PriMera Scientific
Medicine and Public Health
Volume 2 Issue 6 June 2023
DOI: 10.56831/PSMPH-02-065
ISSN: 2833-5627

PriMera Scientific Publications

The Acute Effects of Passive Stretching Intervention on Joint Properties in Patients with Knee Osteoarthritis

Type: Research Article
Received: April 25, 2023
Published: May 04, 2023

Citation:
Theodoros M Kannas., et al. "The Acute Effects of Passive Stretching Intervention on Joint Properties in Patients with Knee Osteoarthritis". PriMera Scientific Medicine and Public Health 2.6 (2023): 04-10.

Theodoros M Kannas[1]*, Parikou Christina[1], Georgios Chalatzoglidis[1], Evangelia Germanou[2], Nikolaos E Koukoulias[3] and Fotini Arabatzi[1]

[1]Laboratory of Neuromechanics, Department of Physical Education and Sport Science, Aristotle University of Thessaloniki, Serres, Greece

[2]Department of Physical Education and Sport Science, Aristotle University of Thessaloniki, Thessaloniki, Greece

[3]Sports Trauma and Orthopaedics Department, St Luke's Hospital, Thessaloniki, Greece

***Corresponding Author:** Theodoros M Kannas, Laboratory of Neuromechanics, Department of Physical Education and Sport Science, Aristotle University of Thessaloniki, Agios Ioannis, 62100, Serres, Greece.

Abstract

Background: Knee osteoarthritis (KOA) is a degenerative disease with over 600 million people suffering worldwide. KOA is considered a major burden for the health systems as the annual healthcare expenses are to be calculated at over 27$ billion only in the USA.

Purpose: The purpose of the present study was to investigate the acute effects of a stretching intervention program in KRoM and knee stiffness in patients with KOA.

Material and Methods: Twenty female selected patients with diagnosed KOA were recruited and randomly assigned into the two groups. The intervention group performed a stretching protocol on an isokinetic dynamometer. The intervention consisted of three times of 60sec. All the measurements were performed on an isokinetic dynamometer. The main outcomes of the present study were the range of motion (KRoM), the maximum torque, and the joint stiffness of the knee joint to assess the joint's functionality. All the parameters were analyzed and compared pre and post-the stretching protocol.

Results: Statistically significant differences were found between the two groups right after the stretching intervention in all outcomes, suggesting that the passive stretching stimulus could be effective regarding KRoM ($F_{1,18} = 8.352$, $p < .001$) and the joint stiffness ($F_{1,18} = 6.384$, $p = .021$).

Conclusion: Passive stretching could provide immediate benefits to KOA female individuals, possibly leading to better knee functionality during activities of daily living.

Keywords: Range of motion; Joint stiffness; passive torque; osteoarthritis; activities of daily living; knee functionality

Introduction

Global Knee Osteoarthritis (KOA) prevalence is estimated to be 16%, a percentage that increases to 22.9% for people aged 40 years old and over, thus around 654 million people suffer from KOA worldwide [1]. KOA is considered a major burden for the health systems [2]. In the USA, the annual healthcare costs for KOA patients approximate 27 $ billion [2]. KOA is the most common type of arthritis which leads to chronic joint degeneration characterized by joint swelling, pain, decreased range of motion, and progressive loss of function [3]. The knee joint seems to be affected more, which results in reduced knee extensors and flexors capability. KOA clinical features include chronic pain accompanied by muscle weakness and joint instability, rigidity, and increased muscle and joint stiffness (*k*muscle and *k*joint, respectively), associated with reduced quality of life [4, 5].

The effects of KOA on the activities of daily living (ADLs) have been extensively studied [6, 7, 8]. KOA patients show secondary gait changes, such as a slower pace due to progressive reduction of knee range of motion (KRoM) [8]. Sit-to-stand motion is also affected in KOA patients, and studies have shown that KOA patients don't perform efficiently - referring to mechanical energy transfer - the specific ADL, causing further joint degeneration [9]. As a result, KOA patients reduce their daily and physical activities to avoid pain, adopting compensatory mechanisms which decrease knee extensors and flexors muscle strength, impairing their functionality [10].

Recent guidelines for the KOA management suggest that an individualized approach should include therapeutic exercise and weight control aiming at knee muscle strength and KRoM increase, as well as *k*muscle and *k*joint reduction [11]. Several kinds of exercises have been proposed and studies' findings have shown their contribution to knee joint functionality and knee pain decrease. Proposed exercises include Pilates/Yoga, aerobic, strengthening, and aquatic exercises [12]. Dynamic combined training was found to increase muscle strength [13], whilst Yoga training resulted in increased KRoM and functionality [14, 15]. Although different modes of exercise seem to decrease the level of pain and improve knee functionality, their effectiveness in KOA patients is not clear [16].

The acute and long-term effects of stretching exercises have been extensively studied previously [17, 18]. Stretching exercises were found to increase joint RoM and functionality. In a meta-analysis of 19 randomized clinical trials involving 1250 patients with KOA, it has been shown that stretching exercises may be helpful for pain management, but they do not affect knee joint functionality [19]. Stretching exercises are also effective in improving ADLs such as household and outdoor activities, improving quality of life [20]. Stretching effectiveness has been established and is related to the KRoM increase during the warm-up preparation before strengthening training programs [3, 21]. Nevertheless, the data regarding the possible acute beneficial effects of static stretching on KOA patients' functionality are limited. Thus, this study aimed to investigate the acute effects of a stretching intervention program in KRoM and the *k*knee in patients with KOA.

Materials and Methods

Participants

This is a cross-sectional study which was held in an outpatient physiotherapy clinic. 20 female selected patients with diagnosed KOA were recruited and randomly assigned into the two groups (interventional group: N=10, and control group: N=10; Mean age: 58.52 ± 6.28 years). Informed written consent for all participants was obtained, whilst University Ethics Committee on Human Research has approved the research protocol. Inclusion criteria included: diagnosed patients with KOA according to Kellegren-Lawrence radiographic evaluation criteria [1], patients aged above 50 years old, participants shouldn't have been diagnosed with heart or respiratory problems or have undergone knee operation.

Stretching intervention program

Participants were randomly divided in two groups: stretching and control group. Passive stretching was implemented in intervention group while patients were in a prone position. Initially, stretching was applied in an extended position, whilst lumbar is positioned at L2-L4 level maintaining lumbar lordosis and immobilizing pelvis - position that assist the full flexion of the joint. A Continuous Passive Mode (CPM) protocol was carried out, during which patients performed bending of knee, until the resistance point and returned back to the initial position of 0 degrees. The exercise was repeated 3 times in a set of 60sec [2].

k_{knee} and KRoM evaluation

An isokinetic dynamometer was used for the evaluation of KRoM, the maximum isokinetic torque and the mean torque. KRoM was defined as 0° from the original extended position in prone decubitus on the dymometer. k_{knee} was calculated by the ratio DF / DL, wherein DF the displacement difference when maximum increase in torque and DL the difference of the angle at this maximum increase in torque. Knee k_{knee} was defined as the final achieved 10% of the range of DF / DL pre and post intervention [2].

Statistical analysis

Descriptive data were calculated for sample characteristics. The analysis of variance with repeated ANOVA (2x2) was applied for pre and post measurements comparison. Post - Hoc test was used for between group interaction for the pre and post intervention measured variables - KRoM, mean torque, MS, maximum torque angle and maximum torque.

Results

Baseline mean KRoM was significantly improved post intervention ($F_{1,18}$ = 8.352, p < .001) for intervention group (Figure 1).

	Stretching group		***Control group***	
	Pre	***Post***	***Pre***	***Post***
KRoM (°)	105.40±12.61	123.40±16.39*	107.20±12.29	109.30±12.57
mean torque (Nm)	7.19±2.24	5.54±2.14*	7.18±2.31	7.23±2.24
MS (Nm/ °)	0.65±0.17	0.48±0.20*	0.61±0.16	0.59±0.20
max torque angle (°)	100.16±14.25	124.80±12.16*	100,22±14.07	103.41±14.48
max torque (Nm)	10.63±3.69	17.74±5.53*	10.63±3.68	11.01±3.7

Table 1: Variables' values pre and post intervention (*: significant different p< 0.05).

k_{knee}, mean torque, maximum torque angle, and mean passive torque were related to the intervention program, as all measurements were significantly different post stretching exercise ($F_{1,18}$ = 6.384, p = .021, $F_{1,18}$ = 8.352, p = .010, $F_{1,18}$ = 37.203, $F_{1,18}$ = 0.843, p = .031) p< .001, respectively) (Figures 2 and 3). Table 1 shows all the variables' correlation pre and post intervention.

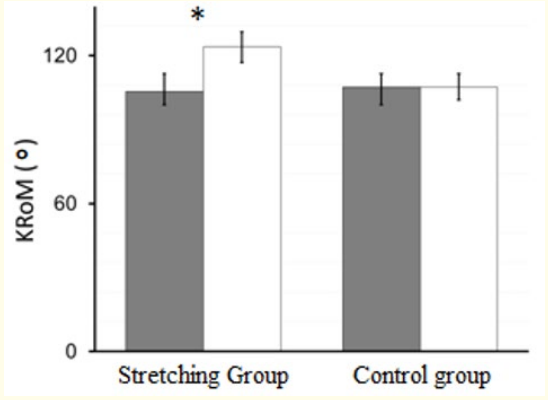

Figure 1: KRoM for both groups (*: significant different, p< 0.05, black bar: Before and white bar: after the interevention, respectively).

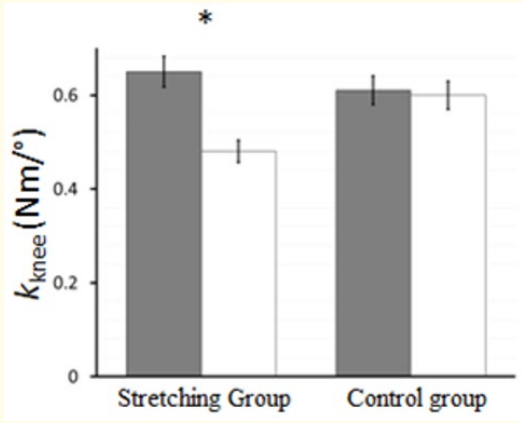

Figure 2: Knee stiffness for both groups (*: significant different, p< 0.05, black bar: Before and white bar: after the interevention, respectively).

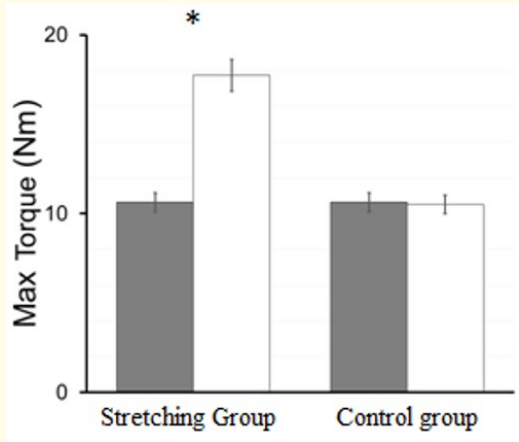

Figure 3: Maximum passive torque for both groups (*: significant different, p< 0.05, black bar: Before and white bar: after the interevention, respectively).

Discussion

KRoM has gained major concern due to increased prevalence in recent decades. Numerous studies have shown the importance of exercising for the patients' pain relief, better ADLs performance and quality of life. Our study aimed to investigate the effectiveness of a stretching intervention program in KRoM and k_{knee}. Our findings suggest that passive stretching exercise improves KRoM and maximum torque angle acutely, whilst reducing k_{knee} and mean torque.

RoM improvement, through stretching exercise has been reported in previous studies [23, 24]. KROM increased 15^0 post-intervention, a finding which is in agreement with previous report [25]. In their study, they found that static stretching could induce mean KRoM increases up to 20.9% in comparison with baseline KRoM. The importance of maintaining KRoM in individualized best possible high level for efficient ADLs performance and quality of life has been previously described [5]. KOA patients appear decreased knee

flexion during walking with a slower pace, whilst ADLs are affected such as sit to stand position. Although the muscle activation differs in different ADL, the common finding is that both velocity and RoM progressively decreases in patients with KOA [6]. Our main finding supports the use of static stretching in OA patients and extends our knowledge about its acute effects on patients' knee functionality.

For the individuals to perform complex ADLs, the mobility and strength capacity of the knee joint is needed. In a meta-analysis of 11 studies (n=453), it was found that the results of the implementation of two separate exercises program - stretching exercise vs strengthening exercise - were not significantly different [7]. Nevertheless, knee stiffness is affected by both strength capacity and knee range of motion. In our study, the *k*knee was reduced after the implementation of stretching exercises. Similarly, it has been previously described that the quadriceps and femoral bicep low stiffness is essential for ADLs performance, such as walking [8]. Additionally, it is shown that low-level extremities exercises may improve the flexibility of the quadriceps muscle resulting in better outcomes for ADLs performance [9]. Similar to our methodology, previous study calculated the k_{knee} post intervention showing that passive stretching leads to significant reduction [2]. Our findings agree with previous studies, which have shown that stretching exercises can reduce stiffness resulting in the improvement of movement flexion and extension of the knee [13, 29]. Given the above, static stretching could promote better functionality of the OA patient, due to decreased knee stiffness, leading to more efficient ADLs.

Previous studies showed that patients with KOA have lower ability to accurately steady control submaximal force and impaired eccentric strength [10]. In our study, we found that passive stretching of the quadriceps did not affect the maximal produced force. Our findings are in agreement with recent findings, according to which short-duration static stretch (< 60'') didn't affect muscle strength and power performance in healthy athletes [11]. It was found that static stretching of 30 and 60 seconds did not affect strength-power qualities of healthy young women [12]. Similarly, it is reported that a > 60 seconds stretching training program might reduce force production 1,1% [13]. Similar results have been reported by previous study [14] which showed that static stretching of 15 or 60 seconds was inefficient to trigger any significant alteration both in power production and mechano-morphological properties. In contrast, previous studies have shown that passive stretching has a negative impact on both power and strength capability [15, 16]. Most of these studies used long-duration stretching, lasting over 60''. The duration used in the present study may be sufficient to cause alteration in knees ROM without affecting torque production.

Conclusion

Significant differences were found in the KRoM, joint stiffness, and maximum torque production in women with KOA, who performed static stretch. The intervention of static stretch is clinically and home applicable and it could be beneficial in KOA patients. Given the above, our data support the potential immediate effect of static stretch on motion and strength capacity of the knee joint resulting in improved ADLs, supporting its use daily.

References

1. A Cui., et al. "Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies". EClinicalMedicine 29-30 (2020): 100587.
2. M Runa, E Lau and RD Altman. "Cost-of-illness of knee osteoarthritis: potential cost savings by not undergoing arthroplasty within the first 2 years". Clin. Outcomes Res 11 (2019): 245-255.
3. MD Kohn, AA Sassoon and ND Fernando. "Classifications in Brief Kellgren-Lawrence Classification of Osteoarthritis". Clin. Orthop. Relat. Res 474.8 (2016): 1886-1893.
4. A Askin., et al. "Quality of life and functional capacity are adversely affected in osteoarthritis patients with neuropathic pain". Kaohsiung J. Med. Sci 33 (2017): 152-158.
5. JA Gustafson., et al. "Dynamic Knee Joint Stiffness and Contralateral Knee Joint Loading during Prolonged Walking in Patients with Unilateral Knee Osteoarthritis". Gait Posture 68 (2020): 44-49.
6. MA Clynes., et al. "Impact of osteoarthritis on activities of daily living: does joint site matter? are the fourth leading cause of morbidity in older people". Aging Clin. Exp. Res 31.8 (2019): 1049-1056.
7. A Hislop., et al. "Hip strength, quadriceps strength and dynamic balance are lower in people with unilateral knee osteoarthritis

compared to their non-affected limb and asymptomatic controls". Brazilian J. Phys. Ther 26.6 (2022): 100467.

8. G Bouchouras., et al. "Women with knee osteoarthritis increase knee muscle co-contraction to perform stand to sit". Aging Clin. Exp. Res 32.4 (2020): 655-662.
9. M Anan., et al. "Gait & Posture Do patients with knee osteoarthritis perform sit-to-stand motion efficiently?". Gait Posture 41.2 (2015): 488-492.
10. T Bieler., et al. "Effectiveness of promotion and support for physical activity maintenance post total hip arthroplasty — study protocol for a pragmatic, assessor - blinded, randomized controlled trial (the PANORAMA trial)". Trials 23.1 (2022): 647.
11. SL Kolasinski., et al. "2019 American College of Rheumatology/Arthritis Foundation Guideline for the Management of Osteoarthritis of the Hand, Hip, and Knee". Arthritis Care Res 72.2 (2020): 149-162.
12. TC Rocha, AG Dias and EA Martins. "The Effects of Physical Exercise on Pain Management in Patients with Knee Osteoarthritis: A Systematic Review with Metanalysis". Rev. Bras. Ortop 5.55 (2020): 509-517.
13. TK Colak., et al. "The effects of therapeutic exercises on pain, muscle strength, functional capacity, balance and hemodynamic parameters in knee osteoarthritis patients: a randomized controlled study of supervised versus home exercises". Reumatol. Int 37.3 (2017): 399-407.
14. AB Kuntz., et al. "Efficacy of a biomechanically-based yoga exercise program in knee osteoarthritis: A randomized controlled trial". PLoS One 13.4 (2018): e0195653.
15. S Deepeshwar., et al. "Effect of yoga based lifestyle intervention on patients with knee osteoarthritis: A randomized controlled trial". Front. Psychiatry 9 (2018): 180.
16. N Pirayeh., et al. "The Effect of Balance Training on Functional Outcomes in Patients with Knee Osteoarthritis: A Systematic Review". Med. J. Islam. Repub. Iran 17 (2022): 107.
17. CD Lima., et al. "Acute Effects of Stretching on Flexibility and Performance: A Narrative Review". J. Sci. Sport Exerc 1.1 (2019): 29-37.
18. N Guissard and J Duchateau. "Neural aspects of muscle stretching". Exerc. Sport Sci. Rev 34.4 (2006): 154-158.
19. L Luan., et al. "Knee osteoarthritis pain and stretching exercises: a systematic review and meta-analysis". Physiotherapy 114 (2022): 16-29.
20. H Chen., et al. "The effects of a home-based exercise intervention on elderly patients with knee osteoarthritis: a quasi-experimental study". BMC Musculoskelet. Disord 20.1 (2019): 160.
21. MH Elgendy., et al. "Efficacy of rectus femoris stretching on pain, range of motion and spatiotemporal gait parameters in patients with knee osteoarthritis: a randomised controlled trial". BMJ Open Sport Exerc. Med 8.4 (2022): e001459.
22. DA Reid and PJ McNair. "Effects of an acute hamstring stretch in people with and without osteoarthritis of the knee". Physiotherapy 96.1 (2010): 14-21.
23. M Nakamura., et al. "Time course of changes in passive properties of the gastrocnemius muscle-tendon unit during 5 min of static stretching". Man Ther 18.3 (2013): 211-215.
24. M Nakamura., et al. "The Comparison of Different Stretching Intensities on the Range of Motion and Muscle Stiffness of the Quadriceps Muscles". Front. Physiol 11 (2021): 628870.
25. MJ Thomas., et al. "Acute flares of knee osteoarthritis in primary care: a feasibility and pilot case- crossover study". Pilot Feasibility Stud 4 (2018): 167.
26. T-S Lee., et al. "Balance factors affecting the quality of life in patients with knee osteoarthritis". South african J. Physiother 78.1 (2005): 1628.
27. JH Park., et al. "Effects of knee osteoarthritis severity on inter - joint coordination and gait variability as measured by hip - knee cyclograms". Sci. Rep (2021): 1-9.
28. J Afonso., et al. "Strength Training versus Stretching for Improving Range of Motion: A Systematic Review and Meta-Analysis". Healthc 9.4 (2021): 427.
29. SB Al-Mhanna., et al. "Effects of Circuit Training on Patients with Knee Osteoarthritis: A Systematic Effects of Circuit Training on Patients with Knee Osteoarthritis: A Systematic Review and Meta-Analysis". Healthc 10.10 (2022): 2041.

30. F Arab., et al. "Association of eccentric quadriceps torque with pain, physical function, and extension lag in women with grade ≤ II knee osteoarthritis". Medicine (Baltimore) 101.31 (2022): e29923.
31. H Chaabene., et al. "Acute Effects of Static Stretching on Muscle Strength and Power: An Attempt to Clarify Previous Caveats". Front. Physiol 10 (2019): 1468.
32. J Palmer., et al. "Surgical interventions for symptomatic mild to moderate knee osteoarthritis (Review)". Conhane Database Syst. Rev 7.7 (2019).
33. DG Behm., et al. "Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: A systematic review". Appl. Physiol. Nutr. Metab 41.1 (2015): 1-11.
34. S Stafilidis and M Tilp. "Effects of short duration static stretching on jump performance, maximum voluntary contraction, and various mechanical and morphological parameters of the muscle-tendon unit of the lower extremities". Eur. J. Appl. Physiol 115.3 (2015): 607-617.
35. D Cannavan, DR Coleman and AJ Blazevich. "Lack of effect of moderate-duration static stretching on plantar flexor force production and series compliance". Clin. Biomech 27.3 (2012): 306-312.
36. SR Freitas, ANZ Milanovic and B Mendes. "Can chronic stretching change the muscle- tendon mechanical properties ? A review". (2018): 794-806.