

## Improvement of Operating Posture among Dental Hygiene Students Through Image Analysis

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**Abstract:** The issue of work-related musculoskeletal symptoms is pertinent to dental hygienists. The objective was to review and correct the operating posture of dental hygiene students by means of image analysis. Subjects included 18 female dental hygiene students. The study was conducted through a survey of operating postures and an analysis of which body areas experienced discomfort or pain after scaling. After capturing images of a subject's posture, a score was calculated using a Posture Assessment Instrument (PAI). Subjects corrected their postures following an analysis of the imagery, after PAI scores were recalculated to determine the effectiveness of corrective measures. Awareness of proper operating postures among the subjects was found to be generally high with most students aware of proper operating postures. However, the study showed that it was difficult for students to maintain the proper operating posture in the head and shoulder areas which resulted in the lowest use of proper operating postures in those body areas. In addition, students who did not maintain the proper operating postures were found to have the highest levels of discomfort/pain. Following review and correction of their operating postures using video equipment and tools, student's overall operating postures were corrected, especially in the wrist and shoulder areas. The use of video equipment and tools in correction of operating posture was shown to be effective in reducing discomfort and pain. These results will be beneficial in creating standardized manuals on operating postures.

**Key words:** Dental hygiene, ergonomics, image analysis, operating posture, scaling, manuals

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### INTRODUCTION

Musculoskeletal symptoms occurring as a result of work are a serious occupational hazard. If a certain part of the body is used repeatedly, chronic issues such as pain, sensory problems and paralysis can ensue. Research tasks that are repeated over long periods of time, improper postures and movements, exertion of an abnormal amount of strength, insufficient rest, research environment and improper use of equipment are some of the causes of pain that can increase the probability of musculoskeletal symptoms (Graham, 2002).

Dental hygienists working in dental clinic tend to be on their feet for long periods of time and use improper operating postures in order to better visualize patient's teeth. Dental hygienists must bend their necks and waists while elevating their arms in order to support dentists during operations. These actions tend to cause pain in certain parts of the body and result in musculoskeletal symptoms (Hayes *et al.*, 2010; Lindfors *et al.*, 2006).

The number of patients with musculoskeletal symptoms is continuing to increase within our country and the presence of such symptoms resulting from research is considered to be a critical health problem among dental hygienists (Hayes *et al.*, 2010). Musculoskeletal symptoms are difficult to cure after they occur and a long period of time is necessary to achieve

full recovery. Individuals may suffer economic losses during such a period if they are unable to research or if the symptoms affect the quality of their own treatment of patients, desire to research or research effectiveness which makes the prevention of musculoskeletal symptoms essential (Crawford *et al.*, 2005; Leggat *et al.*, 2007). The use of improper operating postures by dental hygienists is especially likely to result in pain and musculoskeletal symptoms. Correspondingly, the use of proper operating postures is most important to the prevention of musculoskeletal symptoms.

Many studies in dentistry have been conducted with the aim of assessing the awareness of musculoskeletal symptoms, sites of pain and causes that have emphasized the importance of maintaining proper postures as well as corrective measures (Anton *et al.*, 2002; Morse *et al.*, 2003; Werner *et al.*, 2005; Ylipaa *et al.*, 2002) but research has been lacking into intermediary methods of correcting operating postures. Correspondingly, the present study uses video equipment and tools to review and correct the operating postures of dental hygiene students and examines the effectiveness of such methods.

### MATERIALS AND METHODS

**Subjects and methods:** Participants in the present study were 18 female dental hygiene students. The subjects

**Table 1: Branson’s posture assessment instrument**

Body area (Scores)	Acceptable (each 1 point)	Compromised (each 2 points)	Harmful (each 3 points)
Hips (1-2)	Level on stool	Hips not level on stool	
Trunk (1-9)	Front to back $\leq 20^\circ$	Front to back $>20^\circ, <45^\circ$	Front to back $\geq 45^\circ$
	Side to side $\leq 20^\circ$	Side to side $>20^\circ, <45^\circ$	Side to side $\geq 45^\circ$
	Rotation between planes $\leq 20^\circ$	Rotation between planes $>20^\circ, <45^\circ$	Rotation between planes $\geq 45^\circ$
Head/Neck (1-9)	Front to back $\leq 20^\circ$	Front to back $>20^\circ, <45^\circ$	Front to back $\geq 45^\circ$
	Side to Side $\leq 20^\circ$	Side to Side $>20^\circ, <45^\circ$	Side to side $\geq 45^\circ$
	Rotation between planes $\leq 20^\circ$	Rotation between planes $>20^\circ, <45^\circ$	Rotation between planes $\geq 45^\circ$
Shoulders (1-4)	Relaxed	Slumped forward	
	Both shoulders level with trunk	One or both shoulders elevated above line of trunk	
Wrists (1-2)	Flexion or extension $\leq 15^\circ$	Flexion/Extension $>15^\circ$	
	(either wrist)	(either wrist)	

**Table 2: Subject’s knowledge level, degree of practice and difficulty of practice regarding operating posture (mean±standard deviation)**

Parameters	Knowledge level	Degree of practice	Difficulty
Hips	3.77±1.06	3.39±0.98	2.28±1.13
Trunk	4.17±0.51	2.61±0.78	3.44±1.15
Head	4.33±0.69	2.22±1.00	3.94±1.15
Shoulders	4.17±0.86	2.22±0.81	3.94±0.87
Wrists	4.17±0.71	2.61±1.04	3.55±1.20

completed a self-report survey regarding operating postures to determine awareness of proper operating postures, the use of proper operating postures and the level of difficulty in maintaining the proper operating posture in addition to a review of the discomfort and pain experienced in each body area after a practice scaling session. Awareness of proper operating postures was rated from 1 (Not aware) to 5 (Very aware), use of proper operating postures was rated from 1 (Unable) to 5 (Very proficient) and level of difficulty in maintaining proper operating postures was rated from 1 (Not challenging) to 5 (Very challenging) using a Likert scale. In addition, a semantic differential scale was used to record the level of discomfort or pain in body areas such as the back of the neck, the area between the right shoulder and neck, the right shoulder, right wrist, upper back, waist and buttocks using a scale of 0 (No symptoms) to 10 (Very painful).

To review the correctness of the operating postures of the subjects, a Posture Assessment Instrument (PAI) was used as Table 1 (Branson *et al.*, 2002). The five categories used in the assessment were the hips, trunk (upper body), head and neck, shoulders and wrists with higher scores indicating an improper operating posture.

Based on the PAI scores of the operating postures of subjects during their practice scaling sessions, a posture review was conducted on various areas of the body such as the hips, upper body, head, shoulders and wrists. The subjects reviewed the visual results of their operating postures and received posture correction. Following this stage, another review was performed on the five categories according to subject’s PAI scores.

**Statistical analysis:** The collected data were recorded and analyzed using SPSS 20.0 (SPSS Inc., Chicago, IL, USA). Awareness of proper operating postures, use of proper

operating postures and difficulty in maintaining the proper operating posture were reported as average and standard deviation with the correlation between the PAI scores of the subjects and the discomfort or pain experienced calculated by means of Pearson correlation. In addition, the before/after effects size of video analysis of operating postures were confirmed using the Wilcoxon signed rank test with the significance level set at 0.05.

## RESULTS AND DISCUSSION

Subject’s knowledge level, degree of practice and difficulty regarding operating posture were shown in Table 2. While the awareness of proper operating postures was generally high among all subjects, awareness of the correct operating posture in the hips was the lowest at 3.77 points. Use of the correct operating postures was lowest in the head and shoulder area at 2.22 points with use in the upper body and wrist area being the second lowest at 2.61 points. The level of difficulty in maintaining the proper body posture was highest in the head and shoulder area at 3.94 points with the wrist area coming in second.

The correlation between the PAI scores of the subjects and the pain experienced in each body area was found to be significant in the body areas between the right shoulder and neck, the right shoulder and the upper back as shown in the Table 3. A lower PAI score indicated a more improper operating posture which resulted in a higher correlation with pain experienced in the right shoulder and upper back after performing a scaling session.

Analysis of video recordings capturing the operating posture of the research subjects showed that the PAI of the wrist area decreased from 1.72-1.06 points after posture correction as shown in Table 4, the largest increase among the different body areas ( $p = 0.001$ ). The shoulder area showed the second greatest improvement through posture correction with the PAI decreasing from 3.06-2.33 points after correction ( $p = 0.008$ ).

The present study used video equipment and tools to correct the operating postures of dental hygiene students during their scaling sessions with the aim of determining

**Table 3: Correlation between the PAI of research subjects and discomfort/pain experienced after scaling by body area**

PAI score	Discomfort/Pain experienced after scaling sessions (0-10)						
	Back of neck	Area between right shoulder and neck	Right shoulder	Right wrist	Back	Waist	Buttocks
Total (1-26)	-0.249	-0.429	-0.691**	0.064	-0.554*	-0.217	0.188
Hips (1-2)	-0.220	-0.507*	-0.500*	0.085	-0.451	0.261	-0.048
Trunk (1-9)	-0.258	-0.251	-0.662**	0.223	-0.478*	-0.226	-0.075
Head (1-9)	0.102	-0.337	-0.348	-0.094	-0.334	-0.083	-0.291
Shoulders (1-4)	-0.222	-0.361	-0.608**	-0.135	-0.649**	-0.337	-0.265
Wrists (1-2)	-0.352	-0.174	-0.513*	0.095	0.086	-0.364	-0.018

\*p<0.05, \*\*p<0.01 by Pearson correlation

**Table 4: Posture assessment criteria before and after image analysis of subject's operating postures (mean±standard deviation)**

Parameters	Before	After	Δdifference	Effect size*	p-values**
Total (1-26)	15.72±2.97	11.78±1.77	3.94±2.60	15.2	<0.001
Hips (1-2)	1.28±0.46	1.00±0.00	0.28±0.46	14.0	0.025
Trunk (1-9)	4.33±1.08	3.22±0.73	1.11±1.08	12.3	0.002
Head (1-9)	5.28±1.13	4.17±0.62	1.11±1.08	12.3	0.002
Shoulders (1-4)	3.06±0.80	2.33±0.59	0.71±0.89	17.8	0.008
Wrists (1-2)	1.72±0.46	1.06±0.24	0.67±0.49	33.5	0.001

\*(Δdifference/top score)×100; \*\*By Wilcoxon signed-rank test

the effects of posture correction. In general, if operating postures were not maintained correctly, many students experienced pain and discomfort in the right shoulders and upper back areas after performing a scaling session. Following review and correction of their operating postures with the use of video equipment and tools, the overall operating postures of subjects were corrected, especially in the wrist and shoulder areas.

As dental hygienists must maintain a constant operating posture while treating patients, there is a high probability that they may experience musculoskeletal symptoms as a result of this operating posture. Previous studies showed that musculoskeletal symptoms occurred in 64-93% of dental hygienists (Hayes *et al.*, 2009, 2010). These symptoms are mainly caused by incorrect operating postures and the present study focused on awareness of proper operating postures, use of proper operating postures, the level of difficulty in applying said operating postures and the level of discomfort/pain experienced by dental hygiene students. Most of the students participating in the study were aware of proper operating postures but the findings of the study revealed that it was difficult for students to maintain the proper operating posture in the head and shoulder areas which resulted in the lowest use of proper operating postures in those body areas. In addition, students who did not maintain the proper operating posture were found to have the highest level of discomfort/pain. These results show that in order to effectively prevent the musculoskeletal issues experienced by dental hygienists, efforts to maintain proper operating postures as well as educational sessions that allow dental hygienists to correct their operating postures are needed.

Correlation analysis of the PAI scores which review operating postures with each body area in which the subject experienced discomfort/pain revealed that with increased use of an incorrect operating posture, increased discomfort or pain was experienced between the right shoulder and the neck and the right shoulder and upper back. In previous studies conducted to find the level of pain felt in each body area, the shoulders, neck and waist were reported as the sites in which the most pain was experienced (Marklin and Cherney, 2005). As a result, the development of an operating posture tool will be useful and more importantly, the correct operating posture needs to be recognized by dental hygienists (Beach and DeBiase, 1998; Hayes *et al.*, 2010).

In the present study, a review of the effects of posture correction was conducted by comparing the PAI scores after the implementation of posture correction with the use of video equipment. The body area in which the greatest effect after posture correction was observed was the wrist, followed by the shoulders. These results show that, posture correction video equipment can be effective in reducing discomfort and pain experienced in certain operating postures.

As the number of subjects is low owing to the study being conducted on dental hygiene students, the results of the present study are limited, making it difficult to extract generalized observations. A more scientific research undertaking such as a large-scale intermediary study or specifically designed research project will provide more definitive results relevant to the development of more effective methods of operating posture correction. However, this study was conducted with the intent of providing a foundation for future guidelines regarding methods of improving operating

postures for dental hygienists through a review of the effectiveness of posture correction by means of video analysis and standardized surveys in order to examine various operating postures and levels of discomfort and pain.

### CONCLUSION

The use of video equipment and tools in correction of operating posture was shown to be effective in reducing discomfort and pain. The association between the PAI scores of the subjects and the pain experienced in each body area was especially found to be significant in the body areas between the right shoulder and neck, the right shoulder and the upper back. The results of the present study will be beneficial in creating correction tools and standardized manuals on operating postures that can actively improve the operating postures of dental hygienists.

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