ANALYSIS OF SPINAL MOBILITY AND POSTURE AMONG DENTISTS AND DENTAL HYGIENISTS IN SLOVAKIA

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Abstract: *Aims and objectives. The aim of this study was to investigate the incidence of changes in the axial organ among dentists and dental hygienists as well as to compare the monitored parameters with a group of dental hygiene students.*

Background. The work of dentists or dental hygienists requires prolonged standing in non-ergonomic positions. This has a negative impact on their health. Current prevention programs seem to be ineffective. This paper deals with the biomechanical analysis and assessment of the health risk factors of dentists and dental hygienists.

Methods. In order to evaluate possible risks, postural parameters were detected among 54 dentists and dental hygienists and 75 dental hygiene students by means of the SpinalMouse®. Changes in the basic shape of the spine position in the sagittal and frontal plane and mobility in the sagittal plane were monitored.

Results. The results show an increased incidence of changes in axial organ among dentists and dental hygienists, which indicates a decreased quality of body control in young persons.

Relevance for clinical practice. The study suggests that changes in the axial organ represent a significant burden for the dental profession.

Keywords: *posture, spine mobility, SpinalMouse®, dentist, dental hygienist.*

Introduction

Dentistry, designated as a risk occupation, is given to musculoskeletal disorders, symptoms often ignored as they become chronic pain (Diaz–Caballero et al., 2010; Ratzon et al., 2000; Zoidaky et al., 2013). Many studies report a high incidence of back pain among dentists (Harutunian et al., 2011; Pope-Ford & Jiang, 2013; Szymanska, 2002; Rafie et al., 2015; Wazzan et al., 2001). A survey of 432 dental practitioners in Denmark, of whom 90.4% use the sitting position, showed that 60% suffer from pain in the neck and the lumbar region of the spine. Another survey, in which 465 dentists participated, found that 62.2% of them had had back and neck pain at some point in their lives (Wazzan et al. 2001). According to Wunderlich (2010), it is not only the difficult posture at work that is responsible for their back pain but also the length of the isometric load on the muscles of the spine. The epidemiological studies by McKenzie (2005) and Hertling & Kessler (2006) point out the fact that the etiology of backache concerns a substantial role of mechanical factors. In addition to the negative effects arising from the main – bearing – function of the axial organ, there are studies that confirm the impact of inappropriate postures (flexion, rotation, and isometric and repetitive movements) (Davis et al., 2000; Wilke et al., 2001; Wunderlich et al., 2009; Wunderlich et al., 2010). The posture typically adapted for dental practice has changed over the years. Dentists originally stood when working. With the introduction of four-hand dentistry in 1960, the sitting position has become preferred. Working in a sitting position was an attempt to reduce the fatigue and discomfort associated with working in a dental clinic. However, working in a sitting position with a lying patient did not completely eliminate discomfort. Violating the principles of proper posture while

working in a standing position as well as working while sitting leads to increased musculoskeletal system damage (Martin et al., 2009).

The aim of this study was to evaluate the incidence of changes in the axial organ in dentists and dental hygienists as well as monitored parameters, compared with a group of dental hygiene students.

DATA COLLECTION AND METHODS

The monitoring was carried out in 2010 and 2011 at the Faculty of Health Care of the University of Prešov, Slovak Republic. The research sample consisted of 54 dentists and dental hygienists (10 males and 44 females) and 75 dental hygiene students (15 males and 60 females). The average duration of practice of the dentists and dental hygienists was 18.01 years (min. 5, max. 39). The group consisted of dentists and dental hygienists with at least 5 years of clinical practice. All dentists and dental hygienists from the East Slovakia region who had shown an interest in postural testing were able to take part. Relevant information about the study was published on the university website. Clinical practice of less than 5 years and the occurrence of acute radicular irritation during the last 2 weeks were criteria for elimination.

The subjects chosen for the study were carrying out their clinical practice during the study period. A questionnaire to determine socio-demographic data was used for the purposes of the investigation. For the examination of the shape and mobility in the individual sections of the spine in the sagittal and frontal plane, the SpinalMouse® device was used. The SpinalMouse® is a medical device – a spinal assessment tool – engineered and produced by Idiag AG of Fehraltorf, Switzerland. SpinalMouse® is a diagnostic device used for the non-invasive measurement of the profile of the spine in the sagittal and frontal planes, as well as measuring the angles between the various segments, especially in the sacroiliac joint (Kociová, Mikulaková, 2011). The monitored parameter was evaluated with software equipment according to the reference value characteristic for each particular subject. In combination with a computer program, it evaluates the curvature of the spine without the use of harmful X-ray radiation. It checks spinal alignment, measurements

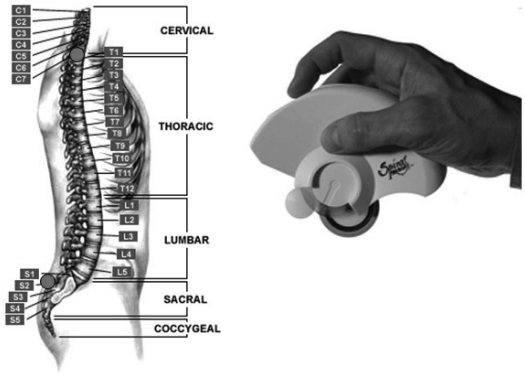

Fig. 1. *The SpinalMouse® device (http://bodyhealth.gr/wp-content/uploads/2014/01/SPINAL-MOUSE.jpg)*

of segmental and global angles in the sagittal and frontal planes, and the mobility of the spine. The measurement results are reflected in a graphical report with clear and comprehensible information about the patient (Fig. 1). The result of the processing is the backbone display with 3D imaging. The results showed excellent concurrence when compared with X-ray documentation. Intraclass coefficients of 0.92–0.95 have been determined for curvature measurement with the SpinalMouse®. The examination was carried out along the spinal protuberances (C7 S3) to capture the contours of the spine. The device is manually guided on the skin, along the spine. The rating has two sets of three measurements, one in the sagittal plane and one in the frontal plane. SpinalMouse® software displays the results, emphasizes values such as hypermobility of the vertebrae or deviations from the reference value (Mannion et al., 2004). This device consists of a measuring head – a "mouse" – which is allocated with three sensors that detect the three-dimensional plane of the so-called Cartesian system for the x-, y-, and z-axes. These are recorded using Bluetooth and processed with the special software algorithms of the SpinalMouse®. The measuring head automatically follows the anterior–posterior and lateral shape of the spine, and the software algorithms transform the records. They are evaluated as information according to calculated clinical parameters (Hirano et al.,2012; Pope-Ford & Jiang,2013).

The following parameters were evaluated: spinal curvature in the sagittal and frontal planes,

mobility of the spine in the sagittal plane of individual sections of the spine. We indicate a given parameter as physiology (standards for individual subjects), or as pathology – reduced curvature, increased curvature of the spine in the sagittal plane, divergence from verticals in the frontal plane, reduction, increase of movement in the sagittal plane. The descriptive statistics were calculated using MS EXCEL XP and SPSS 15 for Windows.

RESULTS

In Table 1, percentage representation of changes in the shape of the spine in the sagittal plane evaluated with SpinalMouse® is presented.

Table 1. *Percentage representation of changes in spinal shape in the sagittal plane as evaluated with SpinalMouse®.*

The shape of the spine in the basic position in the sagittal plane (SpinalMouse®)				
individual sections of the spine	**group**	**reduced curvature**	**correct curvature**	**increased curvature**
pelvic girdle	**S1**	**18.5**	**74.1**	**7.4**
	S2	6.7	86.7	6.7
thoracic	**S1**	**11.1**	**48.1**	**40.7**
	S2	10.7	70.7	18.3
lumbar	**S1**	**11.1**	**70.4**	**18.5**
	S2	12.0	72.0	16.0

Legend: S1 – dental hygienists and dentists, S2 – dental hygiene students

In the basic position, the most significant problems were observed in the sagittal plane of the thoracic spine. Among the examined dentists and dental hygienists, 40.7% had hyperkyphotic posture and 11.1% had a flat back. In the lumbar spine section, 18.5% of the examined practitioners had hyperlordotic curvature. We diagnosed 11.1% of the examined subjects in this group with reduced curvature in this spinal section (Table 1). Most students had correctly shaped curvature of the spine. In the thoracic region of the spine, 18.3% of the students had hyperkyphotic curvature and 10.7% a flat back. Among the students, 16% had increased curvature of the lumbar spine section, while less curvature was demonstrated by 11.2% of the examined subjects in this group.

Table 2. *Percentage representation of changes in spinal shape in the frontal plane as evaluated with SpinalMouse®.*

Shape of the spine in the basic position in the frontal plane (SpinalMouse®)			
individual sections of the spine	**group**	**rate**	**scoliosis curvature**
sacral	**S1**	**100.0**	**0.0**
	S2	92.0	8.0
thoracic	**S1**	**51.8**	**48.2**
	S2	69.4	30.6
lumbar	**S1**	**74.1**	**25.9**
	S2	73.4	26.6

Legend: S1 – dental hygienists and dentists, S2 – dental hygiene students

In the frontal plane, 48.2% of the examined practitioners were diagnosed with a deviation from the vertical axis in terms of scoliosis in the thoracic section; 25.9% in the lumbar sector. In the group of students 30.6% demonstrated pathological curvature of the spine in the thoracic section, (Table 2).

Table 3. *Percentage representation of changes in spinal mobility in sagittal plane flexion as evaluated by SpinalMouse®*

Spinal mobility in flexion (SpinalMouse®)				
individual sections of the spine	**group**	**decreased mobility**	**normal mobility**	**increased mobility**
hip joints	**S1**	**29.6**	**48.1**	**22.2**
	S2	29.3	62.7	8.0
thoracic	**S1**	**18.5**	**37.0**	**44.4**
	S2	14.7	58.7	26.7
lumbar	**S1**	**48.1**	**44.4**	**7.4**
	S2	32.0	58.7	9.3

Legend: S1 – dental hygienists and dentists, S2 – dental hygiene students

By examining the mobility of the spine in flexion, roughly half (48,1%) of the examined practitioners demonstrated reduced mobility in the lumbar section. Their reduced mobility in the lumbar spine was compensated by mobility in the hip joints. In the thoracic spine section, 44.4% of the examined subjects from the group of practitioners showed increased curvature. Signs of hypermobility in the lumbar spine were demonstrated by 7.4% of the examined subjects from the practitioner group. When evaluating spinal mobility for

the extension of the reduced range of motion, we observed 59.3% in the lumbar area for the examined practitioners and 18.5% in the thoracic region. This increased mobility of the thoracic region was demonstrated by 14.8% of the examined practitioners. In the group of students, we can observe a reduction in the range of mobility for extension in 30.7% of the examined subjects. An increased range of mobility of the hip joints is observed in 48% of the students when moving to extension.

Table 4. *Percentage representation of changes in spinal extension mobility in the sagittal plane evaluated by SpinalMouse®*

Spinal extension mobility (SpinalMouse®)				
individual sections of the spine	**group**	**increased mobility**	**normal mobility**	**decreased mobility**
hip joints	**S1**	**40.7**	**55.6**	**3.7**
	S2	48.0	45.3	6.7
thoracic	**S1**	**14.8**	**66.7**	**18.5**
	S2	25.3	65.3	9.3
lumbar	**S1**	**0.0**	**40.7**	**59.3**
	S2	4.3	65.3	30.7

Legend: S1 – dental hygienists and dentists, S2 – dental hygiene students

DISCUSSION

The results of the biomechanical analysis show that the dentists and dental hygienists have experienced significant structural and functional changes in the axial organs. During the evaluation using the SpinalMouse® device, accurate information on changes in the axial organs in individual sections of the spine was obtained. In the basic position, the most significant problems were observed in the sagittal plane in the thoracic spinal section. Hyperkyphotic curvature of the spine in the thoracic region of the spine occurred in 40.7% of the examined group of practitioners. Changes in the frontal plane occurred in 48.2% of the examined subjects in this group. The most significant deviations from the norm were diagnosed in the lumbar section in the examination of spinal mobility. Many studies point out the importance of ergonomics work for the prevention of back pain in dental workers. The impact of the work style as well as years of experience on the health of dental practitioners was addressed by the study of Łukomska–Szymańska (2012). That study demonstrated a statistically significant relationship between the management of dental procedures in ergonomic conditions and reported health problems (x^2 test = .002); namely, 9.1% of the doctors working in ergonomic conditions reported health. On the other hand, of the people working in unergonomic conditions, 42.7% reported health problems. A statistically significant relationship was detected between the position of the torso and the existence of health problems (x^2 test = 0.000). A study by Zoidaki et al (2013) shows that a 45-year-old dentist working 10 hours a day and examining right at his practice is 6.8 times more likely to experience the frequent occurrence of chronic neck pain than a dentist of the same age and with similar work experience who uses their work mirror. An increased incidence of back pain among dentists and dental hygienists is associated with a forced position at work in these professions. Moradia, Patel (2011) reported that as many as 90.6% of respondents maintained the stem region and 83.8% the cervical region of the spine in an ergonomically incorrect position, which may explain the higher incidence of pain in the right lumbar region.

Łukomska–Szymańska et al. (2012) demonstrate that education plays an important role in introducing an ergonomic work style in clinical practice. In their research, Kovalová et al. (2014) evaluated the level of awareness of dental hygiene students and dentists regarding the consequences of improper ergonomics.

The treatment chair should have a broad base for the buttocks and thighs. The seat should be adjustable so that the knees of the dentist or hygienist are slightly separated from each other. The thighs with the torso form an angle of 100 to 110 degrees with a footrest on the ground (Unthank, 2009). The back or lumbar support should be adjustable to suit the base of the treated spine where the curvature of the lower back meets with the curvature of the middle back. The user should sit as far back as possible and should use the maximum advantages of the lumbar support. If a chair with armrests is used, the support should be freely adjustable and allow complete customization by the user (Unthank, 2009).

The different shape and structure of dental instruments can be ergonomically appropriate

(Fredekind, Cuny, 2008). Nowadays, there are no precise production criteria for ergonomic instruments. Most instruments are about the size of a pencil. When we grip a handle with a small diameter, dental caregiver often uses the fingertips for grasping the instrument. This grasping method requires power (voltage) during the motion of the instrument, which concentrates the load mostly within a small group of hand muscles. An instrument handle with a larger diameter allows the user to grasp the instrument with the finger pads, spreading the load-sharing to a larger group of muscles (Martin et al., 2009). Because of this, manufacturers are increasingly developing handles in diverse sizes, shapes, materials, and composition that optimize instrument grasping (Gomolka, 2009). It is necessary to integrate a variation and a balance of activities as well as instruments so the work can shift to other muscle groups (Oberg et al., 2009).

Handles should be the lightest and well balanced. The length of hoses should be as short as possible, extra long hoses create weight. Hoses should be made of lightweight material. The most ideal method for use are flexible hoses with a rotary mechanism in the barrel, so as to rotate with little effort (Pollack, 2009).

The choice of lighting in the room has a great influence on the practioner's working posture. The lighting may positively affect the ergonomics of the musculoskeletal system if suitably chosen and correctly adjusted. Conversely, a well-chosen but poorly adjusted system can contribute to the achievement or even the creation of unacceptable working movement (Rucker et al., 2009).

CONCLUSION

The results of the biomechanical analysis indicate the fact that dentists and dental hygienists are accompanied by significant structural and functional changes in the axial organs. They show that, due to improper ergonomics, dentists and dental hygienists undergo major changes in the axial organ.

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ANALIZA POKRETLJIVOSTI KRALJEŽNICE I DRŽANJA TIJELA KOD ZUBNIH LIJEČNIKA I ZUBNIH HIGIJENIČARA U SLOVAČKOJ

Sažetak: *Cilj istraživanja bio je utvrditi pojavu promjena u aksijalnom organu kod zubnih liječnika i zubnih higijeničara te istodobno usporediti praćene parametre s onima u skupini studenata dentalne higijene.*

Posao zubnih liječnika i zubnih higijeničara zahtjeva da se nalaze duže vrijeme u neergonomičnim položajima, što je razlog nastanka zdravstvenih problema kod ovih zanimanja. Istodobno preventivni programi čine se neučinkovitima.

U radu su prikazani rezultati biomehaničke analize promjena aksijalnoga organa kod 54 zubna liječnika i dentalna higijeničara te 75 studenata dentalne higijene. Biomehanička analiza provedena je korištenjem uređaja SpinalMouse.

Utvrđene su promjene oblika kralježnice u aksijalnom položaju u sagitalnoji i frontalnoj ravnini te mobilnosti kralježnice u sagitalnoj ravnini. Rezultati ukazuju na učestalu pojavu promjena u aksijalnom organu kod zubnih liječnika i dentalnih higijeničara, te istodobno na smanjeni kvalitet posture kod mladih osoba. Promjene u aksijalnom organu ukazuju na značajno zdravstveno opterećenje ove struke te se razmatraju rizični faktori koji utječu na zdravlje zubnih liječnika i higijeničara.

Ključne riječi: *držanje tijela, pokretljivost kralježnice, SpinalMouse®, zubni liječnik, dentalni higijeničar.*