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Is Pain a Determining Factor for Muscle Function and Functionality Impairments in Elderly Women with Knee Osteoarthritis?

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Abstract

Background: Osteoarthritis (OA), is the most frequent joint disease, when is symptomatic, joint pain, lower muscle strength and functionality are observed, but symptoms are not always related to the performance of muscle, than the aim of the present study was to evaluate the muscle function, functionality and pain in elderly women with knee osteoarthritis (OA) and to determine if the pain is an important factor for impairment of both muscle function and functionality in this population.

Methods: Thirty-four ageing women were divided into symptomatic (n=17) and asymptomatic (n=17) groups. All participants answered the Western Ontario and McMaster Universities Osteoarthritis Index questionnaire (WOMAC) questionnaire, and those who had a zero score on the pain and stiffness of WOMAC sections were allocated in asymptomatic group. Muscle function (strength and endurance) of knee extensor was assessed by isokinetic dynamometer, and functionality was assessed by 5-repetition chair stand test (5 × STS). General linear model multivariate and univariate were used for comparison between groups, and adjusted model for age and BMI was applied.

Results: Difference between groups was observed to muscle function, showing that asymptomatic group presented better performance to both strength and endurance than symptomatic group. Regarding the 5 × STS, there was no difference between groups.

Conclusion: The worse performance to muscle function of knee extensor among symptomatic group suggest that the pain affect negatively both strength and endurance of knee extensor, however, the presence of pain did not influence the functionality performance.

Keywords: Muscle strength; Muscle endurance; Lower limb; Isokinetic dynamometer; Aging

Introduction

Osteoarthritis (OA), the most frequent joint disease [1], is one of the major causes of disability in older adults with the pain being the main related symptom that interferes with functional performance [2]. The increase of progressive musculoskeletal changes is associated to ageing, which can contribute to the development of OA [3]. When OA is symptomatic, joint pain, lower muscle strength, and impairment during gait and sit–to-stand movement are observed [4,5]. Individuals with knee OA seem to have lower isokinetic strength, power, and endurance in their lower limbs muscles than individuals without knee OA [6]. A study by Fisher [7] has observed that muscle strength, endurance, and speed are 50% less in knee OA participants than in controls.

Nevertheless, symptoms are not always related to the performance of the quadriceps muscle in individuals with knee OA, as studies have shown that older patients with asymptomatic knee OA presented weakness in their quadriceps muscle [8,9]. Therefore, muscle weakness can be thought to be an outcome or a risk factor for the presence of OA. Therefore, the objective of the present study was to determine the influence of pain on the muscle function (strength and endurance) and the capacity of performing the five-time sit-to-stand test in subjects with knee OA.

Methodology

This is a cross-sectional study, with thirty-four women aged between 60 and 74 years old were recruited from the local community of Ribeirão Preto, Brazil through telephone calls, in which were explained the research objectives and the benefits for the society.

All participants presented a radiographic diagnosis of bilateral knee OA by an experienced radiologist doctor according to the Kellgren and Lawrence method: grade I (joint space narrowing doubtful and possible osteophytes at the edge), grade II (possible joint space narrowing and defined osteophytes) and grade III (defined joint narrowing, multiple moderate osteophytes, some subcondral sclerosis and possible deformity in the bone lining) [10]. The classification of Kellgren and Lawrence was given by the same musculoskeletal radiologist with over 15 years of professional experience; independently and blinded to symptoms and another clinical information.

The subjects were divided into symptomatic (n=17) and asymptomatic (n=17) groups that were classified by the Western Ontario and McMaster Universities Osteoarthritis Index questionnaire (WOMAC). It consists of three domains: pain (5 questions), stiffness (2 questions), and function (17 questions). The higher the score is the worse are the symptoms of OA [11].

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The WOMAC was applied in order to classify the subjects into either symptomatic or asymptomatic groups according to pain and stiffness, subjects scoring zero points in terms of pain and stiffness were included in the asymptomatic group.

The number of participants in each group was determined by a sample size calculation performed using GraphPadStatMate software based on the standard deviation from another study [12] that evaluated the isokinetic muscle strength of the quadriceps at 60°/s for subjects with initial grades of OA, resulting in a sample size of 17 (per group) with power=0.8 and level of significance= 0.05. The exclusion criteria were as follows: presence of cardiopulmonary, neurological or cognitive diseases; vestibular disorders such as diabetes mellitus; uncontrolled high blood pressure; history of bone fractures and/or injuries to the lower limbs in the last six months; history of previous surgery on the hip, knee or ankle; index of body weight greater than 40 (morbidly obese); assistive device usage; implants or prostheses in the lower limbs; corticosteroid knee injections in the last three months; use of chondroprotective and/or drugs for the central nervous system; physiotherapy in the last 6 months. The presence of concomitant disease was obtained by self-report, checking the participant's medications and the last medical appointment.

To ensure that this study was conducted in accordance with relevant ethical principles, each participant signed an institutional informed consent document that had been approved by the institution's ethics committee. The evaluators of the study were 3 physical therapists with at least 2 years of expertise in the research field who were responsible for the application of WOMAC questionnaire, the assessment of muscle function (strength and endurance) and the five-time sit-to-stand (5 × STS) test.

Muscle function assessment

For muscle function assessment of the knee extension, both strength and endurance of the knee extensor muscles, was assessed by isokinetic dynamometer [13] (Biodex System 4 Pro, New York, USA) that was calibrated weekly according to the equipment manufacturer's recommendations. Angular speeds of 60°/s and 180°/s were used as assessment protocol [14]. Prior to the tests, the systemic blood pressure of the subjects was measured before a 5-minute warm-up on an ergometer bicycle [15]. If a patient's blood pressure was higher than 130/90 mmHg, the test was canceled.

For the group of symptomatic women, the painful limb or the most painful limb with OA was evaluated. In the group of asymptomatic women, the dominant lower limb was evaluated. To identify the dominant lower limb, the evaluator asked the patient which leg she would use to kick a ball.

For familiarization with the equipment, the subjects were allowed to perform three submaximal contractions before each task. For evaluation of the knee extensor muscles, the subjects remained seated with their knees flexed at a 90-degree angle and were supported by a chair and stabilized by belts. Five repetitions of maximal contractions at

60°/s were performed to assess the muscle strength. Also, 15 repetitions at 180°/s were performed to assess the muscle endurance. A rest period of 60 seconds was given between the tests. Verbal encouragement was given to the subjects while they performed the test [16]. The values of endurance were related with body mass.

Functionality assessment

For assessed the functionality, five time sit-to-stand (5 × STS) test was applied. Participants were instructed to stand up and sit down 5 (five) times as quickly as they could by following verbal commands while the evaluator recorded the time duration [17]. The subject remained seated on an armless chair with hips, knees, and ankles flexed at a 90-degree angle while the upper limbs remained crossed on the chest. The movement was performed twice, and the mean time spent by the subject was considered.

Statistical analysis

Demographic, anthropometrics, WOMAC, and muscle function (strength and endurance) characteristics were summarized using means and standard deviation (SD). Normal distribution of continuous data was verified using Shapiro-Wilk test, and logarithmic transformation was applied when appropriated. General linear model multivariate was used to compare muscle function (strength and endurance) between symptomatic and asymptomatic groups (independent variable), adjusted for age and BMI. Comparison between groups also was made to 5 × STS test using general linear model univariate. The value $p \leq 0.05$ was used as the significance level for all the tests. All the statistical analyses were carried out using SPSS software (SPSS for Windows, version 16.0, SPSS Inc., USA).

Results

A total of 53 volunteers were initially recruited. Thirteen women were excluded because they were not in the 60- to 75-year-old. Therefore, 40 volunteers aged between 60 and 74 years old were evaluated and radiographically diagnosed as having bilateral knee OA. After being included in the study, five subjects were excluded because they did not complete the evaluation tests and one was excluded due to present grade IV of OA. Thirty-four older women remained in the study, which were divided into asymptomatic (without pain and stiffness) and symptomatic (with pain and stiffness) groups according to the result of the WOMAC classification. Sample characteristics are listed in Table 1.

The general linear model multivariate showed difference between groups in the unadjusted model (λ=0.69; F (2,31)=6.66; p=0.004) to muscle function. Univariate analysis revealed that strength presented between-groups main effect. When the analysis was adjusted by age and body mass index (BMI) the differences in muscle function remained statistically significant (λ=0.80; F (2.29)=3.41; p=0.047). Strength (p=0.030) and endurance (p=0.018) presented between-groups main effects, revealing that asymptomatic group showed better performance in those variables (Table 2). Regarding to 5 × STS test the general linear model univariate showed

Volunteers	Age (years)	Weight (Kg)	BMI (Kg/m²)	WOMAC			
				Pain	**Stiffness**	**Functionality**	**Total**
Asymptomatic (n=17)	67.47 ± 4.05	63.4 ± 12.35	25.9 ± 4.25	0	0	0.37 ± 0.79	0.37 ± 0.79
Symptomatic (n=17)	65.9 ± 4.1	77 ± 11.6	31.01 ± 4.6	5.14 ± 4.04	2.08 ± 2.11	11.27 ± 11.40	18.49 ± 15.35

Table 1: Mean values ± SD of both anthropometric data and WOMAC score from the volunteers with symptomatic and asymptomatic knee OA.

Variables	Symptomatic group n = 17	Asymptomatic group n = 17	Between-group effects (p value)	
	Mean ± SD	Mean ± SD	Not adjusted	Adjusted model
Torque (Nm/Kg) 60º/s	90.30 ± 31.48	127.52 ± 26.93	0.001	0.030
Endurance (W) 180º/s	45.82 ± 19.56	58.44 ± 20.75	0.078	0.018
Adjusted model: Age, body muscle index.				

Table 2: Muscle function between symptomatic and asymptomatic groups.

Variables	Symptomatic group n = 17	Asymptomatic group n = 17	Between-group effects (p-value)	
	Mean ± SD	Mean ± SD	Not adjusted	Adjusted model
5 × STS (sec)	15.84 ± 3.08	13.88 ± 2.66	0.057	0.073
Adjusted model: Age, body muscle index.				

Table 3: Five-time sit-to-stand (5 × STS) test between symptomatic and asymptomatic groups.

there was statistical difference between symptomatic and asymptomatic groups in no adjusted model. When the model was adjusted, it was not found difference between groups. Data showed in Table 3.

Discussion

Knee Osteoarthritis (OA) is the most common form of osteoarthritis and it is associated with pain, decreased in muscle strength of the lower limbs [18], functional impairment, decreased quality of life and high risk of morbidity and mortality [19]. Currently, the definition of OA includes patient-reported symptoms and structural changes within the joint, including the remodeling of articular cartilage, neighboring bone, the synovial inflammation and damage to ligaments and menisci [20]. The World Health Organization estimates that 25% of individuals over 65 years old suffer from pain and disability associated with OA. Studies have shown that pain impairs muscle performance [14,15] and functionality [21]. Wilson and colleagues [22] suggest that have some differences between symptomatic and asymptomatic OA with the same radiographic grade, like biomechanical and muscular activation.

However, it is not yet clear in the literature whether subjects with symptomatic OA have a greater reduction of muscle function and functionality impairment compared to individuals with asymptomatic OA [8,9]. The results of the present study have shown that women who present symptoms of knee OA have low strength and endurance of knee extensor muscles, and a systematic review and meta-analysis suggest that knee extensor muscle weakness was associated with an increased risk of developing knee osteoarthritis [23].

Although the symptomatic women present worse muscle function, this finding did not impair the functional capacity evaluated by 5 × STS, which does not corroborate with the study of van der Esch et al. [24] in which the main finding showed that a decrease in muscle strength was associated with an increase in functional limitations, although they included participants with early symptomatic knee OA.

In another study [25] the strengthening program was effective for increasing the hip muscle strength, reduced knee pain, and improved functional performance on a sit-to-stand test in individuals with symptomatic knee OA. This outcome suggests an association between muscle strength and functionality, which does not corroborate with the present study. The 5 × STS test has been clinically used to evaluate the strength of lower limbs [16] and can also be used to predict functional disability in older patients, as reported by another study [26]. Additionally, balance and functional mobility can interfere with the 5 × STS test performance [25]. A Multicenter study showed that the physical function performance decreases over time in people with symptomatic knee OA [27].

Conclusion

Older women with symptomatic knee OA exhibited lower muscle endurance and strength than asymptomatic women; it seems relevant to include not only muscle strength training but also endurance training in rehabilitation programs for older patients with knee OA. In the presence of OA symptoms, as pain and stiffness, elderly women present lower strength and endurance of knee extensor muscles than elderly women without OA symptoms. However, there was no difference in the ability to perform the 5 × STS test when the model was adjusted.

Ethics Approval and Consent to Participate

Name of the ethics committee that approved the study: Hospital of The Clinics of The Faculty of Medicine of Ribeirão Preto of University of São Paulo. Committee's reference number : 478.727

Consent for Publication

Not applicable

Availability of Data and Materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

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