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RESEARCH ARTICLE

PHOTOGRAMMETRIC QUANTIFICATION OF FORWARD HEAD POSTURE IN PREGNANT WOMEN

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ABSTRACT

Background: forward head position is characterized by a dorso extension of the head together with the upper cervical spine (Cl-C3), accompanied by a flexion of the lower cervical spine (C4-C7), where the cervical curvature is increased, a condition called hyper lordosis, it is one of the most common problems occurred in pregnant women especially in 3rd trimester of pregnancy as a result of increasing abdominal weight, shifting of COG, breast enlargement, hyper laxity of ligaments. **Purpose:** This study was conducted to determine the photogrammetric quantification of the forward head posture in pregnant women. **Method:** sixty women (Thirty non pregnant women and thirty pregnant women) at 3rd trimester of pregnancy from (24 to 36 weeks) of gestation were selected from the outpatient clinic of obstetrics at Mostorod Medical Center, Cairo, Egypt, their age ranged from 20 to 35 years and their BMI<30Kg/m2, they were divided randomly into 2 groups equal in number, group(A)(n=30) (control group) and group B (n=30) (study group). Assessment of forward head posture was done through measuring cranio-vertbral angle (CVA) and gaze angle (GA), for all participants in both groups (A&B). Measurement was done for one shot using the photogrammetry method. **Result:** Showen that there was a statistical significant decrease in the mean value of CVA and GA at group B than group A (p=0.001) and (p=0.007) respectively, Also the results of the current study revealed that there wasa statistical significant positive correlation between CVA and GA in the control group (A), and there was high statistical significant positive correlation between CVA and GA in the study group (B).**conclusion:** forward head posture measured through photographic method is greatly affected during 3rd trimester of pregnancy compared to non -pregnant state.

INTRODUCTION

Forward head posture is defined as hyperextension of the upper cervical vertebrae in addition to forward translation of the cervical vertebrae,It increases compressive loading on tissues in the cervical spine, particularly the facet joints and ligaments (Koseki *et al*., 2019). During pregnancy, a woman's body weight increases by 15 to 25%; this makes a greater burden on the tendons, ligaments, and joints (Korsten-Reck *et al*., 2009). Also, relaxin and estrogen hormones loosen the ligaments and create an additional predisposition for injury (Brunton PJ*et al* 2010). Asfetus grows, a variety of changes appear in a pregnant woman's body. The cervical, thoracic, and lumbar spine curvature were impaired (Ramachandra P *et al* 2015). FHP increases compressive loading on tissues in the cervical spine, particularly the facet joints and ligaments. Studies have reported that symptoms including neck pain, headache, temporomandibular pain, and musculoskeletal disorders are related to FHP and it influences respiratory function by weakening the respiratory muscles (Koseki *et al*., 2019). Also, it increases extension of the atlanto-occipital joint and the upper cervical vertebrae as well as flexion of the lower cervical and upper thoracic vertebrae. Furthermore, this posture causes persistent and abnormal contraction of the suboccipital, neck, and shoulder muscles (Kang JH *et al*, 2012). In FHP, center of gravity (COG) of the head is shifted in the anterosuperior direction, increasing the load on the neck, which causes dysfunction of the musculoskeletal, neuronal, and vascular systems (Harrison *et al*., 2003). To assess head posture three angles should be measured, cranio- vertebral angle (CVA) and gaze angle(GA). CVA is the intersection of a horizontal line passing through the C7 spinous process and a line joining the midpoint of the tragus of the ear to the skin overlying C7 spinous process. Studies have found that subjects with head, neck, and shoulder discomfort are more likely to have a smaller CVA than that of asymptomatic subjects. (Yip *et al*., 2008). Gaze angle is the angle formed between a line drawn through the canthus of the eye and the tragus of the ear and a horizontal line through the tragus of the ear. This angle describes the inclination of the head from the horizontal line. It reflects the relative posture of the upper cervical spine with a greater gaze angle indicating a more extended position of upper cervical spine (McEvoy and Grimmer, 2005). The photographic method is a digital imaging technique that is used to evaluate head and neck posture in the standing position, the photogrammetry method was used for assessing the position of the head.

It is a simple and objective technique for measuring the posture of different parts of the body and has good validity when analyzing head and neck posture (Grimmer *et al*., 2008). This method depends on the use of digital photos to measure angles and distances. It is valid, reliable and non- invasive. Nowadays, the digital photographs are feasible to be used in clinical practice, the photographs provide reliable data to quantify postural changes (before and after treatment).Computer software has been developed to calculate distances and angles on digital photographs. The use of photogrammetry has been shown to be more sensitive for measuring head posture than simple visual assessment (Gadotti and Gonzalez B, 2010). Although previous studies had reported the symptoms related to forward head posture, but no studies have investigated its effect in relation to pregnant women. so, this study was conducted to assess the position of the head through measuring CVA & GA in pregnant women, in order to know at which extent does pregnancy affect FHP.

MATERIALS AND METHODS

Sixty participants, thirty of them were normal pregnant women in their 3rd trimester of pregnancy (28w to 36w) (the study group), compared to thirty normal healthy non pregnant women (control group), selected from the outpatient clinic of obstetrics at Mostorod Medical center ,they were equally distributed into 2 groups (A&B), all participants read and signed informed consent form before initiation of the study .The study was approved by the research ethical committee of Faculty of Physical therapy , Cairo university December,2020 (No: P.T.REC/012/003156) Duration of the study was 17 month from January 2021 to May 2022.

INCLUION CRITERIA: 30non pregnant and 30 pregnant participants (All at 3rd trimester of pregnancy),their age ranged from 20 to 35 years, their BMI was less than 30kg/m2.

Exclusion criteria: Participants were excluded from this study if they had., any cervical problems as cervical pain, muscle spasm or trauma, any musclo-skeletal surgery or dysfunction, Diseases affecting neuromuscular system, any deformity of the spine or extremity.

Subjects: Sixty participants were selected from outpatient clinics of Mostorod Medical Center, Cairo, Egypt. They were divided into two groups equal in number.

Group A(n=30)., non -pregnant participants.
Group B(n=30)., pregnant participants.

Forward head posture was assessed by using the photogrammetric method from lateral standing view then analyzed photo by using kinovea software program to measure cranio-vertebral angle and gaze angle for participants in both groups (A&B).

Procedures

Assessment procedures: Detailed medical and obstetrical histories were taken from each participant in both groups (A&B) before starting the study and was recorded in a data recording sheet, Weight and height of each participant in both groups (A & B) were measured,

- Each participant in both groups(A&B) was given instructions about the measurement procedures.
- Adhesive markers were placed bilaterally on the tragus of the ear and the calcaneocuboid joint of the foot.
- A fuji film digital camera was mounted on a tripod that was placed at a distance of 100cm from the participant lateral foot and the height of the camera was adjusted based on participant height.
- Participant was instructed to stand with the side of the trunk facing the camera.
- Three sagittal plane photos were taken by digital camera from each side and saved.
- Repeated photographs were taken to reduce bias during photography (Ruivo RM, *et al* 2014).

Statistical analysis: Data were expressed as mean± SD. Unpaired t-test was used to compare between measured variables of the two groups. Statistical package for the social sciences computer program (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. P less than or equal to 0.05 was considered significant.

RESULTS

Group A; includes thirty non pregnant participants their ages` mean ± SD value was 27.8±3.9 years, weight mean ± SD value was 66.8±7 kg, height mean ± SD value was 160.5±4.8 cm and BMI mean ± SD value was 26±2.9 kg/m^2 as shown in table (1).

Group B; include thirty 3rd trimester of pregnant participants their ages` mean ± SD value was 25.5±4.5 years, weight mean ± SD value was 69.4±6.8 kg, height with the mean ± SD value was 158.7±5 cm and BMI with the mean ± SD value was 27.6±1.8 kg/m^2 as shown in table (1).

Also the unpaired t test statistics showed that there is no statistically significant difference between groups regarding age, weight height and BMI as t values were 1.008, -1.049, 1.475 and -1.758 and P values were 0.322, 0.303, 0.152 and 0.090, respectively as shown in table (1).

- **Normality test:** Data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. Shapiro-Wilk and Kolmogrov-smirnov tests for normality showed that CVA and GA are normally distributed.
- **Measurement variables:** As tabulated on table (2) and illustrated. In group A, the mean value of cranio-vertebral angle was 40.73 ± 4.07 degrees. But in group B, the mean value of cranio-vertebral angle was 47.8 ± 5.8 degrees, where the paired t value was -.523, which revealed a statistically significant differences, where group B significantly increased than group A, regarding cranio-vertebral angle outcome measure with P value 0.001.

Measurement of Gaze angle (GA): As tabulated on table (2) and illustrated. In group A, the mean value of Gaze angle was 20.25 ± 3.33 degrees. But in group B, the mean value of Gaze angle was 23.62 ± 2.79 degrees, where the paired t value was -3.17, which revealed a statistical significant increase in group B than group A regarding sacral slope outcome measure with P value 0.007

Table 1. Mean value of age, weight, height and BMI in both groups (A&B)

Measured variable	Group A (n=30) Mean ±SD	Group B (n=30) Mean ±SD	t-value	p-value
Age (years)	27.8±3.9	25.5±4.5	1.008	0.322
Weight (kg)	66.8±7	69.4±6.8	-1.049	0.303
Height (cm)	160.5±4.8	158.7±5	1.475	0.152
BMI (kg/m^2)	26±2.9	27.6±1.8	-1.758	0.090

Data are expressed as mean+- SD, NS=P>0.05= non significant

Table 2. Comparing mean values of CVA and GA in both groups (A&B)

Measured variables	Group A Mean ±SD	Group B Mean ±SD	t- value	P value
CVA (degree)	48,95 ± 2.96	40.73 ± 4.07	-5.23	0.001*
GA (degree)	20.25 ± 3.33	23.62 ± 2.79	-3.44	0.007*

SD: standard deviation p-value: probability value *: significant

Table 3. Correlation between CVA and GA in both groups (A&B)

CVA and GA	r value	p value	Sig
Non pregnant women(group A)	0.601	0.018	S
Pregnant women(group B)	0.332	0.227	NS

r value=Pearson correlation coefficient; p value=Probability value; S=Significant, NS= no significant

- **Correlation between cranio-vertebral angle and Gaze angle variables:** Current study results have revealed a statistical positive correlation regarding cranio-vertebral angle and Gaze angle outcome measures where r value was 0.601 with P value 0.018 in Control Group A "non-pregnant", as shown in table (3). On the other hand, present study results have a high statistical significant positives correlation between cranio-vertebral angle and Gaze angle outcome measures where r value was 0.332 with P value 0.227 in study group B , as shown in table (3).

DISCUSSION

Forward head posture is defined as an alignment in which the external auditory meatus is positioned anterior to the plumb line through the shoulder joint (kandell *et al*.,2005). It is the biomechanical stress of the cervical spine and lead to musculoskeletal disorders such as cervical pain,headache, temporomandibular and muscular dysfunction (Fernándezd *et al*., 2006). This abnormal alignment occur specially in sagittal plain when the head is protruded anteriorly in relation to the trunk (Hoy *et al*., 2010). At FHP, the COG is shifted anteriorly and superiorly which cause the load on the neck to be increased causing dysfunction of musclo-skeletal, vascular and neural systems (Harrison *et al*., 2003). As a result of the previous changes, a lot of impairments occurs as muscle ischemia ,pain, fatigue, decreased range of motion of cervical spine, early disc degeneration, tempro-mandibular joint pain and inflammation, tension headache, increase in dorsal kyphosis, decrease in height, decrease in vital capacity, and range of motion of shoulder and arms, mobility impairment in the muscles of the anterior thorax , muscles of cervical spine, and head (Weon *et al*, 2010), impaired muscle performance due to stretched and weak lower cervical and upper thoracic muscles(Levangie *et al*., 2011). The photogrammetric method is a digital imaging method used for assessment of the FHP. It is easy, feasible and quantitatively accurate to evaluate FHP. It also has a good validity and reliability (Nam SH *et al*, 2013). iteliminates the risk of exposure to harmful radiation encountered with the radiographic method and does not require printing of photographs. (Weber P *et al*, 2012). A digital imaging photos was used to measure cranio- vertebral angle (the angle between imaginary line extended from C7 and the ear tragus with the horizontal line) and gaze angle (the angle formed between aline drawn through the eye canthus and the ear tragus) (Yip *et al*,2008). Therefore, the current study was conducted to investigate the photogrammetric quantification of the forward head posture in pregnant women. Sixty participants (30 non pregnant and 30 pregnant participant) participated in this study. They were recruited from the outpatient clinic of obstetrics at Mostorod Medical Center, They were divided into two groups equal in number (A&B), group A non- pregnant participants and group B pregnant participants.

All participants in both groups (A and B) were assessed by measuring CVA &GA using the photogrammetric method. An anatomical land marks were put at C7, in front of ear tragus and the eye can thus at the right side of all participants to measure CVA and GA. The result of the current study revealed that there was a statistical significant increase in the mean value of CVA and GA at group B than group A (p=0.001) and (p=0.002) respectively. Also the results of the current study revealed that there wasa statistical significant positive correlation regarding CVA and GA in the control group (A),while there was a statistical positive insignificant correlation between CVA and GAin the study group (B). The result of the current study could be explained as follows:

As a fetus grow, the center of gravity is shifted anteriorly toward the abdomen causing increase in lumber lordosis, posterior tilting of sacrum and movement of the head to the back to compensate for the weight.(Youssef *et al*.,2011). This may be explained through different reasons: A- the enlarged uterus, breast, and fetus which could shift the COG anteriorly that could aggravate the anterior translation and FHP, (Artal & O'Toole, 2003) B- in pregnancy there was increased relaxin and estrogen which made the ligaments and connective tissue more relaxed and capable of being lengthened, C- the increased BMI and increased blood volume which could explain the increased FHP during the last trimester of pregnancy (Korsten-Reck *et al*., 2009). Furthermore, release of estrogen and relaxin hormones loosen the cervical ligaments which increase the incidence of forward head posture (Brunton *et al*., 2010). The result of this study were in agreement with that of (lee HN *et al*.,2015) who used the photographic method to detect the severity of forward head posture, and evaluated FHP measuring CVA and GA.

Also, the result of this study agreed with that of Suresh Mani *et al*., 2017 who measured the CVA and GA angles using the photogrammetric method to assess the FHP as there was change in the mean value of CVA and GA in participants with FHP than in normal participants. Also, the result of the current study agreed with that of Kang J k *et al*.,2012 who studied the effect of FHP on postural balance in the long- time computer based workers and found that a more severely protruded head causes a more decreased cranio-vertebral and an increased gaze angle; thus, CVA -GA is reduced. Due to head protrusion toward the anterior direction and an increased GA, the upper cervical vertebrae comes under extension moment. This causes a transition of COG to the anterior direction under both static and dynamic conditions. On the other hand, the result of the current study disagreed with that ofZadeh ZS *et al* 2014study who assessed forward head posture in females using the photogrammetry method. As, there was a statistical significant difference at the cranio-vertebral angle between the study and control groups, but there was no dramatic difference at the gaze angle between both groups.

CONCLUSION

It could be concluded that forward head posture measured through photogrammetric method is greatly affected during third trimester of pregnancy compared to non- pregnant state.

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