patients are seen
- Increased job satisfaction
- Quadrant Dentistry:
- Doctor time is maximized, by completing multiple restorations on one patient takes less time than doing the same number on multiple patients
- It minimizes cost.
- It reduces office and doctor stress. Fewer patients equal to fewer scheduling problems.
- It increases the quality of care and revenue.

Periodic Breaks and Stretching.

- Chairside directional stretching:
- Stretching during microbreaks:
- The un-twister:

Legs in tripod position; bend to the left side. Rest your left elbow on left knee. Stretch right arm overhead and look towards the ceiling. Hold for 2-4 breath cycles Repeat.

- Trunk rotation:

Sit tall. Cross right leg over the left leg. Place left forearm on the right thigh and turn the trunk to the right. Hold for 2-4 breath cycles.

- The reversal:

Support wrists on hips and slowly lean backwards. Do not overextend the head. Hold for 2-4 breath cycles.

- Advantages of Stretching:
- Increases blood flow to muscles and produces synovial fluid;
- Reduces the formation of trigger points;
- Maintains normal joint range of motion;
- Creates a relaxation response in the central nervous system;
- Warms up the muscles before starting to work;

IV. DISCUSSION:

[42-44].The common proverb 'Health is wealth' is often forgotten in the process of regular professional activities. Dentistry is a profession where the change in natural posture while working on patients is common, which is not good for overall health in turn giving rise to Musculoskeletal disorders. Musculoskeletal complaints vary in severity but involve one or more of the following: discomfort, pain, hindrance in functioning and loss of working time.

[45].A significant relationship was found between pain and dental practice in a previous study. The reason for this was thought to be compromised operator posture for working on all 4 quadrants in one sitting position, working under direct vision in maxillary arch etc.

[46].Ergonomically designed dental instruments may help reduce the prevalence of musculoskeletal disorders among dental practitioners. The primary objective of dental ergonomics is the prevention of work-related musculoskeletal disorders. It was observed in previous studies that among MDS Graduates, who had sufficient knowledge, attitude regarding the importance of proper working postures and position during providing treatment, did not result in the desired behaviour change among half of the study participants, this indicated that knowledge did not motivate sufficiently to adapt the ergonomic principles.

[47].In the Indian scenario where the number of dentist practising is increasing at a high rate, the prevalence of musculoskeletal disorders is also on a continuous rise. Ergonomics has always been the neglected subject, from both knowledge and practice point of view during clinical work. Also, ergonomics is not a part of the syllabus in both under-graduate and post-graduate level, as a result, the knowledge of ergonomics is spread through informal means only.

Suggestions:

1. To conduct more research through observational studies, physical examination and self - assessments.
2. It is important to conduct intervention programs to expand the students' knowledge and practice of ergonomics.
3. A practical applied approach to ergonomics and inclusion of ergonomics as a more organized topic in the dental curriculum so that the prevalence of WMSDs is reduced at an early stage.

V. CONCLUSION:

A good posture is not a luxury and it does not require major investments but a rethinking of the way of working. Good posture improves personnel comfort, health, morale, productivity and readiness. It is critical to seek prompt medical aid for symptoms of ergonomic stress/detect risk factors. We can find that we have less fatigue at the end of the day, will experience less pain, and will be able to provide the quality of service that we and our patient's demand.

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