Ergonomics problems in dental profession-dentists working position

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Abstract:

Background/Aim: Dental professionals are under higher risk of development musculoskeletal disorders. Working in unnatural position is one of the main risk factor for the development of MSDs. The aim of study was to record inclinations of the back in dentists during typically dental work. **Material and Methods:** In order to monitor the inclination of the body, high-performance sensor systems, triaxial digital 12-bit accelerometers LIS3LV02 (SGS-Thomson Microelectronics, USA) were installed. The inclination of the body was measured in ten dentists, while performing dental work. **Results:** During dental work in a sitting position, sloping back more than 20° was during 74% of the time, while during standing 62% of the time. The participants performed the dental examination sloping to the left side. During sitting, the inclination to the left side was greater than 20° during 65% of the time, while during work in the standing position it was 50%. **Conclusions:** An inclination of the back, more than 20 degrees is state as one of the main risk factor for the development of MSD. Inclination of the dentist's body in antero-posterior and medio-lateral direction during daily work in standing as well in sitting position was greater than 20 degrees. According to those facts dentists are under risk of developing musculoskeletal diseases during their daily working procedure. According to that ergonomics in dentistry is an area of research that needs more attention. The implementation of ergonomic principles in usual dental work leads to increased work performance, greater satisfaction, efficiency and productivity

Keywords: dental ergonomics; risk factors; body incinations; musculoskeletal disorders; working posture

INTRODUCTION

A large number of studies speak in favor of the fact that work-related diseases, primarily musculoskeletal diseases, are very common in the population of dentists [1][2]. The reason for that can be found in the fact that the dental profession is very demanding, it means providing help to patients in a specific work environment [3]. Dentists incorporate their attitudes, values, behaviors to work in the best interest of the patient, and put the patient first. At the same time, dentists often neglect themselves, body position, attitude, habits during work. All this can have consequences for the general health of the dentists themselves. The introduction of a sitting working position, as well as the advanced development of dental equipment, did not contribute to the reduction of the frequency of musculoskeletal pain in dentists. The optimal working position in dentistry is still a research topic [4][5]. These facts speak in favor of the fact that dental ergonomics as a young science is developing more and more, and is becoming the subject of increasing interest of professionals around the world. Dental ergonomics through the adaptation of the work environment and methods of work enables the dentist and other team members to perform their professional activities in a healthy, safe and comfortable manner, while respecting their physical and mental capacities [5].

The specificity of dental work is reflected, among other things, in the fact that they work in a very specific environment: man-machine-man. The essence of ergonomics as a science is that the job, work tasks, dead-

lines and work instruments are adjusted to the person who works and his needs, instead of the person adapting to the needs of the job [6]. The subject of ergonomics is the human-machine system, and adaptation to human biopsychosocial capabilities, in order to make work and the work process more efficient, safer and more productive [5]. The goal and contribution of ergonomics as a science is to improve work performance, to reduce injuries and illnesses related to work through the modification of work space and instruments as well as through the reduction of incorrect position and movement [6]. Harmful factors in the dental profession are classified as physical, biological, chemical, organizational and psychosocial. A higher rate of work-related disorders was observed in health care workers, than in other professions. These work-related disorders are mainly: musculoskeletal disorders, stress, depression and anxiety [7].

Ergonomics as a science, deals with the issues of how to reduce muscle work, irregular posture and movements that are associated with static and repetitive movements that are characteristic of dental work. Also, the elimination and reduction of stress in the workplace is a great challenge for ergonomics as a science [8].

Dentists usually work in a position that is not neutral, due to the hard-to-reach work surface. Inadequate and unnatural position is often necessary for adequate manual and visual access to certain parts of the oral cavity and tooth surfaces [4][5].

According to the literature, most dentists work in a sitting position [9][10][11][12][13]. Long working time in certain position and unnatural movements leads to a dentists static position during work, which is one of the main risk factors for development of Musculoskeletal disorders (MSD).

As insufficient and inadequate lighting and visual requirements can lead to inadequate position during operation, adequate lighting, which is properly positioned, as well as the use of optical magnifiers can be helpful [14]. However, inadequate application of optical devices will not lead to improved posture [14][15]. The use of these means, can lead to reduced movement and longer work without a break, which leads to a static position [15]. Constant static position during work can be very tiring, because the muscles do not have time to relax. Strong muscle contraction, restricts blood flow in blood vessels, which leads to a reduction in oxygen delivery, and removal of metabolic products. This process leads to the development of musculoskeletal pain. Maintaining a static position during dental work requires a certain constant muscle contraction. When a muscle is contracted for a long period of time, the intramuscular pressure is high, which means that this static position during work is the main risk factor for the development of musculoskeletal diseases related to work [10]. In contrast, during dynamic or aerobic work, the phases of muscle contraction and relaxation alternate, so that adequate blood flow is achieved [10].

A very demanding position, which dentists often have to take during work, includes a forced position of the extremities and body; rotation and flexion of the neck, non-physiological flexion and abduction of the shoulders, work with a curved and bent spine. Also frequent, repetitive, hand movements are a characteristic of dental work [4][5].

Continuously unfavorable body position during work, suppresses proprioceptors, neurophysiological feedback from muscles and joints about the load on the body [16][17]. Proprioceptors are sources of perceptions about the position and movements of the body, they send information about the state of the musculoskeletal system to the central nervous system. Working in an inadequate position leads to the formation of the habit of working in that particular position, which causes cumulative microtrauma that leads to permanent damage [17][18].

Under physiological conditions, the muscular system is able to accept and absorb a large dose of load [16]. However, although a neutral position is taken during work, which is a comfortable position during work, due to static load, this position becomes problematic after a long period of time, because the constant action of force on a certain part of the body contributes to the development of musculoskeletal diseases [16]. Muscular load during work, caused by non-ergonomic working conditions (repeated hand movements during work, exposure to vibrations, static loads, inadequate working position) can cause biomechanical, physiological and psychosocial consequences [17][18]. Dental work requires coordinated movements. It consists of precise tasks, which include an extremely high degree of visual and manipulative elements, sometimes even in combination with the use of force [11]. Visual, tactile, proprioceptive perception is necessary. During dental work, the dominant, working and non-dominant hand performs different functions. With the dominant hand, the operator performs fine motor coordination, performing demanding manipulative procedures, while the non-dominant one serves mainly as support [19].

The muscles in charge of maintaining the working position shorten and become stronger over time, while the comparative ones lengthen and become weaker. As a result, asymmetry of the body occurs during dental work, which is one of the risk factors for the development of musculoskeletal disorders. Due to the specifics of dental work, the most endangered areas of the body for the development of musculoskeletal diseases, pain and fatigue are: neck, shoulders and lower back [1][20]. It has been noticed that there is a connection between the biomechanics of work, repetitive bending of the body, work in one position for a long time, the flexibility of the operator, his strength and musculoskeletal disorders [21].

Dental procedures have always required a certain unnatural posture that could lead to the development of musculoskeletal disorders. Adequate working posture is very important for overall health. Working posture of dentists is one of the highest risk factor for developmentof occupational diseases, as one of the main problem in dental profession [4][5]. According to all these suggestions the aim of current study was to record inclinations of the back in healthy dentists in sitting and standing working positions during typically dental work.

MATERIAL AND METHODS

Participants

We conducted biomechanical study, which included ten right-handed dentists, in postgraduate studies, with a minimum of three years of working experience, average age 33 ± 3.4 years, approximately the same length of working experience and length of working hours during the day. The average weight of the subjects was 75 ± 13.2 kg, while the average height was 176 ± 7.3 cm. All respondents have given voluntary informed consent to participate in the study, with the protocol of which was previously approved by the Ethics Committee of the Faculty of Dentistry, University of Belgrade, No. 36/9. Exclusion criteria were degenerative, inflammatory rheumatic diseases and diseases of the central nervous system.

Procedure

The research was conducted at the Clinic for Pediatric and Preventive Dentistry, University of Belgrade. During the work, the respondents were recorded in two positions. In the first, they were sitting during work, on a therapeutic chair, which provides support to the lumbar part of the therapist's body, and in the second position, they were standing during work. In both groups, dentists were located on the right side of the patient. Measurements of back tilt angles during work were performed during the work of dentists under real working conditions. Measurements were performed in the morning, to minimize differences, which may occur due to fatigue during daily activities.

The procedure performed by the respondents during the measurement was a complete dental examination in the upper and lower jaw. The intervention was performed in the established order, which means that the dental examination begins with an examination of the upper right quadrant, then the upper left quadrant, then the lower left, and with the examination of the lower right quadrant ends the dental examination.

Body position

In order to monitor the inclination of the body, high-performance sensor systems, triaxial digital 12-bit accelerometers LIS3LV02 (SGS-Thomson Microelectronics, USA) were installed. The sensors are placed at the level of the 7th thoracic vertebra, symmetrically on both sides of the back of participants. Before starting work, subjects were asked to stand upright with the right body position, to determine the degree of body tilt during work in relation to the neutral-starting position.

Statistical analysis

The statistical program SPSS, version 18 was used for statistical data processing. Descriptive and analytical statistics methods were used in data processing. Numerical features are represented by means of means (arithmetic mean, median) and measures of variability (standard deviation), and attributive by frequencies and percentages. The significance of the difference between the arithmetic means of continuous numerical values, distributed according to the type of normality, was determined by Student 's t test. Significance for values not distributed according to the type of normality was determined by the nonparametric Mann-Whitney test.

RESULTS

Negative values of the angle Θ represent the slope to the left (towards the patient), while positive values represent the slope to the right (away from the patient).

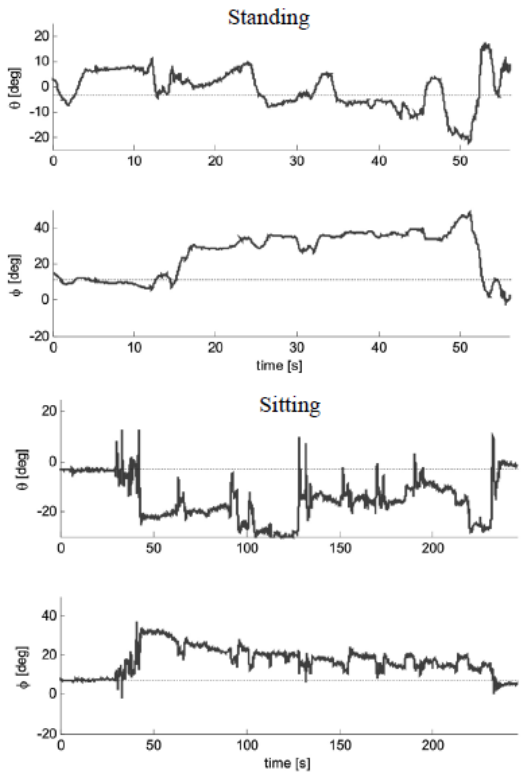

Figure 1.
Example of a change of posture during work from participants under ordinal number 1

Positive values of the angle ϕ represent forward flexion (towards the patient), while negative values represent a backward inclination (from the patient). The degree of antero-posterior and medio-lateral slope of the dentist's back during work in relation to the neutral position during the work of the dentist in the sitting and standing position as a function of time is shown in Figure 2.

During the dental examination in a sitting position, sloping back more than 20° was during 74% of the time, while during standing 62% of the time. The participants performed the dental examination sloping to the left side. During sitting, the inclination to the left side was greater than 20° during 65% of the time, while during work in the standing position it was 50%. There was no statistically significant difference (p = 0.99 for medial-lateral slope, p = 0.99 for anterior-posterior slope).

DISCUSSION

Posture research was based on measuring the antero-posterior and medio-lateral inclination of the dentist's back relative to the neutral position, during a dental examination. Wireless triaxial accelerometers were used in the study, the application of which proved to be relevant in the posture studies [22][23]. Previous studies where the inclination was measured during the work of dentists were mainly based on the measurement of the degree of inclination using video [24][25].

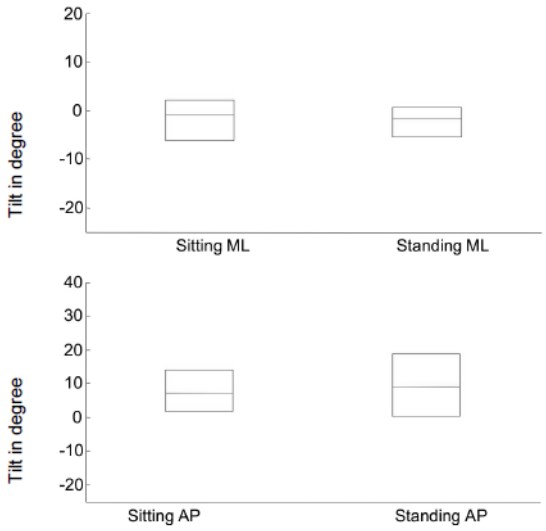

Figure 2.
Boxing plot shows the distribution of antero-posterior and medio-lateral inclination of the back of the dentist's body expressed in degrees, in relation to the neutral position during the work of the dentist in the sitting and standing position

This type of recording was not able to provide detailed information. So we conducted the study in which the inclination of the back during dental work was measured with the help of sensors. In this study, accelerometers were placed to measure the degree of inclination of the back, at the level of the 7th thoracic vertebra, symmetrically on both sides of the back. According to Finsen et al. dentists worked with a degree of inclination of less than 20° about 95% of the time while working in a sitting position [11], while according to the results of a study conducted by Marklin and Cherney the degree of inclination of the body was about 30°., as well as in the standing position [12].

The results of our study show that during the dental examination in a sitting position, leaning back more than 20° was during 74% of the time, while during standing 62% of the time. The participants performed the dental examination leaning to the left side. During sitting, the inclination to the left side was greater than 20° during 65% of the time, while during work in the standing position it was 50%. Although comparison with the results of other studies is not possible due to differences in methodology, all previous studies have given recommendations for additional tests of the degree of body inclination using sensors, as applied in our study.

The degree of inclination of the back of the participants, in both measured directions, was higher in the standing position, although without a statistically significant difference. The time in which the degree of inclination was greater than 20° was longer in the standing position. Working with an inclination above 20° indicates a risk of pain [26]. It is also considered that the risk is increased during work in which the position of the body is such that there is an inclination in both directions, both antero-posterior and mediolateral [26]. The results of our study support the fact that during the dental work, the inclination of the body of the examinee in both directions was measured, which indicates that dentists are at risk fordeveloping MSD.

During the work in both positions, the respondents did not reach a neutral position. Asymmetry of the body during the work was noticed, since the slope to the left side prevailed during the work. This is explained by the fact that the left side of the body is responsible for stabilizing the body during dental work.

In order to avoid a static working position, which carries with it an increased degree of risk for the development of musculoskeletal diseases, it is recommended to combine sitting and standing working position during daily dental work, since there was no statistically significant difference in the degree of back tilt when working in these two positions.

The data from the survey part of the study showed that in our country, 52% of the examined dentists stand during work, 25% combine sitting and standing position during work, while 23% sit during work. This may be a consequence of the fact that most of them adopted such work habits during their studies, and early adopted work habits are later maintained and difficult to change, as well as due to the fact that as many as 47.2% of respondents work independently, without the help of a dental nurse. According to the literature, most dentists work in a sitting position [9][10][11][12][13]. According to Rundcrantz *et al*. in a study conducted in Sweden, 95% of dentists sit during work [9]. These data are in line with the data also obtained in Sweden by Jonkers et al. ten years later, according to which dentists sit for almost 80% of their working time [10]. A Danish study by Finsen *et al*. showed that 82% of dentists sit while working with patients [11]. Marklin *et al*. in a study conducted in the United States, they obtained data indicating that dentists sit during 78% of their working hours [12]. In a Swedish study conducted by Chaikumarn, all examined dentists stated that they work in a sitting position [13]. None of the respondents combined sitting and standing during work. These allegations suggest that dentists work in a static position during work, which is one of the main risk factors for development of MSD.

The transition to a sitting working position was an attempt to reduce the fatigue and pain characteristic of dental work, but the risks of musculoskeletal pain were not avoided, although many therapeutic chairs were constructed for that purpose [24]. The introduction of a sitting working position, as well as the advanced development of equipment, did not contribute to the reduction of the frequency of musculoskeletal pain in dentists. Also, many dental interventions, such as: tooth extractions, occlusion registration, taking impressions, most often require a standing position of the dentist during the work. Many authors continue to suggest standing as a much more efficient position, where the pressure on the dorsal intervertebral discs is reducedduring work [4]. Prolonged non-physiological body position, longer sitting, prolonged static load, characteristic of the dental profession, compromise the vascularization of the intervertebral disc and represent a significant risk factor for the development of diseases related to work primarily musculoskeletal diseases. This indicates the fact that sitting is not a lways better. Also, the results of our study indicate that a higher muscle load on the muscles of the lower back and back of the neck was established in a sitting working position. Working in a sitting and standing position engages different muscle groups. By combining sitting and standing during work, dynamic work can be achieved, some muscle groups would rest while others are under load [4]. Dynamic work is much less tiring, more efficient and more productive than static work. During dynamic work, the muscles relax rhythmically and contract, which makes them act as pumps for blood flow in blood vessels, which enables a better supply of oxygen to the blood and more efficient elimination of harmful products, lactic acid, than during static work [5].

The etiology of musculoskeletal diseases is multifactorial [1]. Long work in one position, combined with static work, is one of the main risk factors. Whenever possible it is necessary to practice dynamic work. Dynamic work can be achieved by a combination of sitting and standing working position [4]. It is very important to give recommendations to dentists to change their position during work. This could be achieved through the introduction of dental ergonomics into the dental education system, which is in line with other studies, the recommendations of the European Dental Ergonomics Association and the American Dental Associa-

tion [20]. Early acquired good work habits are the best strategy in the prevention of musculoskeletal diseases in dentists, and it is very important to work on them based on the very beginning of dental work [27].

Frequent repeated bending of the body, as well as working in one position for a long time, leads to the risk of developing MSD. In order to reduce that risk, in addition to the correct way of working, it is very important for the therapist to improve his physical strength and flexibility of the body, through adequate physical activity.

Exercising physical activity enables the efficiency of the whole organism [28]. Physical exercises increase muscle strength, improve coordination of movements, and contribute to greater flexibility of tendons, connective tissue and ligaments. Physical activity also reduces the risk of overload and the development of degenerative changes in the locomotor system. It is desirable that the type of physical activity be individually adapted to the possibilities and needs [28].

In addition to the modification of the workplace and instruments, it is very important to instruct dentists in the proper biomechanics of the human body through preventive physical exercises in order to strengthen the muscles and avoid possible injuries at work. Ergonomic principles play a key role in prevention. It is necessary to educate dentists in time about all the harmful factors that their job contains, as well as to enable work with devices that help prevent the occurrence of the disease. It is necessary to point out the harmfulness of the risks to which they are exposed every day.

CONCLUSIONS

An inclination of the back, more than 20 degrees is state as one of the main risk factor for the development of MSD. Inclination of the dentist's body in antero-statistically posterior and medio-lateral direction during daily work in standing as well in sitting position was greater than 20 degrees. According to those facts dentists are under risk of developing musculoskeletal diseases during their daily working procedure.

It follows that ergonomics in dentistry is an area of research that needs more attention. The implementation of ergonomic principles in usual dental work leads to increased work performance, greater satisfaction, efficiency and productivity. Dental ergonomics is a young science whose goal is to improve the quality of work and working performance in the dental working procedure. Research, education and popularization of this area will lead to a significant improvement in the health of dentists, their better and easier work, and all of these will improve the service provided by dentists and the satisfaction of patients themselves.

Conflict of Interests

Nothing to declare.

Financial Disclosure Statement

Nothing to declare.

Human Rights Statement

All the procedures on humans were conducted in accordance with the Helsinki Declaration of 1975, as revised 2000. Consent was obtained from the patient/s and approved for the current study by national ethical committee.

Animal Rights Statement

None required.

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