

Risk factors of osteoarthritis that reduce the Steinbrocker's functional capacity of patients with osteoarthritis of the knee

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ABSTRACT

Objective. This study was implemented to determine the risk factors of osteoarthritis which potentially could reduce the Steinbrocker's functional capacity (SFC) of patients with osteoarthritis of the knee.

Method. In this cross sectional study, the cases were taken consecutively from the ambulatory patient with the osteoarthritis of the knee who visited the rheumatology clinic, Cipto Mangunkusumo Hospital. Subjects was interviewed to record the existing and severity risk factors using a structured questionnaire regarding their age, gender, duration of the illness pattern of smoking history of diabetes mellitus, menopause, body mass index (BMI), knee joint deformity, 15 meters walking time and Kellgren Lawrence radiologic index.

Results. One hundred thirteen cases of osteoarthritis of the knee were assigned to the study between July to December 1992, 24 patients were male and 89 were female. Eighteen patients were designated to SFC I, 77 patients to SFC II, 14 patients to SFC III and 4 patients to SFC IV. With the logistic regression analysis, it was found that the significant risk factors of developing SFC II, III and IV from patients of SFC I were being female and smoking. In the second logistic regression analysis we found that the significant risk factors for developing SFC III and IV from patients of SFC I and II were age and BMI.

Conclusion. In this study we have found that age, smoking, female genders, and BMI were the risk factors which potentially could reduce the SFC of patients with osteoarthritis of the knee.

Osteoarthritis (OA) is the most common joint disorder. Its cause and pathogenesis are still unknown and the course of the disease is slow and progressive. This disease usually occurs in the elderly and attacks fingers joint or weight bearing joint of the body. The knee joint is one of the weight bearing joint which often suffers OA.¹ Osteoarthritis of the knee is characterized by pain during movement which disappears with rest, joint stiffness especially after a long rest or after waking up, crepitation, and could be accompanied by synovitis with or without synovial fluid effusion. If the patient become physically inactive and does not willing to exercise, muscle atrophy will occur and worsen joint stability and function. Another consequence is the development of genu varum or genu valgum and subluxation, especially if there is a loosening of the ligament.^{2,3,4}

Several factors such as age, gender, obesity, race, and trauma are known to be the predisposing factors for the development of knee OA. Age is an important risk factor. A study conducted by Cushnagan and Dieppe found that the mean age of knee OA male patients is 59.7 years old and its peak is between 55 and 64 years of age while in women the mean age is 65.3 years old and its peak is between 65 and 74 years of age.¹ Felson et al., found that the number of patients of knee OA increased after the age of 65 years of old.⁵ Van Saase also found that the prevalence of radiographic OA increased in proportion to age in which radiographic severity reached 20%.⁶

Gender also plays a role in the development of OA. In the age group of below 45 years old, the rate of OA for both sexes is the same but in the age group of above 50 years old, the rate is higher in women.^{5,7} In a study conducted by Cushnagan involving 500 OA patients, 41.9% had knee OA in which the rate was higher in women than in men (1.3:1).¹ Forman also found that women and blacks had more severe knee OA than do men and Caucasians.⁸ Similarly, according to HANES I, the rate of OA is higher in women than in men, that is, 7.6% and 4.3% respectively.⁹

Obesity is accepted as a definite contributory factor to the development of knee OA. According to the Framingham study, there is a strong correlation between obesity and knee OA especially in female.¹⁰ In a study conducted by Cushnagan, most OA patients had a mean body weight above the normal weight.¹ Similarly, according to HANES I, there is a strong correlation between body weight and knee OA.⁹ Occupation and sports activities are also a predisposing factor for knee OA. According to HANES I, workers whose work puts much stress on the knees will be more at risk of suffering OA.⁹ Felson reported that smoking is associated with a lower OA risk. The protective factor of cigarette smoke is also associated with the amount of cigarettes smoked.¹¹ HANES I and Framingham study came up with similar results.^{9,10}

Of the above mentioned risk factors of developing OA, the factors that play a role in reducing the functional capacity in knee OA patients are not yet clear. Women and blacks suffer

more severe OA than do men and Caucasians as reported by Forman et al.⁸ A study of the other factors has not been conducted.

This study was conducted to find whether the risk factors of OA will affect the functional capacity of knee OA patients. We used the functional capacity classification criteria of Steinbrocker to evaluate the functional capacity of knee OA patients.

METHODS

This is a cross sectional study conducted from July to December 1992 at the Rheumatology Outpatient Unit of the Internal Medicine Department, Cipto Mangunkusumo Hospital, Jakarta. The subjects were all knee OA patients that did not have other types of disorders of the lower extremities who visited the Rheumatology Outpatient Unit of the Internal Medicine Department, Cipto Mangunkusumo Hospital. The Altman criteria were used for the diagnosis of knee OA which were presence of knee pain, osteophyte and one of the criteria: greater than 50 years of age, morning stiffness for less than 30 minutes, crepitus on active motion of the knee, bony tenderness, bony enlargement, and no palpable warmth.¹² A modified Steinbrocker's functional capacity (SFC) classification was used for scoring (evaluating) the functional capacity reduction:

- I. Has capacity to do normal activities including taking care of his/ her appearance.
- II. Can perform necessary normal activities and only has restricted capacity in some activities such as squatting. No assistive device is necessary for performing the daily activities.
- III. Can not perform most daily activities, including being self dependent. Assistive device is necessary for performing the daily activities such as walking cane.
- IV. Mobilization is restricted in bed or the wheel chair.

The exclusion criteria were: paralysis of the lower extremities, other types of arthritis of the knee, and arthritis of the other joints besides that of the knee joint.

RESULTS

Of the 113 knee OA cases that met the criteria, 24 were men and 89 were women. There were 18 patients designated to SFC I, 77 patients to SFC II, 14 patients to SFC III, and four patients to SFC IV. The ages ranged between 32 to 83 years old and the duration of illness was between one and 120 months. Of the 89 female patients, 71 were menopausal, 24 had diabetes mellitus, 28 had hypertension, and 20 were smokers. Based on the nutritional status, 43 patients were of normal weight, seven were overweight, and the rest were obese.

The correlation between the osteoarthritis risk factor and functional class

Gender

Of the 113 knee OA cases, 24 were men and 89 were women. Table 1 shows the patient distribution based on gender and functional class. It can be seen that the number of female patients is higher than that of male patients of the same SFC

with the exception of SFC IV in which the number is the same for both sexes. Using the chi square test, we found that there was a significant difference between the distribution of each sex in each SFC ($\chi^2 = 50.88$, $df 3$, $p = 0.0001$).

Table 1 Distribution of functional class based on gender

Functional class	Female	Male	Total
I	11	7	18
II	66	11	77
III	10	4	14
IV	2	2	4

Age

The mean age of all the patients studied was 56.48 years old with a median of 57 years old. The youngest patient was 32 years old and the oldest patient was 83 years old. Based on the functional class distribution, the mean age of the patients tend to be older in the higher classes. Using the ANOVA test, we found a significant difference in the distribution of mean age in each functional class ($F = 4$, $p = 0.04$). Using the Spearman Rank Order Correlation, we found a weak correlation between age and functional class ($r = 0.30$, $p < 0.00010$).

Duration of illness

The mean duration of illness of the OA patients in this study is 21.6 months with a median of 12.5 months. The higher functional class had a longer duration of illness. Despite the above, the ANOVA test showed no significant difference in the mean duration of illness in each functional class ($F = 2.29$, $p = 0.08$).

Menopause

Of the 89 female patients, 73 of them were already menopausal and 16 patients were not menopausal. The number of menopausal patients in each functional class was higher than that of non-menopausal patients. The chi square test showed a significant difference between the distribution of menopausal patients and non-menopausal patients ($\chi^2 = 44.744$, $df 3$, $p = 0.0001$).

Diabetes mellitus

Of the 113 patients that were in the study, 24 patients had diabetes mellitus and 89 patients did not have diabetes mellitus. The distribution of patients with diabetes mellitus can be seen in table 2. Using the chi square test, we found a significant difference in the distribution of diabetes mellitus patients in each of the functional class ($\chi^2 = 187,562$, $df 3$, $p < 0.0001$).

Table 2 Distribution of osteoarthritis patients with diabetes mellitus comorbidity based on the Steinbrocker's functional capacity

Functional class	Number of diabetes mellitus patients
I	3
II	16
III	4
IV	1
Total	24

Smoking

Of the 113 knee OA patients, 20 patients smoked in which seven patients were of SFC I, 10 patients were of SFC II, two patients were of SFC III and one patient was of SFC IV. Using the chi square test, we found a significant difference between the distribution of smokers and non smokers in each of the functional class ($\chi^2 = 381.186$, $df 3$, $p < 0.0001$).

Body Mass Index

The mean body mass index (BMI) of all the patients studied was 26.6. The lowest BMI was 14.2 and the highest BMI was 45.9. Using the ANOVA test, we found that there was no significant difference in the distribution of mean BMI ($F = 0.78$, $p = 0.5$).

Correlation between changes caused by knee osteoarthritis and functional class

Joint Effusion

Of the 113 patients included in the study, only three patients had joint effusion in which two of them were of SFC II and one of them was in SFC III. Using the chi square test, we found significant difference in the distribution of patients that had joint effusion in each functional class.

Knee joint deformity

Of the 113 patients included in the study, 27 patients had valgus or varus deformity of the knee. The more severe the functional class, the higher the percentage of patients with deformity. Using the chi square test, we found a significant difference in the distribution of patients with knee joint deformity in each functional class ($\chi^2 = 23.74$, $df 3$, $p = 0.0006$). Using the Spearman Rank Order Correlation, we found a weak correlation between knee joint deformity and functional class ($r = 0.38$, $p < 0.001$).

Correlation between radiographic image (Kellgren Lawrence Index) and functional class

Table 3 shows that the distribution of each Kellgren Lawrence Index is significantly different in each functional class ($\chi^2 = 36.306$, $df 6$, $p = 0.0001$). Using the Spearman Rank Order Correlation, we found a weak correlation between the Kellgren Lawrence Index and functional class ($r = 0.445$, $p < 0.001$).

Table 3 Distribution of Kellgren Lawrence Index in each of the functional class of knee osteoarthritis patients

Class	Kellgren Lawrence Index			
	1	2	3	4
I	16 (14.16%)	2 (1.76%)	-	-
II	67 (59.29%)	9 (7.97%)	1 (0.88%)	-
III	3 (2.65%)	11 (9.72%)	-	-
IV	1 (0.88%)	3 (2.65%)	-	-
Total	87 (76.99%)	25 (22.13%)	1 (0.88%)	-

Time needed to walk 15 meters

The longer the mean time needed to walk 15 meters, the higher the functional class was. In functional class IV, the time needed to walk 15 meters could not even be measured. Using

the ANOVA test of the classes whose time can be measured, we found that the distribution of the mean time needed to walk 15 meters is significantly different in each functional class ($F = 66.7$, $p < 0.0001$). Using the Spearman Rank Order Correlation, we found no correlation between the time needed to walk 15 meters and the functional class ($r = 0.05$, $p < 0.0001$).

Logistic regression analysis

Using logistic regression analysis, we could find the risk factors of developing to SFC II, III, and IV from SFC I in knee OA patients. In this analysis, SFC II, III, and IV were combined to obtain the variable of patients without reduced functional capacity (SFC I) and patients with reduced functional capacity (SFC II, III, and IV). Because the number of SFC III and IV cases was very few compared to the number of SFC I and II cases so that it would make the analysis using logistic regression more difficult, the combining was necessary. From the result of the logistic regression analysis, the variables that are significant as the risk factors for developing to SFC II, III, and IV in knee OA patients without reduced functional capacity (SFC I) were female gender and non smokers. Female knee OA patients have 3 times the risk of developing reduced functional capacity than do the male patients. The non smoking knee OA patients have 2.1 times the risk of developing reduced functional capacity than do smoking patients.

To obtain the risk factor of reduced functional capacity in knee OA patients needing assistive device, we combined the SFC I with SFC II cases (cases that did not need assistive device) and combined the SFC III and SFC IV cases (cases that needed assistive device). With this combining, we found the risk factors of functional capacity disorder needing assistive device were age and BMI. Those who are above the age of 55 years have 2.5 times the risk of developing functional capacity disorder needing assistive device. Those with a BMI of more than 25 have 2.5 times the risk then those with a BMI of less than 25.

DISCUSSION

The role of age in reduced functional capacity in knee osteoarthritis patients

In this study we found the distribution of age in knee OA patients is significantly different in each functional class. The result of logistic regression analysis showed that age is a risk factor in functional capacity disorder needing assistive device (class III and IV).

The study conducted by Cushnagan and Dieppe found that age is a knee OA risk factor, but it has never been reported that age is a risk factor in reduced functional capacity.¹ Felson and Van Saase reported that with the increase in age, the radiographic OA was more severe. However, there was no further explanation on how the clinical picture was.^{5,6} The correlation between OA and age is still unclear. Although cartilage changes occur in line with age, these changes are not found in the early stage of OA. There are also alteration in the blood vessels of the joint that reduce the blood circulation in the affected joint. Therefore, repair response of the cartilage will be disrupted.^{2,3}

The role of gender in reduced functional capacity in knee osteoarthritis patients

In this study we found a difference in distribution of male and female knee OA patients in each functional class. Using the logistic regression analysis we found that women have a higher risk in developing reduced functional capacity than do men. This is similar with the result of study conducted by Cushnagan, Forman, Waldron, and HANES I.^{1, 8, 9, 13}

The role of obesity in reduced functional capacity in knee osteoarthritis patients

Another factor that plays a role in the development of knee OA is obesity. The BMI was used to evaluate the degree of obesity. The recommended classifications for BMI adopted by the National Institute of Health (NIH) and World Health Organization (WHO) are:

1. Underweight : BMI < 18.5 kg/m²
2. Normal weight : BMI ≥ 18.5 to 24.9 kg/m²
3. Overweight : BMI ≥ 25.0 to 29.9 kg/m²
4. Class I obesity : BMI = 30.0 to 34.9 kg/m²
5. Class II obesity : BMI = 35.0 to 39.9 kg/m²
6. Class III obesity : BMI ≥ 40 kg/m². This type of obesity is also referred to as severe, extreme, or morbid obesity.

The definition of overweight and obesity varies by race. The WHO and NIH Guidelines are currently applied to whites, Hispanics, and blacks. For Asians, overweight is a BMI between 23 and 29.9 kg/m² and obesity a BMI > 30 kg/m².^{14, 15}

The result in this study showed that the distribution of BMI in each functional class was not significantly different. Logistic regression analysis showed that BMI was a risk factor in reduced functional capacity in knee OA patients needing assistive device (SFC III and IV). This was similar to the result of previous studies that there was a strong correlation between obesity and knee OA.^{1, 9, 10, 16}

According to a study conducted by Silberger, the obesity factor is not only seen from the biomechanical aspect but is also seen from the metabolic aspect.¹⁷ The number of knee OA cases in mice on a saturated fatty acid diet was higher than that in mice on an unsaturated fatty acid diet.

Maquet tried to explain the biomechanical aspect of the stress received by the knee in obesity. In normal condition, the force of the body weight passes through the medial knee joint and is balanced by the muscles of the central part of the knee joint. In obesity, the force resultant shifts towards the median so that the load distribution in the knee becomes unbalanced. In severe cases, varus malalignment can occur that can even shift the force resultant further towards the median.¹⁸

In this study, we found 11 obese patients that had knee deformity and patients with this knee deformity tend to be in the higher functional class.

The role of smoking in reduced functional capacity in knee osteoarthritis patients

In this study we found a significant difference between distribution of smokers and non smokers in each of the knee OA functional class. In the logistic regression analysis, we also found that smokers had only 0.45 times the risk of developing reduced functional capacity when compared to smokers.

This is similar to the results Framingham study, HANES I and Felson.^{9, 10, 11} The correlation between smoking and the low prevalence of knee OA cannot be clearly explained until today.

According to Felson, the mean body weight of smokers was lower than that of non smokers. Therefore, it was assumed that the body weight was the one that played the role. However, Felson was hesitant in corroborating this.¹¹

In this study, there were 20 smokers that included eight women and 12 men. The number of female non-smokers was much higher than the number of male smokers. It was possible that this was one reason the non smokers had more severe OA than the smokers.

The role of menopause in reduced functional capacity in knee osteoarthritis patients

In this study we found a significant difference in the distribution of menopausal women and non menopausal women in each of the knee OA functional class. However, according to the logistic regression analysis, menopause was not a risk factor for reduced functional capacity in knee OA patients. There was a possibility that the difference in distribution is influenced by the confounding variables (age and gender).

The role of diabetes mellitus in reduced functional capacity in knee osteoarthritis patients

Metabolic factor such as diabetes mellitus is also reported to be a predisposing factor in OA.^{2, 3} In this study we obtained 24 diabetes mellitus patients of the 113 cases studied. Using the chi square test, we found a significant difference in the distribution of diabetes mellitus patients in each functional class. However, from the logistic regression analysis, we did not find that it was a risk factor in reduced functional capacity class II, III, and IV in knee OA patients.

This was not similar with the result of the study conducted by Kalim that found the proportion of severe radiographic knee OA patients was higher in diabetes mellitus patients than that in non diabetes mellitus patients.¹⁹

The correlation between radiographic appearance and functional class in knee osteoarthritis patients

In this study we found 85 patients that met the Kellgren Lawrence criteria grade I. Twenty were in grade II and one was in grade III. The distribution of patients in each grade was different in each functional class. However, using the Spearman Rank Order Correlation, we only found a weak correlation between the Kellgren Lawrence index and functional class. This was different from the study conducted by Claessens et al that reported a positive correlation between knee OA clinical picture and radiographic appearance.²⁰ In his study, Dougados reported that there was clinical and radiographic improvement during evaluation a year after treatment.¹⁶ To evaluate the progression of knee OA, Altman suggested the patient to be in standing up position when taking the knee OA radiograph so it would narrow the joint space. With this position, osteophyte, and sclerosis in the medial and lateral part of the knee joint could be evaluated.²¹

The logistic regression analysis was not done because the

variable was not a risk factor of OA.

The role of daily activity in reduced functional capacity of knee osteoarthritis patients

Occupations and sports activities are also a predisposing factor of knee OA. In this study, occupations and sports activities were not analysed further because it was difficult to determine the mechanical stress on the knee joint in the cases studied. In addition, there was not any patient who exercised regularly.

CONCLUSION

The study showed that being female and non smokers were risk factors for the development of functional class II, III, and IV. The female gender had three times the risk of developing reduced functional capacity than did the male gender. Knee OA patients who were smokers had 2.1 times the risk of developing functional capacity than did knee OA patients who were non smokers.

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