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Original Article

Dentistry Section

Evaluation of Comfort Levels of Patient and Ergonomics of the Dental Surgeon during Manual Scaling under Both Proprioceptive Derivative Concept and Conventional Approach: A Cross-sectional Study

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ABSTRACT

Introduction: The important components that contribute to successful dental care are maximum accessibility, visibility, comfort, and control over clinical processes. Dental practitioners are more prone to developing musculoskeletal disorders due to awkward working postures. To minimise all these risk factors, a new concept called Proprioceptive Derivative (PD) has come into existence.

Aim: The main aim of this study was to evaluate the comfort levels of the patient and ergonomics of the dental professional in the PD approach and conventional approach.

Materials and Methods: A cross-sectional study was conducted in which manual scaling was performed by 20 dentists on 120 patients using the PD concept and conventional concept. A 13-item questionnaire was distributed among the patients and clinicians to record their perceptions of comfort levels, clinicians' treatment satisfaction levels, and the time needed to complete the procedure after mastering the PD concept. In indepedent sample t-test was use to compare the responses among the two groups. $p \leq 0.05$ was considered statistically significant.

Results: The comfort levels of the clinician (q1) during treatment in the conventional approach, with a mean value of 2.96±0.69, were significantly lower than in the PD approach, with a mean value of 3.46±0.85 ($p<0.001$). However, from the perspective of the patients, the mean comfort levels using the conventional strategy were 2.61±1.03, while using the PD approach, it was 2.85±1.11, which was not statistically significant ($p>0.05$).

Conclusion: The clinicians had more ergonomic benefits and improved time factors under the PD concept. By following the work postures according to the PD concept, clinicians can avoid musculoskeletal discomfort, which is beneficial to all clinicians and can increase the longevity of their clinical practice.

Keywords: Dentists, Operating posture, Perceptions

INTRODUCTION

Dentistry is the art and science that encompasses a thorough knowledge of oral structures, including high-precision work that requires effective ergonomic interventions [1]. Optimal accessibility, visibility, comfort, and control over clinical procedures are key factors that need to be incorporated not only to obtain a better view of the intraoral cavity but also to provide a more comfortable position for the patient in the dental chair [2]. The lack of implementation of these factors leads to musculoskeletal disorders, which are common among dental care professionals [2,3]. These disorders can cause fatigue in the neck, shoulders, and upper back, resulting in work-related injuries among dental professionals [4]. Therefore, it is important to identify and prevent these disorders in order to create a healthy working environment and contribute to the well-being of individuals [5].

A dentist's working posture is always a vital parameter in the dental profession as it plays a role in achieving effective performance. Any alteration in working posture can lead to the development of work-related musculoskeletal disorders [3]. To increase dentists' longevity in the profession, it is essential to modify their work postures while working in dental clinics. Hence, effective ergonomic interventions are key factors for successful dentistry, allowing dentists to achieve optimal access, visibility, comfort, and controlled clinical practice [3].

To enhance the working conditions of dental professionals, the concept of changes in dental practice originated many years ago when the concept of ergonomics was introduced to dentistry [6]. A unique concept focusing on the positions, movements, contacts, and comfort that dentists can perceive with their bodies was developed for dental practice by American dentist Dr. Daryl Breach in the mid-1960s. This concept, widely known as the PD concept or Zero Concept Reasoning, emphasises proprioception training to improve balance, movement awareness, and natural tactile sense. The PD concept is connected to the operator, the patient, and the instrument setting, ensuring that the location and positioning of instruments do not interfere with the operator's normal working positions. The PD concept includes a training programme called Skill Acquisition, Training, and Verification (SATV), which allows dental professionals to gain self-derived experience and confidence [1]. Teri, Iwao, and Taniguchi have highlighted the benefits of SATV with the PD concept, including maintaining accurate finger control over work, reducing distractions from the patient, maintaining a healthy spine through an upright and alert posture during procedures, reducing procedure time, and improving accessibility and accuracy [2,7].

The principles behind the PD concept not only improve the accuracy of the clinician's work but also make their work more efficient with less physical and mental strain. It has been documented in the literature that the reduced number of finger instrument contacts minimises the risk of infection and provides dental professionals with improved efficiency in instrumentation, accessibility, and ergonomic benefits [1,2].

Considering this new concept and the scarcity of literature available on the concept of proprioceptive derivation, this study was undertaken to evaluate the ergonomics and comfort levels of both patients and dental professionals during manual scaling using both the PD and conventional approaches.

MATERIALS AND METHODS

A cross-sectional study was conducted from January 2020 to June 2020 in Bhimavaram, Andhra Pradesh. Patients who attended the Outpatient Department of Periodontics and Implantology were enrolled. The study was approved, and ethical clearance was obtained from the Institutional Ethical Committee (IEC Ref No: VDC/IEC/2019/33). All procedures were conducted in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, revised in 2013.

Inclusion and Exclusion criteria: Patients diagnosed with Stage-1 and Stage-2 periodontitis according to the American Academy of Periodontology (AAP) guidelines 2017, with a minimum of 20 teeth in the mouth and who had not received periodontal treatment in the past six months to one year, were included in the study. Patients with uncontrolled systemic diseases and conditions, as well as, special needs patients, were excluded from the study. All four quadrants with Oral Hygiene Index simplified (OHI-s) scores ranging from fair to poor, and all right-handed clinicians were included. Treatment assessments were conducted by faculty members in the Department of Periodontics who had experience in proprioceptive derivation.

A convenience sample of 20 clinicians (16 females and 4 males) was included in the study. All participating dentists were postgraduate students in the Department of Periodontics who had received training in proprioceptive derivation under the supervision of the concerned faculty member. Each dentist treated six patients, following the work postures of both the conventional and proprioceptive concepts. A total of 120 patients who visited the Department of Periodontics were enrolled in the study, and informed consent was obtained from all participants after explaining the working mechanisms of the two approaches.

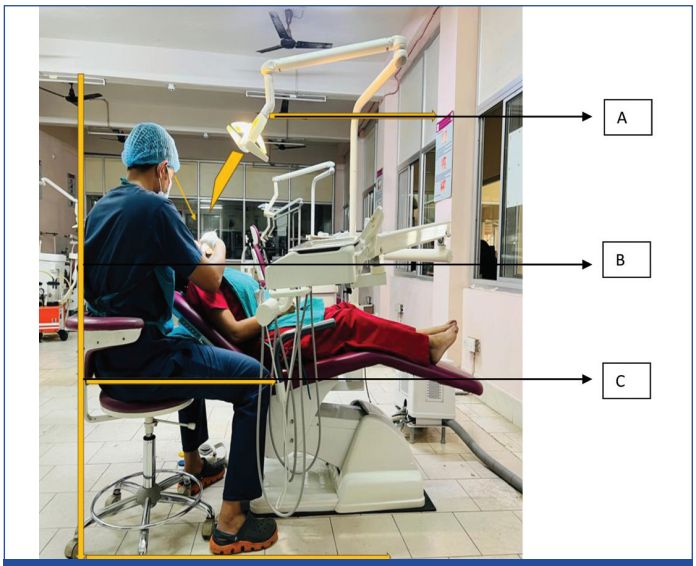
The present study employed a split-mouth design, where selected patients underwent scaling procedures using two different working concepts [Table/Fig-1,2].

Proprioceptive derivation approach: Dentists in this group used dental chairs/flat beds designed according to the PD concept. The operator maintained an upright position. The instruments used in the proprioceptive derivation approach were lightweight and smaller compared to those used in the conventional approach [8]. These lightweight instruments provide the operator with better control over delicate and precise finger movements required during intraoral procedures. The instruments used in the proprioceptive derivation approach were manufactured by MORITA DENTAL PRODUCTS CORP., Japan. The instruments used in the conventional approach differed from those used in the proprioceptive derivation approach [Table/Fig-3,4] [1,2].

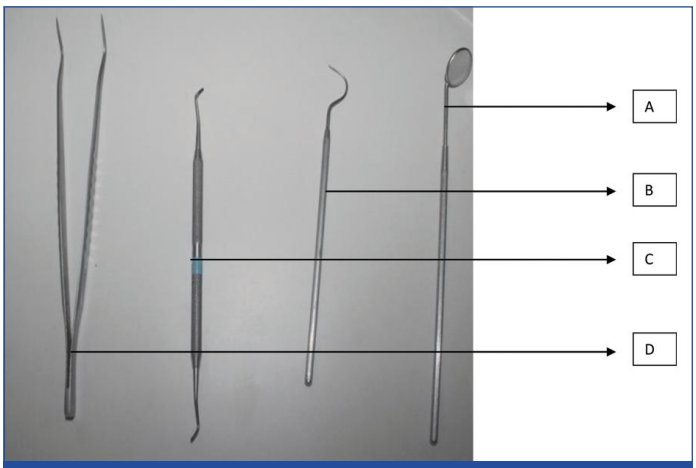
Workstation layout in proprioceptive derivation: The following rules for workstations should be followed:

1. **Dental chair height and operator chair height:** The operator should be in the 12 o'clock position with the arms in a balanced position near the patient's mouth. The height of the operator and patient support should be adjusted according to the operator's height. The height of the assistant's chair should always be taller than the operator's chair.
2. **Patient position:** The patient should be in a supine position on a flatbed, just above the dentist's elbow level.
3. **Instrument tray:** The tray should be positioned at a distance from the patient but within ergonomic range (within one arm's

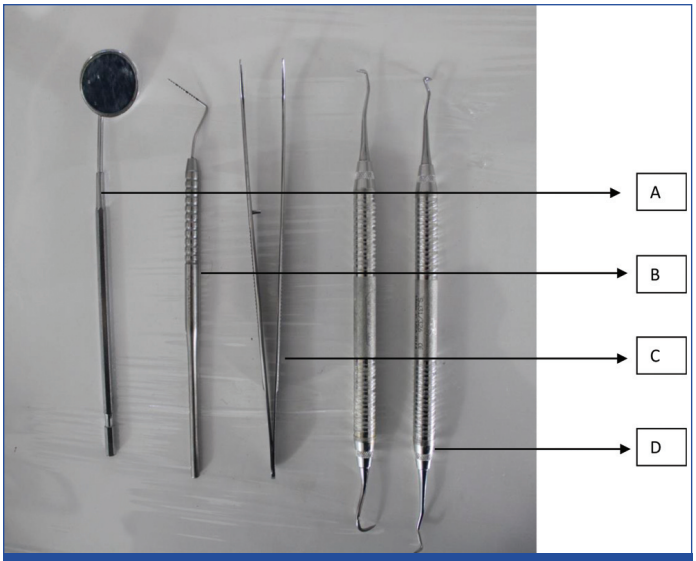
[Table/Fig-1]: Workstation layout in proprioceptive derivation. A. Two way light source; B. Balanced Operator position with straight spine; C. Balanced Operator position with thighs parallel to floor.



[Table/Fig-2]: Workstation layout in conventional approach. A. One-way light source; B. Operator position with no evidence of straight spine posture; C. Balanced Operator position with thighs parallel to floor.



[Table/Fig-3]: Instruments used in proprioceptive derivation approach. A. Mouth mirror; B. Explorer; C. Scaler; D. Tweezer.



[Table/Fig-4]: Instruments used in conventional approach. A. Mouth mirror; B. Explorer; C. Tweezer; D. Scaler.

distance to the clinician). Only frequently used basic instruments should be kept on the tray.

4. **Adjustable headrests:** The headrests can be twisted to the right or left for better access to the oral cavity.
5. **Adequate light source:** The light source should be positioned and fixed along with the operator and patient chair position.
6. **Spittoon:** The spittoon is absent in the proprioceptive derivation set-up.
7. **Instruments:** The instruments used in the proprioceptive derivation set-up are different from conventional instruments in terms of design (size, shape, weight/mass, sharpness) [1,8].

Conventional approach: In this group, dentists used regular office chairs with backrests. The patient was in a supine position with the legs positioned lower than the body. The dentist maintained an upright position with the thighs parallel to the long axis of the floor. The operator's elbow should rest against the patient's mouth [1,2,9,10].

The following parameters were evaluated using a questionnaire:

a) Comfort levels of patients during treatment using the proprioceptive derivation concept and conventional concept.

b) Comfort levels and ergonomic benefits of clinicians using the proprioceptive derivation concept and conventional concept.

c) Time taken to complete the procedure using both the proprioceptive derivation concept and conventional concept.

The questionnaire comprised five patient-related and eight clinician-related questions adapted from the study by Mohan Kumar P et al., and modified according to the current study design [8] [Annexure-1]. The reliability of the questionnaire was checked through a pilot study, and a value of 0.82 was obtained, indicating good internal consistency. Clinicians were asked to fill out the questionnaire after each patient, resulting in a total of 120 responses from clinicians and patients.

STATISTICAL ANALYSIS

The data collected was entered into Microsoft Word and subjected to statistical analysis using SPSS version 21.0 to generate graphs and tables. An independent samples t-test was conducted to compare the responses between the two groups. A p-value <0.05 would be considered statistically significant for the analysis.

RESULTS

Out of the 20 operators, 16 were females, and four were males in a 1:4 ratio. The mean age of the participants was 22±1 years. Each dentist treated six patients, following work postures of both the conventional and proprioceptive concepts.

From the patients' perspective, the mean value of the comfort levels during treatment in the conventional approach was 2.61±1.03. For the PD approach, it was 2.85±1.11. There was no significant difference observed in the comfort levels between the two techniques (p=0.084) [Table/Fig-5a].

Q. No.	Question	Options	Mean	Std. Deviation	p-value
Q1	How comfortable the patient felt during the treatment	C	2.6167	1.03861	0.084
		PD	2.8583	1.11744	
Q2	How has the patient rated treatment satisfactory levels	C	2.7417	1.01663	0.551
		PD	2.8250	1.14248	

[Table/Fig-5a]: Patient's perspectives.
*C: Conventional; PD: Proprioceptive derivative; Std. Deviation: Standard deviation; p: Probability
A p-value less than 0.05 is considered statistically significant

A total of 70 (58.3%) patients chose the PD approach as their preferred method for future treatments. Out of 120 patients, 50 (41.6%) preferred the conventional method and reported that they were more comfortable with it due to familiarity from previous dental appointments (known approach) {20 (16.6%)}, the presence of a spittoon {15 (12.5%)}, and no water clogging {15 (12.5%)} [Table/Fig-5b].

Q. No.	Question	Options	Frequency	Percentage
Q3.	Which chairs the patient preferred for performing treatment in the future?	C	50	41.7
		PD	70	58.3
Q4.	What were the positive points of his/her preferred dental chair position? (Proprioceptive concept)	Minimal chair movement	30	25
		Flat, relaxed chair position	25	20.8
		Proximity of instruments	15	12.5
	What were the positive points of his/her preferred dental chair position? (Conventional approach)	Known concept	20	16.6
		Presence of spittoon	15	12.5
		No clogging of water	15	12.5
Q5.	What factors hindered treatment outcomes in his/her non-preferred dental chair? (Proprioceptive concept)	Absence of spittoon	32	26.6
		Clogging of water lead to difficulty in breathing	18	15
	What factors hindered treatment outcomes in his/her non-preferred dental chair? (Conventional approach)	Jerky chair movements	38	31.6
		Close proximity of instruments	32	26.6

[Table/Fig-5b]: Patient's perspectives on conventional and proprioceptive derivation.
*C: Conventional; PD: Proprioceptive derivative

The comfort levels of the clinician (q1) during treatment in the conventional approach (mean value of 2.96±0.69) were significantly lower than those in the PD approach (mean value of 3.46±0.85) (p<0.001) [Table/Fig-6a].

Q. No.	Question	Options	Mean	Std. Deviation	p-value
1.	How comfortable the clinicians felt while performing the treatment?	C	2.9667	0.69733	<0.001
		PD	3.4667	0.85929	<0.001
2.	How the clinicians rated his treatment outcome levels?	C	2.9500	0.73164	<0.001
		PD	3.3833	0.86173	<0.001

[Table/Fig-6a]: Clinicians perspectives on conventional and proprioceptive derivation.
*C: Conventional; PD; Proprioceptive derivative; Std. Deviation: Standard deviation; p: Probability
A p-value less than 0.05 is considered statistically significant

Seventy-five percent of the clinicians noticed a drastic difference in their comfort levels while working with the PD concept. About

35% of the clinicians rated their clinical satisfaction levels as eight, whereas 27.5% rated it as nine on a scale of 0-10. Seventy-five percent of the clinicians felt that the PD concept would be more helpful in terms of ergonomics and efficiency in instrumentation if it were introduced earlier [Table/Fig-6b]. Approximately 53.3% of the clinicians reported that the time taken for treatment using the PD concept was less compared to the conventional concept, and 64.2% of the clinicians noticed the ease of treatment with the PD concept, although it was initially challenging for them to get used to it. At the beginning of the study, the time taken for hand scaling using the PD concept was 60 minutes. The oral prophylaxis done by hand instruments in the conventional approach took 45 minutes. After adapting to the new work postures, the clinicians were able to complete the scaling procedure in only 30 minutes.

Q. No.	Question	Options	Frequency	Percent
3.	Did you notice a drastic difference in your comfort levels while working on PD chair?	Yes (1)	90	75.0
		No (2)	30	25.0
4.	On a scale of 1 to 10 how would you rate your clinical satisfaction levels when working under PD chair?	0-4	0	0.0
		5	15	12.5.
		6	15	12.5
		7	15	12.5.0
		8	42	35.0
		9	33	27.50
		10	0	0.0
5.	Did you feel PD chair would have been introduced much earlier?	Yes (1)	90	75.0
		No (2)	30	25.0
6.	Did you notice any improvement or change in efficiency of instrumentation due to restriction of movements while working on PD chair?	Yes (1)	90	75.0
		No (2)	30	25.0
7.	Time taken by the procedure on PD chair	Less (1)	64	53.3
		More comparatively (2)	56	46.7
8.	Ease of the procedure on PD	Easy (1)	77	64.2
		Difficult comparatively (2)	43	35.8

[Table/Fig-6b]: Clinicians perspectives.
*PD: Proprioceptive derivative. Each dentist treated six patients in both the approaches. Thus, we calculated 120 responses of clinicians on 120 patients

DISCUSSION

In the present study, there was an improvement in the comfort and satisfaction levels of clinicians while working with the PD concept, although they initially experienced some discomfort in adapting to this new approach. Authors found that the time factor was an improved parameter in this concept, which would help improve patients' compliance with further treatments.

Musculoskeletal disorders are a common occurrence in dental clinicians [11-14]. This study found minimal hand, wrist, and finger movements, which reduces the chances of developing common musculoskeletal disorders such as carpal tunnel syndrome. This may be due to the fact that PD instruments are lighter in weight, thus reducing fatigue on the fingers. Anton D et al., in their study, reported that 44.2% of dental hygienists in the United States showed carpal tunnel syndrome [13]. A systematic review by Pasupuleti Mk also concluded that the use of PD approach can significantly reduce the occurrence of these musculoskeletal disorders [15].

Regarding the patients' perspectives, their comfort and satisfaction levels were similar in both concepts, with a slight increase in comfort and satisfaction levels in PD, although not statistically significant. The findings of this study revealed that switching from traditional to proprioceptive derived work postures resulted in a noticeable improvement in comfort and treatment satisfaction for the clinicians. These findings are consistent with the results of Chaikumarn M's observational study of dentists who use the proprioceptive derivation concept [2].

In the current study, the patients' preferred dental chairs for periodontal therapy were compared. A majority (58.3%) of patients who preferred the proprioceptive derivation idea chose a restricted and relaxed position of the PD dental support. In the proprioceptive derivation approach, the instrument table is not placed right next to the patients, which further helps in reducing patient anxiety during dental treatments. The findings of this study align with a study conducted by Pasupuleti MK et al., in 2023 [16]. The current study demonstrated ergonomic benefits for clinicians when they worked with the proprioceptive derivation concept. All the responses related to comfort and treatment satisfaction showed statistically significant differences when comparing the proprioceptive concept with the conventional method.

A majority of the clinicians included in the study reported increased comfort levels and enhanced treatment accuracy, resulting in reduced working time. This finding aligns with a study conducted by Chaikumarn M, where seven out of twelve dentists acknowledged that the PD concept improved their treatment accuracy and helped reduce physical stress on muscles, leading to reduced treatment time [1].

The clinicians experienced improved efficiency of instrumentation due to the movement restrictions applied in the proprioceptive derived support. These findings are consistent with a 2005 study by Chaikumarn M, which utilised Rapid Upper Limb Assessment (RULA) to examine how dentists' working posture changed when using alternative work concepts like proprioceptive derivation compared to the conventional technique. The proprioceptive derivation idea helps dentists maintain proper posture during dental procedures, thereby reducing musculoskeletal pain [2].

As an essential aspect of dental ergonomics, this study provided optimal access, visibility, comfort, and control during clinical practice. These conclusions are based on research by Mohan Kumar P et al., which examined the impact of clinicians' and patients' comfort levels during conventional oral prophylaxis using ultrasonic scaling [16].

The time taken for hand scaling using the proprioceptive derivation concept was approximately 60 minutes, while the oral prophylaxis procedure took 45 minutes in the conventional approach. After adapting to the new work postures, the clinicians were able to complete the scaling procedure in only 30 minutes. Initially, the treatment procedures performed using the new work postures were difficult for the clinicians, and they took more time to perform them. However, once they gained experience in working with the proprioceptive concept, the majority of the clinicians opted for the new approach. These results are consistent with a study by Chaikumarn M (2005) [2].

Limitation(s)

A major limitation of this study is the small sample size. However, further clinical trials on the PD concept should be conducted as it is a relatively unexplored area that requires more intervention for the benefit of both patients and clinicians.

CONCLUSION(S)

The comfort levels of the patients and the ergonomics of dental professionals working in the PD approach were higher compared to the conventional approach. The concept of proprioceptive derivation has emerged as a boon for dentists, as the results of the present study demonstrated improved benefits in terms of ergonomics and efficiency.

The proprioceptive concept can be recommended to dental professionals as it helps prevent musculoskeletal disorders and enhances work efficiency through its working postures. Thus, this concept increases the longevity of dentists' clinical practice.

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[ANNEXURE-1]

Tool used for comfort levels/treatment satisfaction levels.

Comfort levels: 0- Not at all; 1- No difference 2- Partly; 3-Fairly; 4- Excellent

Satisfaction: 0- Not at all 1- No difference 2- partly; 3-Fairly; 4- Excellent

Patient's Perspectives

1. How comfortable the patient felt during the treatment in:
   Conventional approach: a) 0 b) 1 c) 2 d) 3 e) 4
   Proprioceptive approach: a) 0 b) 1 c) 2 d) 3 e) 4
2. How has the Patient rated treatment satisfactory levels on:
   Conventional approach: a) 0 b) 1 c) 2 d) 3 e) 4
   Proprioceptive approach: a) 0 b) 1 c) 2 d) 3 e) 4
3. Which chairs the patient preferred for performing treatment in the future:
   A) Conventional (1) B) Proprioceptive (2)
4. If so, What were the positive points of his/her preferred dental chair position?
   A) Minimal Chair movement
   B) Flat and relaxed chair position
   C) Proximity of instruments
   D) Known approach
   E) Presence of spittoon
   F) No clogging of water/no difficulty in breathing
5. If not, what factors hindered treatment outcome in his/her non-preferred dental chair:
   A) Absence of spittoon
   B) Clogging of water lead to difficulty in breathing
   C) Jerky Movement of chair- 1;
   D) Close proximity of instruments

Clinician's Perspectives

1. How comfortable the clinician felt while performing the treatment on:
   Conventional approach: a) 0 b) 1 c) 2 d) 3 e) 4
   Proprioceptive approach: a) 0 b) 1 c) 2 d) 3 e) 4
2. How the clinician rated his treatment outcome levels on:
   Conventional approach: a) 0 b) 1 c) 2 d) 3 e) 4
   Proprioceptive approach: a) 0 b) 1 c) 2 d) 3 e) 4
3. Did you notice a drastic difference in your comfort levels while working on PD chair:
   Yes -1; B) No -2
4. On a scale of 1 to 10 how would you rate your clinical satisfaction levels when: working under PD chair._____
5. Did you feel PD chair would have been introduced much earlier?
   A) Yes -1; B) No -2
6. Did you notice any improvement or change in efficiency of instrumentation due to restriction of movements while working on PD chair?
   A) Yes -1; B) No -2
7. Time taken by the procedure on PD chair:
   Less-1; more comparatively -2
8. Ease of the procedure on PD:
   Easy-1; Difficult comparatively-2