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Original article

Effects of static stretching of knee musculature on patellar alignment and knee functional disability in male patients diagnosed with knee extension syndrome: A single-group, pretest–posttest trial

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ABSTRACT

Background: Knee extension (Kext) syndrome is based on movement system impairments and is described as knee pain associated with quadriceps stiffness.
Objective: To investigate the effects of 3 times per week for 4 weeks static stretching of knee musculature on patellar alignment and knee functional disability in male Kext syndrome patients.
Design: A single-group, pretest–posttest clinical trial.
Setting: Hazrat-e-Rasoul Akram Hospital.
Participants: Forty-six male Kext syndrome patients aged 18–35 years.
Methods: Knee functional disability was assessed by the Kujala questionnaire. Patellar tilt was assessed using the skyline view X-ray. In addition, patella alta was assessed by X-ray using the Insall–Salvati ratio. After intervention, changes in knee flexion–extension range of motion (ROM) and hip adduction were assessed by goniometer and inclinometer. Changes in patellar tilt and patella alta were evaluated. Correlations between muscles length, patellar tilt and knee functional disability were also evaluated.
Results: The mean of patellar tilt in male Kext syndrome patients was 15.19°. Only the correlation between rectus femoris shortness and patellar tilt ($P = 0.002$) and the correlation between rectus femoris shortness and knee functional disability ($P = 0.037$) were significant. Patella alta was not severe in male Kext syndrome patients (1.28 ± 0.10). Knee flexion–extension ROM and femoral adduction increased significantly after a 12-session stretching programme ($P < 0.0001$).
Conclusion: The results demonstrated that rectus femoris shortness had higher correlation with patellar tilt and knee functional disability than iliotibial band and hamstring shortness. Stretching was effective in reducing patellar tilt, patella alta, knee functional disability, increasing knee ROM and hip adduction in these patients.

1. Introduction

There are various methods which assist physical therapists in the management of musculoskeletal disorders. Traditional physical therapy assessment of musculoskeletal disorders is based on the patient's history, mechanism(s) of injury, and orthopedic special tests with a focus on identifying the injured tissue or organ that appears to be the source of the symptoms and ruling out other sources that may be referring pain to the symptomatic region (physician's diagnosis) (Caldwell et al., 2007; Magee, 2014). Patient's symptoms are assessed during passive movements (Kalterborn, 1993; Maitland et al., 2005), active movements (Cyriax, 1980; McKenzie and May, 2003; Maitland et al., 2005), sustained positions (McKenzie and May, 2003), repeated movements

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(McKenzie and May, 2003), and combined movements (Edwards, 1999). However, the physician's diagnoses related to the pathoanatomical source of pain are not designed to guide physical therapists in the management of musculoskeletal disorders (Caldwell et al., 2007). Therefore, new classifications have been proposed based on the human movement system (Van Dillen et al., 1998; Sahrmann, 2002, 2011; O'Sullivan, 2005; Luomajoki et al., 2007; Mottram and Comerford, 2008; Harris-Hayes et al., 2008; Ludewig et al., 2013).

These classifications proposed an assessment moving away from patient's symptoms to exploring movement impairments and how these impairments related to the symptoms. These classifications are important where there are no reliable diagnostic tests for musculoskeletal disorders. Thus, classifying movement faults based on the human movement system is gaining recognition and acceptance. Luomajoki et al. (2007) identified *movement control dysfunction* (MCD). A common characteristic of MCD is reduced control of active movements, or movement control dysfunction. The MCD is recognized by a series of clinical tests. The tests are based on the inability to control movements at one segment while producing an active movement at another segment at the same time (Comerford and Mottram, 2001). The reliability of these tests has been shown by Luomajoki et al. (2007) and Roussel et al. (2009). Another classification has been developed by O'Sullivan (2005). His classification is based on *motor control impairment* (MCI). In the MCI, physical therapists focus on altered strategies of postural and movement controls. The interrater reliability of this classification system for six different levels of decision making has been indicated by Vibe Fersum et al. (2009) (For levels 1–4; the mean percentage agreement was 96% (range 75–100%), For level 5; Kappa coefficient and percentage agreement had a mean of 0.82 (range 0.66–0.90) and 86% (range 73–92%), respectively. At the final level, Kappa coefficient and percentage agreement yielded a mean of 0.65 (range 0.57–0.74) and 87% (range 85–92%)). Mottram and Comerford (2008) proposed *uncontrolled movement* (UCM). The UCM is labeled in terms of site and direction based on the ability to cognitively control the movement of a joint segment, not only on observation of altered range of motion (ROM). Van Dillen et al. (1998), Sahrmann (2002, 2011), and Harris-Hayes et al. (2008) described a classification system for the spine and extremities based on *movement system impairment* (MSI). The MSI offers a method of assigning a diagnosis, classify, and a treatment to patients with musculoskeletal disorders. The diagnosis is named for abnormal alignment and altered movement patterns that appear to be related to the patient's symptom during testing or functional activities. Musculoskeletal pain in this classification is improved by correction of the movement impairment. The focus of the MSI is on the movement that produces pain rather than the pathoanatomical source of pain (Sahrmann, 2002, 2011; Caldwell et al., 2007; Van Dillen et al., 2009). In 2008, Harris-Hayes et al. proposed the MSI diagnoses associated with knee pain. The proposed MSI diagnoses include tibiofemoral rotation (TFR) syndrome with valgus or varus (TFRVal or TFRVar), tibiofemoral hypomobility (TFHypo) syndrome, tibiofemoral accessory hypermobility (TFAH) syndrome, knee extension (Kext) syndrome, knee hyperextension (Khext) syndrome, patellar lateral glide (PLG) syndrome, and knee impairment.

Kext syndrome is described as knee pain associated with quadriceps dominance or stiffness that results in an excessive superior pull on the patella, patellar tendon, or tibial tubercle (Sahrmann, 2011). The excessive pull would be in the direction of quadriceps line of force. Patients with this condition may report pain superior to the patella in structures such as the quadriceps muscle or the quadriceps tendon (suprapatellar pain) (Sahrmann, 2011). In this syndrome, patients often exhibit swayback posture and posterior pelvic tilt (Sahrmann, 2011). Kext syndrome patients show decreased knee flexion during activities such as running and walking, especially between heel-strike and foot-flat phases of gait cycle. In addition, the suprapatellar pain is intensified by activities that require repetitive or forceful knee extension such as jumping (Sahrmann, 2011). Patellar involvement following stiffness of the quadriceps muscle could be seen as patella alta. When patellar involvement occurs in Kext syndrome, the retinacular fibers around the knee are often more flexible in comparison to the quadriceps muscle. In addition, Kext syndrome may be associated with poor performance of the hip extensors like the gluteal muscles (Sahrmann, 2011).

To date, several studies have looked at the effects of stretching of knee musculature on patellofemoral joint pain and knee joint disorders. Peeler and Anderson (2007) evaluated the effectiveness of a 3-week static quadriceps muscle stretching programme in individuals with patellofemoral joint pain. Participants of this investigation were instructed to complete the stretching of the quadriceps muscle on a daily basis for a 3-week, with each stretch being held for 30 s, and repeated 5 times in a row. The results of the study confirmed the effectiveness of this regimen for enhancing quadriceps flexibility and knee joint function in individuals with patellofemoral joint pain. In 2010, Reid and McNair compared the effects of an acute stretching intervention on knee extension ROM, passive resistive torque and stiffness in individuals with and without knee osteoarthritis (OA). Three 60-s stretches with 60 s of rest between stretches were applied to the hamstring muscles of both groups. The results of both groups demonstrated a significant increase in knee extension ROM (the mean increase for the OA group and the non OA group was 4.9° and 4.4°, respectively), peak passive torque (the mean increase for the OA group and the non OA group was 4.4 Nm and 1.0 Nm, respectively) and stiffness (the mean increase for the OA group and the non OA group was 0.19 Nm/degree and 0.04 Nm/degree, respectively). In another study, Ahmed (2010) assessed the effectiveness of home-based knee stretching program on knee pain and physical function in patients with knee OA. The results showed that home-based quadriceps and hamstring stretching programmes (once a day for 3 months) have positive effects in reducing knee pain and improvement in knee ROM and knee function among patients with severe OA. However to the best of authors' knowledge, there is no clinical study which has investigated the effects of static stretching of knee musculature on patellar alignment and knee functional disability in patients with Kext syndrome. Therefore, the present study aims to investigate the effects of static stretching of knee musculature on patellar alignment and knee functional disability in male patients with Kext syndrome. Due to the rules and regulations imposed by the Ethical Committee of Tehran University of Medical Sciences and Health Services, this study was carried out only on male patients.

The hypotheses of the current study were as follows:

1 Patellar alignment would be changed in male Kext syndrome patients.
2 There is a relationship between knee functional disability and knee musculature shortness in male Kext syndrome patients.
3 Static stretching of knee musculature would have an effect on knee functional disability and patellar alignment in male Kext syndrome patients.

2. Methods

2.1. Participants

This single-group, pretest–posttest clinical trial was approved by the Ethical Committee of Tehran University of Medical Sciences