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Prevalence of Musculoskeletal Disorders Symptoms among Czech Dental Students. Part 2: the Predictive Value of Digital Assessment

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ABSTRACT

This article is the second part of an evaluation of musculoskeletal disorders (MSDs) prevalence among dental students. As the majority of complaints are in the back region, there is an endeavor to analyze objectively the disorders in this region. One of the non-invasive and non-radiation methods is the spinal curve mapping using the Spinal Mouse® device (Idiag AG, Fehraltorf, Switzerland). The aim of this study was to determine a correlation between subjectively described complaints and the results of an objective examination of the spine using the Spinal Mouse® device. Information about the participants is given in the first part of the article. All the participants were examined with the Spinal Mouse® device in several body positions. Further, the Matthiass test was performed to evaluate neuromuscular stabilization of the axial skeleton in static conditions. Musculoskeletal pain occurred more often in students who had a higher range of motion (ROM) and had worse static stabilization of spine. Other assessed factors or measured parameters did not have any influence on musculoskeletal pain. Some of the parameters measured with the Spinal Mouse® device showed a correlation with the prevalence of musculoskeletal pain.

KEYWORDS

dentistry students; musculoskeletal disorders; objective evaluation

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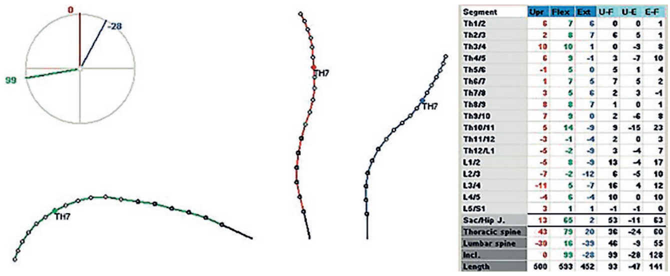
INTRODUCTION

This article is the second part of an evaluation of musculoskeletal disorders (MSDs) prevalence among dental students.

MSDs occur frequently among dentists (1–6) and they often start already during dentistry studies (7–11). The most frequent areas of pain are neck, lower back and shoulders. As the majority of complaints are in the back region, there is an endeavor to analyze objectively the disorders in this region. If X-ray methods were to be used, they would present a radiation dose for the examined persons and for this reason they are not suitable for screening of asymptomatic individuals (12–14). One of the non-invasive and non-radiation methods available is the spinal curve mapping using the Spinal Mouse® device (Idiag AG, Fehraltorf, Switzerland).

The device is provided with a measuring head with two wheels that automatically adjust themselves to the contour of the spine. During the measuring, the examiner stands behind the examined person and fluently guides the wheels in contact with the skin along the spine over the spinous processes from C7 *processus spinosus* to the beginning of the gluteal groove, where is the presumed position of S3 (Fig. 1). The turning of the wheels and the changes of inclination of the device towards the vertical line are simultaneously recorded during the examination. This data is wirelessly transferred to the computer, where

Fig. 1 The Spinal Mouse® device.



Segment	Upr	Flex	Ext	U-F	U-E	E-F
Th1/2	6	7	6	0	0	1
Th2/3	2	8	7	6	5	1
Th3/4	10	10	1	0	-9	8
Th4/5	6	9	-1	3	-7	10
Th5/6	-1	5	0	5	1	4
Th6/7	1	7	5	7	5	2
Th7/8	3	5	6	2	3	-1
Th8/9	8	8	7	1	0	1
Th9/10	7	9	0	2	-6	8
Th10/11	5	14	-9	9	-15	23
Th11/12	-3	-1	-4	2	0	3
Th12/L1	-5	-2	-9	3	-4	7
L1/2	-5	8	-9	13	-4	17
L2/3	-7	-2	-12	6	-5	10
L3/4	-11	5	-7	16	4	12
L4/5	-4	6	-4	10	0	10
L5/S1	3	1	1	-1	-1	0
Sac/Hip J.	13	65	2	53	-11	63
Thoracic spine	43	79	20	36	-24	60
Lumbar spine	-30	16	-39	46	-9	55
Incl.	0	99	-28	99	-28	128
Length	600	593	452	93	-47	141

Fig. 2 Example of results of examination. The reconstructed spinal curves in standing upright position, maximal flexion and maximal extension along with the data chart with intervertebral and segmental angles in different body positions.

the spinal curve is reconstructed. The device can be used for spinal curve mapping and for an evaluation of the range of motion (ROM) in sagittal and frontal planes (14). The acquired information includes the shape of the spine, the length of measured segments, intersegmental angles, the angles of thoracic kyphosis and lumbar lordosis, the range of motion of the whole spine and in individual segments (Th1/2-L5/S1) and the inclination of the sacrum (12–14). The results are presented in pictures and tables, an example is shown in Figure 2.

The relationship between the spinal curve and the development of MSD is not clear. The most common spinal disorders are co-morbid with general health conditions, but there is a lack of clarity in the literature differentiating which conditions are merely co-morbid versus ones that are risk factors (15). It seems that postural defects in the sagittal plane may predict the prevalence of pain with a higher prevalence of pain in people with a higher angle of lumbar lordosis (16). In terms of scoliosis, most findings argue against a major etiological role of the idiopathic scoliotic deformity of adolescents on back pain. However, the impact of pain in adults' scoliosis may be entirely different (17).

Another possible use of this device is an examination of muscular stabilization of the spine, provided by the standardized Matthiass test. This test is one of the methods for objectification of the neuromuscular stabilization of the axial skeleton in static conditions. Impaired neuromuscular stabilization is considered to be an important factor in the development of MSDs. Functioning interplay between the diaphragm, pelvic floor, abdominal muscles and paravertebral muscles is crucial for the spinal stabilization (18). Less activation of the transversus abdominis and multifidus muscle in subjects with low back pain may contribute to decrease the lumbar stabilization especially during stoop lift (19). Matthias test was proposed as a diagnostic tool for posture faults measurement. The typical indicator of a weak posture during this test is a forward hip movement accompanied with lumbar extension (20). Such adjustment of static stance means a failure of a dynamic neuromuscular trunk stabilization principle when the diaphragm should hold the position just above the pelvic floor with an appropriate activation together with abdominal muscles (18).

Spinal mouse was proven to be a suitable tool for research and patient follow-up in the clinical setting as a

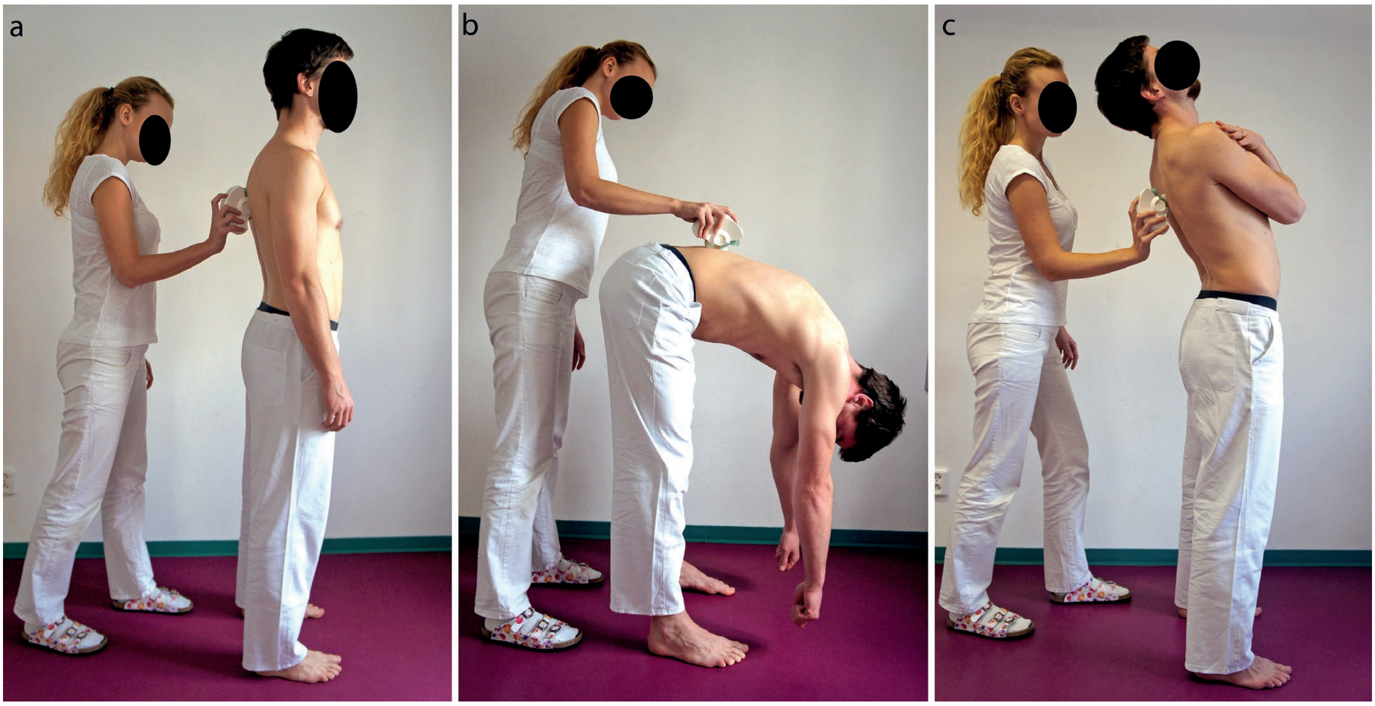


Fig. 3 An examination with the Spinal Mouse® device in standing upright position (a), in maximal flexion (b) and in maximal extension (c).

safe, reliable, quick, and easy to use method with no side effects (21). The reliability was shown to be strong (12). "Armvorhaltetest" according to Matthiass, i.e. so called Matthiass test measures the spinal alignment deviation during upper arms static loading in 90° shoulder flexion (20). This function is included as a standard part of Spinal Mouse® software provided by the manufacturer.

The aim of this study was to gather and analyze information about the prevalence of symptoms of MSDs and the role of potential risk factors among dental students; this is described in the first part of this article. The second aim was to determine a correlation between subjectively described complaints and the results of an objective examination of the spine using the Spinal Mouse® device. The results could contribute to understand the early development of MSDs among dental students and to find out possible risk factors detectable during the objective examination.

MATERIAL AND METHODS

Information about the participants was acquired using a questionnaire and is given in the first part of this article.

All the participants signed an informed consent. This study was approved by the Ethics committee of University Hospital Hradec Králové (Ref. no. 201410 S04P) and by the dean of the Charles University, Faculty of Medicine in Hradec Králové.

All the participants were examined with the Spinal Mouse® device in the sagittal plane. During the examination the participants were measured in three basic positions: standing upright position, maximal flexion and maximal extension; all the positions without knee flexion (Fig. 3a-c). Further, the Matthiass test was performed. During this test the participants held the weight of 1.5 kg in each hand with arms stretched forward. The spinal curve measurement was done in this position at the beginning and was repeated after 30 seconds of staying in this position. The change of the whole spinal inclination (inclination of the

Fig. 4 Matthiass test.

line connecting Th1 and S1 from the vertical line) between the measurements was evaluated (Fig. 4).

The parameters chosen for the statistical analysis of the relationship between the subjectively declared musculoskeletal pain and the results of an objective examination with the Spinal Mouse® device were as follow: thoracic kyphosis angle, lumbar lordosis angle, inclination of the sacrum, the total range of motion, the ratio between the angles of the thoracic kyphosis and the lumbar lordosis (Th/L ratio), and the change of the spine inclination during the Matthiass test.

The collected data were statistically analyzed in the NCSS 10 Statistical Software (2015; NCSS, LLC. Kaysville, Utah, USA, ncss.com/software/ncss) using methods of descriptive statistics, two-sample t-test, nonparametric Mann-Whitney test, Kolmogorov-Smirnov test and nonparametric Kruskal-Wallis analysis of variance with post hoc Dunn's test with Bonferroni modification. The level of statistical significance was set to $\alpha = 0.05$.

RESULTS

A total of 182 students participated in this study; there was a response rate of 94.8%. Their characteristics and answers to the questionnaire are presented in the first part of this article.

The results of the followed parameters measured with the Spinal Mouse® device in total and a comparison between men and women and between the groups of students are summarized in Table 1. As the data were not distributed normally, the median values along with the first and the third quartiles are presented. ROM was statistically significantly higher in the fifth year students than in both the first and the third year students ($p < 0.001$). The difference between the first and the third year students was not statistically significant. There was no statistically significant difference between the years in all other measured parameters.

Musculoskeletal pain was more frequent in students with bigger ROM ($p < 0.05$) and with worse static stabilization of spine evaluated by the Matthiass test ($p < 0.05$). Students with worse static spinal stabilization declared pain in the neck region more often ($p < 0.05$). Other parameters measured with the Spinal Mouse® device didn't have any influence on the prevalence of musculoskeletal pain.

DISCUSSION

The authors endeavored to extend the information from the questionnaires by the data acquired from the objective examination of the participants. The examination with the Spinal Mouse® device is simple, fast and non-invasive and doesn't present any radiation dose for the examined person (13, 14, 22). The measurement is sufficiently valid and reliable in evaluation of longer segments of the spine (12–14, 22–25). During the examination with the Spinal Mouse® device the author encountered several issues. The measurement was difficult in certain participants, mainly women, where there was a sharp angle in the lumbar area during their maximal extension. This was problematic to record because of the size of the device and/or slipping of the wheels (8, 14). The measuring was also difficult in obese individuals for a thicker layer of soft tissues covering the spine (22). An evaluation of individual intervertebral angles may not be valid (26), because the device doesn't measure the angles between the vertebral bodies, but between the spinous processes. Thus, the result may be distorted by the variable angle of spinous processes in individual vertebrae (12). Therefore, the above listed parameters were selected from the Spinal Mouse® measurement results for the statistical analysis. The authors presumed, that a pathology found in the selected parameters may correlate with pain in corresponding regions.

Although the Matthiass test was designed for youngsters between 6 and 16 years, the authors believe that it is

Tab. 1 The results of the Spinal Mouse® examination.

	Total	Gender		Year		
		Male	Female	First	Third	Fifth
	Median (Q1; Q3)	Median (Q1; Q3)	Median (Q1; Q3)	Median (Q1; Q3)	Median (Q1; Q3)	Median (Q1; Q3)
Thoracic kyphosis [°]	35.5 (30; 41)	38 (34; 44)*	34 (30; 39)*	35 (31; 40)	36 (27.5; 41.5)	35.5 (30.25; 42)
Lumbar lordosis [°]	-31 (-37; -24)	-25 (-30; -21)**	-35 (-39; -28)**	-33 (-38; -25)	-32 (-37.5; -24.5)	-30 (-37; -23)
Angulation of the sacrum [°]	19 (14; 24)	14 (10; 17)**	22 (17; 26)**	19 (14; 25)	20 (14; 24)	18.5 (13; 23)
ROM [°]	139 (124; 157)	138 (127; 154)	140 (124; 160)	133 (117.5; 145)	137 (121.5; 151)	151.5 (138.25; 163)**
Th/L ratio	1.15 (0.9; 1.5)	1.5 (1.3; 1.8)**	1 (0.8; 1.2)**	1.1 (0.9; 1.5)	1.2 (0.8; 1.55)	1.2 (0.9; 1.475)
Deviation of Th/L ratio from the value 1	0.3 (0.1; 0.525)	0.5 (0.3; 0.8)**	0.2 (0.1; 0.3)**	0.2 (0.1; 0.55)	0.3 (0.2; 0.55)	0.3 (0.125; 0.575)
Matthiass test [°]	-2 (-3; 0)	-2 (-4; 0)	-2 (-3; 0)	-2 (-3.5; -1)	-2 (-4; 1)	-1 (-3; 0)

* $p < 0.01$; ** $p < 0.001$

applicable also in the young adults and was useful for the purpose of this study, because in contrast with a plain static measurement of the spinal curve shape, it brings the possibility of objectification of neuromuscular stabilization, i.e. an evaluation of the key function of the spine musculature related to the development of the vertebrogenic algic syndrome.

Tsuonda et al. (27) found an influence of lumbar lordosis angle on the cervical spine pain and shoulder pain in a group of 329 volunteers with an average age of 65.5 years. The authors of this study showed in their previous study among dental practitioners with an average age of 38.9 years an influence on the prevalence of musculoskeletal pain by the lumbar lordosis angle, angulation of the sacrum and Th/L ratio (8). On the contrary, the only parameters measured with the Spinal Mouse® with influence on musculoskeletal pain prevalence in this study were ROM and the Matthiass test. An interesting finding was that the worse results in the Matthiass test correlated with higher prevalence of pain in the cervical spine. This shows a close correlation between the neuromuscular stabilization of the thoracic and lumbar spine and the function of the cervical spine. None of the statically measured parameters of the spinal curve shape showed an influence on musculoskeletal pain. The reason may be the relatively low age of the students, where the MSDs are rather of a functional nature and it is not possible to reveal them with statically performed imaging methods. It is also necessary to mention the fact, that the subjectively declared pain is not directly dependent on the structural findings, even in case of advanced imaging methods, such as MRI (28). This can be explained especially by the factor of dynamic neuromuscular stabilization, which is not directly reflected in plain static examination (18). However, the authors assume that the level of neuromuscular trunk stabilization was evaluated by the Matthiass test to a great extent. After several years of dental practice and with an absence of prevention or treatment it can be supposed that MSDs progress more often to structural findings detectable by the Spinal Mouse® device.

A limitation of this study was that different students were involved in different years. For more precise evaluation of the development of the relationship between the musculoskeletal pain and the objective findings it would be useful to evaluate the same students gradually in the first, third and fifth year, followed by an evaluation of the same participants after a few years of dental practice. Also, some other device or method might be used to the objective examination of the locomotive apparatus.

CONCLUSIONS

The correlation of the spinal curve shape in different body positions measured statically in the sagittal plane with the prevalence of musculoskeletal pain was not proved in this study.

The worse neuromuscular stabilization of the spine evaluated by the Matthiass test and the higher ROM of the spine showed a relation with the prevalence of musculoskeletal pain. This indicates that poor neuromuscular spine stability is a risk factor for the development of musculoskeletal pain.

There was a bigger ROM among the fifth year students. No other measured parameter differed between the students in different years.

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