

RESEARCH ARTICLE

Assessment of Impact of new work postures adaptations of dentists on musculoskeletal discomfort by RULA and QEC

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Abstract

Objective: The concept on which the health care system is based is widely called Pd (proprioceptive derivation) or dp (derivations from proprioception) or "0" (zero) concept, centering on the positions, movements, contacts, and discomfort that we sense within our bodies as both providers and receivers of care. During the 1970s, Pd was used for health care records and skill acquisition, which can be applied anywhere in the world. The goal of this study was to evaluate and compare the impact of dental professionals' work postures on musculoskeletal problems by following Rapid Upper Limb Assessment (RULA) and Quick Exposure Check (QEC) while using conventional and proprioceptive derivation methodologies. Methodology: A questionnaire based study on dental clinicians' work postures analysis in dental institute and a symptom survey among dental clinicians working on both conventional and proprioceptive derivation ideas are the primary components of the study. Results: When musculoskeletal diseases among dental surgeons are compared between conventional and Pd work postures, a significant difference are detected. When asked if they felt any physical discomfort when doing oral prophylaxis, almost all of the doctors in Pd position said no. 100% of the clinicians observed that they applied the least force for scaling and polishing in PD posture. Conclusion: Adapting and practicing proprioceptive derived work postures resulted in less discomfort and least possible work-related injuries among dentists.

Keywords

Conventional Dental Chair, Dental Surgeons, Proprioceptive Derivation, Musculoskeletal Disorders, Work Postures

INTRODUCTION

The word "*proprioception*" has Latin roots and means "unconscious awareness of movement." It enables the body to adjust its position for the best possible movement. Internal sensors, like the muscle spindle stretch receptor and the golgi tendon organ, perform it. Proprioception and sustaining

static, mixed, or dynamic balance both depend on the vestibular system of the brain. Balancing, movement sensing, and, natural tactile perception are all improved by proprioception training.

The positional relationship between the operator, the patient, and the setting, including instruments, is derived from the proprioceptive sense. Proprioceptive derivation (PD) is the term

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for it. Through masked eye exams and exercises, proprioceptive sensibility or feedback awareness can be increased. The ideal bodily circumstances and therapeutic environment are determined in the following order; a) proprioceptive sense; b) tactile sense; c) auditory sense; d) visual sense (Chaikumarn et al., 2004).

Proprioceptive derivation concept is validated till now only in dental profession with many research works related to sitting postures and work related musculoskeletal disorders (Chaikumarn et al., 2005; Nowak et al., 2016).

To meet patient requests and obtain finer outcomes, dental practitioners are subjected to a lot of physical effort. Modifying the workplace environment can help to avoid work-related musculoskeletal problems. The majority of dental treatments is time-consuming and need professional expertise to get the desired outcomes. To minimise needless tiredness in the dentistry profession, prior working circumstances such as the structure of the dental chair, the clinician chair, and the position of the clinician and the patient, motions throughout the operation, the kind of tools, and their use must be modified (García-Vidal et al., 2019; López-Nicolás et al., 2019).

The first of its kind, proprioceptive derivation (PD), a revolutionary approach of structuring a dentist workstation as well as working postures, was offered to dental students at Vishnu Dental College in India.

The primary goal of using Proprioceptive Derivation principles at the institutional level is to provide optimum accessibility, visibility, comfort, and control during dental treatments conducted by students. Applying the same at the post-graduate level and in clinical practise will aid in enhancing clinical work circumstances, which will improve the treatment outcome's efficiency.

Applying ergonomic principles to dental practice helped to some extent in preventing work-related musculoskeletal disorders, and the new method of proprioception has an adjunctive effect in preventing work-related disorders as well as clinician comfort, which increases treatment efficacy in any case (Abdolizadeh et al., 2015; Lietz et al., 2018).

In dentistry, the proprioceptive, tactile, auditory, and visual senses all play a part in creating better circumstances for proper treatment. The operator, patient, and instrument design all interact

to create the proprioceptive sense. The instruments should be placed in such a way that they do not interfere with the operator's typical working postures (Ohlendorf et al., 2017; Blanc et al., 2014).

A training programme called SATV (Skill, Acquisition, Training and Verification), which aids dentists in accumulating self-derived experience, is also coupled with the PD concept. The steps of skill acquisition, skill transfer, and skill verification make up the SATV system (Aman et al., 2015).

Dentists employ models for training during the skill acquisition phase. The highest conceivable level of clinical performance-compatible body positions and setting criteria are noted. These circumstances are thought to reduce physical strain during dental treatment. The SATV clinical environment is then modified using the derivations to account for the dentist's particular body dimensions for the best possible treatment delivery. The skill transfer phase emphasizes the potential clinical applications of the learned fundamental abilities, including oral examination, extraction, anesthesia, cavity restoration, root canal therapy, and crown and bridge preparation. A camera, digital video recordings, data forms, and standardized simulated pathologies of skill learning and transmission are used throughout the system for skill verification (Aman et al., 2015).

According to Terui, Iwao, and Taniguchi., 1997, the notion of Pd can provide dentists with a number of advantages by utilising SATV: The benefits of this technique include the following: 1. It establishes and maintains optimal finger control for precision work; 2. It minimises patient (care recipient) distraction; 3. It helps to maintain the dentist's spine's health; 4. It maintains consistent accuracy and reduces treatment time by eliminating unnecessary acts; (Terui et al., 1997). It establishes a foundation of infection control by reducing the number of finger instrument contacts (Ajay et al., 2013).

In regard to the treatment areas in the oral cavity, the dental practitioner must position himself around the patient. Typically, these are determined in respect to a 12-hour clock. However, slumped posture while sitting can lead to low back pain and other musculoskeletal diseases. In the convention sitting posture, it was not adequately explained how the spine must be

kept in a healthy posture with a little muscle strain (Ajay et al., 2013).

Patients with physical limitations can easily access Pd with a dental bed, which also helped clinicians to reduce physical stress on the muscles, especially in the shoulder and back regions, improve treatment accuracy, improve communication with patients and assistants, shorten treatment times, and increase high-quality control of infection by reducing the number of contacts with instruments. Hence, the goal of this study is to evaluate and compare the impact of dental professionals' work postures on musculoskeletal problems while using conventional and proprioceptive derivation methodologies.

MATERIALS AND METHODS

The human subject's ethics board of IECVDC/2021/F/PI/Q/42 dated 17-02-2021 authorized the research study, which was carried out by following the Helsinki Declaration of 1975, as updated in 2013. "The current cross-sectional study was done in VishnuDentalCollege, Andhra Pradesh, India, between June 1st and December 31st, 2021. Before beginning the study, permissions were acquired and the study objectives were explicitly described to all participants. To determine the feasibility and verify the questionnaire, a pilot research was conducted on a group of ten patients and doctors. Cronbach's alpha was found to be 0.75, which is acceptable.

The sample size was calculated using GPower 3.1 software at a level of significance set at 5%, power of the study 80% and for an expected effect size of 0.5 from previous studies by Chaikumarn, M et al., in 2004 and 2005. It was calculated that 64 sample per group were required to perform the study. So the sample size was rounded off to 70 per group.

In studies on dental health, the split-mouth design is frequently used. The right or left half of the dentition is randomly assigned to each of two treatments in this type of split-mouth study. The split-mouth design was used to divide a suitable sample of seventy patients (40 males, 30 females) between the ages of 20 and 55 into two groups, with 70 patients in each group needing treatment for gingival and periodontal disorders. Patients in Group A had non-surgical periodontal therapy performed on a conventional dental chair, whereas patients in Group B had non-surgical periodontal

therapy performed on a proprioceptive dental support.

On the coin toss procedure, seven different doctors were assigned hand scaling of two quadrants on the traditional approach and two quadrants on the proprioceptive derivation approach.

The following are the inclusion criteria

1. Patients diagnosed with gingivitis or periodontitis, as defined by the American Academy of Periodontology (AAP) recommendations for 2018.
2. Patients must have a minimum of four teeth in each quadrant.

The following are the exclusion criteria

1. Patients with uncontrolled systemic illnesses
2. Patients above the age of 55 years.
3. Pregnant women and toddlers who require particular care.

All seven dental experts who had completed the proprioceptive derivation approach were required to practise seated work posture and four-handed dentistry with the assistance of a dental assistant. An observer trained in assessing the changes in adapting new work postures was included in this study. The observer used evaluation methods like QEC and RULA to compare the two techniques in terms of work postures, working time, comfort levels, and efficiency of non-surgical periodontal therapy conducted by dentists.

Quick Exposure Check (QEC)

All physicians should undergo a preliminary observation of sitting postures followed according to the proprioceptive derivation concept for at least one work cycle before assessing the posture (Gandavadi, 2008).

The back posture assessment was carried out while the back was at its most strained. The back has been classified as "Almost neutral," "Moderately flexed or twisted," and "Excessively flexed or twisted" if the individual is seen working with his or her back flexion/extension, twisting, or side bending less than 20°, more than 20° but less than 40°, and more than 40° but less than 60° (Gandavadi, 2008).

Evaluation of shoulder and arm exposure

- a) Shoulder/arm movement is deemed "infrequent" if there is no regular motion pattern.
- b) It is "frequent" if there is a regular motion pattern with occasional minor pauses.
- b) "Regular" if there is a consistent pattern of

movements throughout the workday (Gandavadi, 2008). Wrist and hand exposure assessment: The wrist is termed to be "almost straight" if its movement is limited to a small angular range (e.g. 15°) of the neutral wrist posture. When performing the movement, the wrist is said to be "deviated or bent." (Gandavadi, 2008).

The neck is considered "excessively bent or twisted" if it is bent or twisted at an obvious angle (or more than 20°) relative to the torso. QEC is considered to other assessment methods because it is a valid, sensitive, and trustworthy tool for assessing ergonomic risk is QEC. The QEC has the benefit that workers' tasks are not interrupted during the assessment, is adaptable for usage in a wide range of activities, and is simple to use. Numerous parameters that constitute musculoskeletal risk factors are taken into account by the QEC assessment. A closed set of questions used by QEC to examine the observer's observations and the respondent's responses ensures a high level of objectivity.

RULA – Rapid Upper Limb Assessment

RULA (rapid upper limb assessment)

The range of motion of each body component is divided into sections and accurately recorded. Ranges of movement with few risk factors have the lowest score (Score 1), whereas ranges of movement with severe postures get higher scores (Score 2, up to 6) (Gandavadi, 2008). RULA is considered to other assessment methods because it is useful for measuring musculoskeletal hazards and upper-limb duties. It is also the greatest way for assessing outcomes like equipment fit and productivity. This approach works well for works that are primarily static and for training employees about high risk postures.

Expert in proprioceptive derivation concept was acted as single observer. (Corresponding author) The exposure scores were calculated by combining the observer scores and operators responses by QEC assessment method and grand total scores of RULA were given by the observer by assessing the upper arm, lower arm, wrist, neck and trunk positions while doing dental treatment in conventional and proprioceptive derived sitting postures. Microsoft Excel 2016 for Windows was used to enter the data. In each group, the frequencies and percentages of age were computed. The data was categorical, and the data was analysed using Pearson's chi-square test. Statistical significance was defined as a P-value of less than

0.05. The Statistical Package for Social Sciences, version 21.0, was used to analyse the data (IBM Corporation, Armonk, New York, USA).

RESULTS

Prior to the beginning of this study, we conducted a survey with equal number of males and females participants to know how many of the clinicians need to improve their clinical work environment. According to the findings, 50 percent (n=35) of the questionnaire respondents were male, whereas only 50 percent (n=35) were female. This might imply that both men and women want to improve their workplace health and behaviors.

Approximately 42.8 percent of dentists said they work 8 hours or more per day, while 57.2 percent said they work 4-7 hours each day. When working in a traditional dental chair, 14.2 percent of dentists work without taking any rest breaks, 71.4 percent take rest breaks less frequently, and 14.2 percent take rest breaks more regularly. When working on proprioceptive support, 28.5 percent of dentists work without taking any rest breaks, 58.5 percent take rest breaks less frequently, and 12.8 percent take rest breaks more frequently (Table.1).

According to the findings of this study, 64.2 percent of dentists working in traditional dental chairs had musculoskeletal discomfort and, as a result, musculoskeletal dysfunction. Only 32.8 percent of dentists working on proprioceptive designed assistance reported musculoskeletal discomfort development. In comparison to proprioceptive-derived support, this shows that musculoskeletal diseases are the most prevalent health concern among dentists practising on traditional dental chairs (Table.1).

According to the findings of this study, the hand (30%), neck (28.5%), back (28.5%), wrist (11.4%), and shoulder (1.42%) were the most often afflicted body parts as a result of lengthy working hours in a traditional dental chair. When dentists used a proprioceptive derived method, the portions impacted in decreasing order were the shoulder (54.2 percent), hand (38.5 percent), neck (2.85 percent), wrist (2.85 percent), and back (1.42 percent) (Table.1).

Table 1. Comparison between the clinician's responses while working on conventional and Pd work postures

SL.NO	Question	Options	Conventional	Pd	Chisquare	p-value																																																																																																						
1	Years of work experience as dentists on both conventional and Pd Support	≤ 2 years	0	30	46.694	0.000*																																																																																																						
		≥2 years	70	40			2	Time spent working on patients per day.	>8 hours	30	30	2.778	0.09	4-6ours	40	40	3	Frequency of rest breaks taken while working on conventional and Pd Support	No breaks taken	10	20	64.542	0.000	Less frequent	50	41	More frequent	10	9					4	Any musculoskeletal or medical problems reported while working on conventional and Pd Support	Yes	45	23	1.175	0.001	No	25	47	5	Of the following, the most common part of the body affected due to long working hours	Neck	20	2	34.681	0.001	Wrist	8	2	Hand	21	27	Back	20	1	Shoulder	1	38	6	Are you satisfied with the training on operating positions in your undergraduate and postgraduate level	Yes	43	55	21.778	0.001	No	27	15	7	Have you ever faced any musculoskeletal discomfort while performing oral prophylaxis	Yes	60	15	36.781	0.000	No	10	55	8	Do you observe any change in the application of Force used for scaling and polishing by application of two different work postures:	Least force	3	70	9.876	0.001	Medium force	65	0	Extreme force	2	0	9	Do you report any pain after oral prophylaxis following two different work postures	Yes	63	25	66.78	0.000	No	7	45	10	In which of the following approaches you notice comfortable position, [Upper arm, lower arm, wrist, neck, leg, feet]	Yes
2	Time spent working on patients per day.	>8 hours	30	30	2.778	0.09																																																																																																						
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		No	7	45																																																																																																								
10	In which of the following approaches you notice comfortable position, [Upper arm, lower arm, wrist, neck, leg, feet]	Yes	0	70	11.698	0.001																																																																																																						

The Exposure evaluation for the back was practically neutral for nearly all of the participants. Static postures held for more than a minute, repeated more than four times per minute were not statistically significant for any of the subjects.

There was a favorable effect in that the majority of doctors believed PD work postures were pleasant, and they discovered that adopting Pd work postures resulted in a reduction in musculoskeletal problems (Table.2).

Table 2. Assessment of QEC (1 to 4 questions) and RULA (5 to 9 questions) of 7 clinicians performing scaling on 70 patients in a split-mouth design.

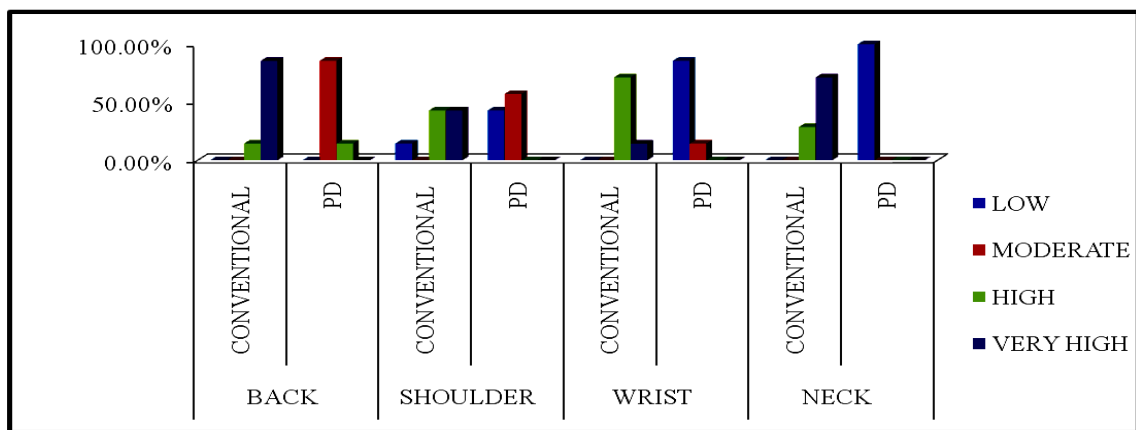
SL. No	Question	Options	Conventional	Pd	Chisquare	p-value
1	Exposure assessment for the back:	Almost neutral	0	7	14.000	0.001
		Moderately twisted	3	0		
		Excessively twisted	4	0		
2	Exposure assessment for the shoulder:	Infrequent	0	7	14.00	0.001
		Frequent	4	0		
		Very frequent	3	0		
3	Exposure assessment for the wrist/hand:	Almost straight	0	7	14.000	0.000
		Deviated	7	0		
		Bent	0	0		
4	Exposure assessment for the neck:	Bent(less than 20 degrees)	0	7	14.00	0.001
		Excessively bent(more than 20 degrees)	7	0		
5	Range of movements recorded for upper arm, lower arm, and wrist.	Flexed	1	1	12.000	0.002
		Straight vertical	0	6		
		Straight inclined forward	6	0		
		Inclined backward	0	0		
		Neutral	0	0		
6	Range of movements recorded for Neck, Trunk, and Legs	Flexed	0	7	14.000	0.001
		Straight vertical	7	0		
		Straight inclined forward	0	0		
		Inclined backward	0	0		
		Neutral	0	0		
7	Postural score on a scale of 1-9 (1 being least musculoskeletal loading)	1	0	0	14.09	0.007
		2	0	2		
		3	0	5		
		4	0	0		
		5	0	0		
		6	2	0		
		7	4	0		
		8	1	0		
8	Muscle use: Static postures held for more than a minute, repeated more than 4 times per minute	Yes	7	0	14.000	0.001
		No	0	7		
9	Force: Total hours of work done in a day	Score 1 for more than 4 hrs less than 6 hrs	1	7	7.778	0.02
		Score 2 for more than 6 hrs	6	0		

By using the quick exposure check (QEC) and Rapid Upper Limb Assessment (RULA) instruments, one trained observer on the proprioceptive concept examined the work postures of seven operators working on both the

conventional and the proprioceptive concept. While adopting proprioceptive derived work postures, the observer also noticed changes in the exposure scores of back, shoulder, wrist and neck parts (Table 3, Graph 1).

Table 3. Describes the total exposure scores given by the observers and the operators in conventional and proprioceptive derived sitting postures

QEC PARAMETERS	GROUP	Mean	Std. Deviation	P Value
BACK	CONVENTIONAL	51.7143	7.78276	.000
	PD	27.4286	3.59894	
SHOULDER	CONVENTIONAL	37.4286	9.43146	.001
	PD	21.1429	1.06904	
WRIST	CONVENTIONAL	39.1429	3.02372	.000
	PD	20.5714	.97590	
NECK	CONVENTIONAL	16.0000	1.63299	.000
	PD	4.5714	.97590	
OPERATOR SELF SCORE	CONVENTIONAL	14.1429	2.67261	.000
	PD	4.2857	1.60357	

Graph 1. Comparison of exposure levels assessed by QEC method in conventional and proprioceptive concept sitting postures

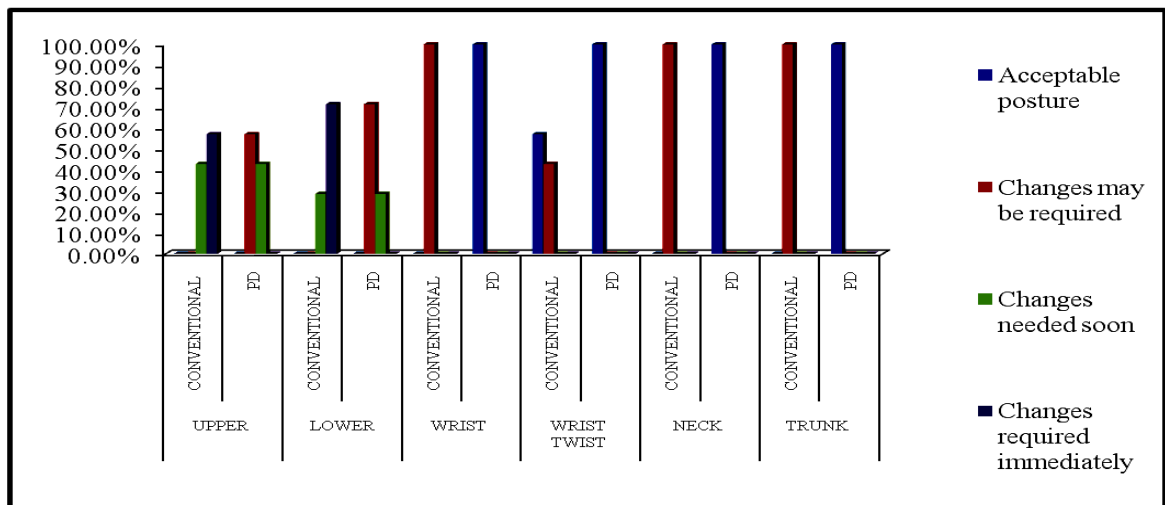
When musculoskeletal issues among dental surgeons are examined between traditional and PD work postures, a significant difference are discovered. When asked if they felt any musculoskeletal discomfort when conducting oral

prophylaxis, almost all of the doctors in PD posture said no, and 100 percent of the clinicians said they had no effect on wrist, neck and trunk when done scaling and polishing in Pd position (Table.4, Graph 2).

Table 4. Describes the grand total scores given by the observers in conventional and proprioceptive derived sitting postures

RULA PARAMETERS	GROUP	Mean	Std. Deviation	P Value
UPPER	CONVENTIONAL	6.5714	.53452	.000
	PD	4.2857	.75593	
LOWER	CONVENTIONAL	6.7143	.48795	.000
	PD	4.1429	.69007	
WRIST	CONVENTIONAL	3.5714	.53452	.000
	PD	1.7143	.48795	
WRST TWIST	CONVENTIONAL	2.4286	.53452	.001
	PD	1.2857	.48795	
NECK	CONVENTIONAL	3.7143	.48795	.000
	PD	1.7143	.48795	
TRUNK	CONVENTIONAL	3.7143	.48795	.000
	PD	1.5714	.53452	

Graph 2. Comparison of Action levels required by RULA assessment method in conventional and proprioceptive concept sitting postures



DISCUSSION

Dentists' working posture is always important in the industry since it helps them perform better. Work-related musculoskeletal problems emerge when working posture is altered in any way (Nguyen et al., 2004) It is critical to adjust dentists' work postures when working in dental clinics in order to enhance their lifespan in the field. The findings of this investigation revealed that switching from a traditional to a Pd work posture resulted in a noticeable distinction in comfort and treatment satisfaction. These findings are from (Chaikumarn's et al., 2005) observational study of dentists who use Pd and (Chaikumarn et al., 2004).

Dental advancements and modifications, such as the proprioceptive derivation (Pd) idea, aimed to provide dental experts with greater comfort and improved health. By adopting the proprioceptive concept, dentists can work more comfortably and effectively compared to the traditional approach.

RULA was used by Nguyen et al., 2004 to assess dentists' working posture. The RULA method was used to watch, question, and assess 19 dentists and dental assistants. The dentists' working posture was found to be abnormal, with static and prolonged sitting, lifted shoulders, bent and twisted necks, and a bowed trunk that needed immediate attention (Nguyen, 2004). Chaikumarn et al., 2005 used RULA to look at how dentists' working posture changed when they used alternative work concepts like proprioceptive

derivation (Pd) vs the standard approach. The Pd concept is a strategy that helps dentists to keep a good posture while performing dental tasks, hence decreasing musculoskeletal pain.

The primary reasons for employing Pd were that it increased comfort, improved treatment satisfaction, improved communication with assistants, increased instrument availability throughout treatment time, and reduced contact with chair/support components, according to the findings. These are in line with Hendrick HW's 2003 book, Principles and Applications in Occupational Ergonomics (Hendrick et al., 2003). This study provided optimal access and visibility, comfort, and control during clinical practise, which is an important component of dental ergonomics. These conclusions are based on Pollack R's findings from 1996 (Pollack et al., 1996). The Ergonomic Work Analysis approach was introduced in a Brazilian dentist's office by Custodio, R. et al. in 2012. The analysis helped identify the restrictions and ways to get around them. The position recommended by the International Organisation for Standardisation (ISO) and the Federation Dentaire Internationale (FDI) was found to be hardly ever used by dentists.

The use of ergonomic stools with lumbar support in conjunction with proprioceptive-derived supports has grown over time, demonstrating comfort in the workplace for dentists and lowering work-related musculoskeletal problems (MSDs). These are the results of Custodio's R study, which

was completed in 2012 (Custodio et al., 2012). Pîrvu et al. (2014) did a study to examine the position dental professionals adopt when working, starting with a balanced posture and moving on to other posture variants. By lowering tiredness and restricting workspace, these measures have been advocated to avoid these prevalent MSDs, and the current study also suggests that modifying work postures and workspace might result in preventing work-related diseases in dentistry.

Kumar et al., 2020 conducted a study to assess the dental student knowledge, attitude, and practice toward ergonomics in three different dental schools. The results of the study shown that ergonomic education of the dental health-care personnel must be focused in all the educational institutions and at continuing dental health programs by delivering ergonomic principles both theoretically and practically and should be a part of the curriculum. The current study results also explained that by following the work postures appropriately one can prevent MSDs. (Belenky et al., 1998) The findings show that there is a statistically significant difference in risk rankings between proprioceptive and traditional dental chairs.

A systematic review was conducted on the available literature to clarify the advantages of the proprioceptive derivation over the conventional approach. The proprioceptive derivation strategy was able to keep the upper limb, trunk, and lower limb joints in an appropriate position, resulting in a good working posture (Pasupuleti, 2023).

Conclusion

When applied to dental doctors' work postures, the RULA and QEC methodologies allowed for a quick assessment of their posture throughout the shift from conventional to proprioceptive derivation principles. These evaluation methods revealed that proprioceptive-derived work postures may maintain an appropriate working position over time, but traditional work postures decline with time, potentially predisposing to the development of musculoskeletal disorders.

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Conflict of interest

The authors declare no conflict of interest. No financial support was received.

Ethics Statement

The human subject's ethics board of IECVDC/2021/F/PI/Q/42 dated 17-02-2021 authorized the research study, which was carried out by following the Helsinki Declaration of 1975, as updated in 2013.

Author Contributions

Study Design, MKP and PDNL; Data Collection, JK and SP; Statistical Analysis, MKP, PVKV; Data Interpretation, SP and KSA; Manuscript Preparation, MKP, JK and KSM; Literature Search, PDNL, JK, SP and KSM. All authors have read and agreed to the published version of the manuscript.

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