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PERCEPÇÃO DE DOR EM MULHERES COM SÍNDROME DE DOR PATELOFEMORAL APÓS INICIAR TREINAMENTO DE FORÇA MUSCULAR: UM ENSAIO CLÍNICO ALEATORIZADO

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Sistema de Geração de Ficha Catalográfica da UFCSPA com os dados fornecidos pelo(a) autor(a).

Dedico este trabalho a minha família, que sempre foi
minha maior apoiadora e incentivadora para que eu fosse
atrás dos meus sonhos e objetivos.
Se hoje concluo mais esta etapa da minha vida,
é porque tive vocês ao meu lado.

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RESUMO

INTRODUÇÃO: Treinamento de resistência tem se mostrado uma boa estratégia para uma reabilitação eficaz em indivíduos com Síndrome da Dor Patelofemoral (SDPF). No entanto, por medo da dor, os pacientes com SDPF demonstram receio de iniciar o treinamento de resistência. O objetivo deste estudo é investigar se mulheres com SDFP que iniciam o treinamento de força apresentam aumentos significativos nos níveis de dor até 48 horas após a primeira sessão de treinamento.
METODOLOGIA: 20 participantes foram dispostas aleatoriamente em dois grupos com volumes de treinamento diferentes para a primeira sessão de treinamento. As participantes do G1 realizaram uma série para cada exercício (volume total = 5 séries), enquanto os participantes do G3 realizaram três séries para cada exercício (volume total = 15 séries). Os seguintes exercícios resistidos foram realizados de maneira unilateralmente: extensão de joelhos na cadeira extensora, extensão de joelhos e quadril no leg press, agachamento afundo, rotação externa de quadril com resistência elástica e abdução de quadril com resistência elástica. A escala numérica de dor foi utilizada para verificar o nível de dor dos participantes antes do primeiro treinamento, imediatamente após o primeiro treinamento e 24h e 48h após o primeiro treinamento.
RESULTADOS: Não houve interação ($p=0,481$) ou diferença significativa entre os grupos ($p=0,699$) para dor no joelho. Um efeito temporal significativo ($p<0,001$) foi observado e a análise post-hoc revelou que os participantes de ambos os grupos apresentaram níveis mais altos de dor no joelho 24h após o exercício e imediatamente após o exercício ($p<0,001$ para ambos) em comparação com a linha de base. 50% das participantes do G1 e 30% das participantes do G3 tiveram apenas uma resposta trivial para dor no joelho enquanto uma minoria das participantes do G1 (10%) e do G3 (20%) apresentaram alta resposta para dor no joelho. **CONCLUSÃO:** Mulheres com SDPF toleram o início dos treinamentos de força sem a exacerbação significativa dos sintomas de dor, tornando assim a opção por iniciar o tratamento com o treinamento de força segura e confiável.

Palavras-chaves: síndrome da dor patelofemoral, treinamento de força

ABSTRACT

INTRODUCTION: Resistance training is an effective rehabilitation strategy of patellofemoral pain syndrome (PFPS). Nevertheless, patients with PFPS are afraid to start resistance training for fear of increased pain. The aim of this study is to investigate whether women with PFPS who start strength training undergo significant increases in pain levels up to 48 hours after the first training session. **METHODOLOGY:** 20 participants were randomly assigned to two groups with different exercise volumes in the first training session. G1 participants performed one set for each exercise (total volume = 5 sets), while G3 participants performed three sets for each exercise (total volume = 15 sets). The following resistance exercises were performed unilaterally: leg extension chair, leg press, deep squat, 'clam' and hip abduction with elastic resistance. The numeric pain scale was used to check pain level of participants immediately before the first training, immediately after the first training, and 24h and 48h after the first training. **RESULTS:** There was no group-time interaction ($p=0.481$) or significant between-group difference ($p=0.699$) for knee pain. A significant time effect ($p<0.001$) was observed, and post-hoc analysis revealed that participants from both groups experienced higher levels of knee pain at 24h post-exercise compared to baseline and immediately post-exercise ($p<0.001$ for both). 50% of G1 participants and 30% of G3 participants had only a trivial knee pain response. A minority of participants in the G1 (10%) and in the G3 (20%) had a high knee pain response. **CONCLUSION:** Women with PFPS tolerate starting of strength training without significant exacerbation of pain symptoms, making the option to start treatment with strength training safe and reliable.

Keywords: patellofemoral pain syndrome, strength training.

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LISTA DE ABREVIATURAS E SIGLAS

PFPS - Patellofemoral Pain Syndrome

DOMS - Delayed-Onset Muscle Soreness

RCT - Randomized Controlled Trials

1RM - One Maximum Repetition

RPM - Repeat Per Minute

MCID - Minimal Clinically Important Difference

NPS - Numerical Pain Scale

SUMÁRIO

INTRODUCTION

Patellofemoral pain syndrome (PFPS) is a musculoskeletal condition with an estimated prevalence of 23% and 29% in adult and adolescent populations respectively[1], and women have a 2.2 times higher incidence of PFPS than men[2]. PFPS is characterized by pain around or behind the patella, which is aggravated by weight-bearing activities on a flexed knee, such as squatting, stair ambulation, jogging/running, and hopping/jumping[3]. This often reduces the ability of those with PFPS to perform sports, physical exercises, and some work-related activities pain-free, which can have a substantial impact on the individual's quality of life[4]. The diagnosis of PFPS is essentially clinical, associating the patient's history and reported symptoms with provocative tests that load the patellofemoral joint in a flexed position (e.g., squatting), as well as exclusion of other knee pathologies (e.g., traumatic injuries, patellar tendinopathy, meniscus injury)[4]. The primary treatment approach for people with PFPS is conservative, primarily including patient education and exercise therapy [4].

The main clinical practice guidelines recommend exercise therapy for treating patients with PFPS, who should include a combination of hip- and knee-targeted resistance exercises to reduce pain and improve patient-reported outcomes and functional performance[5,6,7]. The hip-targeted exercise therapy should focus on the posterolateral hip musculature (i.e., hip abductors and external rotators), while knee-targeted exercise therapy should focus quadriceps muscle including either weight-bearing or non-weight-bearing exercises [4]. The effectiveness of lower limb resistance training for management of people with PFP evidenced by randomized controlled trials (RCTs) seems to have influenced the clinical practice in the 'real world' since two surveys reported that more than 97% of physical therapists applying lower limb muscle strengthening in cases of PFPS[8,9]

Lower limb resistance exercises such as squatting and its variances (e.g., mini-squat, single-leg squat, forward lunge), leg-press, seated knee extension, side-lying hip abduction, and 'clam', among others, have been largely used for treating people with PFPS[9]. However, despite evidence that training volume, especially the number of sets performed per week or per training session, is a critical factor for successfully improving health-related outcomes such as muscle size[10]and strength [11] in the general population, there is no consensus on the minimal or optimal amount of resistance exercise necessary to achieve better outcomes in people with PFPS. For instance, the number of sets performed per session ranges from 3[12] to 27[13] (an impressive 9-fold difference) among RCTs performed with people with PFPS. This heterogeneity makes it difficult for physical therapists to decide about the resistance exercise volume that should be applied to people with PFPS, especially during the initial phase of rehabilitation in which many patients have kinesiophobia [14].

Considering that increases in pain level following a physical therapy session can impair patient adherence to the rehabilitation program, it is imperative to know the amount of resistance exercise tolerated by a PFPS patient at the early stage of treatment. Therefore, this study aimed to describe knee pain responses of women with PFP submitted to a single lower limb resistance training session with different exercise volumes. Since exercise-induced muscle pain can also interfere with patient adherence to treatment, this study also assessed the effects of such resistance training sessions on delayed-onset muscle soreness (DOMS) of participants.

METHODOLOGY

Study design

This study was part of an RCT intended at verifying the effect of lower limb resistance training programs performed with two different volumes on pain and function in women with PFPS, approved by the institutional ethical committee (no.: XXXXX) and registered on the platform clinicaltrials.gov (no.: XXXXX). In this study, the primary outcome was the knee pain level, which was assessed immediately before the first resistance training session of the RCT participants, as well as immediately, 24 hours, and 48 hours after the end of the session. The secondary outcome was quadriceps delayed-onset muscle soreness (DOMS) level, which was assessed 24 and 48 hours after exercise. The resistance training session consisted of five exercises, focusing on knee and hip muscle groups. Participants were randomly allocated into two groups: G1, who performed one sets of each exercise (total volume = 5 sets); and G3, who performed three sets of each exercise (total volume = 15 sets). A researcher not involved in the recruitment, evaluations, or rehabilitation, allocated the participants by blocks in one of the two groups (1:1). The researchers responsible for outcome assessments were blinded to the patient's allocation in the two groups, and the researcher who conducted the resistance training session was blinded to the evaluations.

Participants

The sample consisted of female individuals diagnosed with PFPS, aged between 18 and 40 years, able to carry out the training and proposed evaluations (according to the inclusion and exclusion criteria presented below), and who were available to participate in the study voluntarily after publishing the work on internet social networks. The diagnosis of PFPS was performed by a physiotherapy professional with experience in managing this patient profile. The criteria used for the clinical diagnosis of subjects with PFPS were: (1) pain around and/or behind the patella, (2) pain reproduction during squatting or performing functional activities involving the patellofemoral joint: sustained knee flexion for a longer

period, going up or down stairs, kneeling, running. The following aspects were adopted as exclusion criteria: (1) difficulty to understand and/or to execute test and training protocols. (2) presence of musculoskeletal injuries in lower limbs that prevent or impair the performance of the exercises proposed in the training sessions and tests; (3) physical trauma historic in the last twelve months, specifically involving the knees or lower limbs, such as traffic accidents, falls, bruises; (4) body mass index (BMI) > 34; (5) having performed a rehabilitation protocol for patellofemoral pain syndrome up to six months before data collection.

Proceedings

Initial assessment

Evaluations of two groups were carried out at a private gym in the week before the beginning of training protocol. Evaluations started with a 5-minute stationary bicycle warm-up session, with a load individually stipulated according to the tolerance of each volunteer and an estimated pedaling cycle of 60 to 80 rotations per minute without causing discomfort. Then, volunteers were instructed to perform the knee extension exercises in the leg extension chair and horizontal leg press unilaterally, to stipulate the load for performing a maximum repetition of the proposed movement. Participants were familiarized with the exercises on at least two occasions before taking the test. The implemented load was increased as soon as the participant was able to perform one repetition more than the previously stipulated target number of repetitions of 10 repetitions for the exercise. This was done using the formula: [(repetitions x 0.025)+1] x load = 1RM. The same procedure was repeated until a maximum of 5 attempts were performed in each exercise. The participants were instructed to perform the movements in a total time of approximately 4 seconds (2 seconds for the concentric phase and 2 seconds for the eccentric phase) and had a minimum time of 60 seconds and a maximum of 180 seconds of an interval between each series for rest.

Outcome assessments

Numerical Pain Scale (NPS) from 0 to 10 points was used to assess pain perception of participants[19]. The collection of information about the participants' pain was carried out in four moments: before starting the training and immediately after the first training, 24 hours after, and 48 hours after the first training. To collect information before and immediately after the first training, the Step-down test was used, which consists of going unipodal down a step. Three repetitions of the test were performed, alternating the limbs. The test becomes relevant for this population since it’s a daily activity and those symptomatic individuals with PFPS commonly report pain and/or discomfort when performing it[15]. Pain information 24 and 48 hours after the test was carried out was collected by telephone interview with the

patients, and the method used was the numerical pain scale, in which the patient makes the equivalence according to his pain through the classification numeric, where zero is considered the least pain and ten the maximum pain perceived by the patient[4].

Resistance training session

The resistance training session used by the current study followed the last guidelines of the *American Physical Therapy Association*[16], which indicates the use of resistance exercises for the hip and knee associated with the training program. The training session started with a warm-up on an ergometric bicycle for 5 minutes with load stipulated individually according to the tolerance for maintaining a pedaling cycle of 60-80 RPM without causing discomfort. Afterward, the volunteers performed the following exercises: leg extension chair, leg press, deep squat, 'clam' with elastic resistance, and hip abduction in lateral decubitus with elastic resistance (figure 1). Both groups performed 15 repetitions of each exercise. The load for the first three exercises (leg extension, leg-press and deep squat) was stipulated as 75% of 1RM. For the exercises with elastic resistance (clam and hip abduction), the elastic was choose based on the participants perception.

Figure 1: protocol exercises sequence. (A) knee extension on chair extension; (B) knee extension on leg-press; (C) deep squat; (D) 'clam' with elastic resistance; (E) hip abduction in lateral decubitus with elastic resistance

Statistical analysis

Participants' knee pain was assessed through a two-way repeated measures ANOVA [group (G1 and G3) × time (baseline, immediate, 24 h and 48 h post-exercise)], followed by Bonferroni post-hoc test. Data sphericity was tested through Mauchly's test, and Greenhouse-Geisser correction factor was used when necessary. Considering 2 points as a minimal clinically important difference (MCID) for individuals with PFPS[17], individual responses to knee pain were assessed according to the following criterium: trivial response (<2 points increase from baseline); minor response (2-3 points increase from baseline), medium response (4-5 points increase from baseline), and high response (≥6 points increase from baseline). Regarding the DOMS collected at 24h and 48h post-exercise,

groups were compared through independent t-tests. A significance level of 5% ($\alpha<0.05$) was adopted for all analyses.

RESULTS

Twenty women with PFPS participated in this study, being equally divided between the study groups. Baseline characteristics of the participants are exposed in table 1.

Table 1. Baseline characteristics and physical performance of participants.

	G1		G3	
	Mean (SD)	95%CI	Mean (SD)	95%CI
Age (years)	26.1 (5.72)	3.54	27.7 (6.37)	3.95
Height (m)	1.68 (0.06)	0.04	1.64 (0.05)	0.03
Weight (kg)	65.15 (9.74)	6.03	64.80 (8.95)	5.54
Leg-press 1RM (kg)	106.83 (21.49)	9.41	88.54 (22.80)	9.99
Extension chair 1RM (kg)	51.69 (6.91)	3.03	47.70 (8.84)	3.87

1RM, one maximum repetition; 95%CI, 95% confidence interval; kg, kilograms; m, meters; SD, standard deviation.

There was no group-time interaction ($p=0.481$) or significant between-group difference ($p=0.699$) for knee pain (Table 2). A significant time effect ($p<0.001$) was observed, and post-hoc analysis revealed that participants from both groups experienced higher levels of knee pain at 24h post-exercise compared to baseline and immediately post-exercise ($p<0.001$ for both).

Table 2. Participants' knee pain throughout the study.

	G1		G3	
	Mean (SD)	95%CI	Mean (SD)	95%CI
Baseline	1.30 (2.06)	-0.17; 2.77	1.00 (1.63)	-0.17; 2.17
Immediate post-exercise	1.20 (1.03)	0.46; 1.94	0.90 (1.45)	-0.14; 1.94
24 h post-exercise *	3.00 (2.71)	1.06; 4.94	3.90 (2.92)	1.81; 5.99
48 h post-exercise	2.00 (1.63)	0.83; 3.17	2.80 (2.94)	0.70; 4.90

* Different than baseline and immediate post-exercise ($p<0.05$); 95%CI, 95% confidence interval; h, hours; SD, standard deviation.

Half participants in the G1 group and 30% of participants in the G3 group experienced only a trivial response of knee pain (i.e., <2 points) up to 48 h after the exercise session. A minority of participants in G1 (10%) and G3 (20%) experienced a high response of knee pain (i.e., >6 points) (Table 3)

Table 3. Distribution of participants according to the knee pain increment.

	<2 points	**2-3 points**	**4-5 points**	**≥6 points**
G1	50%	30%	10%	10%
G2	30%	30%	20%	20%

No significant between-group differences were found in relation to quadriceps DOMS measured at 24 h ($p=0.211$) and 48 h ($p=0.192$) after the exercise session (Table 4).

Table 4. Participants' delayed-onset muscle soreness.

	G1		G3	
	Mean (SD)	95%CI	Mean (SD)	95%CI
24 h post-exercise	3.00 (2.87)	0.95; 5.05	5.00 (3.94)	2.18; 7.82
48 h post-exercise	1.90 (2.47)	0.13; 3.67	3.70 (3.40)	1.27; 6.13

95%CI, 95% confidence interval; SD, standard deviation.

DISCUSSION

The main result found in our study was the no significant knee pain or quadriceps muscle pain between the groups after start performing exercise protocol. This result is important due to the high number of patients with kinesiophobia[14] who can benefit from starting a rehabilitation protocol focused on gaining muscle strength.

The trivial response of knee pain (i.e., <2 points) up to 48h after exercise is shown to be important in the treatment of PFPS. According to Azevedo et al.[14], increased joint load of patellofemoral pain during repetitive tasks influences the development and PFP persistence. In our study, despite evaluating the short-term pain after performing the exercise, we could observe the strengthening exercise was not able to increase the pain level to values above trivial ones. Clinical trials have traditionally used a combination of outcome measures designed to address the pain, disability, and functional capacity of participants with patellofemoral pain[16], then the knee pain level at the start of a strength protocol could be useful to help to improve patient's adherence to treatment.

Historically, PFPS has been linked to impairments of the quadriceps muscle, such as strength deficits and imbalances[18]. The low-level DOMS observed in our study encouraging early start of muscle strengthening for PFPS patients. This result serves as a benchmark for physiotherapists at the beginning of PFPS treatment to obtain a better follow-up of the evolution of treatment early symptoms. Treatment beginning can start with conventional volumes of exercise, since no significant between-group differences were found in relation to quadriceps DOMS.

Despite of positive results in our study, some limitations can be referred. The restricted number of participants could be a result bias; however, this number of participants can be explained by the small demand of women with PFPS during the research period. The elastic resistance used in exercises in lateral decubitus can also be a limitation of the study, due to the loss of resistance they present as they are used in the protocol. Despite this limitation, elastic bands still the best option about the possibilities for use in the exercise.

CONCLUSION

Initial data indicate that patients tolerate both protocols well, with no significant difference between groups for knee pain and quadriceps muscle pain. Making it timely, safe, and reliable to start the strength training protocol with high volume, without significant exacerbation of the patient's knee pain symptoms. This protocol can be a reference for physiotherapists to start muscle strengthening with PFPS patients and establish a bond of trust between physiotherapist and patient.

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