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Posture and low back pain during pregnancy — 3D study

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ABSTRACT

Objectives: Back pain is a common complaint of pregnant women. The posture, curvatures of the spine and the center of gravity changes are considered as the mechanisms leading to pain. The study aimed to assess spinal curvatures and static postural characteristics with three-dimensional surface topography and search for relationships with the occurrence of back pain complaints among pregnant women.

Material and methods: The study was conducted from December 2012 to February 2014. Patients referred from University Clinic of Gynecology and Obstetrics were examined outpatient at the Posture Study Unit of Department of Orthopaedics and Traumatology. Sixty-five women at 4–39 weeks of pregnancy were assessed and surveyed with Oswestry Disability Index; posture was evaluated using surface topography.

Results: The study confirmed that difficulties in sitting and standing are significant in the third trimester of the pregnancy. The overall tendency for significant lumbar curvature changes in pregnant women was not confirmed. Major changes in sagittal trunk inclination in relation to the plumb line were not observed in the study group.

Conclusions: The issue regarding how the pregnancy causes changes in spinal curvature and posture remains open for further studies. Presented method of 3D surface topography can reveal postural changes, but that requires several exams of each subject and strict follow-up of the series of cases.

Key words: pregnancy, posture, back pain

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INTRODUCTION

Back pain is a common complaint of pregnant women [1–7]. Authors estimate the presence of the back pain in approximately 50% of pregnant women. The syndrome is heterogeneous regarding severity of symptoms. It impacts the quality of life. Despite the frequent occurrence of the problem, no explicit criteria for diagnosis and therapy guidelines are available in the literature. The occurrence of pain during pregnancy or a previous pregnancy, high body mass index, abnormal posture are mentioned among risk factors. Despite numerous publications, the phenomena of back pain seem to remain under-investigated due to diagnostic restrictions present at the time of pregnancy. Pregnancy itself changes the characteristics of a woman's body including mass, dimensions, and posture [8]. Some investigations have focused on static trunk posture [3, 9]. The results remain unclear whether pain and postural changes are correlated [10–13]. The low back pain in pregnant women is characterized by axial or parasagittal musculoskeletal discomfort in the lower lumbar region [14]. Its origin may be considered as a combination of mechanical, hormonal, circulatory, and psychosocial factors. Women that have a previous history of back pain are at greatest risk of pregnancy-related back pain. They are more likely to experience more severe and long-lasting pain. This phenomenon during pregnancy may be more related to dy-

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namic motion rather than static posture. Gilleard et al. [10] reported altered displacement and velocity parameters for the thoracic and head segments when rising from a chair suggesting differing movement strategies for each segment of the trunk as the pregnancy progressed. Functional changes that occur during pregnancy may cause mild pain/discomfort [1, 11, 15].

There are two main types of back pain in pregnancy: low back pain (or lumbar pain) and pelvic girdle pain, but some women suffer from coexisting conditions — lumbopelvic pain [16]. Some authors suggested that low back pain in pregnancy started at 20–28 weeks [17], but some women may report an earlier onset of discomfort. The mean gestation age at start of pain reported by Morgen et al. [16] was 22.1 weeks, but the pain onset may occur earlier. Sometimes symptoms first appear at about 12 weeks, possibly at this stage of pregnancy they are not yet associated with the change of posture and body weight. Effect of changes in hormone levels, changes in tissue hydration and relaxation of articular joints are considered as the cause of the syndrome. The pain intensity may vary from mild to severe. A pregnant woman may experience a significant decrease in the quality of life and disturbance of daily activities and work abilities.

This study aimed to assess spinal curvatures and static postural characteristics with three-dimensional surface topography and search for relationships with the occurrence of back pain complaints among pregnant women.

MATERIAL AND METHODS

The prospective case-control study was conducted from December 2012 to February 2014. The Institutional Review Board approved the study, and all patients provided informed consent before participating.

Patients referred from the Clinic of Gynecology and Obstetrics were examined outpatient at the Posture Study Unit of Department of Orthopaedics and Traumatology. Scoliotic patients were excluded from this study. Sixty-five women at 4–39 weeks of pregnancy were examined and surveyed with PRO based on Oswestry Disability Index; posture was evaluated using surface topography.

Static standing posture was evaluated using markerless, structured light back surface topography measurement system for posture and scoliosis — 3D Orthoscreen [18–21]. The system used in this study consists of three modules: 3D measurement system, centralized database, and data analysis software on the client side. The 3D analysis module is an optical full-field 3D scanner based on the structured light projection method [22]. During the body surface evaluation process, the subject stands still inside a calibrated measurement volume while a series of images is projected onto his or her body surface. The shape of the back of the trunk surface is calculated based on the deformation of the raster [23]. Dataset produced by the measurement system is a set of points in three-dimensional space that accurately represent the surface of subject's body (dimensions and angles are preserved). The measurement result is correctly oriented in space thanks to the calibration of the plumb line. Measurement accuracy is between 0.2 mm and 0.4 mm, depending on the particular implementation of the system. The acquisition takes roughly 1–2 seconds. Measurement data along with the corresponding patient information are stored in a centralized database and can be remotely accessed using a custom data analysis software. A user account system provides authentication and authorization of the users.

The client software was used to mark relevant anatomical landmarks on the back surface: C7 spinous processus, left and right shoulders, left and right axillae, left and right scapulae, left and right waist triangles, left and right posterior superior iliac spines, top of intergluteal furrow and thoracic kyphosis to lumbar lordosis transition point. Each measurement was analyzed by physiotherapists trained in operating the software. No palpation examination of the subject's body was necessary. Based on the positions of landmarks, the automatic calculation was performed to obtain well-known and commonly used parameters for back surface evaluation [24]: Posterior Trunk Symmetry Index (POTSI) [25–27], Deformity in the Axial Plane Index (DAPI) [24–26], surface kyphosis and lordosis angles and sagittal trunk inclination. The example result of the postural assessment is presented in Figure 1.

The lordosis and kyphosis measurements were performed as described in Debrunner's kyphometric evaluation [28, 29]. Sagittal trunk inclination angle is drawn in the sagittal plane between the plumb line and line that passes through the far posterior surface point of C7 spinous processus and the point of the top of the intergluteal furrow. It is positive if the far posterior surface point of C7 spinous processus is located more distant to an observer about the position of the top of the intergluteal furrow. The subjects did not wear shoes during the assessment and exposed only the back area to ensure privacy.

The Oswestry Disability Index (ODI) [30] was used as the outcome measure Questionnaire for low back pain. It is a self-administered questionnaire divided into ten sections. It is designed to assess limitations in various activities of daily living, namely: Pain Intensity, Personal Care, Lifting, Walking, Sitting, Standing, Sleeping, Sex Life, Social Life and Traveling. Each domain is scored on a 0–5 scale, 5 representing the greatest disability. The questionnaire usually takes up to 5 min to complete. The results are subdivided and as-

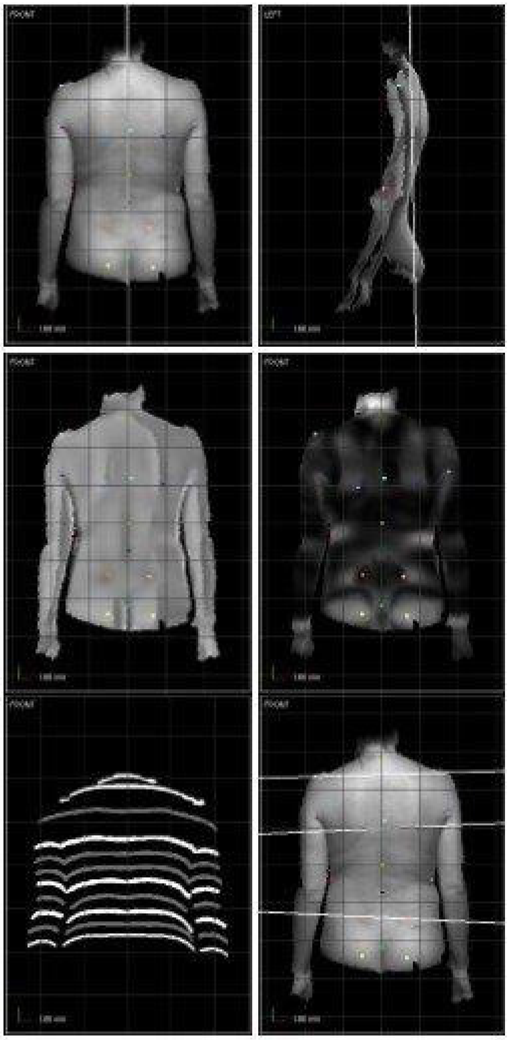

Figure 1. Images show anatomical landmarks and virtually drawn lines, characterizing posture of the pregnant patient

signed to 5 disability groups (0–20% minimal disability; 20–40% moderate disability; 40–60% severe disability; 60–80% crippled and 80–100% bed-bound). Data was statistically analyzed with descriptive statistics and ANOVA. Statistica 10.0 statistical software was used to analyze the results. The results were considered significant at p-value 0.05.

RESULTS

This study was conducted from March 2012 to June 2014. IRB approved the study protocol. Sixty-five women were enrolled in the study. Subjects' average age was 29.9 years from 18 to 46. The gestation week of the subjects varied from 4 to 39 weeks (SD = 10.39). All the distributions were positively tested for normality of residuals using the Kolmogorov-Smirnov test. Data was divided into trimeters, forming clusters of 20, 23 and 22 samples, respectively. The weight of subjects ranges from 48 kg to 118 kg (mean 69.1 kg) and the height ranged from 154 cm to 182 cm (mean 166.5 cm).

The average kyphosis angle measured by surface topography was 14.9 degree from 2 to 87.1 degree (SD = 11.6). The average lordosis angle was 41.7 degree and ranged from 23.1 to 88.2 (SD = 9.4). The trunk of the subjects in comparison to the vertical (plumb) line was inclined forward at a mean of 3.5 degrees (SD = 2.3 degrees). It ranged from –2.8 to 10.3 degree. High correlation (r = 0.68) was observed between kyphosis angle and lordosis angle at $p < 0.05$. Sagittal trunk inclination and sagittal spine curvatures were not correlated. The results of subjects measurements are presented in Table 1. The curve of the mean weight of the study subjects achieved its upper values (circa 70 kg) and remained on the same level in the third trimester of gestation (F = 1.75, p = 0.18). The differences were not statistically significant. The highest values of the kyphosis angle were observed in the second trimester. However, non-significant relationships were observed between kyphosis angle and trimester of gestation (F = 1.16, p = 0.32). The relationships between lordosis angle and trimester of gestation (F = 0.08, p = 0.92) were non-significant. No significant relationships were found between sagittal trunk inclination angle and trimester of gestation (F = 0.41, p = 0.67). Non-significant relationships were found between pain intensity and trimester of gestation (F = 2.0; p = 0.14). The personal care was not affected by the trimester of gestation (F = 1.47; p = 0.24). Unexpectedly, non-significant relationships between lifting objects and trimester of gestation (F = 0.33; p = 0.72) were observed. The sitting was signifi-

Table 1. The summary of the descriptive statistics

	Valid N	Mean	Minimum	Maximum	Std. dev.
Weight	65	69.09	48.00	118.00	12.48
Height	65	166.5	154	182.0	5.64
Kyphosis angle	65	14.93	2.02	87.94	11.63
Lordosis angle	65	41.75	23.13	88.24	9.35
Sagittal trunk inclination	65	3.54	–2.81	10.31	2.34
ODI Total score	65	41.85	20	76	13.72

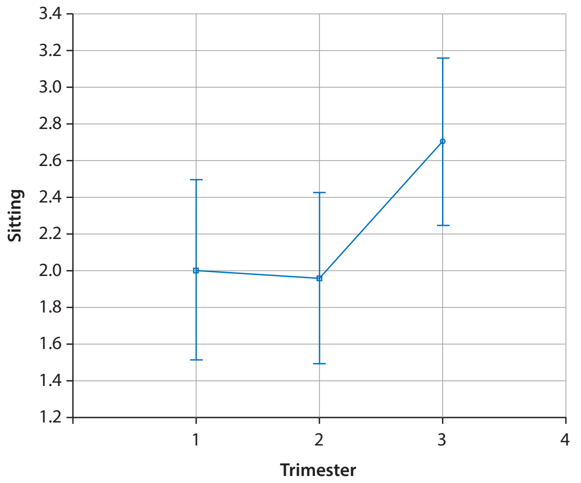

Figure 2. The graph shows the significant rise of the sitting discomfort noted by pregnant subjects during third trimester of gestation (Oswestry Disability Index Item). Current effect: $F(2, 62) = 3.23$, $p = 0.045$. Effective hypothesis decomposition. Vertical bars denote 0.95 confidence intervals

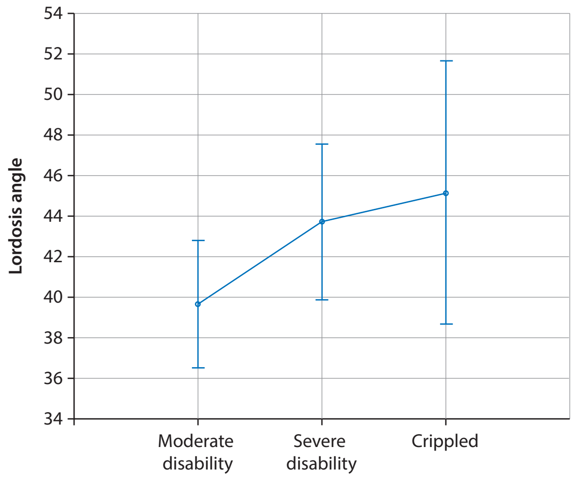

Figure 4. The graph shows the tendency of the disability deterioration expressed by ODI score with increased lordosis angle. Current effect: $F(2, 62) = 1.95$, $p = 0.149$. Effective hypothesis decomposition. Vertical bars denote 0.95 confidence intervals

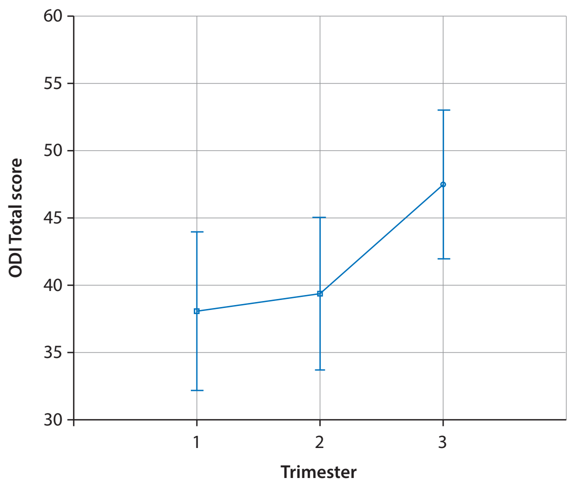

Figure 3. The graph shows back pain related disability deterioration along with advanced gestation. Current effect: $F(2, 62) = 3.25$, $p = 0.045$. Effective hypothesis decomposition. Vertical bars denote 0.95 confidence intervals

cantly more difficult in the 3rd trimester of gestation (Figure 2). The standing discomfort was significant in the 3rd trimester of gestation. The sleeping was not significantly affected in the 3rd trimester of gestation ($F = 0.92$; $p = 0.4$). However, there was a tendency of rising of the sleeping discomfort along with gestation time. The sex life was insignificantly more difficult in the 3rd trimester of gestation ($F = 0.68$; $p = 0.51$). The social life was not affected during pregnancy ($F = 0.06$; $p = 0.94$). The traveling was insignificantly more difficult in the 3rd trimester of gestation ($F = 1.64$; $p = 0.2$). The total ODI scores reported by pregnant women in relation to the trimester of pregnancy are shown in Figure 3. The walking was nonsignificantly deteriorated in the 3rd trimester of gestation ($F = 0.57$; $p = 0.57$). The weight within this study range did not influence significantly on the total Oswestry Disability score ($F = 0.83$; $p = 0.44$). The body height was not related to the ODI score ($F = 0.49$; $p = 0.61$). Due to the exclusion criteria of scoliotic cases, the POTSI remained within the range of the norm, and this was not statistically significant ($F = 2.11$; $p = 0.13$). However, a tendency to increase the POTSI index in highest ODI score patients was observed. In the most disabled, pregnant woman, the kyphosis angles were the highest on average but remained within the range of norm (as described for radiographic criteria). The relationships were not statistically significant ($F = 1.75$; $p = 0.18$). The statistically insignificant relationships of lordosis angles are presented in Figure 4. One can observe a rising tendency of the total Disability score along with higher kyphosis and lordosis angles. However, these tendencies were not significant. The sagittal trunk inclination was the lowest in the most disabled woman. However, it remained within the normal range. The sagittal trunk inclination was not significantly related to the total disability score ($F = 0.44$; $p = 0.65$).

DISCUSSION

Pain in the spine and pelvis is a common problem for a significant percentage of pregnant women. It is a heterogeneous pathology clinical picture regarding the type of symptoms, the severity of symptoms, impact on quality of life and effects of the proposed therapy. The mechanism of the symptoms is not entirely understood, the stage of pregnancy at which the first symptoms appear is hard to predict. There are no explicit criteria for the diagnosis, and unclear pathomechanism causes great difficulty in proposing appropriate prevention and treatment.

The mechanisms considered in the pathogenesis of pain formation of the lower spine posture changes, changes in the curvature of the spine and the center of gravity. In a study by Bullock et al. [31] on 34 pregnant women demonstrated a significant change regarding the curvature of the spine lumbar lordosis and kyphosis. However, there was no effect of body posture changes in severity of pain. Authors revealed no significant relationship between posture and back pain and the study did not support the frequently made assertions that back pain in pregnancy is due to an increase in lordosis [31]. Franklin et al. [12] obtained similar results. In this study, the authors did not confirm the change of curvature of the spine. However, the lordosis angle and pain were the highest in the third trimester of gestation. The changes in the statics of the spine were observed. The study by McCrory [32] demonstrated significant functional differences between the pregnant women, and the women who are not pregnant. In all the quoted studies of posture, biggest changes occurred in the third trimester of pregnancy and were accompanied by greatest symptoms of pain.

In the present study conducted using a new diagnostic system, similar results were obtained. Lordosis and kyphosis angles increased insignificantly with the advancement of gestation. Based on the results, we noticed a bit more intense pain in patients with more pronounced postural changes, but the difference was not statistically significant. These data show the increasing influence of pain on daily activities of patients such as walking, standing, sitting. This finding is consistent with earlier research conducted. Previously published findings are equivocal in preventing back pain symptoms.

To date, there is a lack of precise procedures and consistent and efficient programs of physiotherapy for a pregnant women [33, 34]. The Cochrane database presented a meta-analysis of research describing the methods of prevention and treatment of pain in the pelvis and spine [34]. On the basis of the analyzed studies, authors found that moderate-quality evidence suggested that acupuncture or exercise, tailored to the stage of pregnancy, significantly reduced evening pelvic pain or lumbopelvic pain more than usual care alone, acupuncture was significantly more effective than exercise for reducing evening pelvic pain [34]. It was also found that physiotherapy, osteopathic manipulation, acupuncture, a multi-modal intervention, or the addition of a rigid pelvic belt to exercise seemed to relieve pelvic or back pain more than usual care alone [34]. However, the results were inconclusive, and methodological research limitations do not allow to define clear guidelines.

The effect of pregnancy symptoms or effects of concomitant diseases of pregnancy were not discussed, used or reported.

CONCLUSIONS

This study confirmed that difficulties in sitting and standing are significant in the third trimester of pregnancy. These daily activity impairments prevalent in pregnant women may increase disability due to back pain. Some previous spinal symptoms may worsen disability scores among pregnant woman. This study fails to show the overall tendency for significant lumbar curvature changes in pregnant women. The methodology used in the group of analyzed cases could not confirm significant changes in sagittal trunk inclination about the plumb line. Presented method of 3D surface topography has the potential to reveal postural changes, but that requires strict follow-up of the series of cases. The issue regarding how the pregnancy causes changes in spinal curvature and posture remains open for further studies. Additionally, the coincidence of back pain, its intensity, and spinal curvatures/postural changes need further cohort studies.

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