



Therapeutic modalities and postural balance of patients with knee osteoarthritis: systematic review

Modalidades terapêuticas e equilíbrio postural de pacientes com osteoartrite: revisão sistemática

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Abstract

Objective: The objective of this review was to evaluate the evidence of the influence of therapeutic modalities on postural balance in patients with knee osteoarthritis (OA). **Methods:** A search for published papers on therapeutic modalities was conducted using the Pubmed, Medline, Lilacs and SciELO databases. The keywords “knee” and “balance” in combination with “osteoarthritis” were used as the search strategy. Randomized controlled clinical trials published in the last 10 years in either English or Portuguese were selected. The PEDro scale was applied to assess the quality of the selected clinical trials. **Results:** A total of 46 studies of patients with knee OA were found, of which seven were analyzed in full and 39 were excluded because they did not

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meet the inclusion criteria. Of the seven studies reviewed, six were considered to have a high methodological quality on the PEDro scale. Several therapeutic modalities were found (physical exercise, hydrotherapy, electrotherapy and manual therapy), and postural balance improved in only three studies. **Conclusion:** The studies included in this systematic review had a high methodological quality, so it can be concluded that the therapeutic modalities used in those studies improved postural balance in patients with knee OA.

Keywords: Osteoarthritis. Rehabilitation. Balance. Knee.

Resumo

Objetivo: O objetivo desta revisão foi fornecer evidências da influência das modalidades terapêuticas no equilíbrio postural em pacientes com osteoartrite de joelho. **Métodos:** A busca de publicações sobre as modalidades terapêuticas foi realizada nas bases de dados Pubmed, Medline, Lilacs e SciELO. Foram utilizadas como estratégia de busca as palavras-chave "knee" e "balance", em combinação com "osteoarthritis". Foram selecionados ensaios clínicos aleatórios e controlados dos últimos dez anos, em língua inglesa e portuguesa. Para verificar a qualidade dos ensaios clínicos selecionados, foi aplicada a Escala PEDro. **Resultados:** Foram encontrados 46 estudos com pacientes com OA de joelho, sendo que, 7 estudos foram analisados na íntegra e 39 estudos foram excluídos por não se adequarem ao tema proposto. Dos sete estudos avaliados, seis foram considerados de alta qualidade metodológica na Escala de PEDro. Foram encontradas diversas modalidades terapêuticas (exercício físico, hidroterapia, eletroterapia e terapias manuais), porém em apenas três estudos houve melhora no equilíbrio postural. **Conclusão:** Tendo em vista que os estudos incluídos na presente revisão sistemática têm uma alta qualidade metodológica, pode-se concluir que as modalidades terapêuticas utilizadas pelos estudos melhoraram o equilíbrio postural de pacientes com OA de joelho.

Palavras-chave: Osteoartrite. Reabilitação. Equilíbrio. Joelho.

Introduction

The World Health Organization indicates that knee osteoarthritis (OA) is likely to become the leading cause of disability worldwide, and it is currently the fourth-highest cause in women and the eighth in men (1). Biochemical changes and biomechanical stress in the subchondral bone, articular cartilage and synovial membrane are important factors in the pathogenesis of OA (2). OA is characterized by pain, swelling, proprioceptive deficit, circulatory impairment, muscle stiffness and weakness (3), resulting in functional disability, reduced quality of life (4) and postural balance deficit, all indicators of functional impairment and the risk of falls (5-7).

Postural balance is a complex function that requires interaction between the visual, vestibular, somatosensory and neuromuscular systems (8). Proprioception is important for postural balance given the activation of reflex responses that protect and stabilize the knee's proprioceptive acuity. A proprioceptive deficit occurs in knee OA due to a significant

decrease of mechanoreceptors in the ligaments, as well as in quadriceps muscle strength (9).

In the last 10 years there has been growing interest in the study of the most appropriate therapeutic modalities for the treatment of OA. The review by Roos and Juhl (10) showed that in 17 analyzed studies on non-pharmacological treatments for OA, physical exercise, education and weight loss were the most effective treatments. The systematic review by Silva et al. (11) showed that aerobic and resistance exercise improved postural balance in women with knee OA, and the studies that reported those findings were of high methodological quality and had strong scientific evidence. Physical exercise is a non-pharmacological intervention for knee OA recommended by the American College of Rheumatology (ACR) and the European League Against Rheumatism (12, 13). This intervention aims to prevent muscle atrophy, increase muscle strength and resistance and maintain the range of motion of the knee joint to provide greater functional independence (14). However, other therapeutic resources (electrotherapy, hydrotherapy,

manual therapy, massage) have also been applied for the treatment of patients with knee OA to reduce the risk of falls and pain and to improve physical function, functional capacity, the strength of knee extensors and hip abductors, range of motion, quality of life and postural balance (14-17).

Given that postural balance is one of the factors responsible for falls and functional limitations in patients with OA, the objective of this review is to assess the clinical and scientific evidence of the influence of therapeutic modalities on postural balance in patients with knee OA.

Methods

Databases

Searches were conducted on the PubMed, Medline, Lilacs and SciELO electronic databases to identify publications on the therapeutic modalities proposed to improve postural balance in patients with knee OA.

Search strategy

The search strategy used the keywords “knee”, “balance”, “osteoarthritis” and “treatment”. The bibliographic survey was restricted to publications of randomized controlled clinical trials in the last 10 years (May 2003-April 2013) in English and Portuguese.

Study selection

Only randomized controlled clinical trials that used therapeutic modalities as a form of non-pharmacological treatment in patients with knee OA to improve postural balance were considered. Studies were selected using the following inclusion criteria: patients with a clinical diagnosis of OA; study of the relationship between postural balance and OA; random sampling of patients; and comparison between intervention groups and/or between intervention and control groups for some physiotherapeutic treatment modality. Studies that used pharmacological treatments or surgery were excluded.

The articles were analyzed in their entirety using a structured approach. The following items were taken into account: author/year, sample, study

design, evaluated outcomes, intervention, tools and effects found.

Assessment of methodological quality

The PEDro scale (18) was used to evaluate the methodological quality of the included studies. This scale, based on the Delphi list (19) and translated into Portuguese in 2009 (18), consists of 11 items that evaluate the methodological quality of randomized clinical trials. Studies with a score greater than or equal to 5 (50%) were considered to have high methodological quality (20). The studies were independently analyzed by two reviewers. In cases where there were differences of opinion, discrepancies were reviewed and discussed with a third reviewer to reach a consensus on the score. A critical review of the contents was performed due to the small number of articles.

Results

Studies identified

A total of 46 articles were found in the initial search conducted in the electronic databases. Duplicate studies and studies that did not meet the inclusion criteria were identified after analyzing the titles and reading the abstracts. Seven articles remained that were within the scope of the review, with a total of 564 participants (409 women and 155 men). Critical assessment was then performed to examine the effectiveness of therapeutic modalities on the postural balance of OA patients. Thirty-nine articles were excluded because they did not match the inclusion criteria due to the use of drugs (21-30), the use of surgery (27, 31-36), other aspects that conflicted with the inclusion criteria (32, 37-54) or the absence of a control group or other intervention group to compare with the treatment group.

Evaluation of study quality

The seven articles were analyzed using the PEDro scale (18) (Table 1). Six of the articles were considered to be of high quality on the PEDro scale because they achieved a score greater than 5. Those

that scored highest were the studies by Bennell et al. (55), Hinman et al. (15), Lund et al. (16) and Hale et al. (17), each scoring 8 points. Only the study by Tok et al. (14) was considered to be of low methodological quality.

General data of the selected articles

We selected some information to represent the articles included in this review, summarizing them according to the following aspects: author/year, sample, evaluated outcomes, study design, interventions, tools and effects found (Table 2). Based on a critical analysis of the clinical trials selected, the therapeutic modalities used for the treatment of postural balance

were hydrotherapy (15-17), massage (55), joint mobilization (55), land-based exercise (15, 55), footwear (56), infrared, ultrasound and interferential current (14). However, laser therapy did not lead to any improvement in patients with knee OA (57).

The samples in the seven studies ranged from 39 to 140 individuals. In six studies the sample was composed of both genders (14, 17, 55-57), whereas the treatment group of one study comprised only women. Most studies used the criteria proposed by ACR to perform the clinical diagnosis of OA. All studies were experimental, with pre and post-intervention evaluations. Long-term evaluation (follow-up) occurred in five studies (16, 17, 55-57). Three studies found that interventions significantly improved balance (14, 16, 55).

Table 1 - Methodological classification assessed by PEDro scale

	Bennell et al. (2005)	Nigg et al. (2006)	Hinman et al. (2007)	Lund et al. (2008)	Tok et al. (2011)	Hale et al. (2012)	Hsieh et al. (2012)
Question 1*	Yes	Yes	Yes	Yes	No	Yes	Yes
Question 2	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 3	Yes	No	Yes	Yes	No	Yes	Yes
Question 4	Yes	Yes	Yes	Yes	No	Yes	Yes
Question 5	No	No	No	No	No	No	No
Question 6	No	No	No	No	No	No	No
Question 7	Yes	Yes	Yes	Yes	No	Yes	No
Question 8	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 9	Yes	No	Yes	Yes	No	Yes	Yes
Question 10	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Question 11	Yes	Yes	Yes	Yes	No	Yes	No
Total	8	6	8	8	3	8	6

Note: *Since the score for the first item is on external validity, it is not considered in the final score (Moseley et al. (20)). Question 1: The eligibility criteria were specified; Question 2: The subjects were randomly distributed per group; Question 3: The distribution of the subjects was blind; Question 4: Initially, the groups were similar with respect to prognostic indicators more important; Question 5: All subjects participated in a blind fashion in study; Question 6: All physical therapists who administered the therapy did so in a blinded fashion; Question 7: All evaluators who measured at least one key outcome, they did it blindly; Question 8: Measurements of at least one key outcome was obtained by more than 85% of the subjects initially distributed by the groups; Question 9: All subjects from which they presented measurements of results received the treatment or the condition of control according to distribution or, became an analysis of the data for at least one of the key outcomes of "intention to treat"; Question 10: The results of statistical comparisons between groups were described for at least one key outcome; Question 11: The study presents both measures of accuracy as measures of variability for at least one key outcome.

Table 2 - General data of the selected articles

(To be continued)

Study	Sample	Evaluated outcomes	Study design	Intervention	Tools	Effects found
Bennell et al. (2005)	Diagnosis: ACR Inclusion: XR grades I and II Age: > 65 years (n = 46♂/94♀) Groups: IG = Kinesiotherapy and Kinesio taping (n = 23♂/50♀) CG = Placebo (n = 23♂/44♀)	- Pain - Physical function - Quality of life - Balance - Quadriceps muscle strength	Randomized controlled clinical trial Evaluations: pre- and post-intervention and at 12-week follow-up.	IG = Exercises of quadriceps strengthening, balance, thoracic spine mobilization and kinesio taping CG = Non-therapeutic US and Light (placebo) - 1x/week - 4 weeks - After every 2 weeks for 8 weeks - Groups of 5 people	- VAS - Likert Scale - WOMAC - SF-36 - AqoL - Step test - Kin-Com Dynamometer	- Reduction in pain in both group. - Improvement in self-reported physical function, pain, quality of life, balance and muscle strength in both groups - Quality of life was significantly better in IG
Nigg et al. (2006)	Diagnosis: ACR Inclusion: XR grades II-IV Age: > 50 years (n = 56♂/67♀) Groups: IG = Use of therapeutic footwear (n = 26♂/31♀) CG = Control (n = 30♂/36♀)	- Pain - Stiffness - Physical function - Range of motion - Muscle strength - Balance	Randomized controlled clinical trial Evaluations: pre-intervention and at 3, 6, 9 and 12 weeks of intervention	IG = Use of New Balance 756WB model trainers CG = Walking shoe - 12 weeks	- WOMAC - VAS - Biodex system - Static and dynamic balance	- Pain decreased in both groups after 12 weeks of study - Increase in eversion peak torque in both groups - Significant improvement in balance in IG after 12 weeks
Hinman et al. (2007)	Diagnosis: ACR Inclusion: XR (osteophytes and reduced intra-articular space) and pain Age: > 50 years Groups: IG = Hydrotherapy (n = 9♂/24♀) CG = Control (n = 11♂/24♀)	- Pain - Physical function - Level of physical activity - Quality of life - Muscle strength	Randomized controlled clinical trial Evaluations: pre- and post-intervention and at 6-week follow-up	IG = Strengthening and balance exercises in heated pool (34 °C) - 2x/week (45 to 60 min) - 6 weeks CG = No intervention during the study period, but after the end of that period aquatic therapy was offered	- VAS - Likert scale - WOMAC - Timed "Up & Go" test - Walk test - Step test	- Significant improvement in pain, physical function, muscle strength and quality of life - No differences in step test or timed "Up & Go" test between groups pre- or post-intervention

Table 2 - General data of the selected articles

(To be continued)

Study	Sample	Evaluated outcomes	Study design	Intervention	Tools	Effects found
Lund et al. (2008)	Diagnosis: ACR Inclusion: Primary OA Age: 40-89 years Groups: IG1 = Hydrotherapy (n = 27♀) IG2 = Land-based (n = 25♀) CG = Control (n = 27♀)	- Pain - Physical function - Balance - Muscle strength	Randomized controlled clinical trial Evaluations: pre- and post-intervention and at 3-month follow-up	IG1 = Warm-up, strengthening, endurance, balance and stretching exercises with a water temperature of 33.5 °C. IG2 = Warm-up, strengthening, endurance, balance and stretching exercises on land. - 2x/week - 8 weeks - Group attendance CG = No intervention	- VAS - KOOS - Balance Master Pro™ - Biodex system	- No difference in pain or KOOS between the 3 groups after 8 weeks - IG2 had improvement in pain compared with CG at 3-month follow-up - Improved muscle strength in IG2 compared to CG - No difference was found in balance
Tok et al. (2011)	Diagnosis: XR Inclusion: Grade II or III Age: 42-80 years (n = 10♂/30♀) Groups: IG1 = Electrotherapy (n = 4♂/16♀) IG2 = Electrotherapy and isometric exercises (n = 6♂/14♀)	- Pain and physical function - Quality of Life - Muscle strength - Balance (static and dynamic)	Randomized controlled clinical trial Pre-and post-intervention evaluation	- IG1 = Combination therapy: infrared, interferential current, ultrasound and continuous passive motion (CPM) - IG2 = Combination therapy: infrared, interferential current, ultrasound, biphasic current and isometric exercises - 3x/week - 5 weeks	- WOMAC - SF36 - Cybex 6000 - KAT 2000	- Muscle strength and balance improved significantly in IG1 - Pain and stiffness improved significantly in both groups - Static and dynamic balance improved in both groups
Hale et al. (2012)	Diagnosis: WOMAC Inclusion: OA with pain Age: 45-70 years (n = 10♂/29♀) Groups: IG = Hydrotherapy (n = 6♂/17♀) CG = Control (n = 4♂/12♀)	- Risk of falls - Balance - Self-reported physical function and pain - Balance and fear of falling	Randomized controlled clinical trial Pre-and post-intervention evaluation	IG1 = Warm-up and balance CG = Educational meetings on OA. - 2x/week - 12 weeks	- Physiological profile assessment - Step Test and Timed "Up & Go" - WOMAC	- Improved balance in both groups - Improvement in reaction time and contrast sensitivity - Lower risk of falls

Table 2 - General data of the selected articles

(Conclusion)

Study	Sample	Evaluated outcomes	Study design	Intervention	Tools	Effects found
Hsieh et al. (2012)	Diagnosis: ACR Inclusion: Patients waiting for surgery Age: 40–90 years (n = 10♂/62♀) Groups: IG = electrotherapy (n = 3♂/34♀) CG = control (n = 7♂/28♀)	- Pain - Stiffness - Balance - Muscle strength - Fitness - Balance	Randomized controlled clinical trial Evaluations: pre-intervention, after 1 and 2 weeks of intervention and 1- and 2- week follow-up	IG = 890-nm radiation in affected knee CG = Placebo - 3x/week - 2 weeks	- WOMAC - Stair-climbing test, speed walking test, chair-rising test - Biodex system	- No differences in WOMAC score between groups - No difference in functional capacity or postural stability between groups

Note: ACR = American College of Rheumatology; IG = intervention group; CG = control group; US = ultrasound; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; VAS = visual analogue scale; XR = X-ray; AqoL = Assessment of Quality of Life index; KOOS = Knee Injury and Osteoarthritis Outcome Score.

Discussion

The analysis of the selected studies showed that a variety of therapeutic modalities are used in physiotherapeutic clinical practice to improve postural balance in patients with knee OA. Of the seven studies evaluated, six studies had a PEDro score considered to represent high methodological quality, so their intervention methods can be used in clinical practice. These interventions are electrotherapy (14), hydrotherapy (15-17), massage (55), joint mobilization (55), physical exercise (16, 55) and footwear (56). Three studies reported an improvement in balance in patients with knee OA: Tok et al. (14), Bennel et al. (55) and Lund et al. (16).

The methodological designs of the studies were appropriately described and developed, which enables clinical reproducibility. Moreover, the use of validated tools and the reliability of application increased the consistency of their results and the outcomes evaluated. In most of the studies, the diagnosis of OA was based on the ACR criteria, consisting of clinical and radiographic evaluation according to the Kellgren and Lawrence scale (16, 55, 57).

The representativeness of the sample can be considered adequate, with an average of 20 subjects per group, and only one study used 50 subjects per group. We selected studies that involved OA patients of both genders, but one study was conducted only with

women (16). The percentage of women was higher in all studies, which is consistent with epidemiological data that show that OA is more prevalent in females due to hormonal effects (58).

The therapeutic modalities that stood out in the literature were land-based exercise and hydrotherapy, both aiming to strengthen the muscles of the lower limbs and improve balance (14, 16, 17, 55). Improvement of hip abductor strength helps to stabilize the contralateral hip during gait due to the effect of the center of mass, which can reduce the adduction moment (compressive force), decrease pain and improve the muscle strength and physical function (59). Because knee extensor strength is related to anteroposterior oscillation, Pua et al. (60) designed different central nervous system (CNS) strategies to improve physical function by using the remaining receptors in patients with sensory and motor deficiencies. Furthermore, Slemenda et al. (61) and O'Reilly et al. (62) reported that strengthening the quadriceps and hip abductors leads to reduction in pain and stiffness and improves physical function, thereby contributing to improvement of postural oscillation, as highlighted by Hunt et al. (63). Those findings concur with Bennel et al. (55), who studied the risk of falls in elderly people with and without OA and found that decreased use of assistive walking devices led to reduced risk of falls in the elderly study group, in addition to a self-reported improvement in balance.

The results of the studies that used land-based exercises (16, 55), hydrotherapy (15-17), electrotherapy (14), manual therapy (55) and footwear (56) showed positive effects on some evaluated outcomes, such as pain, stiffness, risk of falls and physical function. However, regarding the outcome of balance, Tok et al. (14) found a significant improvement, while Hinman et al. (15) found no difference in balance between groups. In contrast, Hale et al. (17) found a significant improvement in Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) score, risk of falls, impact of illness and fear of falling and a subjective improvement in self-reported balance, in a study in which the experimental group performed strengthening exercises associated with balance for 4 weeks, once per week. These results demonstrate the effectiveness of strength and balance training in patients with knee OA.

The therapeutic approach used in most studies was hydrotherapy, which produced better results than land-based exercises, manual techniques, use of adapted footwear and electrotherapy. Lund et al. (16) compared water-based and land-based strength and balance exercises in patients with knee OA for 8 weeks, twice a week, and found differences in levels of pain, physical function and quality of life in both groups immediately after the exercise protocol. Nonetheless, the authors reported that hydrotherapy brought more benefits to patients with knee OA than those who performed the land-based protocol, which they attributed to the physical nature of hydrotherapy, which reduces overload on the joints and encourages greater participation compared with land-based exercise.

A recent study by Tok et al. (14), comparing a group who used electrotherapy combined with isometric exercises and a group using only electrotherapy for two weeks, three times a week, found improved balance, pain during activity and stiffness in both groups, but did not observe improvements in pain or function in either study group. Different results were found by Hsieh et al. (57), who did not observe any improvement in balance, pain, function, stiffness or functional capacity from electrotherapy.

Another therapeutic resource used for patients with knee OA is therapeutic footwear. Nigg et al. (56) found improvements in pain and static standing balance using such footwear, but no improvement was observed in these two parameters during walking.

It would appear that any conclusion as to the optimal duration and frequency of intervention, the tools used and the adverse effects would be unwarranted because the intervention period in these evaluated studies ranged from 2 weeks to 12 months, the frequency varied from 1 to 5 times a week and the tools used to assess pain and balance varied.

The present review found that various therapeutic modalities are used for the rehabilitation of patients with OA. Among other goals, those treatments aimed to improve balance. However, their results varied regarding the benefits of the therapeutic modalities, the treatment duration and the frequency of sessions. These inconsistencies are the main limiting factor of the studies analyzed. However, these treatment modalities are widely used in clinical practice by physiotherapists. Given that the studies included in this systematic review are of high methodological quality, it can be concluded that the therapeutic resources proposed and used in rehabilitation programs should be considered in clinical practice because of their positive effects on balance and the other benefits they offer for patients with knee OA.

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