Original Article

J. Phys. Ther. Sci.
27: 3651–3654, 2015

Analysis of the risk factors of musculoskeletal disease among dentists induced by work posture

Hyun-Suk Park, PhD[1)], Jin Kim, DDS, MSD[2)], Hyo-Lyun Roh, PhD, PT[3)], Seung Namkoong PhD[3)*]

[1)] *Department of Health Service Management, Business College, Daejeon University, Republic of Korea*
[2)] *Oral and Maxillofaical Surgery, Department of Dentistry, Daejeon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Republic of Korea*
[3)] *Department of Physical Therapy, Kangwon National University: Dogye-campus, 346 Hwangjo-gil, Dogye-eub, Samcheok-si Kangwon-do, Republic of Korea*

Abstract. [Purpose] The purpose of this study was to ergonomically evaluate the work posture of dentists to examine their subsequent risk of developing musculoskeletal diseases. [Subjects and Methods] Scenes in which the three dentists performed procedures at their dental clinics were videotaped. The videotapes of the dentists' work postures were evaluated and analyzed by using the Rapid Upper Limb Assessment (RULA) and Quick Exposure Check (QEC). [Results] The RULA analysis of the dentists' work posture indicated, "improvement required" in the posture used to treat the anterior and "instant improvement required" in the posture used to treat the maxillary second molar. Of all the work postures studied, the risk was considered particularly high in the lower back and neck, implying prominent problems in these body parts. The QEC analysis showed that the worst work posture was that required to treat the maxillary second molar, which led to a high risk of neck problems and vibrations. [Conclusion] The neck area has the highest risk of developing musculoskeletal disease. Hence, regular rests and the provision of information regarding muscle strengthening exercise for the neck are necessary.
Key words: Dentists, Ergonomic evaluation, Musculoskeletal diseases

(This article was submitted Jul. 21, 2015, and was accepted Sep. 1, 2015)

INTRODUCTION

Musculoskeletal disorders (MSD) pose an important occupational health problem in all healthcare sectors[1)]. The work-related musculoskeletal diseases of hospital-based medical practitioners such as radiologic technicians[2)], dental hygienists[3)], and caregivers[4)] have previously been reported. The MSD risk factors in hospitals include repetitive motion, inappropriate posture, excessive handwork, and the handling of patients or heavy materials[5)]. Dentists' work includes several well-known risk factors that could lead to MSD symptoms[6)]. Dentistry is a demanding profession that involves a high degree of concentration and precision. Dentists must have good visual acuity, hearing, depth perception, psychomotor skills, and manual dexterity as well as the ability to maintain occupational postures over long periods of time[7)]. Static loads over long durations may cause symptoms to develop in the musculoskeletal system[8)]. According to the American Dental Association, >20% of dentists have musculoskeletal problems[9)], most frequently in the lower back (36.3–60.1%) and neck (19.8–85%)[10)].

Physical factors that incur musculoskeletal problems among dental professionals can be largely divided into three areas: work environment, hand strength, and posture. The work environment includes unit chairs and devices[11)]. Hand strength is determined by the material or surface texture of devices and gloves[12)]. Finally, the posture used to maintain and control devices requiring strong force during dental procedures induces MSD[13)]. Various causative factors and correlations can be determined for MSD in each part of the body. The most important agents are likely poor posture and work habits[1)]. Won et al.[14)] pointed out that the posture used during dental work determines the location of the pain about which dentists complain.

An evaluation of the exposure to the risk factors of MSD is the starting point of MSD prevention. However, domestic research[15, 16)] regarding the MSD related to the dental occupation mainly consists of fact-finding surveys, whereas no systematic research has been described. Hence, a systematic analysis is essential when examining the work posture of dentists using ergonomic evaluation tools.

Here we conduct an ergonomic evaluation of dentists' work postures to elucidate their impact on MSD according to tooth location and suggest preventive and physiotherapeutic approaches to MSD.

*Corresponding author. Seung Namkoong (E-mail: seungnk@kangwon.ac.kr)

Table 1. Rapid Upper Limb Assessment scoring

Total score	1–2	3–4	5–6	Above 7
Action level	1	2	3	4
	Acceptable posture	Further investigation, possibly change	Further investigation, change soon	Investigation and implement change

SUBJECTS AND METHODS

Three dentists with >10 years' clinical experience each and no orthopedic or neurological problems in the preceding 3 years were selected as research subjects for this study. The purpose and procedures of this study were fully explained to the experimental participants in accordance with the Helsinki Declaration, and each participated only after voluntarily providing written informed consent. The subjects were right-handed with a mean age of 52 years and an average of 22 years' experience working as a dentist. For the work posture analysis, the dentists were videotaped while treating patients in their dental offices using their usual posture. To clearly observe joint movement during this procedure, the video was recorded from the front, left, and right sides. Based on these data, the dental procedures that were believed to be the most burdensome or the most comfortable were captured. The analysis was repeated three times. The right maxillary second molar and mandibular second molar (#17, 47) procedures were chosen because they require dentists to assume work postures that are the most burdensome, while the maxillary and mandibular anterior region procedure was chosen because it requires a relatively easy posture.

All the work procedures captured above were evaluated and analyzed by using ergonomic evaluation methods, namely the Rapid Upper Limb Assessment (RULA) and Quick Exposure Check (QEC). To maintain objectiveness, three professors who specialized in industrial safety conducted the analysis and the scores were computed through a discussion process in which they were classified according to work posture type.

The RULA evaluation method was developed to evaluate workload from work posture focusing on the shoulder, forearm, wrist, and neck. It is designed to allow the analyst to investigate the work posture through observation and can be useful for evaluating muscle loads in the case of work posture that involves a heavy workload on the upper limbs. The RULA was developed with two objectives. First, it was designed to easily and promptly detect the proportion of workers with disorders of the upper limbs induced by inappropriate work posture. Second, it was intended to evaluate the muscle load from work such as posture, static or repetitive work, and the force required for work procedures that cause muscle fatigue. In particular, the number of movements, static muscle work, strength, and work posture were considered as factors of the RULA evaluation.

In the videotaping process and field observations, elements such as repetitiveness, static work, work posture, and continued working time were evaluated after body parts were divided into Group A (trunk, neck, and leg) and Group B (humerus, shoulder, forearm, and wrist). The risk level was digitized into scores of 1–7 and then classified into five levels according to the suggested responding measure (Table 1)[17].

The QEC enables the evaluation of occupational biomechanics and simultaneously assesses the perception of workers regarding the task demands and work conditions. The advantage of this instrument is its scoring system, for which the calculation is based on the interaction between the observer's technical assessment and the worker's opinion[18]. The QEC is an instrument that assesses ergonomic physical, organizational, and psychosocial risk factors. It is composed of an evaluation form that includes 16 questions about postures and movements performed by the spine and upper limbs as well as other risk factors (amount of weight handled; how long it takes to perform a task; manual force; visual demand; vibration and level of hand force exerted; work pacing; and stress), and a score that allows for a partial (by body area) and total risk quantification. This score results from the combination of answers given by the evaluator and the worker, for instance, posture versus force, duration versus force, posture versus duration, and posture versus frequency. The score can be classified according to the risk exposure categories of low, moderate, high, and very high (Tables 2 and 3)[18].

This study analyzed the work posture of dentists through this ergonomic technique and investigated the risk of their MSD and the most problematic locations.

RESULTS

This study assessed the work posture of dentists by tooth location using the ergonomic RULA and QEC evaluations. Our results are presented below.

According to the RULA analysis results, the work posture of dentists showed "stage 3 further investigation, change soon" in the posture required to treat anterior teeth in the maxilla and mandible. Among the body parts, the lower back and neck showed particularly high risk factor scores. The posture required to treat the second molars of the maxilla and mandible showed "stage 4 investigation and implement change". The RULA is divided into a total of five stages. The work posture for the mandibular second molar and mandible turned out to be stage 4, indicating very poor work posture. Among the work postures, the risk factor evaluation scores were high in the lower back and neck, indicating severe problems with these body parts. The scores of the lower back and neck for treating the molars and incisors were higher relative to the other body parts, implying the need for special management and care of the lower back and neck. In summary, the posture required to treat the maxillary second molar was worse than that required to treat anterior teeth, while the risk of MSD was highest in the case of the lower back and neck.

Table 2. Rapid Upper Limb Assessment analysis results

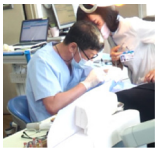
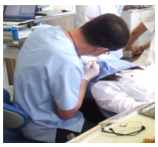
	Maxilla – anterior tooth	Mandible – anterior tooth	Maxilla – second molar	Mandible – second molar
				
Trunk	3	3	5	3
Neck	3	3	5	3
Leg	1	1	1	1
Shoulder (upper arm)	1	1	3	3
Elbow (lower arm)	2	2	2	2
Wrist	2	2	4	4
Wrist twist	1	1	2	2
Force/load	0	0	0	0
Activity	1	1	1	1
Score	5	5	8	7
Action level	3 level Further investigation, change soon	3 level Further investigation, change soon	4 level Investigation and implement change	4 level Investigation and implement change

Table 3. Quick Exposure check analytical results

					Maxilla – anterior teeth	Mandible – anterior teeth	Maxilla – second molar	Mandible – second molar
	Low	Moderate	High	Very high				
Back (static)	8-14	16-22	24-28	30-40	16	16	24	20
Shoulder/arm	10-20	22-30	32-40	42-56	24	24	24	24
Wrist/hand	10-20	22-30	32-40	42-56	20	20	24	20
Neck	4-6	8-10	12-14	16-18	12	12	14	12
Vibration	1	4	9	-	9	9	9	9
Work place	1	4	9	-	1	1	4	4
Stress	1	4	9	16	4	4	4	4

In our analysis of the posture required to treat anterior teeth using the QEC, neck and vibrations showed "high" risk, while the forearm/hand showed "low" risk. In the posture required to treat the maxillary second molar, lower back, neck, and vibration were "high" risk and shoulder and forearm/hand were "moderate" risk.

Among the four work postures, the maxillary second molar required the worst work posture. The risk also turned out to be "high" in the case of neck and vibrations.

DISCUSSION

This study ergonomically evaluated the work postures of dentists and attempted to identify the postures that induce MSD. Here we aimed to provide fundamental material for the prevention and physiotherapeutic management of MSD among dentists.

According to the analytical RULA results, the work posture of dentists was poor, with the results showing "further investigation" or "investigation and implement change". In particular, the work posture required to treat maxillary second molars was worse than that required to treat anterior teeth, both of which showed strong burdens on the lower back and neck. According to the analytical QEC results, the work posture of dentists was worse in cases of treating the maxillary second molar, with the highest risk in the neck and vibration. In summary, with regard to dentists' work postures, the posture required for treating maxillary second molars was the worst, while the neck showed the highest risk of MSD.

Dentistry demands high precision and is often performed with the arms unsupported and the cervical spine rotated and

flexed forward[19]. Holding a static load for a long duration may cause symptoms associated with the musculoskeletal system. Dentists have a high frequency of symptoms in the neck and shoulder regions[20]. A high static load is induced on the shoulder-neck region and shoulder joint by this posture. Yoo et al.[21] conducted research using a sample of dental hygiene students. They reported that shoulder pain was most frequently observed, followed by pain in the neck, wrist, and lower back[21]. On the RULA, the shoulders and waist were commonly the most overburdened, while overload was frequently observed in the neck and forearms[3].

The results of this study of dentists were different from previous studies of dental hygienists. This can be attributed to the differences in the work postures, strengths, and times due to the different specific work features despite similar jobs in the same occupational field. Reviewing the videotaped scenes, the dentists were continuously working in a posture in which the neck flexion exceeded 20° for >5 hours a day except when they were counseling patients or doing recordings. The human skull can be stably maintained in a condition when the upper body is upright. As the skull is located in front of the trunk in the neck flexion condition, the backbone erector of the trapezius and cervical vertebrae should overcome the load of the weight and gravity of the skull, which explains the frequency of neck pain among dentists[22]. Hence, it is necessary to develop an appropriate method to prevent neck pain in dentists.

The results of this study show that the vibrations caused by the use of dental cutters of the dental hand piece require attention. The dental hand piece is one of the most frequently used tools in dental clinics, and dentists are constantly exposed to weak vibrations. Vibrations of the hands and arms not only decrease one's subjective cognitive ability, detailed motor function, and performance capability, they also induce impairments in the circulatory system, nerve function defects, and changes in muscle tissue when after several years of exposure. Hence, improvements in methods through the technological development of such tools that can replace the vibrations are required.

Based on these results, here we deliver physiotherapeutic suggestions for preventing the development of MSD among dentists. First, to prevent neck pain, dentists should perform sufficient neck extension exercises after treating each patient. This may include straightening their lower back and bending their head back until they can see the ceiling and then turning their head to let the lower jaw touch the acromion five to seven times. Muscle strengthening exercises for the muscles behind the neck are also critical. Neck pain is closely related to the shoulder and upper extremity activity. Hence, exercises such as turning the shoulder after treating each patient are necessary to prevent posture-induced injury.

REFERENCES

1) Leggat PA, Kedjarune U, Smith DR: Occupational health problems in modern dentistry: a review. Ind Health, 2007, 45: 611–621. [Medline] [CrossRef]
2) Kim T, Roh H: Analysis of risk factors for work-related musculoskeletal disorders in radiological technologists. J Phys Ther Sci, 2014, 26: 1423–1428. [Medline] [CrossRef]
3) Noh H, Roh H: Approach of industrial physical therapy to assessment of the musculoskeletal system and ergonomic risk factors of the dental hygienist. J Phys Ther Sci, 2013, 25: 821–826. [Medline] [CrossRef]
4) Roh H, Lee D, Kim Y: Prevalence of work-related musculoskeletal symptoms and their associations with job stress in female caregivers living in South Korea. J Phys Ther Sci, 2014, 26: 665–669. [Medline] [CrossRef]
5) Janowitz IL, Gillen M, Ryan G, et al.: Measuring the physical demands of work in hospital settings: design and implementation of an ergonomics assessment. Appl Ergon, 2006, 37: 641–658. [Medline] [CrossRef]
6) Ratzon NZ, Yaros T, Mizlik A, et al.: Musculoskeletal symptoms among dentists in relation to work posture. Work, 2000, 15: 153–158. [Medline]
7) Ayers KM, Thomson WM, Newton JT, et al.: Self-reported occupational health of general dental practitioners. Occup Med (Lond), 2009, 59: 142–148. [Medline] [CrossRef]
8) Murtomaa H: Work-related complaints of dentists and dental assistants. Int Arch Occup Environ Health, 1982, 50: 231–236. [Medline] [CrossRef]
9) Werner RA, Franzblau A, Gell N, et al.: Prevalence of upper extremity symptoms and disorders among dental and dental hygiene students. J Calif Dent Assoc, 2005, 33: 123–131. [Medline]
10) Hayes M, Cockrell D, Smith DR: A systematic review of musculoskeletal disorders among dental professionals. Int J Dent Hyg, 2009, 7: 159–165. [Medline] [CrossRef]
11) Crawford L, Gutierrez G, Harber P: Work environment and occupational health of dental hygienists: a qualitative assessment. J Occup Environ Med, 2005, 47: 623–632. [Medline] [CrossRef]
12) Laroche C, Barr A, Dong H, et al.: Effect of dental tool surface texture and material on static friction with a wet gloved fingertip. J Biomech, 2007, 40: 697–701. [Medline] [CrossRef]
13) Hui D, Peter L, Alfredo V, et al.: Pinch forces and instrument tip forces during periodontal scaling. J Periodontol, 2007, 38: 525–531.
14) Won IJ, Kwon KR, Pae AR, et al.: An influence of operator's posture on the shape of prepared tooth surfaces for fixed partial denture. J Kore Acade Prosthodo, 2011, 49: 38–48. [CrossRef]
15) Cha JH, Ryu TB, Choi HS, et al.: Survey of musculoskeletal disorders in Korean dentists. J Ergono Soci Kore, 2007, 26: 137–147. [CrossRef]
16) Yoo JH, Jang SC: A study of the musculoskeletal disorders among dentists. J Kore Acade Temporomandi Dis, 1994, 6: 103–115.
17) McAtamney L, Nigel Corlett E: RULA: a survey method for the investigation of work-related upper limb disorders. Appl Ergon, 1993, 24: 91–99. [Medline] [CrossRef]
18) David G, Woods V, Li G, et al.: The development of the Quick Exposure Check (QEC) for assessing exposure to risk factors for work-related musculoskeletal disorders. Appl Ergon, 2008, 39: 57–69. [Medline] [CrossRef]
19) Green EJ, Brown ME: An aid to the elimination of tension and fatigue: body mechanics applied to the practice in dentistry. J Am Dent Assoc, 1963, 67: 679–697. [Medline] [CrossRef]
20) Chaffin DB, Andersson GB: Occupational biomechanics. New York: John Wiley & Sons 1984, pp 331–347.
21) Yoo JH, Ro HL, Lee MY: The musculoskeletal pain and inconvenient feeling during hand instruments with mannequin and intra-oral cavity in dental hygiene students. J Kore Soci Physi Med, 2008, 13: 247–254.
22) Ko TS, Jeong UJ, Lee KW: Effects of the inclusion thoracic mobilization into cranio-cervical flexor exercise in patients with chronic neck pain. J Phys Ther Sci, 2010, 22: 87–91. [CrossRef]