Postural Changes during Normal Pregnancy

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Abstract: This study was conducted to determine the postural changes during normal pregnancy. Forty normal primigravid women at first trimester of pregnancy (12 weeks' gestation) from the Out-Patient Clinic of Obstetric Department at Bab EL-Sheria Hospital, AL-Azhar University shared in this study. Their ages ranged from 20 to 30 years old and body mass index did not exceed 30 kg/m^2. Thoracic kyphosis angle, lumbar lordosis angle and pelvic inclination angle were evaluated by the formetric II at 12, 22 and 32 weeks' gestation in Spinal Shape Analysis Laboratory at Faculty of Physical Therapy, Cairo University. The obtained results showed a statistically highly significant increase ($P< 0.001$) in the thoracic kyphosis angle, lumbar lordosis angle and pelvic inclination angle between 12&22, 22&32 and 12&32 weeks' gestation. Accordingly, it could be concluded that there is a statistically highly significant increase in the thoracic kyphosis angle, lumbar lordosis angle and pelvic inclination angle during normal pregnancy.
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1. Introduction:

Pregnancy is a normal physiologic state that is characterized by growth of both the mother and fetus. There are extensive biomechanical, physiological and structural changes to provide a suitable environment for nutrition, growth and development of the fetus as well as to prepare the mother for the process of parturition (Artal *et al.*, 2000).

Many of the dramatic changes that occur during pregnancy are mediated by the changing hormone levels. Progesterone and estrogen are well known hormones for causing salt and water retention, also relaxin secreted by the corpus luteum till the 12th weeks' gestation, then from placenta after that, tends to soften the ligaments, thus joints are more vulnerable to injuries (Peggy, 2001).

Progesterone, relaxin and estrogen hormones in pregnancy are known to affect the musculoskeletal system for the preparation of labour. Although, the effect of relaxin is disputed, but progesterone and estrogen are known to influence the biomechanical structures of the pregnant posture by changing the structure of connective tissue and increase mobility of joint capsules and spinal segment, as well as the pelvic joint structure (Schauberger *et al.*, 1996).

Deviation from good balanced posture usually results in poor posture during pregnancy, the C.O.G. is being anteriorly, the head elevated, the cervical spine hyperextended and the knee as well as ankle joints extended (Rungee, 1993).

Artal and Toole (2003) reported that increased ligamentous laxity secondary to the influence of increased levels of estrogen and relaxin predispose pregnant women to increased incidence of strains and sprains. Also, the pregnant uterus enlarges and the mother's weight distribution is altered so, the front of the abdomen becomes heavier, and normal curvature of the lumbar spine is exaggerated. This alters the mother's gait, making falls more likely than in the non-pregnant state (Cunningham *et al.*, 1997).

Pregnant women typically develop hyper lordotic posture, which contributes to a very high prevalence (50%) of low back pain (Artal and Toole, 2003). Also, joint laxity is coupled with the increased lumbar lordosis and protuberant abdomen, which leading to unsteadiness of gait and trauma from falls as a result of loss of balance which is common during pregnancy than any other time in women's life (Gabbe *et al.*, 1996).

Postural changes have often been implicated as a major cause of back pain in pregnant women (Lane, 2007). While, Franklin and Conner-kerr (1998) found that from the first to the third trimesters of pregnancy, lumbar lordosis, posterior head position and pelvic tilt increases. However, the magnitudes and the changes of these posture variables are not related to back pain.

The increased weight in pregnancy may significantly increase the forces across joints such as hips and knees as much as 100% during weight bearing activity. Such large forces may cause discomfort to these normal joints and increase damage to arthritic or previously unstable joints (Artal and Toole, 2003).

The increasing weight is distributed primarily in the abdominal girth. After 12 weeks of pregnancy, the uterus expands out of the pelvis and moves superiorly, anteriorly and laterally. So, many of the problems evoked are postural, caused by inability of the woman to adapt to her forward movement of C.O.G that resulted in increasing the lumbar lordosis and anterior tilting of the pelvis (Mayo Clinic Staff, 2007).

Black and Anastasi, (1995) found that in 34 pregnant women lumbar lordosis and thoracic kyphosis increased between the forth and ninth months of pregnancy. The increased lordosis could be due to increase growth and weight of the anteriorly displaced fetus, producing anterior tilting of the pelvis (Franklin and Conner-kerr, 1998). In contrast, Ostgaard *et al.*(1993) found no change in lumbar lordosis with advancing pregnancy.

Collition (1996) reported that posture changes which occur during pregnancy, help the woman to maintain balance in upright position as fetus grows.

Moreover, hyperlordotic posture causes paraspinal muscles to become shortened and strained, thus resulting in mechanical imbalance between abdominal" and paraspinal muscles which contributes to a very high prevalence (50%) of low back pain in pregnant women (Fast *et al.*, 1990). Balance may be affected by changes in the posture of pregnant women, predisposing to loss of balance and increased the risk of falling (Artal & Toole, 2003).

Because of the importance of postural changes during pregnancy and their impact on the women's life during pregnancy and after delivery, so it seems to be important to study these postural changes.

2. Subjects, Material and Methods:

Subject's Criteria: -

Forty normal primigravid women having single fetus at first trimester of pregnancy (12 weeks' gestation which confirmed by ultrasound) from the Out-Patient Clinic of Obstetric Department at Bab EL-Sheria Hospital, AL-Azhar University shared in this study. Their ages ranged from 20 to 30 years old and body mass index did not exceed 30 $kg/m^{2.}$ All participated women were housewives and free from any musculoskeletal and/or neurological disorders, pervious fractures and/or operations at the back, pelvis and lower extremities, diabetes mellitus, varicose veins and hypertension. All pregnant women did not take any medications that might affect the neuromuscular functions at least three months before pregnancy and/or during the study course. Gestational age of each pregnant woman participated in this study was detected and calculated starting from the first day of last menstrual cycle – date of inclusion in the study then ÷ 7 days and *confirmed by* ultrasonography before the beginning of this study by obstetrici*an.*

Instrumentation:

1) Recording data sheet: All data and information of each pregnant woman of who participated in this study were recorded in a recording data sheet.

2) Weight-height scale: It was used for measuring the body weight and height of each pregnant woman in this study to calculate the body mass index.

3) Ultrasound machine: It was used at start of 12, 22 and 32 weeks gestation to estimate the gestational age of the fetus and to exclude any fetal congenital anomalies, hydramnios as well as twins of each pregnant woman who participated in this study.

4) Formetric II: It is an optical 3D-spine, posture and measurement system, which is reliable, valid and safe to be used during pregnancy (Drerup and Hierholzer, 1994). Formetric II instrument system serves for the determination of the geometry of the back surface of the human being based on non-contrast 3D - scan and derived from it, a spatial reconstruction of the spine by means of a specific mathematical model (Drerup and Hierholzer, 1996). It was used for evaluation of all pregnant women (Fig. 1).

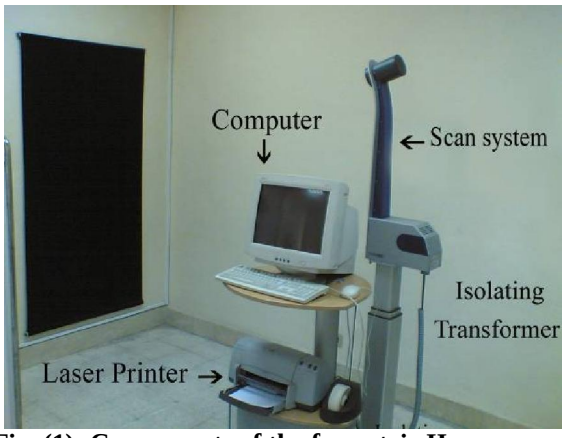

Fig. (1): Components of the formetric II instrument.

Methods:-

A full history was taken from each pregnant woman before starting this study at her first trimester (12 weeks' gestation) according to the items of the recording data sheet. The height was measured before starting the study, while the weight was repeatedly measured and body mass index was calculated according to the following equation: Body mass index = weight/height (kg/mr^2) before starting each measurement at12, 22 and 32 weeks' gestation. After that, each pregnant woman was instructed carefully about the evaluative procedures and she was advised to evacuate her bladder and removed her shoes as

well as socks (i.e. bare feet) before starting the measurement procedures.

Measurement Procedures:-

1- System calibration:

Formetric II has no external calibration, but it has internal calibration. That means it calibrates itself after entering the patient's personal data (internal calibration for system configuration only).

2- Data of each pregnant woman:

Before starting spinal measurement, the Physical Therapist should feed the computer with data of each assessed pregnant woman including body weight (kg) and height (cm) which are important in calibration of the measurements and should be saved in the software of the system.

3- Imaging using Formetric II:

Each pregnant woman was standing bare feet in a neutral, upright position in a distance of 2 m in front of the 3D scanning equipment. The scanner adjusted according to the height of each pregnant woman. The scanning time was very short (40ms), in order to eliminate movement artifacts. The formetric II system analyzed the backs surface form in a sophisticated, automatic way, with no need for manual fixation of markers on the vertebrae. Anatomical landmarks, vertebral position and rotation were automatically detected, using the reconstructed high- resolution surface and anatomical and pathological knowledge models. The resulting model showed the complete form and the measurement data of the examined spine and pelvis but the subject's trunk had to be bared skin (Fig. 2).

4-Processing and editing:

The data of each pregnant woman was preceded and edited into the formetric II software in which spinal image was generated.

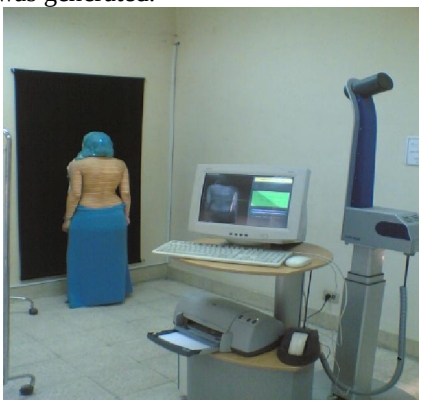

Fig. (2): The scanning of the spine. (Posterior view)

Statistical analysis:

The collected data in this study was statistically analyzed using descriptive statistics as mean, standard deviation and percentage. Comparison of means: by using T-test and Anova test were used for comparison within groups and in between groups. Level of significance: For all the statistical tests done, the threshold of significance was fixed at the 5% level (P- value). A P-value > 0.05 indicates non significant result. A P-value < 0.05 indicates significant result and the P-value was the degree of significance. The smaller the P- value obtained, the more significant was the result (Bendate and Piersol, 1991).

3. Results:

I- Physical characteristics of the women:

The ages of the pregnant women ranged from 20 to 30 yrs, with a mean value of 25.65±2.85 yrs, height ranged from 153 to 171 cms, with a mean value of 161.5± 0.06 cms and their weight in the 12, 22 and 32 weeks' gestation of normal pregnancy ranged from 59 to 79 kgs, 64 to 85 kgs and 69 to 93 kgs, respectively, with a mean value of 68.05±7.3 kgs, 74.5±7.4 kgs and 79.75±7.52 kgs, respectively.

II- Thoracic kyphosis angle:

The thoracic kyphosis angle of the pregnant women at the 12, 22 and 32 weeks' gestation of normal pregnancy ranged from 44.4° to 56.4°, 50.2° to 62.7° and 57.3° to 68.4° respectively, with a mean value of 50.78°±3.58°, 56.86°±3.72° and 63.08°±3.7° respectively. There was a statistically highly significant increase (P< 0.001) between 12&22 weeks' gestation, 22&32 weeks' gestation and 12&32 weeks' gestation as shown in table (1), Fig. (3). Repeated measurement ANOVA revealed a statistically highly significant difference (P< 0.001) within subjects and between subjects.

III- The lumbar lordosis angle:

The lumbar lordosis angle of the pregnant women at the 12, 22 and 32 weeks' gestation of normal pregnancy ranged from 24.6° to 35.8°, 29° to 42.1° and 33.3° to 52.3° respectively, with a mean value of 30.55°±3.27°, 35.94°±3.66° and 42.92°±5.02° respectively. There was a statistically highly significant increase (P< 0.001) between 12&22 weeks' gestation, 22&32 weeks' gestation and 12&32 weeks' gestation as shown in table (1), Fig. (3). Repeated measurement ANOVA revealed a statistically highly significant difference (P< 0.001) within subjects and between subjects.

IV- The pelvic inclination angle:

The pelvic inclination angle of the pregnant women at the 12, 22 and 32 weeks' gestation of normal pregnancy ranged from 13.7° to 23.2°, 16.3° to 29.5° and 18.3° to 33.5° respectively, with a mean value of 18.66°±3.08°, 22.78°±3.53° and 27.77°±3.78° respectively. There was a statistically highly significant increase (P< 0.001) between 12&22 weeks' gestation, 22&32 weeks' gestation and 12&32 weeks' gestation as shown in table (1), Fig. (3). Repeated measurement ANOVA revealed a statistically highly significant difference (P< 0.001) within subjects and between subjects.

Table (1): Thoracic kyphosis, lumbar lordosis and pelvic inclination angles at 12, 22 and 32 weeks' gestation.

	Thoracic kyphosis angle (º)			Lumbar lordosis angle (º)			Pelvic inclination angle (º)		
	12 WGs vs. 22	22 WGs vs. 32	12 WGs vs. 32	12 WGs vs. 22	22 WGs vs. 32	12 WGs vs. 32	12 WGs vs. 22	22 WGs vs. 32	12 WGs vs. 32
Mean difference	6.01	6.22	12.33	5.39	6.97	12.37	4.12	4.98	9.11
Percentage of change	12%	12%	24%	18%	23%	41%	22%	27%	49%
t-value	18,71	19,17	37.89	6.93	8.97	15.89	8.99	10.86	19.85
Level of significance	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

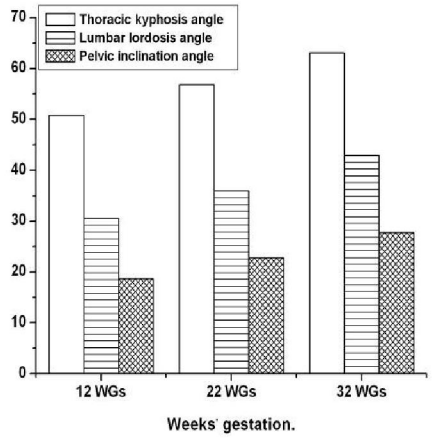

Fig. (3): Mean values of Thoracic kyphosis, Lumbar lordosis and pelvic inclination angles at 12, 22 and 32 weeks' gestation.

4. Discussion

Postural changes occurring in pregnancy may influence the musculoskeletal system and locomotor function. In the non pregnant women the line of gravity falls in line with the ear, shoulder joint, hip joint, middle of the knee joint and through the middle of the forefoot. In the pregnant woman the line of gravity falls posterior, to compensate the increase in abdominal weight (Alane, 2004).

Forty normal primigravidae women at first trimester of pregnancy (12 weeks' gestation which confirmed by ultrasound) shared in this study. In this study we studied the postural changes during normal pregnancy including lumbar lordosis angle, thoracic kyphosis angle and pelvic inclination using an objective method (Formetric II) which gives a numerical and quantitative data.

Formetric II is an optical 3D-spine, posture and measurement system, which is reliable, valid and safe to be used during pregnancy (Drerup and Hierholzer, 1994). Formetric II instrument system serves for the determination of the geometry of the back surface of the human being based on non-contrast 3D- scan and derived from it, a spatial reconstruction of the spine by means of a specific mathematical model (Drerup and Hierholzer, 1996).

The results of this study found that, there was a statistically highly significant increase (P< 0.001) in the thoracic kyphosis angle, lumbar lordosis angle and pelvic inclination angle between 12&22 weeks' gestation, 22&32 weeks' gestation and 12&32 weeks' gestation.

Results of this study agreed with those of Black and Anastasi (1995) who found that lumbar lordosis and thoracic kyphosis increased between the forth and ninth months of pregnancy.

The results of this study also, agreed with that of Ibrahim (2002) who found that, lumbar curvature showed a very highly significant increase between 20 and 24, 28 &32 weeks' gestation, with mean values of 34.04±6.62, 43.94±7.69, 47.12±7.48 and 52.62±7.16 degrees respectively using flexible curve rule.

Also, the results of this study were supported by Franklin and Conner-kerr(1998) who found that from the first to the third trimesters of pregnancy, lumbar lordosis, posterior head position, lumbar angle and pelvic tilt increases. However, the magnitudes and the changes of these posture variables are not related to back pain.

The results of the current study supported by those Bullock *et al.* (1987) who found a significant

increase in lumbar and thoracic curves during pregnancy, which was still evident at the end of puerperium.

The increase in the thoracic kyphosis angle, lumbar lordosis angle and pelvic inclination angle during pregnancy could be explained by the changing hormone levels. Progesterone and estrogen are well known hormones for causing salt and water retention, also relaxin secreted by the corpus luteum till the 12th weeks gestation, then from placenta after that, tends to softens the ligaments, thus joints are more vulnerable to injuries (Peggy, 2001).

Progesterone, relaxin and estrogen hormones in pregnancy are known to affect the musculoskeletal system for the preparation of labour. Although, the effect of relaxin is disputed, but progesterone and estrogen are known to influence the biomechanical structures of the pregnant's posture by changing the structure of connective tissue and increase mobility of joint capsules and spinal segment, as well as the pelvic joint structure (Schauberger *et al.*, 1996).

The increased lordosis adaptation could be due to increase growth and weight of the anteriorly displaced fetus producing anterior tilting of the pelvis (Black and Anastasi, 1995).

The body's C.O.G. shifts upward and forward due to the increases in weight of the uterus and its contents, lumbar lordosis increase to compensate for the shift of the C.O.G. and the knees hyperextended probably due to the change in the line of gravity, weight shifts toward the heels to bring the C.O.G. to a more posterior position (Kisner and Colby, 1990).

The increasing weight is distributed primarily in the abdominal girth. After 12 weeks of pregnancy, the uterus expands out of the pelvis and moves superiorly, anteriorly and laterally. So, many of the problems evoked are postural, caused by inability of the woman to adapt to her forward movement of C.O.G that resulted in increasing the lumbar lordosis and anterior tilting of the pelvis (Mayo Clinic Staff, 2007).

This increase could be explained as pelvic tilt is controlled by muscular action of the abdominal muscles, hip flexors, hip extensors and spinal extensors muscles. The alternation of strength or resting length of these muscles will also change the angle of pelvic tilt and, in turn, the lumbar curvature. Increased lordosis will result from a forward tilt of the pelvis occurring due to weak abdominal muscles, the lordotic posture is one in which the lumbosacral angle is increased and the pelvis tilts forward. The condition may exists in parallel with increased thoracic kyphosis and a forward- held head. The anterior longitudinal ligament will be lengthened, the posterior lumbar disc space narrowed, and the facet joint approximated with accompanying dural compression and synovial irritation. Hip flexors are tight, as well as lumbar extensors, while the abdominals are weak and stretched (Franklin and Conner-kerr, 1998).

The results of this study are not in agreement with the results of Ostgaard *et al.* (1993) who found that no change in lumbar lordosis with advancing pregnancy.

Conclusion:

It can be concluded that there was a statistically highly significant increase in the thoracic kyphosis angle, lumbar lordosis angle and pelvic inclination angle during normal pregnancy.

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