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## Evaluation Of Ergonomic Training Programme Among Dental Undergraduates In Preclinical Conservative Dentistry: An Interventional Study

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### Abstract:

**Background:** The prevalence of musculoskeletal symptoms and potential risk factors are more among dentists, dental hygienists and dental students. However, studies on WMSD among dental and dental hygiene students are quite limited. The objective of the study is to quantitatively evaluate the experiences of students enrolling in the preclinical conservative class with ergonomic practice.

**Methods:** The study is a single group interventional study planned amongst all second year undergraduate dental students, in the department of Conservative dentistry and Endodontics, MES Dental College, MES Academy of medical sciences, Perinthalmanna, Kerala, India. Informed consent was taken from the students involved in the study. The total duration of the study was 8 months. First 3 months were training period in which theory classes and practical classes on ergonomic postures were covered. Classes were taken twice in a week. The students were assessed by the investigator based on the criteria given in the checklist. For each item classified as correct received one point each and each incorrect point received zero point. The total score was out of 10. This assessment was done thrice i.e. at the end of first month, second month and third month. During the training period, a questionnaire consisting of 15 questions were provided to the students at the end of first month. At the end of third month of training programme, the same questionnaire with 15 questions were given to the students and the difference in their responses were analysed. The remaining time period of 5 months was observation period during which the investigator observed the students performing ergonomic work postures while doing procedures. And interventions were done whenever the students performed in a wrong ergonomic posture. The number of times interventions done for a particular student during the observation period were documented.

**Results and discussion:**

Assessment of preclinical scores of the students revealed that the percentage score was maximum from first to third month (43.69%) when compared to first to second (24.31%) and second to third month (25.39%). Pairwise comparison of three groups among time periods were found to be significant (p value=0.001). Comparison of pre and post training questionnaire showed significant improvement in student's response with p value <0.05 for each question. To correlate the number of interventions and preclinical scores of each students, a negative correlation of 0.7 was observed i.e., the students with maximum preclinical

scores during training period required only few interventions in the observation period and the students with minimum preclinical scores during training period required more interventions during the observation period.

Conclusion:

Ergonomic training program incorporated in preclinical classes helped students to adopt and internalize correct work posture throughout their academic year

**Keywords:** Ergonomics, WMSD, Posture, MSD, Occupational risk.

### 1. Introduction

The term Ergonomics has been derived from Greek words 'Ergo' mean work and 'nomic' mean natural laws, an applied science concerned with designing and arranging things people use so that the people and things interact most efficiently and safely. The goal of ergonomics is to stabilize a safe, healthy and comfortable working atmosphere, thereby preventing health issues and improving productivity and efficiency.<sup>1</sup> if ergonomic principles are applied in the field of dentistry, it helps to decrease mental and physical stress, prevent occupational hazards, thus helps to improve output and provide more comfort to the dentist and patient.<sup>2</sup> Work related musculoskeletal disease (WMSD) have become a major concern in the field of dentistry. It is crucial to highlight this problem as WMSD in dentistry might contribute significantly to sick leave, reduced productivity and future likelihood of abandoning the profession at an early age. Working atmosphere and its characteristics were considered as key factors affecting the incidence of WMSD.<sup>3</sup>

Dentistry as a very fine and precise profession is naturally stressful. Dental professionals habitually endure from physical and psychological tensions while working. Prolonged working time, static body posture, vigorous and repetitive motions, poorly designed instruments or workplaces can contribute to WMSD.<sup>4</sup>The dental profession involves skillful procedures with great accuracy and control. Muscles used for this purpose are at higher risk of becoming fatigued and causing pain to the dentist. Dentists are most susceptible to postural problems due to limited access and restricted view which makes them more prone to occupational risks A Proper ergonomic design should be given extreme importance to prevent tiresome strain injuries which can eventually lead to long-term disability. Ergonomic principles help to establish a relatively safe and healthy working environment for practitioners which will eventually lead to increased productivity.<sup>5</sup>

Despite of many documented data for dental professionals, only limited studies were conducted on dental students to evaluate WMSD. It has been reported that 64- 93% of dentists and 70% of dental students suffer from WMSD and moreover they are at risk of neurovascular and postural disorders.<sup>4</sup>Habits are formed when we do anything routinely over a period of time which becomes quite difficult to unlearn. Challenge to unlearn an acquired behavior and replace with another is well known. Hence, correct postural awareness and coaching to internalize good posture as an automated behavior, given during the dental undergraduate studies may prevent or minimize the work related musculoskeletal disorder in future dentists.

### 2. Materials and methods:

Study Design : Single group interventional study  
Study setting : Department of Conservative Dentistry & Endodontics,  
MES Dental College, Perinthalmanna

Duration of study: 2nd year academic year (2019-2020)  
Total duration of 2 nd year preclinics was 8 months.

Sample size : All second year preclinical students (n=64) who  
Provided consent to take part in the study.

### 3. Sample Collection Criteria

Study population: Second year BDS students undergoing preclinical conservative dentistry training

Inclusion criteria

Second year dental students (academic year 2019-2020), who are willing to participate in the study

**Exclusion criteria**

1. Absentees
2. Students who are already having musculoskeletal problems
3. Students who have not attended more than 5 training classes

The study is a single group interventional study planned amongst all second year undergraduate dental students, in the department of Conservative dentistry and Endodontics , MES Dental College, MES Academy of medical sciences, Perinthalmanna, Kerala, India .Ethical approval from the Research Ethics Committee at MES Medical College has been obtained.

First, an expert committee was formed comprising of principle investigator and clinical supervisors. A literature review on subjects related to the research area was carried out to provide an initial basis for formulating the questions to be included in the questionnaire.

Informed consent was taken from the students involved in the study. The total duration of the study was 8 months. First 3 months were training period in which theory classes and practical classes on ergonomic postures were covered. Video demonstration showing the routine procedures of dental restorative and endodontic procedures was done in the training programme. Classes were taken twice in a week.

The students were assessed by the investigator based on the criteria given in the checklist. For each item classified as correct received one point each and each incorrect point received zero point. The total score was out of 10.This assessment was done thrice i.e.; at the end of first month, second month and third month.

During the training period, a questionnaire consisting of 15 questions were provided to the students at the end of first month. The terminology used in the questionnaire were straightforward and immediately understandable by all respondents and as short as possible to prevent respondent exhaustion. The response given by the students in the questionnaire were checked and attempts were done to resolve their problems in the second month of training. At the end of third month of training programme, the same questionnaire with 15 questions were given to the students and the difference in their responses were analyzed. By this an ergonomics awareness assessment was done for all students to evaluate their knowledge concerning work-related musculoskeletal disorders (WMSD) before and at the end of the coaching program.

After the 3 months training period, the remaining time period of the academic year 5 months was observation period during which the investigator observed the students performing ergonomic work postures while doing procedures in preclinical conservative lab. Interventions were done whenever the students were performing in a wrong ergonomic posture. The number of times interventions done for a particular student during the observation period were documented.

**4. Check List For The Faculty****ITEMS REQUIREMENTS OBSERVED**

- 1) Sitting with thighs parallel to the ground, forming an angle of 90 degrees with the leg
- 2) The two feet should be well supported on the ground
- 3) The back should be supported with the backrest of the stool
- 4) Sitting on the stool with a slightly straight spine
- 5) The head of the dental mannequin should be positioned downwards for work in the maxilla, upwards for work in the mandible, and lengthwise for work on the buccal surfaces of the anterior teeth (upper and lower)
- 6) The reflector must be positioned at the front of the mouth of the dental mannequin for work in the maxilla and perpendicular to the head for work in the jaw
- 7) A distance of 30-40 cm should be maintained between the operator's eyes and the mouth of the dental mannequin
- 8) The right arm must be close to the body
- 9) The left arm must be close to the body
- 10) The frequently used instruments should be positioned in the ideal handling Space

**5. Results:**

Null hypothesis: 2nd year preclinical students will not adopt and continue the ergonomic work posture after proper behavioral modification training programme.

Alternate hypothesis: 2nd year preclinical students will adopt and continue the ergonomic work posture after proper behavioral modification training programme.

- Data was entered into Microsoft excel data sheet and was analyzed using SPSS for Windows (Statistical Presentation System Software, SPSS Inc.) version 17.0.
- Continuous data was represented as mean and standard deviation. Repeated measure ANOVA and Kruskal Wallis test and their respective post hoc test were used.
- Count data was represented as number and proportions. McNemars test and Chi square test were used.

Graphical representation of data: MS Excel and MS word was used to obtain various types of graphs such as bar diagram

p value (Probability that the result is true) of  $<0.05$  was considered as statistically significant after assuming all the rules of statistical tests.

Statistical software: MS Excel, SPSS version 17.0 was used to analyse data.

## 6. Discussion:

The objective of academic dentistry programmes is to provide dental students with scientific, technical, humanistic and social training, as well as with theoretical knowledge and motor skills. The acquisition of these skills begins in the preclinical training phase, during which students perform procedures simulating cavity preparation and restorative procedures in dental mannequins. The basic training for dentistry students begins with an understanding of the biology, physiology and pathologies of the oral cavity this initial phase is closely linked to the formation of general academic and cognitive abilities, which are familiar to students who have experienced this type of training in their previous academic experiences. Thus, the difficulties of this initial phase can be overcome with dedication and study. As students advance in the programme, preclinical practical training is required to prepare students for patient care. Other studies have reported that many students find it difficult to translate theory into practice. This difficulty occurs because students need to develop visual and motor skills, hand-eye coordination, spatial awareness, and knowledge on how to visualize three-dimensional oral structures in fine detail in a restricted and shadow-filled operating field.<sup>43</sup>

Garcia et al found that dental students had adequate theoretical knowledge about the principles of ergonomics. However, they faced some obstacles when putting them into practice. One of the reasons provided for the failure to implement ergonomic posture was the amount of concentration required to perform the dental procedures themselves. The students reported that the level of focus required meant that they failed to prioritise their own occupational health.<sup>15</sup> With these findings, the question arose of whether the difficulty of performing dental procedures could be associated with the degree of difficulty of adopting ergonomic posture. For this reason, the current study considered this issue by focusing on restorative dentistry procedures during preclinical training.

Due to the irreversibility of dental procedures, students focus on implementing the techniques they have learned and may not be aware of the external factors affecting their work. Therefore, it is important to evaluate dental students' perceptions of risk factors involved in the development of musculoskeletal disorders. Such assessments may provide insight into the adequacy of the training process to protect dentists' occupational health.<sup>44</sup>

In the dental ergonomics area, there are some requirements that are taught to students for the adoption of ergonomic, and therefore, healthy posture. The implementation of a periodic control of the compliance of these requirements can be advantageous in the dental educational. This would allow for observation of the evolution of students' practice over time and give feedback to students accordingly. There is also the possibility of identifying the students' difficulties in applying these requirements. The requirements for ergonomic work posture in dentistry are rules taught during the professional training phase with the objective of maintaining musculoskeletal health. These rules are related to the adequate positioning of the patient in the dental chair, the equipment and instruments, as well as the posture of the operator's head, neck, trunk, arms, forearms, hips, thighs, legs and feet during clinical care.<sup>45</sup>

Work-related musculoskeletal injuries are common in several professions. Of these, dentists warrant special attention, because they work in a restricted operative field, in poor light, and with limited accessibility. These work-related difficulties compel dentists to adopt inappropriate postures which, when associated with other factors, such as static posture, lack of breaks and occupational stress can damage their health and cause pain and discomfort, mainly in the upper limbs. Students performing laboratory and clinical activities during their undergraduate dentistry course may face the same difficulties as those faced by dentists. In addition, they would lack the physical skills and psychological preparation required by a fully qualified dentist. Therefore, to reduce the risk of developing musculoskeletal disorders, it is extremely important that training is initiated as early as possible, whilst the students are still being academically modelled into the profession to identify and correct potential postural defects.<sup>33</sup> Posture reflects the position that an individual maintains in space via his bone–muscle–skeletal system, according to a static or dynamic balance. By maintaining a good posture, the body lowers its energy expenditure, improves organ functioning and is protected against disturbances that could undermine occupational practice.<sup>35</sup>

Carpal tunnel Syndrome (CTS) is the most common compression neuropathy. Jobs with frequent and repetitive hand movements are one of the risk factors for this syndrome. The prevalence of CTS was more among dentists and CTS prevalence was increased with age. The dentist population with more working hours per week and more experience years were more susceptible for this syndrome. Using suitable gloves, wrist splints and short periods of resting during vigorous continuous working can decrease the symptoms of this disease.<sup>46</sup>

Repetitive movements and prolonged body postures can be expected to cause muscle damage, as well as ligament and joint injuries. Daily work planning should allow a break for the alternating muscle groups in order to maintain productive work. The ergonomic factors to be taken into account could be summarized as supports of the upper limbs, the use of instruments with large handles, and working with a mechanically adjustable chair presenting an adjustable backrest. The use of indirect vision and correct patient positioning in the dental chair to avoid awkward or forced neck postures are also important. Proper lighting and the use of systems such as magnifiers and microscopes also help reduce fatigue and increase productivity.<sup>47</sup>

There are a vast number of risk factors that contribute to the onset of WMSD which for simplicity can be broken down into three categories; individual factors (gender, age, height and weight), physical work factors (repetition, forceful exertion, fixed postures and vibration) and psychosocial factors (internal work demands, external work demands and the characteristics of the individual such as personality and attitude).<sup>48</sup>

In the last decade, various studies have been published around the world citing the high prevalence of WMSDs among dental professionals. The most affected regions reported are the back and neck. The need for prevention of these disorders has been identified, including identification and modification of risk factors associated with this profession.<sup>49</sup> Pain and work-related musculoskeletal disorders interfere significantly with the dentists' lives. In the case of dental surgeons there is a significant correlation between pain intensity and disability.<sup>50</sup>

High numbers of musculoskeletal problems should make practitioners concerned about their early diagnosis and treatment. It is necessary to focus on appropriate preventive interventions that can help to reduce the prevalence of WMSDs. It is important that the education and application of ergonomic principles should begin at an early stage of dental education and continue throughout the career.<sup>51</sup>

In this study, the first 3 months of training period assessed preclinical scores of the students and the statistical analysis revealed that the percentage score was maximum from first to third month (43.69%) when compared to first to second (24.31%) and second to third month (25.39%).

Comparing the questionnaire survey, in the pertaining questionnaire 47 students (73.4%) complained of pain during preclinical exercises whereas after the training it was reduced to 11 (17.2%). The curvature of spine was forward among 57.8% students before the training classes which was corrected and was able to achieve 100% straight spine in the post training survey. The activity producing maximum pain was reported as in maxillary posteriors which was reported as 65.6% before training and it was reduced to 18.8% after the training programme.

According to Pearson correlation, which was used to correlate the number of interventions made in the observation period of 8 months and the preclinical score, a negative correlation of 0.7 was observed i.e., the students with maximum preclinical scores during training period required only few interventions in the

observation period and the students with minimum preclinical scores during training period required more interventions during the observation period.

## 7. Conclusion

Within the limits of the study, following conclusions were drawn:

- 1) The behavior modification approach done among dental undergraduates in preclinical conservative dentistry curriculum had improved the ergonomic posture of the students.
- 2) The quantitative evaluation of the experiences of students enrolling in the preclinical conservative class were satisfactorily improved during the training programme.
- 3) By the end of the study, all the students were familiar with and adopted the ergonomic principles.

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**IMAGES:**

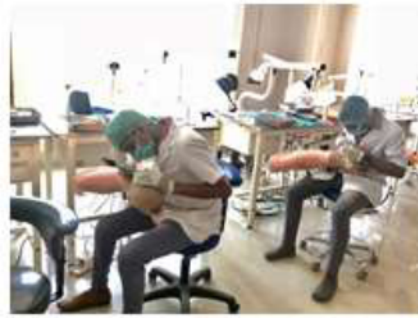


**Figure 1 preclinical phantom head lab**



**Figure 2 – Students performing restorative Procedures on phantom head**





**Figure 3-Awkward postures noted**



**Figure 4 Demonstration of correct postures During restorative procedures**



**Figure 5 -Questionnaire- Participants**



**Figure 6 Training classes Filling questionnaire after the first Month of training**



Figure 9-Observation Period



Figure 10 Interventions done during observation period

TABLES AND GRAPHS:

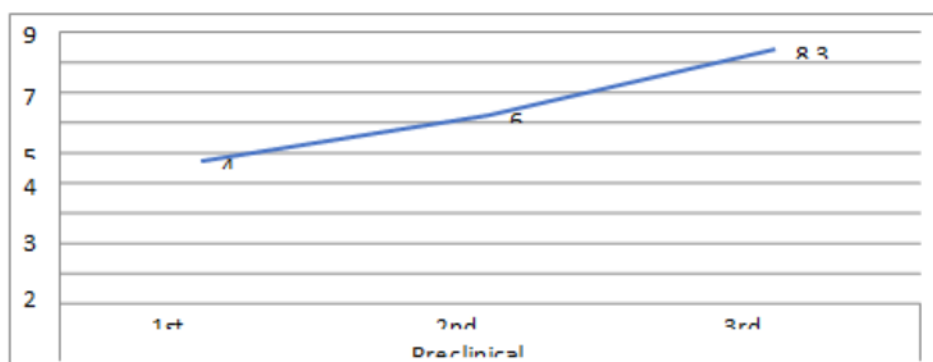
**Table-1**  
Descriptive details of preclinical score based on checklist criteria

Preclinical score	Groups	N	Mean	Std. Deviation	Minimum	Maximum
Time period	1 <sup>st</sup> month	6 4	4.70	1.191	2	7
	2 <sup>nd</sup> month	6 4	6.20	.839	4	8
	3 <sup>rd</sup> month	6 4	8.36	.966	6	10
% change in score	1 <sup>st</sup> month-2 <sup>nd</sup> month	6 4	24.31%	16.119%	0.00%	60.00%
	2 <sup>nd</sup> month--3 <sup>rd</sup> month	6 4	25.39%	9.08%	0.00%	44.44%
	1 <sup>st</sup> month -3 <sup>rd</sup> month	6 4	43.693%	13.256%	12.50%	71.43%
	Noofintervention	6 4	7.37	3.680	1	15

**Table- 2**  
Comparison of preclinical score along time period

	Groups	N	Mean	Std. Deviation	Std. Error Mean	P-value
Pre-clinical score	1 <sup>st</sup> month	64	4.70	1.191	.149	<b>0.001* (Significant)</b>
	2 <sup>nd</sup> month	64	6.20	.839	.105	
	3 <sup>rd</sup> month	64	8.36	.966	.121	

\*significant at the 0.05 level using Repeated measure ANOVA.



Graph 1- Comparison of mean score along time period

Table-3 Pairwise-Comparison of the three groups among the time periods

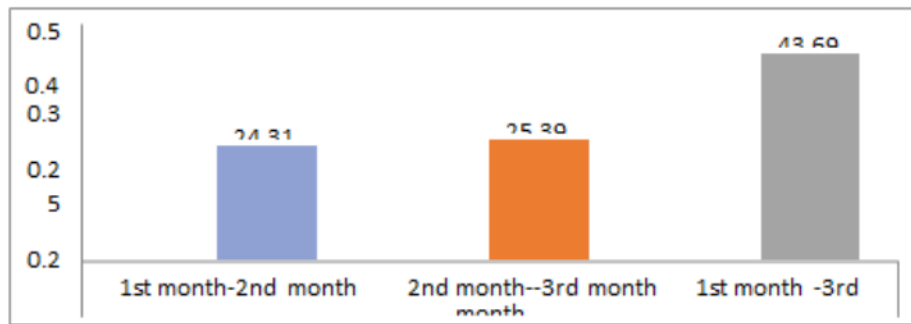
Dependent Variable	(I) var	(J) var	Sig.
Time period	1 <sup>st</sup> month	2 <sup>nd</sup> month	<b>0.001* (Significant)</b>
		3 <sup>rd</sup> month	<b>0.001* (Significant)</b>
	2 <sup>nd</sup> month	3 <sup>rd</sup> month	<b>0.001* (Significant)</b>

Table-4 Comparison of Percentage change in time period among the three groups

Pre-clinical score	Groups	N	Mean	Std. Deviation	Std. Error Mean	P-value
% change in score	1 <sup>st</sup> month - 2 <sup>nd</sup> month	64	24.31%	16.119%	2.007%	<b>0.001* (Significant)</b>
	2 <sup>nd</sup> month - 3 <sup>rd</sup> month	64	25.39%	9.08%	1.126%	

	1 <sup>st</sup> mont h - 3 <sup>rd</sup> mont h	6 4	43.693 %	13.256%	1.664%	
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\*significant at the 0.05 level using Kruskal wallis test.



Graph 2- Comparison of percentage change in time period among the three groups

Table- 4 B Pairwise-Comparison of the three groups among the time periods

Dependent Variable	(I) var	(J) var	Sig.
% change in score	1 <sup>st</sup> mont h- 2 <sup>nd</sup> mon th	2 <sup>nd</sup> mont h-- 3 <sup>rd</sup> month	0.914
		1 <sup>st</sup> month -3 <sup>rd</sup> month	0.001 (Significant t)*
	2 <sup>nd</sup> mont h-- 3 <sup>rd</sup> month	1 <sup>st</sup> month -3 <sup>rd</sup> month	0.001* (Significant t)

\*significant at the 0.05 level using mannwhitney u test with bonferroni correction.

Table- 5 Correlation between number of interventions made in observation period and preclinical score

		No o fintervention
Pre clinics score	Pearson Correlation	-.731
	Sig. (2-tailed)	.001*
	N	64

\*significant at the 0.05 level.