

The Correlation between Body Fat Distribution and Medial Tibiofemoral Joint Space Width in Obese Knee Osteoarthritis Patients

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Background: Obesity is a major risk factor for knee osteoarthritis. The relationship between obesity and OA may not be simply due to a mechanical factor. Evidences suggest that metabolic factors related to body fat play important roles, but the specific type of fat that contributes to OA is unclear. The objective of this study was to examine the possible correlation between body fat distribution with knee OA.

Methods: This study was a cross sectional study of OA patients with obesity visiting the Rheumatology and Geriatric-Internal Medicine clinics at Cipto Mangunkusumo Hospital between January-March 2016. Data was collected by consecutive sampling. Knee OA was diagnosed from clinical and radiologic evaluation based on American College of Rheumatology 1986 criteria. Body fat distribution was measured by bioelectrical impedance analysis (BIA). Conventional radiography of the knee was used to evaluate joint space narrowing (JSN). The correlation between body fat distribution and joint space width was analyzed by bivariate analysis

Result: A total of 56 subjects were recruited, majority were women (73.2%). Median visceral fat was 12% (7.5-16.5), median subcutaneous fat was 30.2% (16.5-37.9), and median visceral to subcutaneous fat ratio was 0,40 (0,26-0,80). The mean medial tibiofemoral joint space width was 2.34 mm (SD 0.78). Bivariate analysis revealed a correlation between visceral fat and medial tibiofemoral joint space width ($r: -0,474$ $p: < 0,001$). There is no correlation between subcutaneous fat and medial tibiofemoral joint space width ($r: -0,187$ $p: 0,169$); and visceral to subcutaneous fat ratio and medial tibiofemoral joint space width ($r: -0,225$ $p: 0,09$).

Conclusion: Visceral fat is correlated with medial tibiofemoral joint space width ($r: -0.474$ $p: < 0.001$). There is no correlation between subcutaneous fat, and visceral to subcutaneous fat ratio, with medial tibiofemoral joint space width.

Keywords: Osteoarthritis, obesity, visceral fat, subcutaneous fat, visceral to subcutaneous fat ratio, medial tibiofemoral joint space width

BACKGROUND

Osteoarthritis (OA) is the most common type of arthritis found in the population, and it is a chronic disease which able to affect all joints. The most commonly affected joints are the knees, hands, and hips. The prevalence of knee OA in USA and in Europe is relatively similar, approximately affecting 50% of the individuals above the age of 75 years old.¹ Based on *Riskesdas* 2013 (National health survey, 2013), the prevalence of joint disease in Indonesia is 11.92%.²

Osteoarthritis of the knee is a multifactorial disease with several known risk factors including age, obesity, genetic predisposition, muscle weakness, history of trauma, and female gender.³ Obesity, as a risk factor, receives special attention as the prevalence is relatively high and it is one of the modifiable risk factors.⁴ The pathophysiology of OA due to obesity is thought to have a metabolic and mechanical basis. The mechanical basis of this condition is brought about by an increase in the weight carried by the joint; a decrease in muscle power; and a biomechanical change. On the other hand, the metabolic basis is thought to involve adipokines (leptin, adiponectin, resistin) and cytokines (interleukin, tumor necrosis factor). Currently, fat tissue is considered as an endocrine organ that actively secretes adipokines and cytokines that play a role in the process of cartilage destruction, as well as the progression of OA.⁴⁻⁶

Fat tissue includes visceral fat and subcutaneous fat; both actively secrete adipokines and cytokines, though visceral fat secretes relatively higher amounts of these compounds. Therefore, in comparison, visceral fat is more metabolically active and more sensitive towards lipolytics than subcutaneous fat.^{7,8}

Several studies have demonstrated the association between excess fat and knee OA. For instance, Wang, et al⁹ reported that an increase in fat mass has a deleterious effect on joint cartilage among healthy individuals without knee OA. Another study by Berry, et al¹⁰ reported similar results, stating that an increase in fat mass causes

heightened risk of cartilage destruction. These studies report that fat mass causes destruction of cartilage but which type of body fat plays a more important role in OA, visceral fat or subcutaneous fat, is still unclear.

This research was designed to identify the correlation between body fat distribution and tibiofemoral medial joint width among knee OA patients.

METHODS

This is a cross sectional study with a consecutive sampling approach.

Subjects

Fifty six subjects (41 females and 15 males) were involved in this study. The inclusion criteria include knee OA patients with grade I obesity at the rheumatology, geriatric, and internal medicine clinic of FKUI/RSUPNCM. The exclusion criteria are: pregnant patients; patients with autoimmune disease, diabetes mellitus, chronic stage V kidney failure, stroke with extremity weakness; patients with history of trauma, heavy physical activity, and surgery around the knee.

Body Fat Distribution

Evaluation of body fat composition was performed using bioelectrical impedance analysis (BIA) and the Karada Scan HBF-375.

Tibiofemoral Joint Width

The width of the joint was measured by antero-posterior plain radiography of the knees in the standing position (weight bearing), with both knees completely extended. Following the examination, the file was input into the Picture Archiving and Communication System Software (PACS) in the computer. Joint width was measured using the same magnification for all patients.

Statistical Analysis

The correlation between body fat distribution and the tibiofemoral joint width was analyzed using the Spearman Correlation Test.

RESULTS

Research Subject characteristics

Among the 56 subjects involved in this study, 41 were women (73.2%). The age range of the subjects was 52 to 80 years old, and the median duration of knee OA disease was 24 months (3 – 120). Furthermore, the median time in the obese condition was 10 years (2 – 20); the median visceral fat was 12% (7.5 – 16.5), whereas the median subcutaneous fat was 30.2% (16.5 – 37.9); and the median visceral/subcutaneous fat ratio was 0.40 (0.26 – 0.80). Tibiofemoral joint width measurement was done as a surrogate marker for cartilage thickness. The average distance obtained was 2.34 mm (SD 0.78).

The research subject characteristics can be seen in Table 1.

Table 1. Research subject characteristics

| Characteristic | Result N=56 |
|--------------------------------------|--------------------|
| Gender | |
| Male, n (%) | 15 (26.8 %) |
| Female, n (%) | 41 (73.2 %) |
| Age (years) | 69.30 ± 5.56* |
| BMI (kg/m ²) | 27.47 (25-29.9)** |
| History of obesity (years) | 10 (2-20)** |
| Duration of knee OA disease (Months) | 24 (3-120)** |
| Visceral fat mass (%) | 12 (7.5-16.5)** |
| Subcutaneous fat mass (%) | 30.2 (16.5-37.9)** |
| Visceral/subcutaneous fat ratio | 0.40 (0.26-0.80)** |
| Medial tibiofemoral joint width (mm) | 2.34 ± 0.78* |

* :Mean±SD; ** :median (range)

Correlation Analysis

The correlation analysis between body fat distribution and joint width in this research was done using the Spearman test, as the data was not normally distributed. Results of the correlation test are presented in Table 3.

Table 2. Correlation Body Fat Distribution and Medial Tibiofemoral Joint Width

| Variable | r | P |
|---|--------|---------|
| Visceral – medial Tibiofemoral | -0.474 | < 0.001 |
| Subcutaneous – medial Tibiofemoral | -0.187 | 0.169 |
| Visceral/subcutaneous ratio – medial tibiofemoral | -0.225 | 0.090 |

DISCUSSION

Average age of the subjects in this study was 69.3 years (SD 5.56). The results found in this study are similar to those reported by previous research which show that knee OA is found primarily in individuals > 60 years old.^{11,12} The female gender is more dominant, making up 73.2% of the research subjects, compared to number of male subjects. This finding is also similar to the reports found in the existing literature.^{11, 13-15} An increase in OA prevalence among women after menopause is thought to be the effect of the hormonal changes that occur. A decrease in the level of estrogen that occurs in women after menopause play an important role in the development of OA. This finding is in accordance with the study reported by Mahajan, et al¹⁶ that reported an acceleration in the degradation and erosion of joint cartilages in female rats that underwent ovariectomy, though further research is required to confirm this finding.

In this study, the median duration of knee OA was 24 months (3 – 120) with 75% of the subjects having a history of knee OA ≥ 24 months. In general, the progression of knee OA is slow, taking up to several years. Conventional radiology is able to display any abnormalities 2 years after the beginning of the pathology.¹⁷

We found a moderate statistical correlation between visceral fat and the medial tibiofemoral joint width ($r: -0.474$, $p < 0.001$). Prior research, such as the one published by Sanghi, et al¹⁵ from India have reported similar results. Sanghi found a significant difference in the average WHR among second degree K-L OA and fourth degree K-L OA, with a higher WHR average found among the latter. Another research by Berry, et al¹⁴ reported that for every 1 kg increase in android fat, there is a correlated increase risk of tibiofemoral cartilage defects (OR 1.32; 95% CI: 1.04, 1.64; $P = 0.02$). Similarly, Sower, et al¹⁸ reported that for every increase in 1_{\log} of fat mass, there is an increased risk of tibiofemoral cartilage defects (OR 8.02; 95% CI: 2.1, 28.1; $P < 0.05$).

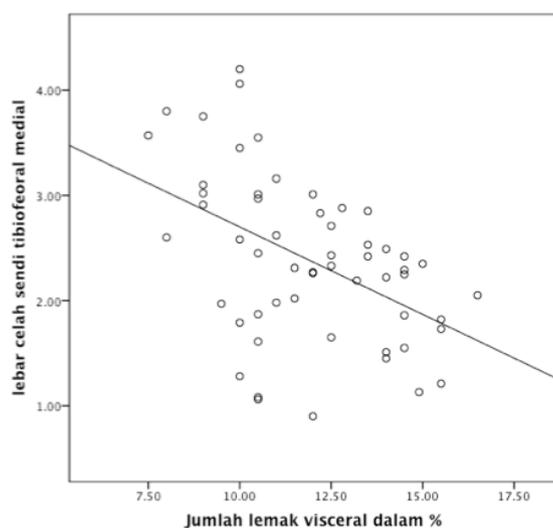


Figure 1. Correlation Distribution Diagram of Visceral Fat and Medial Tibiofemoral Joint Width

The results obtained in from this research is in accordance with the existing literature, showing that there is a correlation between visceral fat and medial tibiofemoral joint width as previous studies have suggested that visceral fat is more metabolically active and more sensitive towards lipolytics. Various cytokines, adipokines, and free fatty acids (FFA) is produced by visceral fat and directly enters the portal vein, thus bringing about a metabolic effect. Visceral fat secretes more IL-1, IL-6, TNF- α , MCP-1, and adipokines compared to subcutaneous fat. The additional cytokines and adipokines induces the expression of degradation enzymes such as MMPs and ADAMTs from chondrocytes and sinoviocytes at a higher rate, thus hastening the progression of OA.^{8,19}

There was no statistically significant correlation identified between subcutaneous fat and the medial tibiofemoral joint width.

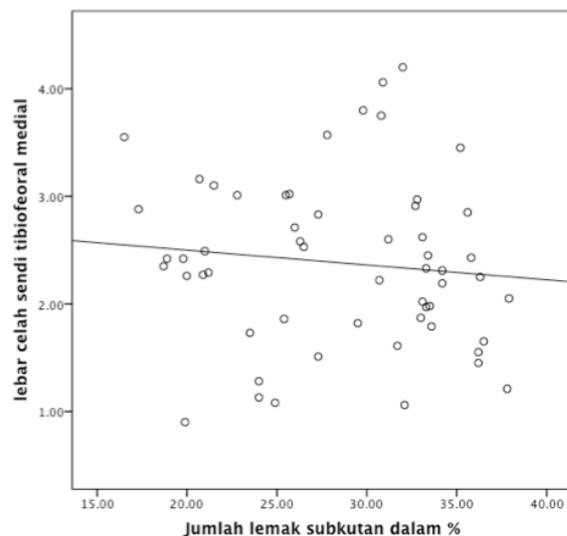


Figure 2. Correlation Distribution Diagram Of Subcutaneous Fat And Medial Tibiofemoral Joint Width Medial

The insignificant results found from this research may be attributed to subcutaneous fat being less sensitive towards the lipolytics, and the secretion of several proinflammatory cytokines (IL-6, IL-1, TNF- α , CRP) at a lower level compared to visceral fat, similar to the lesser amount of adipokine, such as adiponectin, secretion.^{8,19} Adiponectin serves as a proinflammatory factor at the joints, and this is associated with the degradation process matrix of the joints. Adiponectin affects chondrocytes by inducing NOS₂ through the PI3 kinase signaling pathway.²⁰

There was no statistically significant correlation identified between the visceral/subcutaneous fat ratio and the medial tibiofemoral joint width.

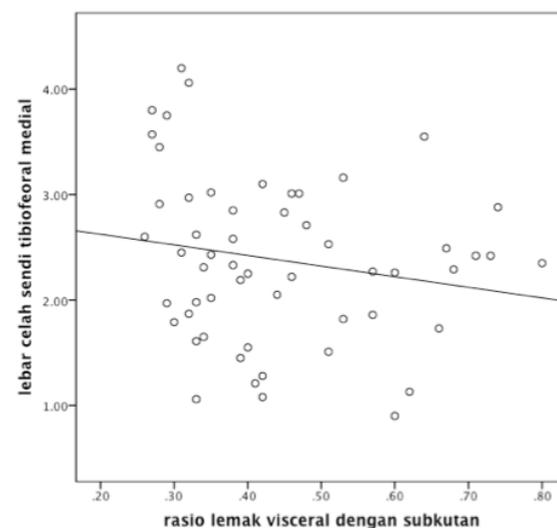


Figure 3. Correlation Distribution Diagram Of Subcutaneous/Visceral Fat Ratio And Medial Tibiofemoral Joint Width Medial

Analysis of the relationship between the visceral/subcutaneous fat ratio and knee OA has never been conducted. This ratio has been associated with a range of other chronic diseases such

as hypertension. In addition, it has also been linked to the an increase in the risk of other cardiometabolic conditions such as insulin resistance, diabetes mellitus, low HDL levels, and high triglyceride levels.²¹ Karrameita²² found a correlation ($r: 0.36$) between visceral/subcutaneous fat ratio and the systolic blood pressure.

CONCLUSION

Visceral fat is moderately, negatively correlated with the medial tibiofemoral joint width ($r: -0.474$ $p: < 0.001$). There was no correlation found between subcutaneous fat and the visceral/subcutaneous fat ratio with the medial tibiofemoral joint width.

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