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Original Research Article

Correlation between Ergonomic Risk Factors and Work-Related Musculoskeletal Disorders in Dental Surgeons

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ABSTRACT

Overview: Despite the availability of highly sophisticated dental equipment, several ergonomic risk factors such as repetitive tasks and non-neutral physical postures do contribute greatly to work-related musculoskeletal disorders in dental surgeons. The current study was carried out to analyze the correlation between ergonomic risk factors and work-related musculoskeletal disorders in terms of perception of pain and stiffness experienced by dental surgeons.
Materials and Methods: One hundred and thirty dental surgeons with one year of work experience and having moderate to severe pain on the Numeric Pain Rating Scale were asked to participate in the pre-test. Both male and female dental surgeons were equally distributed and they were in the age group of 20-35 years. After explaining the purpose of the study, an informed written consent was obtained from the participants on voluntary basis. After a six week ergonomic awareness training program, the correlation between ergonomic risk factors and work-related musculoskeletal disorders were analyzed using structured questionnaire, Musculoskeletal Disorder Rating Scale and Dental Workstation Observation Checklist.
Results: A significant positive correlation was observed in the post-test between (i) physical energy demands ($r=0.285$, $p=0.001$), other musculoskeletal demands ($r=0.578$, $p < 0.001$) and intensity of pain. (ii) Other musculoskeletal demands($r = 0.404$, $p < 0.001$) and frequency of stiffness.
Conclusion: Work-related musculoskeletal disorders resulting from various ergonomic risk factors in clinical dentistry can be mitigated by application of ergonomic awareness training program.

Keywords: Pain, Stiffness, Physical energy demands, Environment, Manual material handling, other musculoskeletal demands.

INTRODUCTION

Work-related Musculoskeletal Disorders (WMSDs) are musculoskeletal disorders of the muscles, nerves, tendons, joints, cartilage, and spinal discs, in which the work environment and performance of work contribute significantly to the condition; and/or the condition is made worse or persists longer due to work conditions or workplace risk factors. [1] Basic operating posture is an important occupational health issue for dental surgeons. It is generally agreed that the physical posture of the dental surgeon should be such that all the muscles are in a relaxed, well-balanced and neutral position. Postures other than this neutral position are

likely to cause musculoskeletal discomfort. [2]

Dental work poses some characteristic ergonomic challenges. While performing typical work tasks, the dental surgeons have to repeatedly change their positions to sitting, standing and sometimes remaining in one position (static posture) for long periods. They bend forward or to the side while working on patients. While treating the patients, the dental surgeons are concerned about patients' comfort and pay little attention to their own comfort and, consequently, health until they begin to experience discomfort or pain in their body. With a little attention and creativity, dental surgeons can improve their comfort while performing their work tasks. [3]

Good ergonomic design of the workplace is a basic requirement for improving musculoskeletal health. The nature of the dental profession and the positions assumed by the dental surgeons during an average work day has a huge impact on the dental surgeon's body and carries with it a higher prevalence of WMSDs. The effects of WMSDs manifest themselves not only in their productivity but quality of life as well.

A poor ergonomically designed workplace may not show immediate ill health effect, because the human body has capacity for adapting to a poorly designed workplace or structured job. However, the compounding effect of job and workplace deficiencies will surpass the body's coping mechanisms causing WMSDs. The successful application of ergonomics assures high productivity, avoidance of illnesses and injuries and increased satisfaction among dental professionals. Unsuccessful application of ergonomics, on the other hand, can result in WMSDs. [2,3]

The purpose of the study is to analyze the correlation between ergonomic risk factors and WMSDs in terms of perception of pain and stiffness experienced by dental surgeons.

MATERIALS AND METHODS

The study was conducted in two dental colleges and 20 private dental clinics in Mangalore city, Southern Karnataka District, India and data was collected using non-probability convenience sampling method. One hundred and thirty out of 300 dental surgeons amongst post graduate dental students, faculty members of dental colleges and private dental practitioners with one year of work experience and having moderate to severe pain on the 0-10 Numeric Pain Rating Scale were invited to participate in the study. Both male and female dental surgeons were equally distributed (50.0%) and majority (86.2%) of these was in the age group of 20-35 years.

In order to test the correlation between ergonomic risk factors and WMSDs in terms of perception of pain and stiffness in dental surgeons, a pre-test was administered by using a structured Musculoskeletal Disorder Rating Scale (MDRS) and Dental Workstation Observation Checklist (DWOC). [4] Reliability of MDRS (Pain and Stiffness scale) was established by using internal consistency reliability. The reliability was calculated by using Cronbach's alpha and it was found to be 0.793 and 0.660 for frequency of pain and intensity of pain respectively and 0.728 for frequency of stiffness. Reliability of DWOC was established by interrater reliability-Pearson's correlation coefficient (r) and it was found to be 0.673.

A six week of Ergonomic Awareness Training Program (EATP) for selected dental surgeons was developed to provide training. It included lecture-discussion and demonstration sessions. The methodology used in the study was an observation of the dental surgeon at work with a patient for about 15-20 minutes by using DWOC containing 33 items. All positive (yes) observations were given a score of one and all negative (no) observations were given a score of zero. The focus during the observation was on manual material handling, physical energy demands,

instruments, environment and other musculoskeletal demands. The lecture-discussion concentrated on dental workstation planning, types of WMSDs, signs and symptoms of WMSDs, risk factors of WMSDs, importance of ergonomics and physical exercises. Demonstration sessions were given for work postures, lighting and adjustment of the patient and dental surgeon's chair, work-rest schedules, personal protective equipment and chair side directional stretching exercises to be adapted as a practice during mini breaks while working.

In order to find the perception of pain and stiffness experienced by dental surgeons a pain and stiffness scale was administered. Pain and stiffness scale (51 items) was developed on the basis of survey to quantify the perception of pain and stiffness experienced by working dental surgeons in the past six months of their body parts. This scale has three components such as frequency of pain, intensity of pain and frequency of stiffness. Pain was assessed using both a frequency and an intensity component. Participants were asked to respond to the following questions 'always, sometimes or never'. If the question was answered 'always' one point was given on the pain and stiffness scale, similarly two points for 'sometimes' and three points for 'never'. For example, if the dental surgeon has experienced pain and/or stiffness in the neck always, then the point given was one. In addition to providing a numeric rating of their pain intensity, the researcher administered 0-10 Numeric Pain Rating Scale which consisted 0: no pain, 1-3: mild pain, 4-6: moderate pain and 7-10: severe pain. The dental surgeons were asked to mention the appropriate number corresponding to their body parts. For instance, if the dental surgeon marks six number against lower back and it shows that he/ she has moderate pain in the lower back.

To make the EATP effective, an ergonomics awareness training manual was prepared and used during the training. After imparting the EATP, the researcher visited each dental surgeon every two weeks for a period of six weeks to find out any difficulties regarding the application of interventions demonstrated during the training period. Any help or explanation required by the dental surgeons was provided on the spot by the researcher to facilitate use of interventions by the dental surgeons. After six weeks of training, the researcher visited each dental surgeon under study while performing their professional work to observe their working environment, working postures and to find the reduction of perception of pain and stiffness by using DWOC and MDRS respectively.

Ethical clearance to conduct the study was obtained from Yenepoya University Ethical Committee. After explaining the purpose of the study, an informed written consent was obtained from the participants on voluntary basis. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 17.0 software. The analysis was done by using Pearson's correlation coefficient and statistical significance was accepted for $p < 0.05$.

RESULTS

Table 1: Correlation coefficient computed between pre-test and post-test scores of ergonomic risk factors and frequency of pain N= 130

Sl. no	Ergonomic risk factors	Frequency of pain			
		Pre-test		Post-test	
		r	p	r	P
1.	Manual Material Handling	0.091	0.303	0.072	0.414
2.	Physical Energy Demands	0.010	0.914	0.212	0.015*
3.	Instruments	0.011	0.901	0.061	0.492
4.	Environment	0.055	0.533	0.043	0.630
5.	Other Musculoskeletal Demands	0.091	0.303	0.562	<0.001**
r: Pearson's correlation coefficient p: Probability ** Highly significant * Significant					

The data on pre-test and post-test scores of ergonomic risk factors and frequency of pain are presented in Table1indicatedthat in pre-test there was positive correlation between manual material handling, physical energy demands, instruments, environment, other musculoskeletal demands and frequency of pain, but they were not statistically significant.

In post-test, there was positive correlation between manual material handling, physical energy demands, instruments, environment, other musculoskeletal demands and frequency of pain. However, statistically significant positive correlation was found between physical energy demands and frequency of pain. Statistically, highly significant positive correlation was found between other musculoskeletal demands and frequency of pain.

Table 2: Correlation coefficient computed between pre-test and post-test scores of ergonomic risk factors and intensity of pain N=130

Sl. no	Ergonomic risk factors	Intensity of pain			
		Pre-test		Post-test	
		r	p	r	P
1.	Manual Material Handling	0.050	0.571	0.095	0.285
2.	Physical Energy Demands	0.052	0.559	0.285	0.001**
3.	Instruments	0.054	0.542	0.049	0.578
4.	Environment	0.050	0.569	0.019	0.833
5.	Other Musculoskeletal Demands	0.204	0.020*	0.578	<0.001**
r: Pearson's correlation coefficient p: Probability ** Highly significant * Significant					

The relationship between pre-test and post-test scores of ergonomic risk factors and intensity of pain is presented in Table 2, which shows that in pre-test there was positive correlation between manual material handling, physical energy demands, instruments, environment, other musculoskeletal demands and intensity of pain. There was statistically significant positive correlation between other musculoskeletal demands and intensity of pain.

In post-test, there was positive correlation between manual material handling, physical energy demands, instruments, environment, other musculoskeletal demands and intensity of pain. However, statistically highly significant positive correlation was found between physical energy demands, other musculoskeletal demands and intensity of pain.

Table 3: Correlation coefficient computed between pre-test and post-test score of ergonomic risk factors and frequency of stiffness N= 130

Sl.no	Ergonomic risk factors	Frequency of stiffness			
		Pre-test		Post-test	
		r	p	r	P
1.	Manual Material Handling	0.099	0.263	0.068	0.440
2.	Physical Energy Demands	0.011	0.898	0.067	0.448
3.	Instruments	0.026	0.770	0.022	0.802
4.	Environment	0.012	0.888	0.010	0.914
5.	Other Musculoskeletal Demands	0.008	0.924	0.404	<0.001**
r: Pearson's correlation coefficient p: Probability ** Highly significant					

The relationship between pre-test and post-test scores of ergonomic risk factors and frequency of stiffness depicted in Table 3 shows that in pre-test there was positive correlation between manual material handling, physical energy demands, instruments, environment, other musculoskeletal demands and frequency of stiffness but they were not statistically significant.

In post-test, there was positive correlation between manual material handling, physical energy demands, instruments, environment, other

musculoskeletal demands and frequency of stiffness. However, statistically highly significant positive correlation was found between other musculoskeletal demands and frequency of stiffness.

The results concluded that after undergoing EATP for six weeks there was reduction in ergonomic risk factors associated with dental workstation which in turn reduced the WMSDs in terms of frequency of pain, intensity of pain and frequency of stiffness.

DISCUSSION

Correlation between Ergonomic Risk Factors and Frequency of Pain

The findings of the study showed that the pre-test scores of ergonomic risk factors and frequency of pain were positively correlated to each other but they were not statistically significant. The post-test showed statistically significant positive correlation (r=0.212, p=0.015) between physical energy demands and frequency of pain. Statistically, highly significant positive correlation (r=0.562, p< 0.001) was found between other musculoskeletal demands and frequency of pain.The findings of current study are supported by a similar study [5] which showed correlations between musculoskeletal symptoms with other variables of practice and behaviors of dental surgeons.

The longer duration of placement of dental surgeon's legs directly beneath the patient's chair is associated with decreased upper back pain (p=0.034).Dental surgeons who undertake maxillary work and whose operating lights are positioned farther away from their sight lines (towards the patient's feet) are likely to experience lower back pain (p=0.008). Use of surgical magnification is associated with a decrease of pain in the lower back (p=0.034). Increased use of lumbar supports on operating stools is associated with decrease in leg pain (p = 0.007). [5]

Dental surgeons who are more likely to raise their dominant elbow while they work are possible to experience musculoskeletal symptoms in many regions of the body. Dental surgeons who utilize such positions more than 50% of the time are more prone to experience pain in the hands (p=0.001), shoulders (p=0.007), neck (p=0.001) and upper back (p= 0.003).The time spent by dental surgeons practicing with their shoulders tipped to the side are expected to experience pain in the hands (p=0.017), arms (p=0.026), shoulders (p=0.001), neck (p=0.001), upper back (p<0.001) and lower back (p=0.006).The time spent by dental surgeons practicing with their torsos (trunks) rotated to any discernible degree are promising to experience pain in the hands (p=0.047), shoulders (p=0.003), neck (p=0.003), upper back (p<0.001) and lower back (p<0.001). However, dental surgeons utilizing an assistant (four-handed) in their practice are less tending to experience shoulder pain (p= 0.041). [5]

A study revealed that at least one physical risk factor was significantly related to the occurrence of low back pain, neck pain, and shoulder and hand/wrist complaints. On the contrary, chronic complaints did not show any correlation with physical factors except hand/wrist complaints. [6]

Correlation between Ergonomic Risk Factors and Intensity of Pain

The findings of the study showed that the pre-test scores of ergonomic risk factors and intensity of pain were positively correlated to each other. However, statistically significant positive correlation (r=0.204,p=0.020) was found between other musculoskeletal demands and intensity of pain. The post-test showed statistically high significant positive correlation between physical energy demands (r=0.285, p=0.001), other musculoskeletal demands (r= 0.578, p<0.001) and intensity of pain. However, other studies [7-9] observed that theoretically anticipated positive relationships between score values on physically demanding work conditions and values on intensity of pain were not found in

the dental surgeon's groups, but they were presented in other occupational groups.

No significant correlation values concerning physical demands and estimated intensity of pain from different parts of the body have been reported.[10] However, female dental surgeons reported a positive correlation value (r=0.38) between physical demands at work and intensity of pain in the shoulders. The female dental surgeons reported a negative correlation (r=−0.41) between social support at work and self-reported intensity of pain in the neck/shoulder region, while male dental surgeons revealed a positive correlation (r=0.39). Thus, female dental surgeons are likely to benefit from additional improvement of the work environment in reduction of intensity of pain in the neck/shoulder region than male dental surgeons.

Correlation between Ergonomic Risk Factors and Frequency of Stiffness

The current study showed that the pre-test scores of ergonomic risk factors and frequency of stiffness were positively correlated to each other but they were not statistically significant. The post-test showed statistically high significant positive correlation ($r = 0.404$, $p < 0.001$) between other musculoskeletal demands and frequency of stiffness. Some of the studies [11-17] although of not exactly the same, nature as current study, show some relationship between ergonomic risk factors and pain and stiffness experienced by the dental surgeons.

A study [11] conducted at Noida, India, showed that there is a statistically significant direct correlation (r=0.885, P<0.001) between the number of sessions taken for physical activity and the self-perceived improvement in the symptoms. Extensive review studies [1,12] indicate uncertainty concerning the relation between physical workload and MSDs for the neck, but not for other parts of the body, such as the shoulders. The relationship is not clear as the work environment is multifactorial with many mutual relationships that may interact in different ways.

A study [13] revealed that the participants who did stretching or other preventive actions among patients suffered lesser low back pain, though no significant differences were found (Student t-test; p=0.398). Oral surgeons reported a higher incidence of pain and stiffness in the wrist than the rest of the professionals (Student t-test; p=0.043). No significant correlations were found between workload (weekly days and hours of work and number of attended patients) and pain and stiffness in the different anatomical locations (Pearson correlation; p>0.05).

A study [14] using inclinometer to measure physical load showed that deterioration in working position occurs when work becomes less dynamic. In comparison with other risk groups such as cashiers [15] and supermarket employees [16] the results for the dental surgeons indicate an even worse work situation. Self-rated assessments of precision demands and work posture correlated in the questionnaire data, indicating that the precision-demanding dental work in patients' mouths also demands uncomfortable working postures. Study conducted at Ankara, Turkey [17] revealed that musculoskeletal pain and stiffness in some cases are directly attributed to specific clinical tasks such as crown and bridge tasks, scaling, root planning, operation of hand pieces and other power tools, involving very controlled fast motions and excessive upper body immobility.

CONCLUSION

Ergonomic risk factors are responsible for developing WMSDs among dental surgeons and reducing the work efficiency which leads to early retirement from their professional career. The study revealed that all ergonomic risk factors are positively correlated with the WMSDs in terms of pain and stiffness. However, ergonomic risk factors such as physical energy demands and other musculoskeletal

demands were significantly correlated with pain and stiffness.

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