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Effectiveness of Elastic Resistance in Rehabilitation of Patients With Patellofemoral Pain Syndrome: What Is the Evidence?

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Context: Patellofemoral pain syndrome (PFPS) is associated with muscle imbalance at the knee and hip. Therapeutic exercise is effective at reducing pain associated with PFPS.

Objective: To identify and analyze clinical trials of elastic resistance in patients with PFPS to determine its efficacy.

Data Sources: PubMed, CINAHL, and PEDro databases were searched for terms relevant to PFPS rehabilitation in patients aged 12 to 40 years.

Study Selection: Only peer-reviewed clinical trials lasting at least 4 weeks and specifying the use of elastic resistance in their protocols were included.

Data Extraction: Eight eligible studies were analyzed for design, sample, intervention, outcomes, and clinical application.

Results: The studies included in this review lacked high-quality design, often using exercise as a "quasi-control" condition. Most studies did not provide specific exercise prescription or progression. Although participants in each study reported significant improvements in pain, deficiencies in scientific design limit the conclusion.

Conclusion: Elastic resistance exercise may reduce pain and improve function and strength in patients with PFPS.

Keywords: patellofemoral pain; elastic resistance; therapeutic exercise

Patellofemoral pain syndrome (PFPS) is characterized by retropatellar or peripatellar pain with walking, running, ascending or descending stairs, squatting, or prolonged sitting. The cause of PFPS remains unclear, although it is typically associated with muscle imbalances. Females are twice as likely as males to develop PFPS.[4]

Traditionally, PFPS was thought to result from weakness of the vastus medialis muscle, theoretically creating a more laterally tracking patella. The flexibility of the hamstrings, quadriceps, and gastroc/soleus complex has been associated with PFPS.[18,24,26] Researchers have suggested that PFPS is related to muscular weakness at the hip, causing lateral patellar tracking caused by poor eccentric strength and control of hip abductors and external rotators.[14,23] Females appear to be predisposed to proximal influences more so than males.[19]

Elastic resistance exercises are commonly prescribed for rehabilitation[17] in osteoarthritis,[16,22] total knee replacement,[21] anterior cruciate ligament reconstruction,[5] and as part of a multimodal approach to PFPS.[2] Despite the widespread clinical application of elastic resistance exercise, few studies have investigated its efficacy in treating PFPS. The purpose of this systematic review is to analyze clinical trials of elastic resistance in PFPS.

METHODS

Data Sources and Extraction

An online search of 3 databases (PubMed, CINAHL, and PEDro) was performed in August 2010 for studies published since 1970. Search terms included *patellofemoral*, *rehabilitation*,

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Table 1. Clinical exercise trials for patellofemoral pain syndrome (PFPS) using elastic resistance.[a]

Study: Design and Sample	Intervention /Elastic Exercises	Outcomes	Implications
Bily et al[3]			
Randomized, quasi control, prospective; n = 38, bilateral PFPS	3 months, 2 groups Group 1: Supervised physical therapy (Thomee[20] protocol) Group 2: Supervised physical therapy + electrical stimulation Both groups performed 4 direction kicks with tubing. Specified elastic resistance intensity and progression	↓ Pain, *both groups ↑ Functional score, *both groups Strength, no significant difference, both groups No significant difference between groups	Supervised physical therapy including elastic resistance effective at reducing pain and improving function without increasing strength; electrical stimulation provides no additional benefit
Doucette and Goble[7]			
Pretest/posttest, retrospective; n = 28, lateral patellar compression syndrome	Avg: 8-week treatment Individualized, not standardized Tubing exercises included seated leg press, single and double dips, resisted walking, knee flexion/extension. No specific prescription or progression of elastic exercises	84% pain-free	Individualized physical therapy program including elastic resistance eliminated pain in 84% of PFPS patients; cause and effect cannot be established because of design
Eng et al[8]			
Randomized, quasi control, prospective; n = 20 young females, PFPS and poor foot biomechanics	8 weeks, 2 groups Group 1: Exercise Group 2: Exercise + orthotics Both groups progressed to straight leg raise exercise with weights or elastic looped around ankles; no specific prescription or progression of elastic exercises	↓ Pain*both groups Exercise + orthotics = significantly more improvement	Exercise including elastic resistance significantly decreased pain in young females with PFPS; when elastic resistance is combined with orthotics, the reduction is significantly greater
Harrison et al[9]			
Randomized, quasi control, prospective; n = 113, PFPS	1 month, 3 groups Group 1: Home exercise program Group 2: Exercise + manual therapy Group 3: Exercise + taping and biofeedback All groups suggested to use tubing hip adduction exercise; no specific prescription or progression of elastic exercises	↓ Pain, *all groups at 12 months ↑ Clinical score, *all groups at 12 months ↑ Function, *all groups at 12 months Taping and biofeedback more effective than exercise and manual therapy at 1 month	Home exercise including elastic resistance exercise effective at reducing pain and improving function over long term; short-term relief better when exercise combined with patellar taping and biofeedback

(continued)

Table 1. (continued)

Study: Design and Sample	Intervention /Elastic Exercises	Outcomes	Implications
Kettunen et al[11]			
Randomized, quasi control, prospective; n = 56, chronic PFPS	8 weeks, 2 groups Group 1: Home exercise program Group 2: Home exercise program + arthroscopic surgery Both groups performed elastic band kicks, leg pulls, and terminal knee extension; no specific prescription or progression of elastic resistance intensity levels (only repetitions are provided)	↓ Pain, * both groups ↑ Functional score, * both groups ↑ Cost, * surgical group	Home exercise program including elastic resistance exercise is effective at reducing pain and improving outcomes in PFPS; arthroscopic surgery provides no additional benefit and significantly increases health care costs compared with a home exercise program alone
Loudon et al[13]			
Quasi randomized, pretest/posttest, controlled, prospective; n = 29, PFPS	8 weeks, 3 groups Group 1: Home exercise program Group 2: physical therapy clinic exercise Group 3: Control Both exercise groups performed elastic knee curls; no specific prescription or progression of elastic resistance intensity levels (only repetitions are provided)	↓ Pain, * both exercise groups ↑ Strength * and functional score, * both exercise groups ↓ Pain * in physical therapy group compared to home exercise group	Both home exercise and supervised physical therapy exercises including elastic resistance decrease pain and improve function and strength
Nakagawa et al[15]			
Randomized, quasi control, prospective; n = 14, PFPS	6 weeks, 2 groups, home exercise program Group 1: Quad exercises Group 2: Quad + hip exercises Group 2 included hip rotation, trunk stabilization, and lunges with elastic resistance	↓ Pain, * group 2 ↑ Muscle activation, * group 2 ↑ Knee strength, * both exercise groups Hip strength, no significant difference, both groups	Additional hip exercises including elastic resistance are more effective at reducing pain in PFPS compared with knee exercise alone, without an increase in hip strength; however, sample size was small
Thomee[20]			
Randomized, prospective, no control; n = 40 females, PFPS	12 weeks Group 1: Isometric exercise (elastic) Group 2: Eccentric exercise Isometric group performed 4-direction elastic band kicks on both legs. Specified elastic resistance intensity and progression	85% pain-free across all participants ↓ Pain, * both groups ↑ Strength, * both groups	Both eccentric and isometric exercise including elastic resistance reduced pain and improved strength in females with PFPS; however, cause and effect cannot be established, because no control group was included

*Statistically significant.

Table 2. PEDro scores from clinical trials using elastic resistance to treat patellofemoral pain syndrome.

PEDro Attribute	Bily et al[3]	Doucette and Goble[7]	Eng et al[8]	Harrison et al[9]	Kettunen et al[11]	Loudon et al[13]	Nakagawa et al[15]	Thomee[20]
Random allocation	•		•	•	•		•	
Concealed allocation	•				•		•	
Baseline comparability	•		•	•	•		•	•
Blind subjects								
Eligibility criteria[a]	•			•	•			
Blind therapist								
Blind assessor				•			•	
Adequate follow-up					•		•	•
Intention-to-treat analysis					•		•	•
Between-group comparison	•		•	•	•	•		•
Point estimates and variability	•			•	•	•	•	•
Total PEDro score	5	NA	3	5	7	2	7	5

[a]Not factored into total score.

exercise, *knee pain*, *Thera-hand*, and *elastic* in a variety of combinations. Studies of knee osteoarthritis, Osgood-Schlatter disease, patella tendonitis/tendinosis, patella dislocation, plica, and meniscus were excluded. Clinical trials greater than 4 weeks in length were scanned for the use of elastic resistance in the protocol. The study design, sample, intervention, outcomes, and clinical implications were reviewed (Table 1). In addition, PEDro scores (http://www.pedro.org.au), where available, were determined (Table 2).

RESULTS

Eight clinical studies met the criteria for this review.

Study Design

Seven studies were randomized prospective studies; 1 was retrospective.[7] Only 1 study[13] used a nonexercising control group. Most studies used a "quasi-control" design: The exercise group was the control limiting the conclusions (Table 2). Two studies received PEDro scores of 7 (out of 10),[11,15] generally limited by blinding of raters and subjects.

Sample

All but 1 study[15] had 20 or more participants. Adequate power was found in 3 studies.[3,11,20] The analyzed studies had similar inclusion and exclusion criteria. One study[7] investigated patients with "lateral patellar compression syndrome," with diagnostic criteria similar to PFPS. Most samples included both males and females, although all studies had a greater number of females, representative of the PFPS population.

Intervention

All interventions lasted 4 to 12 weeks, with most lasting 8 weeks. Only 2 studies specified the intensity and volume of the elastic resistance exercise progression.[3,20] Overall, well-defined protocols with elastic resistance exercises were lacking, limiting the replication or clinical application of the study and threatening external validity. Most studies combined multiple modes of exercise within groups, such as stretching, balance, and cardiovascular exercise, precluding analysis of exercise mode effectiveness. Elastic exercise was separately evaluated in 2 studies.[15,20] Thomee[20] found no difference between the elastic

and isotonic groups. Nakagawa[15] noted some additional benefit to adding specific elastic resistance exercises for the hip.

Two studies on healthy participants showed that elastic resistance exercises are as effective as isotonic resistance exercises for muscle activation and improving strength.[1,6] Adding elastic resistance to terminal knee extension exercise significantly increases vastus medialis obliquis and vastus lateralis activity.[25] Hopkins et al[10] analyzed leg pulls with surface electromyogram, noting higher levels of vastus medialis activity.[11]

Outcomes

All studies reported significant reduction in pain regardless of the exercise intervention. Electrical stimulation, orthotics, patellar taping, biofeedback, and arthroscopic surgery had little to no additional benefit. Four studies assessed functional outcomes,[3,9,11,13] reporting significant improvements over time without between-group differences. Three studies[11,13,20] found significant improvements in strength, whereas 1 study did not.[3] One study[15] found improvements in quadriceps strength but not at the hip.

DISCUSSION

Elastic resistance exercise appears to be as effective as other modes of resistance for PFPS. Electromyogram studies have confirmed that elastic resistance is comparable to isotonic exercise.[1,6]

The overall lack of blinding and suitable control groups reduces the ability to detect differences based on elastic resistance alone. Unfortunately, none of the reviewed studies used isolated elastic resistance exercise as an independent variable in PFPS interventions.

The cause of PFPS is not well established; patients may exhibit different impairments (ie, hip weakness versus knee weakness). Stratification by impairment may help improve clinical decision making for therapeutic exercise prescription. A systematic review of females with PFPS showed hip weakness, indicating strong evidence for decreased strength in hip external rotation, abduction, and extension compared with controls.[27] Eccentric hip abduction and adduction are weaker in females with PFPS, whereas rotation strength appears normal.[12]

CONCLUSION

In summary, exercise interventions including elastic resistance in patients with PFPS are effective at reducing pain and improving function and strength.

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