The Risk Factors Effect of Knee Osteoarthritis Towards Postural Lateral Sway

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Abstract

Background: Osteoarthritis (OA) is the main cause of impairment and disability in elderly. Patient with OA experience progressive functional impairment shown in increasing dependence on walking, using stairs and etc. Patients with OA experience increased static postural sway in the lateral and anteroposterior due to several factors.

Objective: This study aims to analize the risk factors of knee osteoarthritis on postural lateral sway.

Method: This research is a cross sectional study. The severity of the respondents' knee OA, unilateral/ bilateral, dominant side, knee joint alignment, body mass index (BMI), and postural lateral sway were measured with Gait Analyzer Peak Motus 2000, and their quadriceps muscle activity was assessed with Myomed. Respondents involved in this study were 38 elderly with unilateral or bilateral knee OA stage 1 until 3 based on the criteria of Kellgren & Lawrence. The data were analyzed with multiple linear regression.

Results: The results showed that postural lateral sway was 2.23±0.59 cm. BMI, dominant side, OA types, OA severity, Quadriceps angle, and tibio-fibular angle (TFA) were found with the *p* value = 0.421, 0.599, 0.780, 0.913, 0.596, and 0.984 respectively. The Visual Analogue Scale (VAS) variable was R Square = 0.291, *p* = 0.001, Y = 0.3096 and X = 0.9393.

Conclusion: Pain is the strongest predictor factor of postural lateral sway disturbances in patients with knee OA.

Keywords: *osteoarthritis, postural lateral sway, pain.*

Introduction

Osteoarthritis (OA) is known as degenerative joint disease that is considered to be the most common form of arthritis. The characteristics of OA include joint and bone damage followed by the formation of new bone on the joint surface[1]. The common types of joints that tend to experience OA are knee, pelvis, hand, and spine joint. The incidence of knee OA is 240 per 100.000 individuals per year. In Indonesia, the prevalence of osteoarthritis is 5% in individuals aged <40 years old, 30% in individuals aged 40-60 years old, and 65% in individuals aged >61 years old. The prevalence of knee OA is deemed high, which is 15.5% in males and 12.7% in females[2]. The risk factors of OA are genetic, age, gender, ethnicity, obesity, occupation, muscle weakness, and biomechanics [3,4].

The elderly patients with OA will experience an increased postural sway if the gravitation center shifts from the center of the body. Proprioceptive suboptimal limbs cause the increase of the received force to be transmitted to the hip and knee. If it repetitively happens, the force triggers the occurrence of OA [3]. Patients with knee OA encounter increased static postural sway in the lateral and anteroposterior, decreased knee proprioception, and decreased maximal voluntary contraction and quadriceps muscle activation

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compared to control group in the same age group. The most influential factor of OA in postural sway is the severity of pain[5,6]. Other factors are age, gender, knee joint stiffness, and maximal walking speed [7].

This study intended to investigate the factors that are related to the knee OA cases such as the severity of knee OA, unilateral and bilateral knee OA, the dominant side of knee, knee joint alignment (TFA and Q angle), BMI, pain, and quadriceps muscle activity towards the incidence of postural sway in patients with knee OA.

Method

This study applied cross sectional and observational analytic design and was conducted on January until April 2012, in which the sample was collected using consecutive sampling. The criteria of knee osteoarthritis diagnosis are based on the guidelines set by the American College of Rheumatology (ACR). There were 38 samples that fulfilled the inclusion criteria including: (1) Patients with unilateral or bilateral knee OA stage 1 until 3 based on the criteria of Kellgren & Lawrence; (2) Aged 40-65 years old; (3) No limited range of motion of the lower limb member joints; (4) understand and follow the examination conditions; (5) Able to ambulate independently without ambulatory aids; (6) willing to participate in the study.

Measurements on the knee OA severity to decide whether it was unilateral or bilateral, dominant side of the body, knee joint alignment, and body mass index were conducted using Gait Analyzer Peak Motus 2000 to measure postural lateral sway while the quadriceps muscle activity was measured by Myomed equipment. The data were analyzed with multiple linear regression by using SPSS program for Windows (SPSS, Chicago, IL, USA).

Results

The result of sample measurement in this study revealed that knee OA mostly occurred in 41-65 year-old patients and the average stage was 58.03 years old and the SD was 5.635. The postural sway in the subjects was measured by using the equipment of Gait Analyzer with Peak Motus 2000 program. The measurement of postural sway was in the form of shifting center of body mass toward lateral (Table 1). The postural lateral sway was 1.25 cm until 3.37 cm with the average of 2.23 cm and SD of 0.59. The results of Kolmogorov–Smirnov test found the significance value of 0.468. The data of postural sway was considered normally distributed. Afterwards, the regression test was performed.

Table 1. The Result of Sample Measurements

Descriptions	Results	Mean	Standard Deviation
Age (years)	41-65	58.03	5.635
Postural sway (cm)	1.25-3.37	2.23	0.59
Body Mass Index (kg/m2)	19.14-34.17	26.7	3.728
Visual Analogue Scale	3-7	4.16	1.027
Quadriceps Angle (o)	5-20	13.55	4.032
Tibio-femoral angle (o)	160-190	172.97	6.883
Max Vastus medial scale amplitude	36-400	95.39	60.102
Max vastus lateralis amplitude	45-307	94.03	51.78
Average vastus medial oblique amplitude	12-114	43.68	17.996

Cont... **Table 1. The Result of Sample Measurements**

Average vastus lateralis amplitude	21-98	41.84	18.306
Power vastus medial oblique	969-8868	3410	1398.7
Power vastus lateralis	1614-7628	3260	1420
Average vastus medial oblique - vastus lateralis amplitude ration (%)	54.55-214.29	110.02	34.42
Max vastus medial oblique - vastus lateralis amplitude ratio (%)	64.06-151.11	103.9524	24.39
Vastus medial oblique - vastus lateralis power ratio (%)	55.28-216.05	110.31	34.67
Vastus medial oblique - vastus lateralis activation latent (second)	-2 to 1	-0.037	0.714

The result of pain and postural sway measurement based gender and OA characteristics with p = 0.05 showed statistically insignificant variable (Table 2). Most samples (33 individuals or 86.8%) are categorized in the overweight and obesity group based on the Asian scale of body mass index (Table 3). Another study regarding OA in Indonesia revealed that most OA patients (74.7%) had BMI more than 23, which is considered to be overweight 8. To add, a stud conducted in Malaysia showed that people with obesity likely experience osteoarthritis 9.

Table 2. The result of pain and postural sway measurement based on gender and knee OA characteristics

Descriptions		**Average VAS**	**Average postural sway**	**P value**
Gender	Male	4.3	2.75 cm	0.016
	Female	4.1	2.13 cm	
Osteoarthritis types	Unilateral	4.18	2.19 cm	0.857
	Bilateral	4.15	2.24 cm	
Osteoarthritis sides	Dominant	4.1	2.21 cm	0.628
	Non-dominant	4.2	2.35 cm	
Osteoarthritis severity	Stage 1	4.5	2.09 cm	0.863
	Stage 2	3.9	2.18 cm	
	Stage 3	4.3	2.27 cm	

The coefficient table (Table 4) was drawn to discern the role of each predictor (beta) and see if any predictor was significant in predicting DV (t value). Afterwards, the multiple linier regression analysis was conducted based on the method. According to pain variable, VAS had the square R value of 0.291 and the significance value of 0.0001. It can be seen that the variable was significant in predicting the postural sway (table 4).

Table 3. The result of VAS and postural sway measurement based on body mass index

Body Mass Index	N	Average Visual Analogue Scale	Average postural sway	Statistical analysis
Normal	5	4	1.79 cm	F = 1.707 Sig = 0.196
Overweight	9	3.7	2.23 cm	
Obese	24	4.3	2.31 cm	

Table 4. The effect of variables in predicting the value of postural sway

Variables	Beta	t	Sig
BMI	0.264	0.821	0.421
Dominant side of Osteoarthritis	-0.142	-0.534	0.599
Osteoarthritis types	-0.075	-0.283	0.780
Osteoarthritis severity	0.021	0.111	0.913
Visual Analogue Scale	0.376	1.766	0.092
Quadriceps Angle	0.099	0.539	0.596
Tibio-femoral angle	-0.004	-0.020	0.984
Vastus medial oblique - vastus lateralis ratio	1.783	0,360	0,722
Different latent of Vastus medial oblique - vastus lateralis	-0.208	-0,956	0,350
Stepwise method	Criteria 0.05 – 0.1 → VAS R Square = 0.291 Sig 0.0001		

Discussions

From the result of the multiple linier regressions based on the enter method, it was revealed that the pain scale is the most influential factor towards the increase of postural sway in the study sample. The pain can alter the patient's walking pattern, in which there is an unequal gait parameter between the pain in the form of a shorter stance phase. The restriction of joint motion and less muscle contraction in the location of the pain can affect the magnitude of the postural lateral sway[10]. Another variable that was investigated in the study showed the significant result with the p value of p = 0,238; however, it has a pivotal role in the case of postural sway.

This study found that the postural sway value ranged from1.25-3.37 cm, with the average value of 2.23 cm. The observation in normal subjects using similar equipment and measurement method showed that postural lateral sway ranged from 1-2.5 cm with the average of 1.86 cm. In the comparison among normal individuals, there was a statistically significant difference measured by t test (p = 0,03). Another study in Indonesia revealed that the average postural sway in knee OA patients using posturography equipment was 2.32 cm [8]. Despite employing different equipment, the result was quite similar with our study with the average postural lateral sway of 2.23 cm. This is due to the similarity between the basic characteristics of the study sample. Body mass index had weak positive correlation in predicting the postural sway with the correlation value of 0.112.

The femoral shaft walks slightly to the medial towards the knee. The oblique orientation occurred due to the inclination angle of 125^o in femoral proximal. The joints of the proximal tibia are horizontally oriented; thus, the angle is formed (tibio-femoral angle/TFA) from the lateral side of 170 until 175^o. The large angle formed by the pull of quadriceps is called a quadriceps angle or Q-angle. This angle is formed by (1) a line describing the resultant force of the quadriceps, formed by the point on the anterior superior iliac spine (SIAS) to the midpoint of the patella, and (2) the line connecting the tibia tuberosity and the center line of the patella [11]. The increase of TFA and femoral anteversion angle is a predictor factor for the increase of Q-angle [12]. The knee joint efficacy assessed with Q angle and TFA did not show any significant results in this study to predict the increase of postural sway with $p = 0.596$ for Q angle and $p = 0.984$ for TFA. This result is possible because of the relatively normal knee joint sessions in the study sample, in which the mean Q angle of 13.55 and the mean TFA of 172.97 are included in the normal range.

In other studies observing postural sway isometrically, it revealed that the activation and quadriceps muscle strength had significant correlation with the increased postural sway cases in patients with knee OA [13]. However, different results of other studies are because most patients have obtained muscle quadriceps exercise program; thus, the activity of quadriceps muscle is improved. It can be discerned from the measurement results: the average VMO amplitude ratio towards VL was 110.02 and the average difference of VMO muscle latency towards VL was 0.037 second.

Due to the limitation of the sample with OA stage I, there is a possibility in error on the withdrawal of conclusions from the statistical analysis. Furthermore, there was no measurement in patients' balance and questionnaire regarding the functional condition. Therefore, the effect of postural sway towards functional condition and patients' balance in daily activity cannot be investigated.

Conclusion

Pain is the most influence of postural lateral sway in patients with knee OA. Other variables such as body mass index, OA types (unilateral/bilateral), dominant side of the limb with knee OA, knee joint, and quadriceps muscle activity have weak correlations and have no statistically significant effect.

Ethical Clearance: The study protocol was approved by the Ethical Commission to conduct basic science/clinical research in Dr. Soetomo General Hospital Surabaya, Indonesia. The present study was carried out in accordance with the research principles. This study implemented the basic principle ethics of respect, beneficence, non-maleficence, and justice.

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References

1. Klippel JH, Stone JH, White PH. Primer on the rheumatic diseases. Springer Science & Business Media; 2008.
2. Sudoyo AW, Setiyohadi B, Alwi I, Simadibrata M, Setiati S. Buku ajar ilmu penyakit dalam. Jakarta Fkui. 2006;400–11.
3. Kelly BM. DeLisa's Physical Medicine & Rehabilitation: Principles and Practice. JAMA. 2011;306(2):214–5.
4. Sharma L, Berenbaum F. Osteoarthritis: a companion to rheumatology. Elsevier health sciences; 2007.
5. Hassan BS, Doherty SA, Mockett S, Doherty M. Effect of pain reduction on postural sway, proprioception, and quadriceps strength in subjects with knee osteoarthritis. Ann Rheum Dis. 2002;61(5):422–8.
6. Kean CO, Birmingham TB, Garland SJ, Bryant DM, Giffin JR. Minimal detectable change in quadriceps strength and voluntary muscle activation in patients with knee osteoarthritis. Arch Phys Med Rehabil. 2010;91(9):1447–51.
7. van der Esch M, Steultjens MPM, Harlaar J, van den Noort JC, Knol DL, Dekker J. Lateral trunk motion and knee pain in osteoarthritis of the knee: a cross-sectional study. BMC Musculoskelet Disord. 2011;12(1):141.
8. Tarigan TJ, Kasjmir YI, Atmakusuma D, Lydia A, Bashiruddin J, Kusumawijaya K, et al. The degree of radiographic abnormalities and postural instability in patients with knee osteoarthritis. Acta Med Indones. 2009;41(1):15–9.
9. Afolabi HA, Zakaria Z bin, Hashim MNM, Vinayak CR, Ahmed Shokri A Bin. Body Mass Index and

predisposition of patients to knee osteoarthritis. Obes Med. 2019 Dec;16(September):100143.

10. Basmajian J V. Therapeutic exercise. Williams & Wilkins; 1978.
11. Neumann DA. Kinesiology of the musculoskeletal system-e-book: foundations for rehabilitation. Elsevier Health Sciences; 2013.
12. Nguyen A-D, Boling MC, Levine B, Shultz SJ. Relationships between lower extremity alignment and the quadriceps angle. Clin J Sport Med Off J Can Acad Sport Med. 2009;19(3):201.
13. Hassan BS, Mockett S, Doherty M. Static postural sway, proprioception, and maximal voluntary quadriceps contraction in patients with knee osteoarthritis and normal control subjects. Ann Rheum Dis. 2001;60(6):612–8.