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Relationship between Hip Abductors, External Rotators Strength and Dynamic Knee Valgus in Jumper's Knee

TAMER GALAL, M.Sc.*; SALWA F. ABD ELMAGEED, Ph.D.** and MOHAMED EZZAT MOHAMED, Ph.D.**

Physical Therapist at Ministry of Health and Department of Physical Therapy for Musculoskeletal Disorders and its Surgery**, Faculty of Physical Therapy, Cairo University*

Abstract

Background: Jumper's knee may be a common and noteworthy issue experienced in sports medicine and sports injuries. The relationship between proximal hip muscle strength and dynamic knee valgus would modify the load on the patellar tendon which can cause jumper's knee.

Aim of Study: To investigate the relationship between the isometric strength of the hip abductors, external rotators and dynamic knee valgus angle in subjects with or without jumper's knee, and to check out if there's an association between those factors with pain level and level of disability.

Material and Methods: Forty-five male subjects extended (from 18 to 35) years-old recreationally active people were enrolled to take part in this study. All athletes were evaluated by HHD to measure peak force of isometric strength of hip abductors and external rotators. And frontal plane projection point (FPPA) was evaluated by Kinovea Computer Program (KCP) video analysis. The level of pain and knee dysfunction level were assessed by victorian institute sports assessment-patellar tendon questionnaire and visual analogue scale.

Results: There no significant correlations were found between peak abductors and external rotators isometric strength with VISA-P and VAS. No significant correlations were observed between dynamic knee valgus with VAS and VISA P score. No significant correlations were observed between dynamic knee valgus and isometric strength of hip abductors and external rotators.

Conclusion: It was conducted that no significant relationships were observed between hip abductors, external rotators and dynamic knee valgus with level of pain and knee disability in jumper's knee athletes.

Key Words: *PT (patellar tendinopathy) – Jumper's Knee – FPPA (frontal plane projection angle) – VISA-p (Victorian institute sports assessment patella).*

Introduction

JUMPER'S knee or Patellar tendinopathy (PT) might be a persistent abuse damage of the patellar tendon, characterized by activity related anterior knee pain [1]. Jumper's knee might be an exceptionally common disorder in sports that includes running and jumping [2]. The prevalence of jumper's knee had been detailed to be the most elevated among sports including jumping, such as volleyball (44%) and basketball (32%) [3]. For the development of therapies and preventative measures, in-depth information of the genesis of an injury was necessary. Numerous theories had been proposed on the pathogenesis of Jumper's knee, including vascular, mechanical, impingement-related, and nervous system causes [4]. During sports including repetitive jumping and landing, such as basketball, soccer and volleyball, subjects repeatedly had put large loads on their knee extensor mechanism, including the patellar tendon [5]. A survey of the relationship between jump biomechanics and jumper's knee suggested that utilizing a more adaptable jumping design may diminish the improvement of jumper's knee [6]. Knee valgus might put rotational forces on the patellar tendon and overload the tissue asymmetrically [7]. The presence of hip abductor and external rotator weakness, range of motion impairments and anatomical alignment at the hip joint may influence lower extremity movement patterns and, consequently, alter the force distribution on the knee joint structures (e.g. patellar tendon) [32].

Correspondence to: Dr. Tamer Ibrahim Mohamed Galal, E-Mail: tamergalal33@gmail.com

Material and Methods

Study design:

This was a correlation study and prior to data collection, ethical approval was obtained (No: P.T.REC/012/ 003139). The study was conducted at Smouha, Sporting, Telecom Egypt, El-Ettihad clubs and Physiosport clinic in Alexandria, Egypt. Since May 2021 till March 2022.

Participants:

Sample size calculation was carried out using G Power and Sample Size Calculations software, type 3.0.11 for MS Windows (Walton D and William D. DuPont., Vanderbilt University, Tennessee, USA). Based on a report by a previous publication, using 80% power at a = 0.05 level and effect size = 1.12. Forty-five male athletes ranged (from 18 to 35) years-old.

Patients were allowed to get involved in the study if they had the subsequent criteria:

(a) They had pain at the inferior pole of the patella and/or if they reported that it had been diagnosed by a physician [2,8]. (b) self-reported pain within the tendon during loading task activities such as jumping, squatting, and so on [9]. (c) Pain on palpation of the inferior pole of the patella [10]. (d) Score 80 on the Victorian Institute of Sport Assessment Scale-Patella (VISA-P), indicating decreased function [9]. (e) Being male athlete. Because of higher male rate injury [11]. (f) Patients with subchronic (duration of continuous symptoms during activity 3 weeks to 3 months before the baseline examination) to chronic (duration of continuous symptoms during activity more than 3 months before the baseline examination) symptoms and signs typical of jumper's knee would be included [12]. While patients were excluded from the study if they exhibited one of the subsequent criteria: (1) Concomitant injury or pathology of other knee structures. (2) Previous knee surgery. (3) Patellofemoral instability (history of sublaxation or dislocation; positive apprehension test). (4) Knee joint effusion. (5) Hip or lumbar spine pain (local or referred). (6) Sessions of Physiotherapy on knee joint within previous year; prior foot orthoses treatment or use of anti-inflammatories or corticosteroids. All participants were informed about the process that would be conducted during the study and signed in informed consent following standards of the institutional ethical committee for researches involving human subjects.

Measurement Procedures:

2-D Frontal plane projection angle:

Frontal plane projection angle measures 2-D angle with an inexpensive, easy-to-use, single-camera solution. In arrange to calculate the FPPA value, the framework had made utilize of intelligent markers put on wanted subject's body joints, and tracks them through a sensor. All the data enlisted was prepared by a computer application [13].

The participants performed the test with uncovered feet to dispose of potential impacts of footwear on lower extremity mechanics. Test performance was recorded with the digital video camera placed on a tripod 3-m anterior to the participant [14]. Fig. (1).

Three reflective markers were attached at the anatomic points proposed in: (1) Anterior superior iliac spine, (2) Middle of tibio-femoral joint and (3) Middle of ankle mortise. The markers alignment drew two lines, whose frontal projected angle was recorded as FPPA [15]. Fig. (1).

Fig. (1): Step down with sound leg and made squat with injured leg.

Hip abduction strength testing:

Subjects were positioned side-lying on a treatment table for the hip abduction isometric strength test. The hip of the subject's leg was abducted by around 10° in relation to a line joining the anterior superior iliac spines after a pillow was put between their legs, with additional pillows used if necessary. A mark that would be 5cm away from the lateral knee joint line was set directly over the center of the force pad of a hand-held dynamometer. The subject was instructed to push the leg against the dynamometer with maximal effort for 5 seconds. One practice trial and 3 experimental trials were performed with 15 seconds of rest between trials. The peak value from the 3 experimental trials was recorded [16]. Average peak torque (Nm) was recorded and normalized with body mass (Nm/kg). Fig. (2).

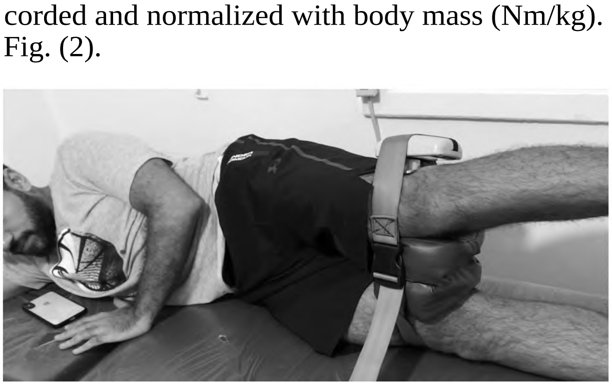


Fig. (2): Isometric hip abductors muscles measurement by using hand held dynamometer in injured leg.

Hip external rotation strength testing:

Hip external rotation (ER) isometric strength testing was performed with subjects would be positioned on a padded chair with the hips and knees were flexed to 90°. The dynamometer was placed such that the center of the force pad would directly over a mark that was 5cm proximal to the medial malleolus. A strap around the leg and around the base of a stationary object held the dynamometer in place during contractions. After zeroing the dynamometer, the subject was instructed to push the leg inward with maximal effort for 5 seconds. The force value was displayed on the dynamometer will be recorded and the device would be re-zeroed. One practice trial and 3 experimental trials will be performed with 15 seconds of rest between trials. The peak value from the 3 experimental trials were recorded [17]. Average peak torque (Nm) was recorded and normalized with body mass (Nm/kg). Fig. (3).

Fig. (3): Isometric hip external rotators muscles measurement by using hand held dynamometer in injured leg.

Results

The mean age of the studied patients was 24 ±5 years. The mean weight and height were 86.1 ±12.1kg and 191±9cm, respectively, with a mean BMI of 23.5±1.9 (Table 1).

Table (1): General characteristics of the studied patients.

	Mean ± SD
Age (years)	24±5
Weight (kg)	86.1±12.1
Height cm	191±9
Body mass index	23.5±1.9

Peak abductors & external rotators strength:

The mean peak abductors strength was 1.83 ±0.3Nm/kg, while the mean peak external rotators strength was 0.84±0.24Nm/kg (Table 2, Fig. 4).

Table (2): Peak abductors and external rotators strength.

	Mean ± SD
Peak abductors strength (Nm/kg)	1.83±0.3
Peak external rotators strength (Nm/kg)	0.84±0.24

Data were expressed as mean ± Standard deviation.

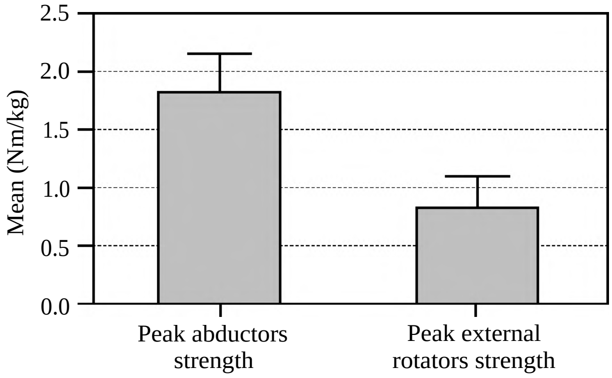


Fig. (4)

VAS, VISA-P, and dynamic knee valgus:

The mean VAS was 4.1±1.8. The mean VISA-P score was 77±4, while the mean dynamic knee valgus was 173±4 (Table 3).

Table (3): VAS, VISA, and dynamic knee valgus in the studied patients.

	Mean ± SD
VAS	4.1±1.8
VISA P score	77±4
Dynamic knee valgus	173±4

Data were expressed as mean ± Standard deviation.
VAS : Visual analogue scale.
VISA P: Victorian Institute of Sport Assessment-Patella.

Correlation between peak abductors strength and other parameters:

Significant negative correlations were observed between peak abductors strength and weight (r=–440, p=0.002), height (r=–0.366, p=0.013), and BMI (r=–0.312, p=0.037). No significant correlations were observed with other parameters (Table 4, Fig. 5).

Table (4): Correlation between peak abductors strength & other parameters.

	Peak abductors strength	
	r	*p*
Age (years)	–0.062	0.686
Weight (kg)	–.440*	0.002
Height cm	–.366*	0.013
BMI	–.312*	0.037
VAS	–0.248	0.1
VISA p score	0.284	0.059

r : Correlation coefficient. * Significant.
VAS : Visual Analogue Scale.
VISA P : Victorian Institute of Sport Assessment-Patella.

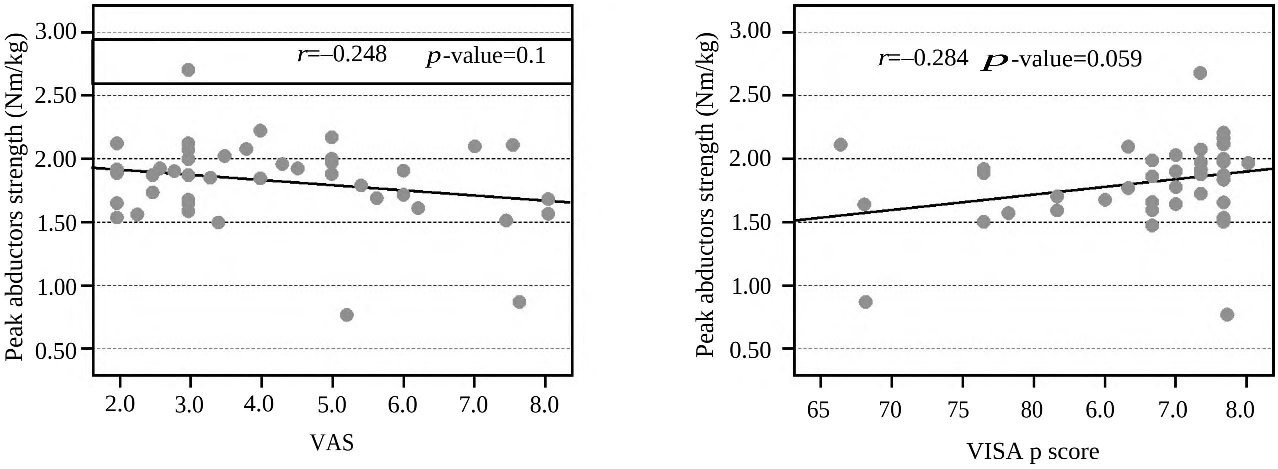


Fig. (5): Correlation between peak abductors strength & VAS and VISA-P.

Correlation between peak external rotators strength and other parameters:

Significant negative correlations were observed between peak external rotators strength and weight (*r*=–380, *p*=0.01) and BMI (*r*=–0.456, *p*=0.002). No significant correlations were observed with other parameters (Table 5, Fig. 6).

Correlation between dynamic knee valgus and other parameters:

No significant correlations were observed between dynamic knee valgus and age (*r*=0.063, *p*= 0.738), weight (*r*=0.141, *p*=0.449), height (*r*= 0.051, *p*=0.784), BMI (*r*=–0.153, *p*=0.411), VAS (*r*=–0.038, *p*=0.839), and VISA P score (*r*=0.012, *p*=0.948) (Table 6, Fig. 7).

Table (5): Correlation between peak external rotators strength & other parameters.

	Peak external rotators strength	
	r	*p*
Age (years)	–0.097	0.527
Weight (kg)	–.380*	0.01
Height cm	–0.165	0.279
BMI	–.456*	0.002
VAS	–0.107	0.486
VISA p score	0.192	0.206

r : Correlation coefficient. * Significant.
VAS : Visual Analogue Scale.
VISA P : Victorian Institute of Sport Assessment-Patella.

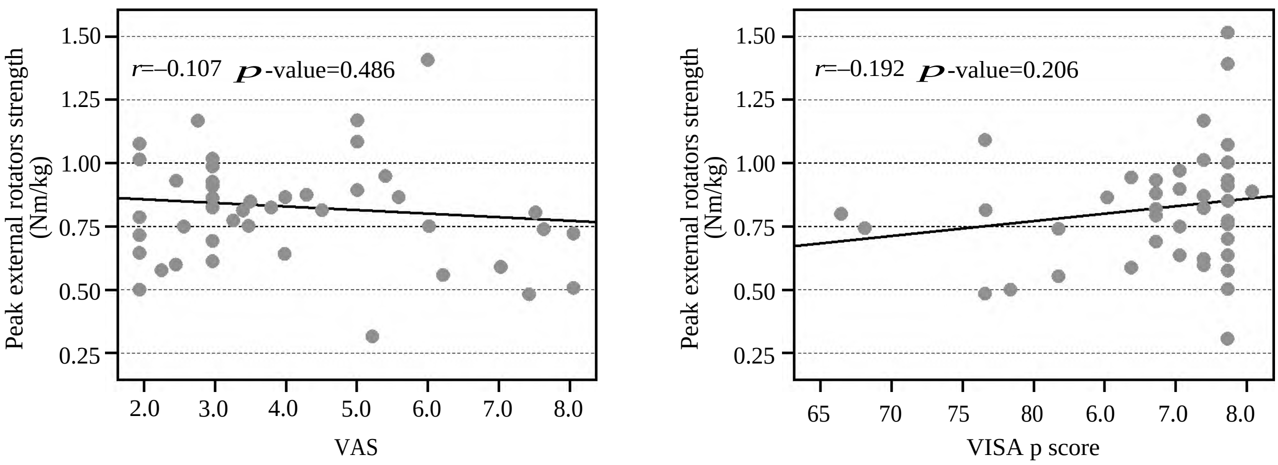
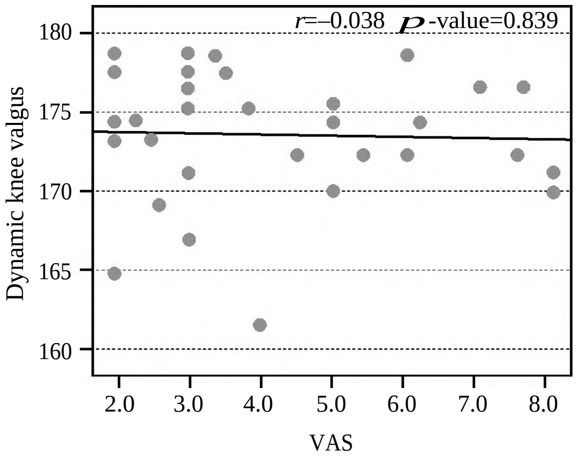


Fig. (6): Correlation between peak external rotators strength & VAS and VISA.

Table (6): Correlation between dynamic knee valgus and other parameters.

	Dynamic knee valgus	
	r	*p*
Age (years)	0.063	0.738
Weight (kg)	0.141	0.449
Height cm	0.051	0.784
Body mass index	0.153	0.411
VAS	–0.038	0.839
VISA p score	0.012	0.948

r : Correlation coefficient.
VAS : Visual Analogue Scale.
VISA P : Victorian Institute of Sport Assessment-Patella.



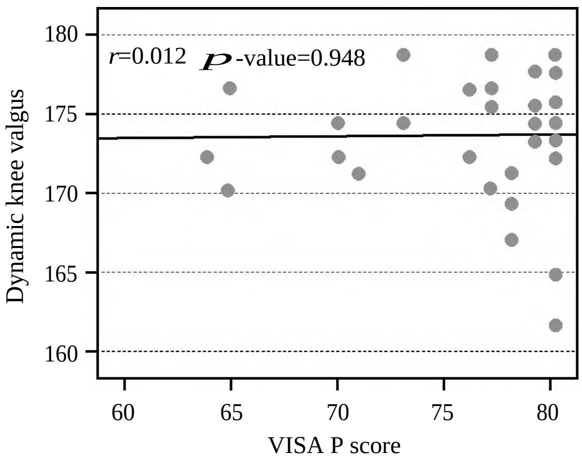


Fig. (7): Correlation between dynamic knee valgus and VAS and VISA-P.

Correlation between dynamic knee valgus and isometric strength of hip abductors and external rotators:

No significant correlations were observed between dynamic knee valgus and isometric strength of hip abductors (r=0.066, p=0.723) and external rotators (r=0.156, p=0.401) (Table 7).

Table (7): Correlation between dynamic knee valgus and isometric strength of hip abductors and external rotators.

Isometric strength	Dynamic knee valgus	
	r	*p*
Hip abductors	0.066	0.723
Hip external rotators	0.156	0.401

r: Correlation coefficient.

Discussion

The aim of this study was to show is there any relationship between hip abductors, external rotators isometric strength and dynamic knee valgus in athletes with Jumper's knee.

Unfortuantely there wasn't enough information about that relationship study for those variables and possible risk factors in jumper's knee athletes. But this work was based on recommendations of some studies like Van der Worp and colleagues (2016) that mentioned in their study, further research into risk factors for Jumper's knee was required, as no strong or moderate evidence was found for an association between PT and any of the investigated factors [25]. Also the idea of the present study supported the recommendations of the treatment protocol of subjects suffering from jumper's knee toward realignment of knee structure and pain alleviation in patient with jumper's knee. Although our study showed some interesting results which found that correlations between peak abductors isometric strength with pain intensity and level of disability were not significant and that result was disagreed with some studies that showed a positive effect of strengthening hip abductors in patient with Jumper's knee.

Concerning of that relationship, the effects of glutei strengthening and increasing hip mobility on a track and field athlete suffering from jumper's knee were determined which showed that these treatments were successful in decreasing pain and allowing the patient to be more functional. This study showed short-term results for this specific plan that was made for this specific athlete. Future studies shall examine more long-term effects of these treatments, as well as study each treatment individually in order to determine the effect of each. This information could also be used to create specialized prevention programs for athletes who are predisposed to jumper's knee [26].

Specific hip abductor and extension exercises to control hip adduction could be a focus of therapy, in addition to eccentric quadriceps exercises. Hip abduction exercises were successful in assisting in movement patterns for patellofemoral pain patients, which could help in reducing other knee injuries. Investigating whether to use patellar stabilizer braces to reduce the lateral movement of the patella during flexion, as opposed to the traditional patellar strap that was commonly used, was an area for future research [27].

The authors of another previous study showed that the presence of adequate hip abductor strength could decrease jumper's knee occurrence in athletes with high passive hip IR ROM [28].

Another interesting finding showed that no significant correlations were observed between peak external rotators isometric strength with pain intensity and level of disability.

The current findings were disagreed with some studies that showed patients with jumper's knee had more lateral mobility of the patella as well as increased hip adduction and increased ankle external rotation during functional tasks of step down and drop vertical jump [27].

And with hip adduction, valgus collapse of the knee, and increased movement of the patella laterally during flexion, abnormal forces could occur over the proximal tendon, since the patellar tendon was fixed distally [27].

And under specific biomechanical loads such as jumping sports, the combination of increased lateral patellar mobility with poor proximal hip strength and control during landing might lead to further tensile stresses to the proximal patellar tendon [27].

Also the relationship between dynamic knee valgus with pain intensity and level of disability was not siginficant so these finidings were disagreed with some studies that showed evidence that impairments in trunk control were associated with knee injuries and decreased hip abductor strength had shown to increase knee valgus angles in single leg squats and landings [24].

Another study demonstrated that this altered hip joint movement pattern during landing was the primary risk factor that predicted both the presence and the severity of patellar tendon abnormalities [21].

Last interesting finding showed that relationship between dynamic knee valgus with hip abductors and external rotators isometric strength was not significant in results and this finding agreed with one study that mentioned, female runners with a large peak hip adduction angle during running did not exhibit less eccentric hip abductor muscle strength, or poorer hip neuromuscular control than runners with a small angle during clinical performance tests. While they did have a greater hip width to femoral length ratio, this did not explain the variance in peak hip adduction angle [20]. Another important outcome was that hip external rotation strength had no effect on sagittal or frontal plane angular motion throughout the landing cycle at the hip and knee [23].

In the contrary to the findings of present study the relationship between hip strength and dynamic lower extremity valgus was conflicting, meta-analysis revealed lower extremity dynamic valgus was consistently associated with hip strength in single leg ballistic tasks, but not double leg ballistic or single leg squat tasks. The relationship between hip strength and dynamic lower extremity valgus might be conditional to task demand [14].

Based on the results of another study, during rehabilitation for jumper's knee, clinicians shall be target proximal hip musculature strengthening and provide effective interventions to prevent or minimize biomechanical shifts that could be caused by the knee valgus angle. There was an evidences in the literature supporting the effectiveness of proximal hip muscles strengthening on the realignment of knee structure and pain alleviation [29].

There were other contrary literatures that discussed the forces that act on the knee joint could stress the patellar tendon like increased varus foot alignment and limited ankle dorsiflexion angle [31].

One study showed that landing with greater trunk flexion could interfere and affect the vertical ground reaction force and peak patellar tendon load in patient with jumper's knee [32].

Honestly there were many factors could impact our results that discussed because knee joint and patellar tendon are affected by biomechanical loads such as jumping, patellar mal-tracking and landing strategies that mentioned by Lazaro and colleagues 2021 [26].

They speculated that many of risk factors were identified to increase possibility of jumper's knee injury like hours of training, previous knee injury, hamstring flexibility and male gender [30].

Limitations:

Limitations of this study included: (1) Absence of a control group to compare their mean values of each measurement. (2) Recommend further studies to measure relationship between hip joint mobility, hamstring flexibility, quadriceps strength, patellar position, and patellar laxity that could potentially have a correlation to the symptoms and should be observed. (3) There were a variety of physical activity levels among participants varying from the elite athletes in this study might not apply to recreational or younger athletes with different levels of training and experience. (4) Recommend future studies could want to create subcategories of participants to provide a more expanded analysis in patients with jumper's knee.

In conclusion, in the present study there were no significant relationships between isometric strength of hip abductors, external rotators and dynamic knee valgus with level of pain and knee disability in jumper's knee athletes.

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العلاقة بين قوة عضلات مفصل الفخذ المبعدة والدورانية للخارج بزاوية انحراف الركبة للداخل فى مرضى الركبة القافزة

الهدف من البحث : أجريت الدراسة لمعرفة هل هناك علاقة بين قوة عضلات مفصل الفخذ القريبة ودرجة زاوية انحراف الركبة للداخل فى مرضى الركبة القافزة.

طريقة البحث : شارك خمسة واربعون رياضياً مصاباً بالركبة القافزة فى هذه الدراسة. تراوحت أعمارهم بين ١٨ و٣٥ سنة. تم اختيار المرضى من فوق كرة السلة فى نوادى سموحة السكندرى والاتحاد السكندرى والمصرية للاتصالات ونادى الاسكندرية الرياضى وعيادة فيزيو سبورت بالاسكندرية. خصع جميع المشاركين لقياسات عزم القوة لعضلات الفخذ المبعدة والدورانية للخارج باستخدام جهاز قياس الديناميكية المحمول باليد وأيضاً قياس زاوية انحراف الركبة للداخل أثناء النزول من على الدرج باستخدام برنامج سوفت وير لتحليل الحركة مع ملئ استبيان مقياس الالم المرئى ومقياس معهد فيكتوريا لتقييم الركبة القافزة

نتائج البحث :

- كانت هناك علاقة سلبية بين قوة عضلات الفخذ المبعدة مع الوزن والطول ومؤشر كتلة الجسم.
- ولا توجد علاقات ذات دلالة إحصائية بين قوة عضلات الفخذ المبعدة والعمر، VISA-P و VIS.
- ولوحظ وجود علاقات سلبية بين قوة عضلات الفخذ الدورانية للخارج والوزن ومؤشر كتلة الجسم. ولا توجد علاقات ذات دلالة إحصائية بين قوة عضلات الفخذ الدورانية للخارج والعمر والطول و VISA-P و VIS.
- لم يلاحظ أى علاقة بين درجة زاوية انحراف الركبة للداخل والعمر، الوزن، الطول، مؤشر كتلة الجسم و VIS وVISA-P.
- لم يلاحظ أى علاقة بين درجة زاوية انحراف الركبة للداخل وقوة عضلات الفخذ المبعدة والدورانية للخارج.

الاستنتاجات : فى ضوء النتائج التى كشفت عنها هذه الدراسة، يمكن الاستنتاج أنه لا توجد علاقة قوية يمكن الاستدلال منها على وجود علاقة بين قوة عضلات مفصل الفخذ القريبة وبين زاوية انحراف الركبة للداخل أثناء الحركة وتأثير ذلك على مقياس الالم والاعتلال الوظيفى لمفصل الركبة لمرضى الركبة القافزة.

انتهت الدراسة إلى التوصيات التالية :

عرضت نتائج الدراسة الحالية الحاجة إلى النظر فى التوصيات التالية :

- يجب إجراء دراسات مستقبلية لتقييم تأثير زيادة قوة العضلات القريبة من مفصل الفخذ على مرضى الركبة القافزة.
- يجب إجراء دراسات مستقبلية لتقييم تأثير درجة زاوية انحراف الركبة للداخل أثناء الهبوط من القفز على مقدار تحمل وتر الرضفة
- يجب إجراء دراسات مستقبلية لمعرفة تأثير زيادة قوة عضلات الحوض وعضلات العمود الفقرى العميقة على مستوى الالم واداء الركبة فى مرضى الركبة القافزة.