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Original Articles

Correlation between Obesity and Lumbar Lordosis in Obese Pre-Menopausal Korean Females

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Objective : Obesity is associated with degenerative arthropathy giving stress on joints. It also amplifies loads of weight bearing joints by changing the gravity line of the body. Our aim is to investigate the correlation between obesity and lumbar lordosis in obese pre-menopausal Korean females. The hypothesis was tested that there is a correlation between obesity and lumbar lordosis.

Methods : A cross-sectional evaluation of 44 Females (baseline age 30.77 ± 6.46) with BMI 31.53 ± 3.82 (kg/m^2) was done. Body composition was measured using bio-impedance analysis (BIA), and anthropometry was done by the same observer. A lateral whole spine X-ray was taken in standing position to measure the lumbar lordotic angle (LLA), Ferguson angle (FA) and lumbar gravity line (LGL). A Pearson correlation was used to measure the correlation between obesity and lumbar lordosis (SPSS 10.0 for windows).

Results : Body mass index (BMI kg/m^2) had a negative relationship with LLA(γ=-0.469), FA(γ=-0.347) and LGL(γ=-0.389). Body fat rate had a negative relationship with LLA only(γ=-0.385). Waist circumference had a negative relationship with LLA(γ=-0.345) and LGL(γ=-0.346). WH ratio had no relationship with lumbar lordosis.

Conclusion : These data show that obesity is related to mechanical structures, such as lumbar lordosis. BMI was the most useful index, which reflects a change of mechanical structure of lumbar, more than other variables in this study.

Key Words: Obesity, BMI, Lumbar lordosis, cross-sectional study, Female

Introduction

Spinal curvature in the sagittal plane, especially lumbar lordosis, is necessary for effective weight bearing, increasing efficiency of paraspinal muscles, and maintaining erect posture[1-2]. If lumbar lordosis changes into hypo or hyper lordosis, load on facet joint and disc increase and compression of nerve root, degeneration of disc and facet joints, contracture of para spinal muscle and sprain of para spinal ligaments can occur[3-5]. Investigators have claimed that anthropometric characteristics such as increased lumbar lordosis and diminished abdominal muscle force by themselves can increase the risk of chronic low back pain[6]. This would be very important for physicians or physical therapists.

Obesity has many metabolic complications like syndrome X, but it also causes musculoskeletal

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disorders such as degenerative arthropathy. Changing of mechanical structure (such as lumbar lordosis) by obesity could cause much weight loading on joints[7-9]. For routine clinical use, anthropometric measurements have been preferred because of ease of measurement and low cost. Waist circumference and BMI (body mass index, weight kg/height m^2) are commonly used surrogates in diagnosing obesity and fat distribution.

The aim of this study is to investigate the correlation between obesity and lumbar lordosis in obese premenopausal Korean females, and to know if obesity can affect lumbar lordosis and low back pain.

Materials and Methods

1. Protocol

All medical evaluations were carried out on the same day. Subjects reported for testing in the morning in a fasted state to the Dept. of Oriental Rehabilitation, Kyung Hee Medical Center. The study was approved by the Institutional Review Board of Kyung Hee Oriental Medical Center and the subjects gave written consent to participate.

2. Subject Recruitment

Subjects were required to be independent, community dwelling obese (BMI >25 kg/m^2) premenopausal Korean females, aged 21-45 years. Inclusion criteria required that subjects be ambulatory, nonexercising, nonsmoking, and have maintained current body weight 3 kg over the previous 3 months. Subjects with untreated diabetes mellitus, malignant/catabolic conditions, missing limb, joint replacement, on estrogen replacement therapy, or those taking medications that could potentially influence body composition were excluded from the study. Recruitment occurred through advertisements in newspapers and websites. The study period was from April 1, 2003 to May 31, 2003 and data were collected on 44 females.

3. Anthropometrics

Wearing a hospital gown, body weight and height were measured to the nearest 0.1 kg and 0.5 cm respectively. Waist circumference and waist-to-hip ratio (W/H) were measured twice according to the WHO method (circumference of waist over 3 cm from ASIS) by the same observer.

4. Bioelectrical impedance (BIA)

Body weight, fat mass, fat free mass (FFM) and bone mineral content were measured by BIA method (Inbody 2.0, Biospace, Seoul, Korea).

5. Lateral lumbar X-ray

Lateral lumbar X-ray was taken in Dept. of Radiology, Kyung Hee Medical Center. Lumbar lordotic angle, Ferguson angle and lumbar gravity line on erect lateral lumbar X-ray were measured to estimate lumbar lordosis (Fig. 1,2,3).

Lumbar lordotic angle was measured between elongated margin of 1st lumbar upper border and 5th lumbar lower border.

Ferguson angle was measured between basement plane of sacrum and horizontal line.

A diagonal line to the opposite angle of 3rd spine and a perpendicular line from point of contact was drawn. Lumbar gravity line passes within anterior 1/3 of sacral basement in normal.

Data were analyzed by SPSS 10.0 for Windows. Pearson correlations were used to determine the correlation between each of the obesity measurements and lumbar lordosis (p<0.05). Age, number of pregnancies and birth to lumbar lordosis were adjusted when analyzed effects of body weight to BMI, % of fat, waist circumference and WH ratio.

Fig. 1. Lumbar Lordotic Angle Measurement

Fig. 2. Ferguson Angle Measurement

Fig. 3. Lumbar Gravity Line Measurement

Table 1. Distribution of Age, Height and Weight

Age(year)	Number(%)	Height(cm)	Weight(Kg)
21～30	24 (55)	161.13±4.92*	82.25±11.74
31～40	15 (34)	159.73±5.65	80.82±12.99
41～45	5 (11)	159.00±8.03	78.64±13.24
Total	44 (100)	160.41±5.48	81.35±12.10

* : Values are Mean ± SD

Table 2. Distribution of BMI, Body Fat Rate, Waist Circumference and WH Ratio

Age(year)	BMI(Kg/m²)	BFR(%)	WC(cm)	WH ratio
21~30(n=24)	31.62±3.87	46.21±7.99	93.90±8.21	0.84±4.04
31~40(n=15)	31.56±3.93	45.78±6.74	94.87±7.02	0.84±2.99
41~45(n=5)	31.02±4.02	46.10±7.38	96.60±5.08	0.86±2.07
Total(n=44)	31.76±3.81	46.05±7.35	94.53±7.44	0.84±3.54

Values are Mean ± SD
BFR indicates Body Fat Rate
WC indicates Waist Circumference

Results

1. Distribution of age, height and weight

Mean age of volunteers was 30.77±6.46 (Max 45, Min [21]). Mean of heights was 160.41±5.48 cm, and mean weight was 81.35±12.10 kg. Distribution of age, height and weight is in Table 1.

2. Distribution of BMI, body fat ratio, waist circumference and WH ratio

Distribution of BMI, body fat ratio, waist

Table 3. Distribution of Lumbar Lordotic Angle, Ferguson Angle and Lumbar Gravity Line

Age(year)	LLA(°)	FA(°)	LGL(ratio)
21～30(n=24)	44.17±11.09	36.75±7.26	0.71±0.35
31～40(n=15)	44.53±8.96	36.60±6.66	0.87±0.41
41～45(n=5)	42.40±13.52	37.00±6.93	0.66±0.41
Total(n=44)	44.09±10.46	6.73±6.87	0.76±0.38

Values are Mean ± SD

LLA indicates Lumbar Lordotic Angle

FA indicates Ferguson Angle

LGL indicates Lumbar Gravity Line

Table 4. Relationship between BMI and Lumbar Lordosis.

LLA(°)	FA(°)	LGL(ratio)	Pearson
Correlation	-0.486*	-0.379**	-0.406*

LLA indicates Lumbar Lordotic Angle

FA indicates Ferguson Angle

LGL indicates Lumbar Gravity Line

* : Statistically significant (*p*<0.01)

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Table 5. Relationship between % of Fat, Waist circumference, WH ratio and Lumbar Lordotic Angle, Ferguson Angle, and Lumbar Gravity Line.

Pearson	LLA(°)	FA(°)	LGL(ratio)
Correlation			
% of fat	-0.381	-0.280	-0.244
Waist circumference	-0.358	-0.216	-0.359
WH ratio	-0.020	-0.063	-0.225

LLA indicates Lumbar Lordotic Angle

FA indicates Ferguson Angle

LGL indicates Lumbar Gravity Line

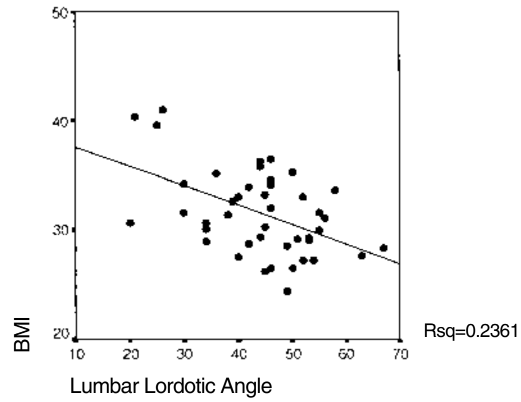

Fig. 4. In simple linear correlation analysis between BMI and Lumbar Lordotic Angle, there is a significant negative correlation (Rsq=0.2361).

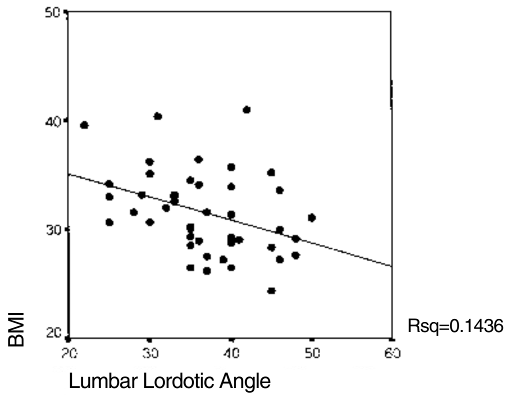

Fig. 5. In simple linear correlation analysis between BMI and Ferguson Angle, there is a significant negative correlation (Rsq=0.1436).

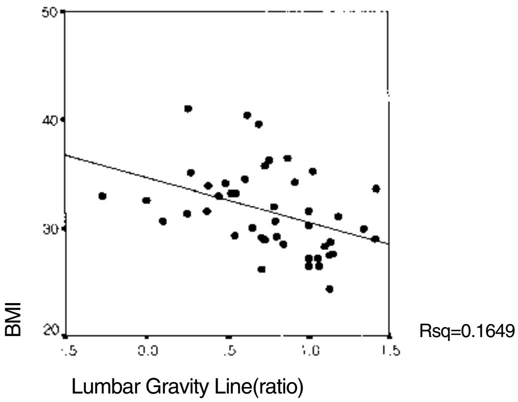

Fig. 6. In simple linear correlation analysis between BMI and Lumbar Gravity Line(ratio), there is a significant negative correlation (Rsq=0.1649).

circumference and WH ratio are in Table 2.

3. Distribution of Lumbar lordotic angle, Ferguson angle and lumbar gravity line

Distribution of Lumbar Lordotic Angle, Ferguson Angle and Lumbar Gravity Line is in Table 3

4. Correlation between obesity measurements and lumbar lordosis

There was a significant correlation between BMI and lumbar lordosis. BMI was correlated with lumbar lordotic angle, Ferguson angle and lumbar gravity line (Table 4, Fig. 4, 5, 6). Slight correlation was found between % of fat and lumbar lordotic angle (Pearson correlation -0.381). However its significance disappeared after adjusting for body weight. Waist circumference also had slight correlation with lumbar lordotic angle (Pearson correlation -0.358) and lumbar gravity line (Pearson correlation -0.359). However, its significance disappeared after adjusting for body weight. WH ratio had no correlation with lumbar lordosis (Table 5).

Discussion

Spinal curvature plays an important role in increasing elasticity against axial compression, and in keeping balance of body weight axis[2)]. Curvature of sagittal plane depends on not only articular surface but many other factors such as para spinal muscle tone, balance of agonist and antagonist muscles, habit of posture, fatigue and so on[10-11)]. Change of lumbar lordosis causes overloading on facet joint and intervertebral disc. In addition, nerve root compression, muscle contracture, degenerative change, and ligament injury can follow it[3-5)].

Obesity is not the only the cause of metabolic complication like syndrome-X. but one of the factors of musculo-skeletal disorder by its weight stress itself. It is also known as a moderate risk factor of low back pain[7-9)]. In addition, obesity can change body shape and axis of weight balance, which can affect lumbar curvature[12-13)].

Bener et. al[7)] reported that obesity is moderately associated with low back pain in 802 male and female subjects. Lake et. al[8)] investigated an association between obesity and back pain in 4395 men and 4468 women. In that study, no significant relationships were found for men. The risk of pain onset among women was evident in relation to BMI at baseline (age 23) and cannot therefore be explained by an effect of back pain on adiposity, which was the same direction of the current study.

The National Institutes of Health (NIH) and the World Health Organization (WHO) recently adopted similar body weight (adjusted for height) guidelines for overweight and obesity[14-16)]. The body mass index (BMI = weight kg/height m^2) continues to be the most commonly used index of weight status, where normal weight is a BMI 18.5 - 25.9 kg/m^2 overweight is a BMI 25.0 - 29.9 kg/m^2 and obese a BMI >30.0 kg/m^2 [16)]. However, in the Asia-Pacific guideline, BMI>25kg/m^2 defines as obesity[17)]. Despite BMI not being a measure of body composition, it is commonly considered an index of fatness due to the high correlation between BMI and percent body fat in children[18)] and adults[19)].

In this study, BMI was significantly correlated with lumbar lordosis. It is thought that BMI reflects height and body weight, which decide body shape. Other measurements showed slight correlations. However, after adjusting for body weight, their significance disappeared.

It is possible that changed body shape due to obesity can affect mechanical structure as well as various musculo-skeletal disorders. In conclusion, BMI was the most useful index which reflects change of mechanical structure of lumbar than other variables in this study. Further study is necessary to elucidate the mechanism of lumbar spinal disorders in obesity and the criteria of BMI that increase complications of lumbar musculo-skeletal disorders.

Study limitation

The current study population is limited to pre-menopausal women because of the sample size and birth history was not checked. Since birth history can be related to lumbar lordosis, following studies should be done including this factor. In addition, case-control studies are thought to be necessary afterward.

Conclusion

We compared the correlation between obesity and lumbar lordosis in 44 obese pre-menopausal Korean females, and got results as below.

1. BMI had a negatively significant correlation with lumbar lordotic angle, Ferguson angle and lumbar

gravity line.

2. There was a weak correlation between % of fat and lumbar lordotic angle (Pearson correlation -0.381). However, its significance disappeared after adjusting for body weight.
3. Waist circumference had a slight correlation with lumbar lordotic angle (Pearson correlation -0.358) and lumbar gravity line (Pearson correlation -0.359). However, its significance disappeared after adjusting for body weight.
4. WH ratio had no correlation with lumbar lordosis.

These data show that obesity is related to mechanical structures, such as lumbar lordosis. Obesity can be a stressor of the lumbar spine, and cause of lumbar spinal disease. BMI could be thought as a most useful factor which creates effects on lumbar curvature.

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