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Accelerometric assessment of physical performance during the sit-to-stand test in knee osteoarthritis: A cross-sectional study

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Abstract

Introduction: Knee osteoarthritis is the most common rheumatic disease, which causes functional disability and impairment in quality of life. The aim of this study was to evaluate physical performance in knee osteoarthritis by clinical tests and accelerometer measurements and analyze factors associated with physical performance alteration.

Methods: This is a cross-sectional study, included 40 women with knee osteoarthritis. All participants were instructed to perform sit-to-stand transfers during 30 seconds. We measured the speed, force and muscular power of the lower limbs during this test using the Myotest PRO® accelerometer. A correlation analysis was performed in search of factors associated with physical performance alteration.

Results: The median speed during the sit-to-stand test was 4.3 [3.1-6.2] cm/sec. The median muscular force and power during this test were 15.2 [13.6-17.7] Nm/kg and 14.5 [9.9-21.7] W/kg respectively. Body mass index (BMI) correlated negatively with the 3 parameters of physical performance measured by the Myotest PRO® accelerometer (speed, force and muscular power) during the sit-to-stand test.

Conclusions: This pilot study assessed the physical performance of the lower limbs in knee osteoarthritis subjects, by measuring the speed, force and muscle power during the sit-to-stand test. It suggests an association between obesity and physical performance impairment.

Keywords: knee Osteoarthritis; Physical performance; Sit-to-stand test; Accelerometer.

1. Introduction

Osteoarthritis (OA) is the most common rheumatic disease, that affects the entire joint structure resulting in pain, stiffness and loss of function.[1,2] Most often, OA affects weight-bearing joints such as the knee, which causes functional disability and impairment in quality of life.[1]

Daily tasks, such as using stairs and getting up from a chair are linked with the lower limbs physical performance.[3] Patients with knee OA have difficulty in performing their daily activities, which can negatively affect their

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independence.[4] These patients have reduced physical performance which can be attributed to joint pain, stiffness, deformity and loss of muscular strength of the lower limbs.[5,6]

The muscular impairments of the lower limbs in patients with knee OA are well documented in the literature.[7,8] Isokinetic dynamometry is usually used to test the performance of the lower limb muscles, the quadriceps in particular.[9,10]

In order to assess the strength of the lower limbs in knee OA, the sit-to-stand test (STS) is a valid clinical test, frequently used in clinical practice.[11-13] This requires muscular force to accelerate/decelerate the body's mass against the gravitational pull.

The Myotest PRO® is a lightweight portable accelerometer, it's accompanied by PC software offering the possibility of professional biomechanical analyses of all types of muscular activity measured with the Myotest. This device is most often used in sports, which enables the muscular performance of an athlete to be measured quickly and easily. This accelerometer can measure force and power production in the squat and bench press exercises, as well as the jump height.[14-16] However, no study has yet used the Myotest PRO® to evaluate physical performance in knee OA.

The aim of this study is to assess physical performance in knee OA using the Myotest PRO® during the STS test and to analyze the factors associated with impaired physical performance. We hypothesized that an association between physical performance parameters and clinical measures of knee OA should be observed.

2. Materials and methods

2.1. Subjects

This is a cross-sectional study, which consecutively included 40 patients with knee OA followed in consultation at El Ayachi Hospital in Salé, an institution of Ibn Sina university hospital center, Rabat, Morocco, specialized in rheumatic diseases and reeducation. All patients gave their consent to participate in this study.

This study included patients over 50 years, suffering from symptomatic knee OA, with a radiography grade ≥ 1 according to the KL (Kellgren-Lawrence) classification, uni or bilateral. Patients using walking aids, with a history of knee surgery, suffering from other rheumatic diseases, or pathologies that could affect their balance or movement (myopathies, neurological and cardiovascular diseases) were excluded.

2.2. Intervention

Socio-demographic and anthropometric data of patients were collected (age, gender, level of education, profession, body mass index (BMI)). The body composition of the participants was assessed by impedancemetry using the Tanita BC 420 MA S. This is an easy, non-invasive measurement of body fat percentage.

The level of physical activity was assessed by the short Arabic version of the International Physical Activity Questionnaire (IPAQ), which evaluates the duration of physical activities of variable intensity during the last 7 days. An average score was calculated and expressed in MET-min/week, then the patients were classified into 3 groups: low physical activity, moderate activity, high activity.

The 0-10 cm Visual Analog Scale (VAS) was used to quantify the combined pain of both knees. The functional impact of knee OA was assessed by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Lequesne index.

The TUG (Timed up and Go) test was conducted for all participants to assess their balance and gait. They were asked to get up from the chair, walk a distance of 3 meters, turn around and return to the chair and then sit down. The test execution time was measured using a stopwatch (a normal execution time is between 12 and 20 seconds).

All participants underwent a radiography examination of both knees using an anterior-posterior view in weight-bearing, the stage of internal and/or external tibiofemoral knee OA according to the K/ L classification for the knee(s) was noted. For patients with different stages in both knees, the most advanced grade was taken as the basis for evaluation.

2.3. STS measurement

Participants performed an STS test for 30 seconds, the Myotest PRO® was used to assess the physical performance of the lower limb muscles (Figure 1). Weight, height, and gender of the participant were indicated in this accelerometer, which made it possible to calculate speed (cm/sec), force (N/kg) and muscular power (W/kg) of the lower limbs during the transition from sitting to standing position.

Figure 1 Myotest PRO® accelerometer

The subject sat on a chair with no backrest, armrests, and wheels, the chair height set to give both knee angles 90° of flexion **(Figure 2).** The patient holds the Myotest® with both hands resting against the sternum in order to have the most vertical accelerometer trajectory possible, this position of the arms removes any help from the upper limbs in the act of standing up.

The device emits a beep after one second of immobility in the seated position, this beep warns the patient that he can perform a sit-stand phase. At each beep, the patient must get up from the chair quickly and powerfully, then sit down, repeatedly for 30 seconds. Hence, at the end of the test, the following three parameters were noted for each patient: speed of execution of the movement, force and muscular power of the lower limbs.

Figure 2 Positions of patient during the STS test

2.4. Statistical analysis

Statistical analysis was performed using SPSS software version 24. The data were represented as mean and standard deviation or median and quartile using descriptive statistics, meanwhile, the qualitative variables were represented in percentages.

The correlations analysis between the parameters of the Myotest PRO®, the characteristics of the patients, and their knee OA was examined using the Spearman test. The level of statistical significance was set at $p < 0.05$.

3. Results

3.1. Characteristics of patients and their knee OA

A total of 40 patients (100% female, mean age 57.6 ± 5.2 years) with knee OA were included in this study, the median duration of disease progression was 36 months [24-69]. Characteristics of the patients and their knee OA are shown in Table 1.

Table 1 Characteristics of the subjects (N=40)

Characteristics	Subject
Female (%)	100
Age* (years)	57.6 ± 5.2
Weight* (kg)	72.3 ± 11.9
Height* (cm)	156.3 ± 5.7
BMI* (Kg/m2)	29.6 ± 4.7
Excess fat mass (%)	65
IPAQ*(MET-min/semaine)	2988 ± 1459
VAS pain* (0-10 cm)	4.3 ± 0.8
WOMAC score**	30.5 [22-43]
Lequesne score**	8.6 [5.5-11]
TUG* (s)	13 ± 3.2
OA grade (K/L) :	
Grade 1 (%)	17.5
Grade 2 (%)	55
Grade 3 (%)	25
Grade 4 (%)	2.5
Bilateral knee OA (%)	80

BMI: Body masse index; IPAQ: International Physical Activity Questionnaire; VAS: Visual analogue scale; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; TUG: Timed up and go; OA: osteoarthritis; K/L: Kellgren / Lawrence.; * Values expressed as mean and standard deviation; ** Values expressed as median and quartile.

3.2. Parameters calculated using the Myotest PRO ®

The physical performance parameters calculated during the 30 seconds STS test are shown in Table 2.

Table 2 Parameters calculated using the Myotest PRO ®

Parameter	N=40
Speed (cm/s)**	4.3 [3.1-6.2]
Force (N/kg)**	15.2 [13.6-17.7]
Power (W/kg)**	14.5 [9.9-21.7]

** Values expressed as median and quartile.

3.3. Correlation between the parameters measured by the Myotest PRO®, characteristics of the patients and their knee OA

No correlation was found between the parameters of physical performance (speed, force and muscular power) and the characteristics of Knee OA (pain, WOMAC and Lequesne) (p>0.05). The analysis showed a negative correlation between the parameters of physical performance and BMI (p<0.05). The muscle force measured by the Myotest® correlated negatively with the percentage of fat mass (r=-0.435; p=0.005) (Table 3).

Table 3 Correlations (r) between the parameters measured by the Myotest PRO® and patients characteristics

	Speed		Force		Power	
	r	p	R	p	r	p
BMI	-0.357	**0.024***	-0.446	**0.004***	-0.382	**0.03***
% fat masse	-0.15	0.356	-0.435	**0.005***	-0.177	0.275
IPAQ	-0.16	0.324	-0.278	0.083	-0.168	0.3
VAS pain	0.161	0.32	-0.039	0.81	0.146	0.37
WOMAC	-0.024	0.885	-0.108	0.508	-0.049	0.764
Lequesne	-0.01	0.953	0.034	0.836	-0.03	0.856
TUG	0.001	0.993	-0.198	0.221	-0.01	0.951

BMI: Body masse index; IPAQ: International Physical Activity Questionnaire; VAS: Visual analogue scale; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; TUG: Timed up and go.*(r) Correlation coefficient; * Significant correlations with p<0.05*

4. Discussion

The aim of the current study was to evaluate physical performance in knee OA during the STS test and to analyze factors associated with physical performance alteration.

Several studies have evaluated physical performance in knee OA patients. The STS test is a valid clinical test, frequently used to assess the strength of the lower limb muscles in knee OA.[17,18] In addition, the quantification of this physical performance and, mainly, the strength of the quadricipital muscle is most often done by the isokinetic dynamometer.[7]

However, no study has yet quantified the physical performance of the lower limbs in knee OA patients using the Myotest PRO® accelerometer. This device is generally used in sports in the evaluation and monitoring of the motor performance of athletic gestures.

In this study, the Myotest PRO® was used to assess physical performance in knee OA patients, by measuring the speed of Chair Stand, force and muscular power of the lower limbs. This coupled assessment is feasible in daily practice since it requires a short time to perform it.

In the present study, no correlation was found between the parameters of physical performance measured by the Myotest PRO® and the characteristics of knee OA (pain, WOMAC and, Lequesne). We had presumed that patients with more symptomatic knee joint would have impairment of the physical performance, however, this was not confirmed by the results. Previous studies have reported the presence of an association between pain and functional impairment caused by knee osteoarthritis and impaired physical performance.[19-21] In this study, the absence of this link could be explained by the size of the sample and the absence of a control group.

In addition, two negative correlations were found: one between BMI and the three parameters of physical performance of the lower limbs; and the second between the percentage of fat mass measured by impedancemetry and the muscular force of the lower limbs. These results show that patients suffering from knee OA with a high BMI and a high percentage of body fat have impaired physical performance. This outcome is in agreement with a previous study, Verlaan et al [22] evaluated the physical performance of the knees during the STS test. They compared the physical performance between knee OA patients and a control group by analyzing the link with obesity; these authors found that obesity was associated with a decrease in physical performance in knee OA patients.

Since obesity itself can modulate movement patterns during the STS movement, it should not be overlooked in biomechanical analyzes.[23,24] According to Sibella et al., subjects with obesity tend to unload the lower back by transferring the load to their knees.[24] These difficulties encountered by individuals with obesity translate into a reorganization of the sit-stand transfer strategy. People with obesity adapt their movement strategy to the morphological constraints of their trunk. Thus, overweight can lead to a reduction in joint amplitudes, functional limitations, and therefore an alteration in physical performance. In this study, a comparison of two obese populations (knee OA patients and a control group) would have been more relevant for distinguishing between the effects of high body mass and knee OA in this impairment.

5. Conclusion

Despite the limitations of this study, in particular absence of a control group, it the first to have evaluated the physical performance in knee OA using Myotest during the performance of the STS test. The principle of this simple and rapid approach seems entirely applicable in current practices. It would be interesting to continue the study of this combination in the early assessment and in the longitudinal follow-up of knee OA patients, in order to validate it and possibly integrate it into the overall management of knee OA.

In addition, further studies with a control group are therefore necessary to better identify the link between the physical performance of the lower limbs and the clinical parameters of knee OA.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no competing interest.

Statement of informed consent

The patient has given their informed consent for publishing the photos.

Authors' contributions

All authors have read and agreed to the final version of this manuscript and have equally contributed to its content and to the management of the manuscript.

References

[1] Lespasio MJ, Piuzzi NS, Husni ME, Muschler GF, Guarino AJ, Mont MA. Knee osteoarthritis: A primer. Perm J. 2017; 21:16-183.

[2] Loeser RF, Goldring SR, Scanzello CR, Goldring MB. Osteoarthritis: a disease of the joint as an organ. Arthritis Rheum. 2012; 64(6):1697-1707.

[3] Schurr K, Sherrington C, Wallbank G, Pamphlett P, Olivetti L. The minimum sit-to-stand height test: reliability, responsiveness and relationship to leg muscle strength. Clinical Rehabilitation. 2012; 26(7):656-63.

[4] Baliunas AJ, Hurwitz DE, Ryals AB, Karrar A, Case JP, Block JA, et al. Increased knee joint loads during walking are present in subjects with knee osteoarthritis. Osteoarthritis Cartilage 2002; 10(7):573–9.

[5] Hu B, Skou ST, Wise BL, Williams GN, Nevitt MC, Segal NA. Lower Quadriceps Rate of Force Development Is Associated With Worsening Physical Function in Adults With or at Risk for Knee Osteoarthritis: 36-Month Follow-Up Data From the Osteoarthritis Initiative. Arch Phys Med Rehabil. 2018; 99(7):1352–1359.

[6] Koca I, Boyaci A, Tutoglu A, Boyaci N, Ozkur A. The Relationship between Quadriceps Thickness, Radiological Staging, and Clinical Parameters in Knee Osteoarthritis. J Phys Ther Sci. 2014; 26(6):931–936.

[7] Alnahdi AH, Zeni JA, Snyder-Mackler L. Muscle impairments in patients with knee osteoarthritis. Sports Health. 2012; 4(4):284–292.

[8] Iijima H, Suzuki Y, Aoyama T, Takahashi M. Quadriceps Weakness in Individuals with Coexisting Medial and Lateral Osteoarthritis. JB JS Open Access. 2019; 4(1):e0028.

[9] Diracoglu D, Baskent A, Yagci I, Ozcakar L, Aydin R. Isokinetic strength measurements in early knee osteoarthritis. Acta Reumatol Port. 2009; 34(1):72-77.

[10] Emrani A, Bagheri H, Hadian MR, Jabal-Ameli M, Olyaei GR, Talebian S. Isokinetic strength and functional status in knee osteoarthritis. J Phys Ther Sci. 2006; 18(2):107-114.

[11] Csuka M., McCarty DJ. Simple method for measurement of lower extremity muscle strength. The American Journal of Medicine. 1985; 78(1), 77-81.

[12] Sagawa Y, Bonnefoy-Mazure A, Armand S et al. Variable compensation during the sit-to-stand task among individuals with severe knee osteoarthritis. Ann Phys Rehabil Med. 2017; 60(5):312-318.

[13] Anan M, Shinkoda K, Suzuki K, Yagi M, Ibara T, Kito N. Do patients with knee osteoarthritis perform sit-to-stand motion efficiently? Gait Posture. 2014; 41(2):488-92.

[14] Casartelli N, Müller R, Maffiuletti N. Validity and reliability of the Myotest accelerometric system for the assessment of vertical jump height. Journal of Strength and Conditioning Research. 2010; 24(11):3186-3193.

[15] Bampouras T M, Relph N, Orme D, Esformes J I. Validity and reliability of the Myotest Pro wireless accelerometer. British Journal of Sports Medicine. 2010; Volume 44, issue14.

[16] Comstock BA, Solomon-Hill G, Flanagan SD, et al. Validity of the Myotest® in measuring force and power production in the squat and bench press. J Strength Cond Res. 2011; 25(8):2293-2297.

[17] Turcot K, Armand S, Fritschy D, Hoffmeyer P, Suvà D. Sit-to-stand alterations in advanced knee osteoarthritis. Gait Posture. 2012; 36(1):68-72.

[18] Medina-Mirapeix F, Vivo-Fernández I, López-Cañizares J, García-Vidal JA, Benítez-Martínez JC, Del Baño-Aledo ME. Five times sit-to-stand test in subjects with total knee replacement: reliability and relationship with functional mobility tests. Gait and Posture. 2018; 59:258-260.

[19] Kim D, Park G, Kuo LT, Park W. The effects of pain on quadriceps strength, joint proprioception and dynamic balance among women aged 65 to 75 years with knee osteoarthritis. BMC Geriatr. 2018; 18(1):245.

[20] Gökçen N, Başaran S, Benlidayi İC, Özdemir Ç, Seydaoğlu G. Which Predicts Quadriceps Muscle Strength in Knee Osteoarthritis: Biological Markers or Clinical Variables?. Arch Rheumatol. 2016; 32(1):32–38.

[21] Koca I, Boyaci A, Tutoglu A, Boyaci N, Ozkur A. The Relationship between Quadriceps Thickness, Radiological Staging, and Clinical Parameters in Knee Osteoarthritis. J Phys Ther Sci. 2014; 26(6):931–936.

[22] Verlaan L, Boekesteijn RJ, Oomen PW, et al. Biomechanical Alterations during Sit-to-Stand Transfer Are Caused by a Synergy between Knee Osteoarthritis and Obesity. Biomed Res Int. 2018; 3519498.

[23] Capodaglio P, Castelnuovo G, Brunani A, Vismara L, Villa V, Capodaglio EM. Functional limitations and occupational issues in obesity: a review. Int J Occup Saf Ergon. 2010; 16(4): 507-523.

[24] Sibella F, Galli M, Romei M, Montesano A, Crivellini M. Biomechanical analysis of sit-to-stand movement in normal and obese subjects. Clinical Biomechanics. 2003; 18(8):745-50.