

The Clinical Prediction of Patients' Age & BMI to Quadriceps Muscle Strength Training on Knee Pain and the Functional Activity Level in Female Patients with Knee Osteoarthritis

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Abstract

Background: Osteoarthritis (OA) is a chronic degenerative joint disease, which commonly affects the knees.

Aim of Study: To investigate if patients' age and BMI can predict patients' response to quadriceps muscle strength training on knee pain and the functional activity level in female patients with knee osteoarthritis.

Patients and Methods: Forty female patients with The mean age of (54±8) years and The mean BMI of (33±5) kg/cm², were referred by orthopedist diagnosed as knee osteoarthritis patient they all met the inclusion criteria then, Patients' personal data, age, body mass index, Knee pain intensity level and functional activity level all were recorded in patient evaluation sheet before applying quadriceps muscle strengthening exercise.

Results: The patients' response to treatment was estimated by calculating the mean difference for pain intensity level (measured via VAS) and the function activity level (measured via 50 feet walk test & time up and go test). The correlation between results before and after Quadriceps muscle strength training exercise program was calculated. the results showed a significant difference between pre and post 50 feet walk test (56±12; 39±8 respectively), time up and go test (26±8; 18±6 respectively), pain intensity level (VAS) (7±1; 3.5±1.6 respectively), (*p*-value <0.05).

Conclusion: Patients' age, BMI (height & weight) can be predictors of success for quadriceps muscle strength training exercise program in female patients with knee osteoarthritis.

Key Words: Knee osteoarthritis – Quadriceps strength training – Functional activity level.

Introduction

KNEE osteoarthritis is a common degenerative musculoskeletal disorder characterized by pain that increase with use and decrease with rest [1].

Other presenting signs and symptoms include stiffness that generally improves after 30 minutes of activity, crepitus, swelling, and limping. In advanced cases, patients may need knee arthroplasty [2].

The role of physiotherapy in knee osteoarthritis is to strengthen the lower limb muscles with emphasis on quadriceps muscle to decrease the pain which is associated with knee osteoarthritis [3]. Up to authors knowledge there is nospecific guidelines or rules which help physiotherapists to determine whether or not a patient is a good candidate for quadriceps strength.

Weakness of the quadriceps muscle is well reported in subjects with knee OA, also it strongly associated with pain, which considered an important determinant of disability [4].

It was demonstrated that strengthening the quadriceps muscle result in changes in pain, physical work, and quality of life in knee OA patients [3].

Clinical prediction rules (CPRs) are devices designed to improve decision making in clinical practice by assisting specialists in making a particular diagnosis, establishing a prognosis, or matching patients to the most effective interventions based on groups of predictor variables from the history and physical examination of the patients [5].

Clinical prediction rules were developed so that it can improve decision making for physiotherapists [6].

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Patients and Methods

This study designed as Predictive validity, diagnostic study, covered the standards required for research and approved by the Ethics Committee of the Faculty of Physical Therapy, Cairo University. The patient's data were collected at the time from 9-2020 to 4-2021. All participant signed a consent form before starting the study and they were provided by sufficient information of the work procedure. Study was conducted at the physical therapy department at Met Fares Hospital, Menofia Government, Egyptian Ministry of Health Hospitals. Forty female patients with The mean age of (54±8) years with minimum of 42 years and maximum of 68 years with The mean BMI of (33±5) kg/cm², with the minimum of 22.5kg/cm² and the maximum of 42.5kg/cm² were referred by orthopedist to physical therapy department at met fares hospital diagnosed as knee osteoarthritis, they were included in the study according to the following inclusion criteria.

Inclusion criteria:

The subjects selected according to the following criteria: Age between 40-70 years [3], Grade 2 or 3 Kellgren/ Lawrence radiographic changes in the knee joint) [7]. Independent gait (using a single cane is allowed or knee splint) [8].

Exclusion criteria: Patients were excluded if they; Had undergone total knee arthroplasty [7], exhibited uncontrolled hypertension [9], had a history of cardiovascular disease [9], had history of neurologic disorders that affect lower extremity function (e.g., stroke, peripheral neuropathy) or any health problem that will affect lower extremity function [9], had undergone knee surgery, oral steroids and knee injection were excluded from this study [10].

Evaluation procedure:

The patients were evaluated before the intervention by:

- 1- Patient sheet.
- 2- Body Mass Index:

The BMI is defined as the body mass divided by the square of the body height, and is expressed in units of kg/m², Major adult BMI classifications are underweight (under 18.5kg/m²), normal weight (18.5 to 24.9), overweight (25 to 29.9), and obese (30 or more) it's valid and reliable [11].

Knee pain and function were assessed before and after using quadriceps muscle exercise in the form of:

1- Visual analogue scale (VAS):

It is a 100-mm horizontal line anchored by word descriptors at each end by "no pain" on the left and "worst imaginable pain" on the right. It is reliable and valid [12].

2- Functional test:

a- 50 feet walk test: Bring subject to start on a 50 foot walk test course (25 feet out and 25 feet back) and ask the subject, on the command "go" to walk as quickly as they can to the 25-foot mark and back. Time from the command "go" until the starting line is crossed on the way back [13].

b- Time up and go test: Is a simple test used to assess a person's mobility and requires both static and dynamic balance. It uses the time that a person takes to rise from a chair, walk three meters, turn around, walk back to the chair, and sit down. During the test, the person is expected to wear their regular footwear and use any mobility aids that they would normally require [14].

Intervention procedure:

- 1- Terminal knee extension: Using a roll just to start the knee in a little bit of flexion and then the patient tried to fully extend the knee [15].
- 2- Knee extension in sitting: Start from sitting with knee at 90° flexion then the patient were asked to fully extend the knee using resistance of ankle weights [16].
- 3- Straight leg raise-start supine, raise leg to 30° hip flexion using resistance of ankle weights [17].
- 4- Closed chain exercise the patient tried to get terminal knee extension against theraband from standing position [18].

Results

Forty female patients with knee osteoarthritis (Grade 2 or 3 Kellgren/Lawrence radiographic changes in the knee joint) had participated in this study. There was no relevant gender distribution in this study group as all patients included in this study were female [i.e. 40 (100%)].

The mean age of participants in this study was (54±8) years with minimum of 42 years and maximum of 68 years. The mean height of participants in this study was (160±10) centimeters with minimum of 150 centimeters and maximum of 170 centimeters. The mean weight of participants in this study was (86.5±13) kilograms with minimum of 59kg and maximum of 110kg. The mean BMI of participants in this study was (33±5) kg/cm², with minimum 22.5kg/cm² and maximum 42.5kg/cm².

cm². The patients' response to treatment was estimated by calculating the mean difference for pain intensity level (measured via VAS) and the function activity level (measured via 50 feet walk test & time up and go test). The correlation between results before and after Quadriceps muscle strength training exercise program, the results showed a significant difference between pre and post 50 feet walk test as regarding (56±12; 39±8 respectively), time up and go test (26±8; 18±6 respectively), pain intensity level (VAS) (7±1; 3.5±1.6 respectively), (*p*-value <0.05) (Table 1).

Table (1): Distribution of function activity level, pain intensity level pre & post treatment for all patients.

| Variable | Range (Min-Max) | Mean (SD) |
|-----------|-----------------|-----------|
| Pre-50FW | 40 (39-79) | 56±12 |
| Post-50FW | 35 (30-65) | 39±8 |
| Pre-TUG | 27 (15-42) | 26±8 |
| Post-TUG | 26 (12-38) | 18±6 |
| Pre-VAS | 4 (5-9) | 7±1 |
| Post-VAS | 6 (1-7) | 3.5±1.6 |

Then the ROC curve (receiver operating characteristic curve) was performed to determine the predictors sensitivity and specificity and to know at what point the predictors are most predictive to benefit from Quadriceps muscle strength training program (Table 2, Fig. 1). The results showed that the pain intensity level (measured via VAS), function activity level measured (via 50 feet walking test & time up and go test) at baseline assessment, all had high sensitivity in predicting the patients' response to Quadriceps muscle strength training program in cases of female knee osteoarthritis patients (Table 2, Fig. 1).

The pain intensity level (VAS) showed excellent results, and area under curve(AUC) was (=0.931), its sensitivity was (1.000) and 1-specificity (.275), it could be predictor if (≥4.50). The 50 feet walking test showed good results, and area under curve (AUC) was (=0.884), its sensitivity was (.875) and 1-specificity (.300), it could be predictor if (≥41.50). (Table 2, Fig. 1).

Table (2): Description of the ROC curve, demonstrating area under curve (AUC), sensitivity and specificity of interfering with this procedure, and Cut off points.

| Variable | AUC | Result | Cut Off Points | | |
|----------|------|-----------|--------------------------------------|-------------|---------------|
| | | | Positive if Greater Than or Equal To | Sensitivity | 1-Specificity |
| 50FW | .884 | Good | 41.50 | .875 | .300 |
| TUG | .813 | Good | 18.50 | .850 | .375 |
| VAS | .931 | Excellent | 4.50 | 1.000 | .275 |

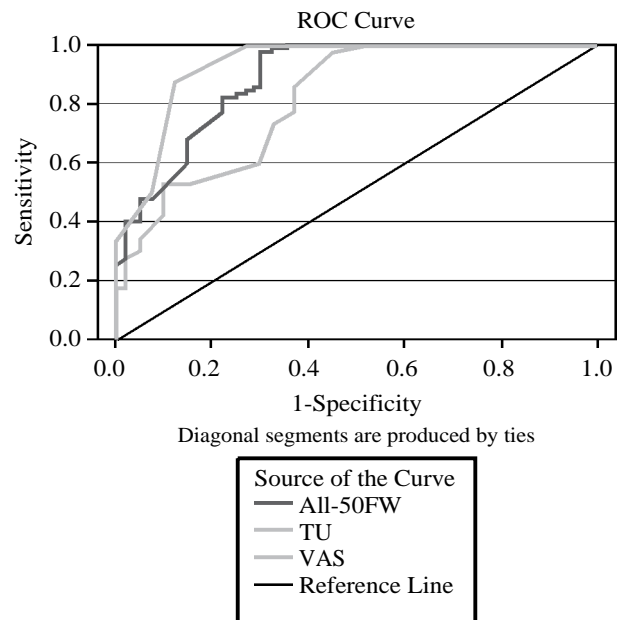


Fig. (1): ROC curve, demonstrating area under curve (AUC), sensitivity and specificity of interfering with this procedure, and Cut off points.

The time up and go test showed good results, and area under curve (AUC) was (.813), its sensitivity was (.850) and 1-specificity (.375), it could be predictor if (≥18.50). (Table 2, Fig. 1).

So there was statistically significance difference between pre & post treatment pain intensity level, pre and post function activity level (50 feet walking test & time up and go test).

Discussion

The results of this current study indicated that, quadriceps muscle strengthening exercise is effective in relieving pain, improving function in patients suffering from Knee OA. It showed a significant difference between pre and post results, pain intensity level measured via VAS [7±1; 3.5±1.6 respectively], function activity level measured via (50 feet walk test (56±12; 39±8 respectively) and time up and go test (26±8; 18±6 respectively) [*p*-value (<0.05)].

According to Lim, et al., [19] strengthening the quadriceps has a beneficial effect on pain and function in patients with knee osteoarthritis. The study conducted by Amin, et al., [20], reported that subjects with greater quadriceps strength had less knee pain and better physical function than those with minimal strength.

These results were similar to those of Salihet al., [21] who found that obese patients are at increased risk of premature joint failure. However, the overall outcome of knee OA in obese patients

is worse than in the non-obese group, Mazure et al., [22] found that all patients improved biomechanically and clinically in gait parameters, regardless of their BMI. Other studies conducted by Loeser et al., [23] also support our findings and found that the effects of aging on chondrocytes and their matrix results in tissues less able to maintain homeostasis under stress, resulting in rupture and loss of articular cartilage, a hallmark of osteoarthritis.

In addition, Segal et al., [24] they suggest that people with greater knee extension strength have a reduced risk of symptomatic knee osteoarthritis but not radiographic knee OA. Shakoor et al. [25] studied the effects of isometric quadriceps muscle strengthening exercise and non-steroidal anti-inflammatory drugs (NSAIDs) on knee osteoarthritis, found that strengthening exercise of quadriceps muscle has a better effect when used in addition to NSAIDs in the knee joint with osteoarthritis. Quadriceps muscle exercise can reduce the need for NSAIDs, and thus the side effects of NSAIDs can be avoided.

Conclusion:

Patients' age and BMI (height & weight) can be predictors of success with to quadriceps muscle strength training exercise program in female patients with knee osteoarthritis.

Limitations:

- 1- All patients were female.
- 2- The mean BMI of the participants of the study was high.

Recommendation:

Future studies should investigate the effect of other factors on patient's outcome following quadriceps muscle strength training exercise program.

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التنبؤ السريري بعمر المريض ومؤشر كتلة الجسم لتدريب قوة العضلات رباعية الرؤوس على آلام الركبة ومستوى النشاط الوظيفي لدى النساء المصابات بخشونة الركبة

هذه الدراسة صدقية تنبؤية، دراسة تشخيصية لمرض (خشونة الركبة) هو أكثر أمراض المفاصل التنكسية المزمنة شيوعاً وهدف هذه الرسالة هو التحقيق في تأثير مؤشر كتلة الجسم على استجابة المريض لقوة عضلات الفخذ. عن طريق أربعين مريضة بمتوسط عمر (48±8) سنوات بمتوسط مؤشر كتلة الجسم (33±5) كجم/سم²، تمت إحالتهم من قبل جراح العظام تم تشخيصه على أنه مريض مصاب بخشونة الركبة، وقد استوفى جميعاً معايير التضمين ثم وقعوا الموافقة (الملحق الثاني)، في البداية، بيانات المريض الشخصية، والعمر، ومؤشر كتلة الجسم، ومدة الأعراض وزاوية ثنى الركبة، بالإضافة إلى مستوى شدة آلام الركبة ومستوى النشاط الوظيفي، تم تسجيلها جميعاً في ورقة تقييم المريض قبل تطبيق تمرين تقوية العضلات الرباعية الرؤوس وقد تم تقدير استجابة المرضى للعلاج من خلال حساب متوسط الفرق لمستوى شدة الألم يقاس عبر مستوى نشاط الوظيفة يقاس من خلال اختبار المشى لمسافة 50 قدماً واختبار الوقت والبدء. العلاقة بين النتائج قبل وبعد برنامج تمارين القوة العضلية الرباعية الرؤوس، أظهرت النتائج فرقاً وتحسناً ملحوظاً في مستوى الألم وتحسين الأداء الوظيفي.