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The effect of magnification lenses on reducing musculoskeletal discomfort among dentists

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Abstract

Background: Work-related musculoskeletal disorders are the most important problems in the health workforce. These discomforts cause many working days losses, increase absenteeism from work, and impose annual economic costs. Awkward posture is the most important factor among the risk factors for work-related musculoskeletal disorders. This study aimed at implementing an interventional ergonomic program to minimize musculoskeletal disorder among dentists.

Methods: This semi- experimental study was conducted on 75 dentists of Milad hospital using a census method. The Nordic Questionnaire was used to determine the prevalence of musculoskeletal disorders. In this study, the intervention was to apply optical magnification lens whose impact on reducing musculoskeletal disorder had been previously investigated. Corlett and Bishop Scale was used to evaluate musculoskeletal disorders before and after the intervention. Paired t-test was conducted to compare the discomfort intensity before and after the intervention

Results: The results revealed that the prevalence of musculoskeletal disorders in neck, back, shoulder, and arm were higher than other areas of the body in dentists. There was a significant difference in discomfort intensity of the neck, shoulder, arm, back, elbow, forearm, and the whole body after the ergonomic intervention ($p<0.05$). Surveys on improving working conditions using the magnification lens revealed that more than 89% of the individuals expressed that the use of the lens increased the ease while working.

Conclusion: The present study revealed that the use of optical magnification loupes, because of providing a suitable posture while working, could reduce musculoskeletal disorders in different areas of the body. Thus, we can predict that the prevalence of musculoskeletal disorders will be reduced in dentists in a long run if they use optical magnification loupes.

Keywords: Assessing Body Conditions, Corlett and Bishop, Dentists, Ergonomic intervention, Musculoskeletal Disorders.

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Introduction

Work-related musculoskeletal disorders are the most important problems in the health workforce. These discomforts cause many working days losses, increase absenteeism from work, and impose annual economic costs (1-4). These discomforts are the most common occupational injuries and disability in industrialized and developed countries.

These discomforts involve the lumber, cervical spine, and upper limbs (5). These main causes of discomforts are repetitive movements, suitable working postures, excessive force, and working for a long time (6). About 40% of the paid compensation

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costs to employed individuals were related to musculoskeletal disorders (7,8). Therefore, preventing the discomforts are particularly important. One of the main objectives of the ergonomics in the recent decades has been to prevent discomforts (9). In previous studies, it has been shown that unsuitable posture is a major risk factor for musculoskeletal disorders (10-12). Improved posture reduces the risk of musculoskeletal disorders, increases occupational health, and reduces stress and discomfort during the work shift. These factors could increase productivity in any organization (13,14).

Chronic musculoskeletal disorders occur among dentists (15). Body posture is an ergonomic risk factor in dental work (16). Caballero et al., found that more than 89% of the participants have posture changes when working in alternating shifts (17). In addition, they stated that more than 80% of the dentists had musculoskeletal disorders. In dental jobs, work is done in a sitting position. During the work, dentists are mostly in a static state for a long time and without mobility (15). Since dental restoration work requires high precision and delicacy, dentists need to enhance the visibility to create the optimal distance vision while working (18). Therefore, to reach an optimal distance vision, the dentists have to have a body posture in which the upper body including head and neck is bent forward. This position creates an awkward posture in the body of dentists and predispose musculoskeletal disorders (19). To date, several studies have been done on the prevalence of musculoskeletal disorders on dentistry. For example, in a study conducted on Spanish dentists, it was found that the musculoskeletal disorders have a high prevalence in the upper extremity of their body (19). Leggat et al., (2006) found a high prevalence of musculoskeletal disorder in the neck, shoulders, hands, and waist in dentists (20). Moreover, it was found that working in a sitting position with the head and neck bent forward is one of the major risk factors that cause musculoskeletal disorders in dentists (20).

According to the mentioned topics and the results of the previous studies on the posture of the dentists while working, it was found that awkward posture also plays an important role in musculoskeletal disorders. Due to the sensitivity and accuracy requirements, dentists' heads and necks are bent forward to provide optimum visual conditions (3). These conditions cause awkward postures and may lead to occurrence of musculoskeletal disorders in the neck and back. It seems that using magnification lenses can prevent awkward posture in the dentists because of its increased magnification and clarity of vision. Thus, this semi- experimental study aimed at evaluating the ergonomic intervention (using magnification lenses) to reduce pressure on the neck and trunk and reduce musculoskeletal discomfort in the dentists while working.

Methods

This semi- experimental study was conducted on 75 male dentists at Milad hospital in Tehran province, using census sampling method. Because of the type of intervention (using magnification lenses), those who used prescription eyeglasses were excluded. Data collection methods and procedures of the study were as follow:

The Nordic Questionnaire

Data were collected using questionnaires and interviews, which collected personal details including age, weight, height, job experience, and the number of work hours per day. To determine the prevalence of musculoskeletal disorders among the dentists, the Nordic Questionnaire was used. This questionnaire was designed by Kuorinka and colleagues at the Institute of Occupational Health Design provided for Scandinavian countries (21).

Evaluation of Body Discomfort before the Intervention

The first symptoms of musculoskeletal injuries include fatigue, pain, or discomfort

in the limbs. Therefore, Corlett and Bishop's body area discomfort scale was used to evaluate body discomfort before and after the intervention. Corlett and Bishop's (1976) body part discomfort scale is a subjective symptom survey tool that evaluates the respondent's direct experience of discomfort at different body parts (22,23). They were available to dentists at the beginning and end of their work shift. For example, if the dentists reported a shoulder pain, they were given a score of 9 at the end of working shift, and a score of 3 at the beginning of the working shift, and their discomfort score would have been equal to 6 during the work shift. Calculating the total body pain intensity was done by adding the different areas with discomfort intensity. Thus, the discomfort of the organs and the total body of the dentists during the work shift were calculated.

Intervention

In this study, the ergonomic intervention was the optical magnification loupes for increased visual clarity to reduce musculoskeletal discomfort in dentists. Figure 1 displays a magnification loupes used in this study. The lens size was changeable for each person and the frame was made of titanium. The magnification for all dentists was 3.5x. First, the dentists were trained to work with the magnification loupes lens. At the start of the intervention, dentists were evaluated for visual working distances, and each was fitted with either the standard frames or headbands, depending on their individual visual needs. The time for using the devices for each person was a full working shift (7 to 8 hours). At the end of the work shift, the dentists were surveyed about the usefulness of the optical zoom lens.

Fig. 1. Optical Magnification Loupes Used in the Study

Evaluating Body Discomfort after the Intervention

After the intervention, discomfort intensity was assessed at the beginning and end of the work shift, similar to before the intervention. Finally, the dentists were asked to consider the usefulness and comfort of the magnification loupes.

Statistical Analysis

Data were analyzed using SPSS 22 software. Paired t-test was used to compare the discomfort intensity before and after the intervention. A p-value of less than 0.05 was considered as significant.

Results

The mean age of the study population was 35.08 years, and the average work experience was 8.7 years. Table 1 displays the dentists' demographic characteristics.

Prevalence of Musculoskeletal Disorders

Table 2 demonstrates the prevalence of musculoskeletal disorders symptoms that dentists experienced over the last 12 months. The prevalence of symptoms in the neck, back, shoulders, and arms was high and constituted a high percentage of the study participants.

Body Discomfort Intensity before and after the Intervention

Table 3 demonstrates the results of the discomfort assessment in different areas of the body and the whole body at the beginning and end of the working shift before the intervention. The results revealed that the discomforts of dentists were most pronounced in the neck, shoulders and arms, and back. Table 4 demonstrates the results of the discomfort assessments in different areas of the body and the whole body at the beginning and end of the work shift after

Table 1. Demographic Characteristics of the Study Population (n=75)

Demographic Characteristics	Minimum	Maximum	Mean±SD
Age (years)	28	57	35.08±6.94
Height (cm)	164	191	174.21±5.21
Weight (kg)	54	101	65.12±10.14
Assembly experience (years)	5	27	8.7±6.01
Daily working hours (h)	7	10	8.4±1.02

Table 2. Distribution of Musculoskeletal Disorder Symptoms in Different Body Organs of the Dentists in the Past Year (n=75)

Body Regions	No. of Cases	%
Neck	69	92
Shoulder and Arm	64	85.3
Elbow and Forearm	32	42.6
Hand and Wrist	42	56
Back	52	69.3
Low Back	71	94.6
Thigh	14	18.6
Knee	44	58.6
Legs and feet	36	48

Table 3. Discomfort Intensity in Different Body Areas at the Beginning and the End of the Work Shift before the Intervention (n=75)

Body Regions	Mean of Discomfort Intensity at the Beginning of the Work Shift	Mean of Discomfort Intensity at the End of the Work Shift	Difference of Discomfort Intensity at the Start and End of the Work Shift
Neck	1.19	5.91	4.72
Shoulder and arm	1.13	4.41	3.28
Back	2.12	4.98	2.86
Elbow and Forearm	1.07	2.12	0.42
Hand and Wrist	1.1	1.6	0.5
Hips	1.06	1.8	0.74
Thigh and knee	1.12	1.21	0.09
Legs and feet	1.05	1.17	0.12
Whole body	9.84	23.02	13.18

the intervention. The results revealed that discomfort intensity increased in neck, back, shoulder, and arm at the end of the work shift even after the intervention. However, the increased discomfort intensity in this stage was far less compared to before the intervention.

Variations of Discomfort Intensity after the Intervention

Table 5 illustrates the results of the discomfort intensity before and after the intervention. The results revealed a significant difference in discomfort intensity in the neck, shoulders and arms, back, elbow, forearm, and the whole body ($p<0.05$). On the other hand, no significant difference was observed in reducing discomfort in the hands and wrist, buttocks, thighs and knees, and feet ($p>0.05$).

Table 4. Discomfort Intensity in Different Body Areas at the Beginning and End of the Work Shift after the Intervention (n=75)

Body Regions	Mean of Discomfort Intensity at the Beginning of the Work Shift	Mean of Discomfort Intensity at the End of the Work Shift	Difference of Discomfort Intensity at the Start and End of the Work Shift
Neck	1.17	3.54	2.37
Shoulder and arm	1.14	2.71	1.57
Back	2.13	3.69	1.56
Elbow and Forearm	1.08	1.47	0.39
Hand and Wrist	1.1	1.3	0.2
Hips	1.07	1.51	0.44
Thigh and knee	1.13	1.68	0.55
Legs and feet	1.05	1.16	0.11
Whole body	9.87	17.06	7.19

Table 5. Discomfort Intensity before and after the Intervention (n=75)

Body Regions	Difference between Discomfort Intensity at the Beginning and End of the Work Shift before the Intervention	Difference between Discomfort Intensity at the Beginning and End of the Work Shift after the Intervention	p
Neck	4.72	2.37	<0.001
Shoulder and arm	3.28	1.57	<0.001
Back	2.86	1.56	0.028
Elbow and Forearm	0.42	0.39	0.031
Hand and Wrist	0.5	0.2	0.598
Hips	0.74	0.44	0.726
Thigh and knee	0.09	0.55	0.664
Legs and feet	0.12	1.17	0.771
Whole body	13.18	7.19	<0.001

Judgments about the Usefulness of Optical Magnification Loupes

The results revealed that 96% of the dentists (22) believed that the magnification loupes facilitated their work. Moreover, 89% of them reported using these loupes comfortably. Furthermore, 92% believed using the magnification loupes made working conditions better than before.

Discussion

Demographic Data

Based on age mean and experience, the study populations were relatively young and experienced. Thus, their opinions about working conditions and the ergonomic intervention were reliable. Average working hours were over 8 hours per day, which could increase the risk factors of musculoskeletal disorders.

Prevalence of Musculoskeletal Disorders

The results revealed that musculoskeletal symptoms were highly prevalent among the dentists, with the highest rate in the neck, back, shoulder, and arms. This finding is consistent with that of other studies (15,17-20). Caballero et al., found that more than 80% of musculoskeletal disorders in dentists were caused by poor posture (17). Therefore, in ergonomic intervention programs for dentists, eliminating the risk factor of musculoskeletal disorders, in these areas are highly important. On the other hand, ergonomic intervention programs should be utilized to reduce musculoskeletal disorder areas among dentists.

Body Discomfort Intensity before and after the Intervention

The results revealed that discomfort among the dentists was highest in the neck, shoulders and arms, and back. These findings are in accordance with the general prevalence of musculoskeletal disorders among dentists. Assessment of discomfort in different areas of the body before the start of work showed highest levels of discomfort in the back area at the beginning of the work shifts. This finding could indicate that discomfort in the back area is a chronic problem among the dentists.

Their findings agree with the results of the discomfort assessment using a numerical rating scale in the present study. The results showed the highest accumulation of discomfort in the neck, back, shoulders and arms after the intervention at the end of the work shift.

This increase was less than the increase in discomfort intensity before the intervention. These results imply that the ergonomic intervention (using magnification loupes) significantly reduced discomfort intensity in these body areas. Therefore, it appears to be effective in reducing the incidence of musculoskeletal disorders in these areas. Caballero et al., (2010) found that the main risk factor in the job is awkward postures while working (17). Thus, it can be concluded that improving posture while working can reduce musculoskeletal disorders in dentists in the long term (17). Several studies on the effect of magnification loupes on improving dentists' posture also found that these lenses had a significant impact on improving the posture of the neck and trunk

(22-24). The results of these studies are in accordance with the findings of the present study. In addition, the mean intensity of the whole body discomfort was significantly different after the intervention, showing that the intervention had a positive effect on reducing musculoskeletal stresses in the dentists' body.

Variations of Discomfort Intensity after the Intervention

After the intervention, a significant reduction was obtained in discomfort intensity of the neck, shoulders and arms, back, elbow, forearm, and the whole body in the dentists, suggesting that the intervention had the potential to reduce the prevalence of MSD in dentists in the long term.

Judgments about the Usefulness of Optical Magnification Loupes

The results of the present study revealed that the dentists liked the magnification loupes. The findings also revealed that the use of these loupes led to better working conditions and facilitating the work. Moreover, these findings suggested the consensus of the dentists about the effectiveness of optical magnification loupes in production operations.

Conclusion

The results of the present study revealed a high prevalence of musculoskeletal disorders among the dentists. Moreover, these disorders were more common in the neck, back, shoulder, and arm. The study found that ergonomic interventions (using magnification loupes) had a significant effect on reducing discomfort intensity in these body areas. Therefore, they appeared to be effective in reducing the incidence of musculoskeletal disorders. Dentists agreed that using these loupes improved their working conditions. Thus, it can be concluded that magnification loupes can be considered an effective intervention. In this study, the short-term effects of using magnification loupes were studied (during a work shift). Thus, to achieve more accurate results, for the future studies it is highly recommended that dentists use magnification loupes for longer periods.

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References

1. Bhattacharya A. Costs of occupational musculoskeletal disorders (MSDs) in the United States. International Journal of Industrial Ergonomics 2014;44(3):448-54.
2. Aghilinejad M, Bahrami-Ahmadi A, Kabir-Mokamelkhah E, Sarebanha S, Hosseini HR, Sadeghi Z. The effect of three ergonomics training programs on the prevalence of low-back pain among workers of an Iranian automobile factory: a randomized clinical trial. The international journal of occupational and environmental medicine 2014;5(2):65-71.
3. Aghilinejad M, Kabir-Mokamelkhah E, Labbafinejad Y, Bahrami-Ahmadi A, Hosseini HR. The role of ergonomic training interventions on decreasing neck and shoulders pain among workers of an Iranian automobile factory: a randomized trial study. Medical journal of the Islamic Republic of Iran 2015;29:190.
4. Aghilinejad M, Tavakolifard N, Mortazavi SA, Kabir Mokamelkhah E, Sotudehmanesh A, Mortazavi SA. The effect of physical and psychosocial occupational factors on the chronicity of low back pain in the workers of Iranian metal industry: a cohort study. Medical journal of the Islamic Republic of Iran 2015;29:242.
5. Staal JB, De Bie RA, Hendriks EJM. Aetiology and management of work-related upper extremity disorders. Best Practice & Research Clinical Rheumatology 2007;21(1):123-33.
6. Widanarko B, Legg S, Stevenson M, Devereux J, Eng A, Cheng S, et al. Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group. International Journal of Industrial Ergonomics 2011;41(5):561-72.
7. Piedrahita H. Costs of work-related musculoskeletal disorders (MSDs) in developing countries: Colombia case. International Journal of Occupational Safety and Ergonomics 2006; 12(4):379-86.
8. Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic

evidence and the debate. Journal of electromyography and kinesiology 2004;14(1):13-23.

9. Van Cleave R, Osseck J, Hartman A, Frausto D, Kramer A. Workplace Ergonomics: A 3-Phase Intervention at the Workplace. Undergraduate Research Journal for the Human Sciences 2012; 11(1).

10. Aaras A, Stranden E. Measurement of postural angles during work. Ergonomics 1988;31(6):935-44.

11. Haslegrave CM. What do we mean by a working posture? Ergonomics 1994;37(4):781-99.

12. Karwowski W, Marras WS. The occupational ergonomics handbook: Crc Press; 1998.

13. Bernard BP. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back: NIOSH; 1997.

14. Corlett EN, Eklund JAE, editors. The measurement of spinal loads arising from working seats. Proceedings of the Human Factors and Ergonomics Society Annual Meeting; 1983: SAGE Publications.

15. Valachi B, Valachi K. Preventing musculoskeletal disorders in clinical dentistry: strategies to address the mechanisms leading to musculoskeletal disorders. The Journal of the American Dental Association 2003;134(12):1604-12.

16. Bramson JB, Smith S, Romagnoli G. Evaluating dental office ergonomic risk factors and hazards. The Journal of the American Dental Association 1998;129(2):174-83.

17. Diaz-Caballero AJ, Gomez-Palencia IP, Diaz-Cardenas S. Ergonomic factors that cause the presence of pain muscle in students of dentistry. Med Oral Patol Oral Cir Bucal 2010;15(6):e906.

18. Valachi B, Valachi K. Mechanisms leading to musculoskeletal disorders in dentistry. The Journal of the American Dental Association 2003; 134(10):1344-50.

19. Harutunian K, Gargallo Albiol J, Barbosa de Figueiredo RP, Gay Escoda C. Ergonomics and musculoskeletal pain among postgraduate students and faculty members of the School of Dentistry of the University of Barcelona (Spain). A cross-sectional study. Medicina Oral, Patología Oral y Cirugia Bucal 2011;16(3):425-429.

20. Leggat PA, Smith DR. Musculoskeletal disorders self-reported by dentists in Queensland, Australia. Australian dental journal 2006;51(4):324-7.

21. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sorensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Applied ergonomics 1987;18(3):233-7.

22. Maillet JP, Millar AM, Burke JM, Maillet MA, Maillet WA, Neish NR. Effect of magnification loupes on dental hygiene student posture. Journal of dental education 2008;72(1):33-44.

23. Branson BG, Bray KK, Gadbury-Amyot C, Holt LA, Keselyak NT, Mitchell TV, et al. Effect of magnification lenses on student operator posture. Journal of dental education 2004;68(3):384-9.

24. Aghilinejad M, Azar NS, Ghasemi MS, Dehghan N, Mokamelkhah EK. An ergonomic intervention to reduce musculoskeletal discomfort among semiconductor assembly workers. Work 2016 Jan 1;54(2):445-50.