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HIP AND LUMBO-PELVIC STRENGTH IN SUBJECTS WITH PATELLOFEMORAL PAIN SYNDROME: A SYSTEMATIC REVIEW OF THE LITERATURE

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The aim of this work was to: (i) review the current state of art about the strength of hip and lumbo-pelvic muscles in patients with Patellofemoral Pain Syndrome (PFPS), (ii) examine and (iii) establish considerations of the findings of the studies. Several databases were searched from 1980 to 2009 containing keywords related to PFPS and strength of Core muscles. After application of inclusion/exclusion criteria, 12 studies were selected in the literature search. The results suggest that most part of the studies found indicated that PFPS group showed a decreased ability to generate force, mainly by hip abductors, extensors and external rotators and trunk lateral flexors. These results point to a demand for training of these muscles during rehabilitation. None of these studies demonstrated a causal relationship between strength and appearance of PFPS.

KEY WORDS: Core, Strength, PatelloFemoral Pain Syndrome, Systematic Review

INTRODUCTION: Patellofemoral pain syndrome (PFPS) is an orthopedic injury with higher incidence in young female athletes (Taunton et al., 2002). It is estimated that approximately 25% of patients seeking orthopedic clinics have a diagnosis of PFPS (Devereaux & Lachmann, 1984). This injury has an insidious onset, remaining the understanding and treatment as an orthopedic paradigm (Witvrouw et al., 2000).

This syndrome is characterized by pain in the retropatellar region, with increased symptoms during activities such as squatting, running, climbing up and down stairs, jumping (Witvrouw et al. 2000). The mechanism of injury is characterized by increased stress on the retropatellar region, caused by different factors such as biomechanical, structural and functional changes, and alterations in the recruitment of lower limb muscles (Powers, 2003).

In the past, most of the studies about this syndrome were focused on the knee joint, because it is the site of occurrence and appearence of the first signs of pain and crepitation (Powers, 2003, Witvrouw et al., 2000). Recently, however, most attention has been given to the importance of hip and lumbo-pelvic, also known as Core region (Wilson et al., 2005, Zazulak et al., 2007). The core region consists of passive and active elements that contribute to whole body stability initiated by the control of the trunk.

Nevertheless, the contribution of passive structures, as bone architecture and soft tissues, to the maintenance of stability during sport activities is small compared to the muscular component. The main function of those muscles is to provide dynamic stability and control of the trunk in the three planes, avoiding inadequate movements and maximizing the transfer of strength and speed to the lower and upper extremity (Leetunet al., 2004, Wilson et al., 2005). However, little is known about the strength of core muscles in patients with PFPS. Therefore, the purpose of this work was to (i) systematically review the current state of art about the strength of Core muscles in patients with PFPS, (ii) examine and (iii) establish considerations of the findings of the studies.

METHODS: Inclusion and Exclusion Criteria: The analysis was composed of prospective and cohort studies in which have been evaluated the strength and torque from the Core region in individuals with PFPS. Systematic reviews, meta-analysis and studies that have evaluated the effects of any kind of treatment of PFPS were excluded from this work.

Search Strategy: The search was established between the years of 1980 and 2009 and the databases PUBMED, SCIELO, OVID, LILACS, ISI WEB KNOWLEDGE, SPORTDISCUS, SCOPUS and COCHRANE LIBRARY were consulted. To increase the sensitivity and specificity of the search the following keywords were used: Patellofemoral Pain, Anterior Knee Pain, Chondromalacea, Chondropathy, Runner`s Knee. All of these were combined with one or more of the keywords: Core, Hip and Trunk.
Review Process: All titles and abstracts initially selected were indexed in the program Endnote version 9 (Thomson & Reuters, CA, USA) to further analysis. Each title and abstract was evaluated by two independent examiners. In case of doubt in the selection of the article based only in the abstract, the full text was read. Any discrepancy between evaluators was resolved at a consensus. If no agreement was reached, a third evaluator, without knowledge of the two previous assessments, was consulted.

RESULTS: In the initial search 569 articles were identified. The application of the inclusion and exclusion criteria for each article allowed the final selection of a total of 12 studies (see Table 1).

Table 1
Description of studies that have examined muscle strength in patients with PFPS.

Reference	Type of Strength	Muscles	Instrumentation	Results
Ireland et al., 2003	IsoMSt	H_ABD, H_ER	IsoK Din	PFPS group < CG
Piva et al., 2005	IsoMSt	H_ABD, H_ER	Hand-Held Din	NSD
Cichanowski et al., 2007	IsoMSt	H_ABD, H_ER, H_ADD, H_IR, H_FLX, H_EXT	Hand-Held Din	PFPS group < CG, but H_ADD showed NSD
Robinson et al., 2007	IsoMSt	H_ABD, H_ER, H_EXT	Hand-Held Din	PFPS group < CG
Bolgla et al., 2008	IsoMSt	H_ABD, H_ER	Hand-Held Din	PFPS group < CG
Dierks et al., 2008	IsoMSt	H_ABD, H_ER	Hand-Held Din	PFPS group < CG
Liebensteiner et al., 2008	IsoTSt	H_EXT	Force Measuring Leg Press System	PFPS group < Ecc_P_St in relation to CG.
Boling et al., 2009	IsoKT	H_ABD, H_ER, H_EXT	IsoK Din	PFPS group < Ecc_P_T in relation to CG for H_ABD. PFPS group < Ecc_A_T and Con_A_T in relation to CG for H_ER. NSD for H_EXT.
Piva et al., 2009	IsoMSt	H_ABD, H_ER	Hand-Held Din	NSD and no correlation among strength, function and pain
Souza et al., 2009	IsoMSt	H_ABD, H_EXT	IsoK Din	PFPS group < CG
Souza et al., 2009	IsoMSt, IsoKT, IsoTT	H_ABD, H_ER, H_EXT, P_L	IsoK Din	PFPS group < CG. H_EXT endurance was the only predictor of hip IR
Wilson et al., 2009	IsoMSt	T_FLX, H_ABD, H_ER	Hand-Held Din	PFPS group < CG

PFPS: Patellofemoral Pain Syndrome Group; CG: Control Goup; NSD: No Significant Differences; H_ABD: Hip abductors; H_ER: Hip external rotators; H_ADD: Hip adductors; H_IR: Hip internal rotators; H_FLX: Hip flexors; H_EXT: Hip Extensors; T_FLX:Trunk Lateral Flefors; P_L: Pelvic Lifters; IsoMSt: Isometric Strength; IsoTT: Isotonic Torque; IsoKT: Isokinetic Torque; Hand-Held Dyn: Hand-Held Dynamometer; IsoK Din: Isokinetic Dynamometer; Ecc_P_St: Eccentric Peak Strength; Ecc_P_T: Eccentric Peak Torque; Ecc_A_T: Eccentric Average Torque Con_A_T: Concentric Average Torque;

Individuals with PFPS showed a significant reduction in isometric strength (IsoMSt) of hip abductors and external rotators. Only two studies have not observed these alterations. Hip extensor muscles showed a decrease in IsoMSt, Isokinetic torque (IsoKT) and muscular endurance. Cichanowski & Schmitt (2007) reported a smaller IsoMSt of hip internal rotators and flexors, but no differences for the hip adductors, in the PFPS group. The trunk lateral flexors showed decreased IsoMSt, Isotonic strength, IsoKT and muscular endurance in PFPS group compared do healthy subjects (Table 1).

DISCUSSION: The purpose of this systematic review was to delineate the state of art about hip and lumbo-pelvic strength in individuals with PFPS. The importance of this review is that the core region is essential in controlling the position of the upper and lower limbs during sports activities (Wilson et al., 2005). Based on the results of this review, PFPS group tended to show several changes in muscle strength compared to healthy individuals.

Individuals with PFPS showed, in most studies examined, a decrease in the capacity of generating strength in hip abductors and external rotators (Table 1). Only two studies did not find differences for those muscles. This could be explained by the fact that the tests in these two studies were performed with the individuals in prone, with the knee flexed at 90° and the hip in neutral position. This position seems to be inapropriate to achieve maximum muscle contraction compared with the strategy adopted by the studies presented above, which performed the tests in the sitting position. The inadequacy in the strength of these muscles can lead to contralateral pelvic drop and hip adduction, generating an increase in knee valgus and hip internal rotation. These biomechanical alterations can increase the lateralization of the patella, which reduce the pattelofemoral contact area and increase the retropatellar stress (Leetun et al., 2004). However, due to the transversal design of the studies used in this review, it is no possible to infer a relationship of cause and effect between decreased strength in these muscles and PFPS.

In relation to the other muscles of core region, only hip flexors, internal rotators and adductores muscles were examined. Cichanowski & Schmitt (2007) showed decreased strength of hip flexors and internal rotators in the PFPS group, compared to healthy subjects. Nevertheless, these results should be interpreted with caution, due to the low number of studies found. In order to extrapolate these results, new studies with more controlled experimental conditions should be conducted.

Despite these results, three aspects, present in most studies, limit the generalizability of the results: the type of force evaluated, the instrumentation used in testing and the processing techniques used in the analysis of muscle strength. Although it seem to have some relationship between pelvic drop and hip abductor weakenss, as dscribed above, in general the assessment of the strength does not occur in a functional form. Among the instruments used in the evaluation of strength, it is recurrent the use of isometric and isokinetic dynamometer, during the execution of open kinetic chain exercises. However, the alterations in biomechanical behavior in PFPS group, as described in the literature (Wilson et al., 2008, Souza et al., 2009), were observed in closed chain exercises. In relation to the data processing, all studies found used parametric variables, as the peak or the average behavior of the strength, to report their results. Parametrization techniques extract instantaneous values of signal amplitude, which ignore the pattern of movement. According to Chau (2001) the extraction of these pre-defined parameters is subjective and neglects the temporal information of the signal, containing limited information about the movement. To obtain information that describe the main differences between the tasks or groups, it is necessary to consider the whole waveform. Other techniques of processing, commonly used in other areas of biomechanics, like Principal Component Analysis, Support Vector Machine and Probabilistic Neural Network (Donà et al., 2009, Muniz et al., 2010), should be introduced in the analysis of muscle strength.

Thus, it is unclear to what extent the differences in strength and endurance found in the studies reflect, in fact, the functional changes demonstrated by PFPS group. In this sense, it is recommended the development and application of tests using closed kinetic chain exercises with instruments that would allow a greater degree of functionality, based on the replication of activities that commonly cause pain in this population.

CONCLUSION: From the evidences found in this review, we conclude that the hip abductors, external rotators and trunk lateral flexors are some of the weaker muscles in

PFPS group, in comparison to healthy individuals. Therefore, during the rehabilitation process it is important to strengthen these muscles to decrease the difference in relation to healthy subjects. However, it is not possible to affirm if these changes are cause or consequence of the injury, due to the transversal design of the studies. Furthermore, it is necessary, in future studies, to develop new tests to measure muscle strength, contemplating aspects related to the function executed by the subject in each sport, aiming to overcome the lack of internal validity of isometric and isokinetic strategies.

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