

## [ Physical Therapy ]



# Effect of Therapeutic Modalities on Patients With Patellofemoral Pain Syndrome: A Systematic Review

David A. Lake, PT, PhD,\* and Nancy H. Wofford, PT, DPT, OCS, Cert MDT

**Context:** Patellofemoral pain syndrome (PFPS) is a common orthopaedic condition for which operative and nonoperative treatments have been used. Therapeutic modalities have been recommended for the treatment of patients with PFPS—including cold, ultrasound, phonophoresis, iontophoresis, neuromuscular electrical stimulation, electrical stimulation for pain control, electromyographic biofeedback, and laser.

**Objective:** To determine the effectiveness of therapeutic modalities for the treatment of patients with PFPS.

**Data Sources:** In May and August 2010, Medline was searched using the following databases: PubMed, CINAHL, Web of Science Citation Index, Science Direct, ProQuest Nursing & Allied Health, and Your Journals@OVID.

**Study Selection:** Selected studies were randomized controlled trials that used a therapeutic modality to treat patients with PFPS. The review included articles with all outcome measures relevant for the PFPS patient: knee extension and flexion strength (isokinetic and isometric), patellofemoral pain assessment during activities of daily life, functional tests (eg, squats), Kujala patellofemoral score, and electromyographic recording from knee flexors and extensors and quadriceps femoris cross-sectional areas.

**Data Extraction:** Authors conducted independent quality appraisals of studies using the PEDro Scale and a system designed for analysis of studies on interventions for patellofemoral pain.

**Results:** Twelve studies met criteria: 1 on the effects of cold and ultrasound together, ice alone, iontophoresis, and phonophoresis; 3, neuromuscular electrical stimulation; 4, electromyographic biofeedback; 3, electrical stimulation for control of pain; and 1, laser.

**Discussion:** Most studies were of low to moderate quality. Some reported that therapeutic modalities, when combined with other treatments, may be of some benefit for pain management or other symptoms. There was no consistent evidence of any beneficial effect when a therapeutic modality was used alone. Studies did not consistently provide added benefit to conventional physical therapy in the treatment of PFPS.

**Conclusions:** None of the therapeutic modalities reviewed has sound scientific justification for the treatment of PFPS when used alone.

**Keywords:** systematic review; patellofemoral pain syndrome; therapeutic modalities

Patellofemoral pain syndrome (PFPS) is one of the most common orthopaedic conditions in adolescents and young adults.<sup>26</sup> It is the most common overuse injury in adolescent girls.<sup>26</sup> It affects approximately 26% of young athletes<sup>14</sup> and 7% of young active adults.<sup>14,29</sup> PFPS is so common in runners and other endurance athletes that it is often referred to as *runner's knee*.<sup>15</sup> PFPS is generally characterized by diffuse anterior knee pain, aggravated with specific activities that heighten the compressive loading forces across the

patellofemoral joint,<sup>6,9,24,28</sup> including ascending and descending stairs, squatting, and prolonged sitting.<sup>6,24,28</sup> Altered lower extremity kinematics<sup>28</sup> and knee and hip muscle weakness<sup>29</sup> contribute to the pain and dysfunction associated with PFPS.

Both operative and nonoperative approaches are used in the treatment of PFPS, and many patients improve with nonoperative rehabilitation care.<sup>17,26</sup> The principal goals of a rehabilitation program for PFPS are to decrease pain and edema, correct biomechanical deficiencies, increase strength

From the Department of Physical Therapy, Armstrong Atlantic State University, Savannah, Georgia

\*Address correspondence to David A. Lake, PT, PhD, Department of Physical Therapy, Armstrong Atlantic State University, Savannah, GA 31219 (e-mail: david.lake@armstrong.edu).

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and endurance, and restore motion and function.<sup>10,23</sup> Among the nonoperative treatment approaches that are recommended in a rehabilitation program for PFPS are the therapeutic modalities.<sup>3,4,10,15,16,20,27</sup> In addition, the American Physical Therapy Association's *Guide for Physical Therapist Practice*<sup>2</sup> recommends the use of therapeutic modalities for a variety of musculoskeletal conditions, including PFPS.

Recommended modalities for use in patients with PFPS include

- cryotherapy for reducing pain and edema<sup>10,20,27</sup>;
- thermotherapy (therapeutic heat) for local vasodilation to reduce pain and stimulate healing, in the forms of ultrasound,<sup>20,27</sup> moist hot packs,<sup>20</sup> and warm whirlpool<sup>27</sup>;
- phonophoresis<sup>20,27</sup> and iontophoresis<sup>20</sup> to reduce inflammation and pain;
- monophasic pulsed stimulation for edema<sup>20,27</sup>;
- transcutaneous electrical nerve stimulation (TENS) for pain<sup>20,27</sup>;
- neuromuscular electrical stimulation (NMES) to facilitate quadriceps muscle activity, which may be helpful in muscle reeducation in those who have acute pain, edema, or significant weakness and are unable to properly activate their vastus medialis<sup>9,10,20,27</sup>; and
- electromyographic (EMG) biofeedback to promote selective activation of the vastus medialis for selective strengthening or to restore muscle balance in knee extension.<sup>3,16,21,31</sup>

Despite the incorporation of these therapeutic modalities into the recommended treatment of PFPS patients, there has not been a systematic review of evidence for such practice. The purpose of this review is to examine the evidence basis for the use of therapeutic modalities in the rehabilitation of the PFPS patient.

## METHODS

### Search

In May and August 2010, the literature was searched using the following databases for the years 1970 to 2010: PubMed, CINAHL, Web of Science Citation Index, Science Direct, ProQuest Nursing & Allied Health, and Your Journals@OVID. The database review began with a general search using the term *patellofemoral pain syndrome treatment*, followed by searches using the term *patellofemoral pain syndrome* paired with *therapeutic modality*, *cryotherapy*, *cold*, *Cryocuff*, *thermotherapy*, *heat*, *diathermy*, *ultrasound*, *moist hot pack*, *whirlpool*, *electrical stimulation*, *TENS*, *NMES*, *biofeedback*, *EMG biofeedback*, and *laser*.

Only studies in peer-reviewed journals were considered. No abstracts, dissertations, theses or articles from meeting proceedings were reviewed.

### Study Selection

Studies had to meet the following criteria:

*Population:* principal diagnosis of PFPS; no additional knee pain diagnoses; both sexes and all age ranges included

*Study design:* randomized controlled trial—either direct comparison to control or 2-group (or more) comparison

*Interventions:* one of the therapeutic modalities as the intervention; no limitations placed on the use of concurrent treatments or the nature of control groups

*Outcome measures:* knee extension and flexion strength (isokinetic and isometric), patellofemoral pain assessment during activities of daily life, functional tests (eg, squats, step-up/step-down), Kujala patellofemoral score,<sup>19</sup> and EMG recording from knee flexors and extensors (specifically comparing vastus medialis and vastus lateralis) and quadriceps femoris cross-sectional area.

*Language:* non-English-language studies excluded

### Quality Assessment

Quality was independently assessed by both authors using the PEDro Scale<sup>22</sup> and a second system,<sup>8</sup> specifically designed for interventions for patellofemoral pain.

This system uses 4 main criteria: population, interventions, effect size, and data presentation and analysis. Each criterion is composed of 3 or 4 scored items for a total of 100 points. This scale has a high interrater reliability, with intraclass correlation coefficients for items ranging from 0.64 (for intervention standardization and description) to 0.99 (for the blinding of outcome assessors). The intraclass correlation coefficient for the total quality score was 0.97.

## RESULTS

### Study Selection

Twelve studies were identified that met the criteria: 1 investigated the effects of cold and ultrasound, ice alone, iontophoresis, and phonophoresis<sup>4</sup>; 3 studied the effects of NMES<sup>7,11,12</sup>; 4 investigated the effects of EMG biofeedback<sup>16,18,21,31</sup>; 3 evaluated the effects of electroanalgesia (electrical stimulation for management of pain)<sup>1,5,13</sup>; and 1 studied the effects of low-intensity laser therapy<sup>25</sup> (Table 1).

### Quality Assessment

Quality scores were based on the analysis of 2 independent reviewers (D.A.L., N.H.W.). Reviewers' scores on the patellofemoral-specific scale<sup>8</sup> ranged from 19 to 79 (maximum score, 100). Average quality scores based on the use of the PEDro Scale ranged from 4 to 8 (maximum score, 10).

## DISCUSSION

### Ultrasound and Ice Massage, Ice Bags, Phonophoresis, and Iontophoresis

The single study<sup>4</sup> of the ultrasound and ice massage, ice bags, phonophoresis, and iontophoresis modalities reported improvement in subjective symptoms and hamstring and quadriceps strength. However, there was no control group, and

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Table 1. Study Characteristics.<sup>a</sup>

Intervention	Outcomes	Results
<p>Akrcalli et al<sup>1</sup>: 44 patients randomized to 2 groups</p> <p>First group: conventional exercise, both isometric and eccentric exercises, 6 weeks, 5 times per week</p> <p>Second group: exercise program in addition to high-volt monophasic pulsed stimulation over the vastus medialis for pain relief, 6 weeks, 5 times per week</p>	<p>Pain levels</p> <p>Quadriceps strength</p>	<p>At the third week, both groups showed a significant reduction in pain and an increase in quadriceps strength; the reduction in the high-volt monophasic pulsed stimulation group was significantly greater than that in the control group (<math>P &lt; 0.05</math>).</p> <p>At the sixth week, there was no significant difference (<math>P &gt; 0.05</math>) in pain reduction or increase in quadriceps strength between the groups</p>
<p>Antich et al<sup>4</sup>: 53 with 67 symptomatic knees randomized to 4 groups</p> <p>All received 4 exercises and 1 modality, 4 treatments over 7 to 8 days</p> <p>Phonophoresis: 1 mL of Hexadrol and 1 mL of 4% topical Xylocaine for 7 min</p> <p>Iontophoresis: 1 mL of Hexadrol and 1 mL of 4% topical Xylocaine for 20 min with Phoresor unit</p> <p>Ultrasound/ice massage contrast, 3 cycles of 3 min of heat with 2 min of cold</p> <p>Ice bags to the anterior and posterior knee for 10 min</p>	<p>Subjective change in "condition"</p> <p>Isometric quadriceps and hamstring torque</p>	<p>Subjective improvement: ultrasound/ice, 47%; phonophoresis, 32%; iontophoresis, 24%; ice bags, 22%</p> <p>Isometric quadriceps torque increase: ultrasound/ice, 28%; phonophoresis, 13.3%; iontophoresis, 14.5%; ice bags, 5%</p> <p>Isometric hamstring torque increase: ultrasound/ice, 34.1%; phonophoresis, 0%; iontophoresis, 15%; ice bags, 15.4%</p> <p>No inferential statistics done</p>
<p>Avraham et al<sup>5</sup>: 30 patients randomized to 3 groups</p> <p>All patients were randomly allocated into 3 groups</p> <p>Group 1: conventional knee rehabilitation program included quadriceps strengthening and TENS</p> <p>Group 2: hip-oriented rehabilitation included stretching, hip external rotators strengthening, and TENS</p> <p>Group 3: combination of the above programs</p> <p>TENS: 15 min, sensory level, 100 Hz, and 150-<math>\mu</math>s phase duration</p> <p>Two 30-minute treatments/week for 3 weeks</p>	<p>11-point visual analog scale</p> <p>Everyday function assessed by patellofemoral evaluation scale (0-100 points)</p>	<p>All 3 groups had significant decreases in pain and improvement in function</p> <p>TENS conducted in all 3 groups, so its contribution could not be assessed</p>
<p>Bily et al<sup>7</sup>: 36 patients randomized to 2 groups</p> <p>One group—supervised physical therapy training for 12 weeks</p> <p>Second group—physical therapy and NMES applied to the knee extensors for 20 min, 2 times daily, 5 times a week, for 12 weeks at 40 Hz, with a pulse duration of 26 ms, at 5 seconds on and 10 seconds off, and maximal tolerable intensity up to 80 mA</p>	<p>Patellofemoral pain assessment with visual analog scale during activities of daily life</p> <p>Kujala patellofemoral score</p> <p>Isometric strength</p> <p>Both assessed before and after 12 weeks' treatment, as well as after 1 year</p>	<p>Significant reduction of pain in both groups during activities of daily life (<math>P = 0.003</math> and <math>P &lt; 0.001</math> for physical therapy and physical therapy + NMES, respectively)</p> <p>Significant improvement (<math>P &lt; 0.001</math>) of Kujala patellofemoral score in both groups</p> <p>Improvement of function and reduction of pain at both the 12-week treatment and 1-year follow-up</p> <p>Between-group differences not significant</p> <p>No significant change in isometric knee extensor strength in either group</p> <p>Significant correlation between pain and Kujala patellofemoral score before treatment (<math>\rho = -0.54</math>, <math>P &lt; 0.001</math>), after 3 months (<math>\rho = -0.77</math>, <math>P &lt; 0.001</math>), and after 12 months (<math>\rho = -0.64</math>, <math>P &lt; 0.001</math>)</p>

(continued)

Table 1. (continued)

Intervention	Outcomes	Results
<p>Callaghan et al<sup>12</sup>: 16 patients randomized to groups</p> <p>One a standard sequential mixed-frequency NMES protocol (NMES-STD)</p> <p>NMES from a newly designed simultaneous mixed-frequency device (NMES-EXP)</p> <p>Both units used an asymmetrical biphasic pulse to a maximum of 90 mA at 200- to 350-µs pulse duration with a duty cycle of 10:50</p> <p>Stimulation was applied for 1 hr each day, daily for 6 weeks</p>	<p>Isometric and isokinetic extension torque</p> <p>Muscle fatigue rate: frequency analysis of surface electromyogram</p> <p>Pain: 10-cm visual analog scale</p> <p>Kujala patellofemoral function questionnaire</p> <p>Step test and squat knee flexion</p> <p>Quadriceps cross-sectional area</p>	<p>Significant improvement (<math>P = 0.019</math>) in isometric quadriceps torque in NMES-STD but not NMES-EXP</p> <p>Significant improvement (<math>P = 0.005</math>) in isokinetic quadriceps torque in NMES-EXP but not NMES-STD</p> <p>Significant improvement (<math>P = 0.045</math>) in the Kujala functional questionnaire scores in NMES-STD but not NMES-EXP</p> <p>No change any other measure</p> <p>No difference between groups in any measure</p>
<p>Callaghan and Oldham<sup>11</sup>: 80 patients randomized to 2 groups</p> <p>Customized experimental stimulator with simultaneously delivered mixed-frequency stimulation pattern (EXPER)</p> <p>Standard fixed-frequency NMES stimulator (EMPI)</p> <p>Both units used an asymmetrical biphasic pulse to a maximum of 90 to 100 mA at 200- to 350-µs pulse duration with a duty cycle of 10:50</p> <p>Stimulation was applied for 1 h each day, daily for 6 weeks</p>	<p>Same measures as in Callaghan et al<sup>12</sup> (2001)</p> <p>Assessments at 1, 2, 3 weeks after 6-week stimulation protocol</p>	<p>Significant increase (<math>P = 0.0001</math>) in isometric strength with EXPER unit only</p> <p>Significant increase (<math>P = 0.008</math>) in isokinetic strength with EMPI unit only</p> <p>Significant increase (<math>P = 0.021</math>) in quadriceps cross-sectional area with EXPER unit only</p> <p>Both forms of NMES showed significant improvement in the Kujala functional questionnaire scores (<math>P = 0.007</math> and <math>0.001</math> for NMES-EXP and NMES-STD, respectively)</p> <p>Both forms of NMES showed significant improvement in pain (<math>P = 0.004</math> and <math>0.047</math> for NMES-EXP and NMES-STD, respectively)</p> <p>Both forms of NMES showed significant improvement in step test (<math>P = 0.0001</math> and <math>0.0001</math> for NMES-EXP and NMES-STD, respectively)</p> <p>Both forms of NMES showed significant improvement in knee flexion (<math>P = 0.003</math> and <math>0.0001</math> for NMES-EXP and NMES-STD, respectively).</p> <p>No changes in fatigue with either intervention</p> <p>No difference between groups in any measure</p>
<p>Can et al<sup>13</sup>: 30 patients with 42 affected knees randomized to 2 groups</p> <p>Both groups received 4 or 5 sessions per week for 6 weeks; isometric, closed and open kinetic chain, and stretching exercises</p> <p>First group: 30 min, TENS with 20- to 60-µs pulses delivered at 100 Hz</p> <p>Second group: 5 to 6 min diadynamic current therapy with both diphasic fixe and long phase components delivered at 100 Hz</p>	<p>Pain assessed with 10-cm visual analog scale</p> <p>Lysholm' Knee Scoring Scale: 0- to 100-point scale assessing pain, edema, activities of daily life</p> <p>Knee function assessed by number of squats performed in 30 s</p> <p>Four-level activity scale measuring activities of daily life, stair-climbing, and sports and recreational activities</p>	<p>Significant improvements in all measures in both groups</p> <p>No difference between the 2 groups in any measure</p>

(continued)

Table 1. (continued)

Intervention	Outcomes	Results
<p>Dursun et al<sup>16</sup>: 60 patients randomized to 2 groups</p> <p>Knee strengthening, flexibility, proprioception, and endurance exercises</p> <p>Biofeedback + exercise with biofeedback training emphasizing increasing vastus medialis (VM) activity and decreasing vastus lateralis activity for 30 min/session</p> <p>Exercise: 5 days/week for the initial 4 weeks, then reduced to 3 days/week</p> <p>Biofeedback training: 3 days/week for 4 weeks</p>	<p>Maximum and mean electromyographic amplitudes (<math>\mu</math>V) during contraction of the vastus medialis and vastus lateralis</p> <p>Knee pain on 10-cm visual analog scale</p> <p>Score on Functional Index</p> <p>Questionnaire of 8 leisure activities</p> <p>At the start and at monthly intervals for 3 months</p>	<p>All measurements showed significant improvement in both groups</p> <p>No consistent significant difference between the groups, with the exception of vastus medialis mean, was significantly higher in the biofeedback + exercise group than in the exercise-only group at 1 month (<math>P = 0.046</math>), 2 months (<math>P = 0.042</math>), and 3 months (<math>P = 0.036</math>)</p>
<p>Harrison et al<sup>18</sup>: 113 patients randomized to 3 groups</p> <p>Group 1: home program education, lower extremity stretching, and quadriceps and adductor strengthening</p> <p>Group 2: clinic program of activities in group 1 with patellar glides</p> <p>Group 3: clinic program of group 2 with patellar taping and electromyographic biofeedback</p> <p>Treatments: 3 times/week for 4 weeks</p>	<p>Score on Functional Index</p> <p>Questionnaire of 8 leisure activities</p> <p>10-cm visual analog scale</p> <p>Clinical score using Patellofemoral Function Scale: 15 items scored 0 to 100</p> <p>Clinical change: no change, better, or worse</p> <p>Knee pain threshold during step test</p>	<p>Significantly greater improvement in Functional Index Questionnaire in group 3 at 1 month (<math>P &lt; 0.05</math>) but no difference between groups at 1 year</p> <p>Significantly greater improvement in visual analog scale in group 3 at 1 month for "worse pain" (<math>P = 0.011</math>) and "usual pain" (<math>P = 0.016</math>) but no difference between groups at 1 year</p> <p>Significant improvements in all remaining measures over study period but no significant differences between groups</p>
<p>Ng et al<sup>21</sup>: 26 patients randomized to 2 groups</p> <p>Warm-up, knee extensors strengthening, proprioceptive training, and agility drills for vastus medialis oblique strengthening</p> <p>Exercises with biofeedback unit to increase in vastus medialis oblique activity</p>	<p>Vastus medialis oblique:vastus lateralis electromyographic ratio</p>	<p>Significant change (<math>P = 0.016</math>) in vastus medialis oblique:vastus lateralis electromyographic ratio only in biofeedback + exercise group</p>

(continued)

Table 1. (continued)

Intervention	Outcomes	Results
<p>Roggi-Hansen et al<sup>25</sup>: 36 patients randomized to 2 groups</p> <p>Eight treatments in 5 weeks: 17-mW, 1000-Hz GaAs laser over patella for 10 min, peroneal muscles for 1 min, and femoral nerve in groin for 1 min</p> <p>Sham treatment control group</p>	<p>Pain description</p> <p>10-cm visual analog scale</p> <p>Body chart for pain</p> <p>Influence of pain on mood, gait, sleep, work, and sport</p> <p>Before and after interventions and at 8- to 12-week follow-up</p>	<p>There was improvement in pain and disability in both groups but no between-group difference between the laser and sham control groups.</p>
<p>Yip and Ng<sup>31</sup>: 26 patients randomized to 2 groups (probably same as in Ng et al<sup>27</sup>)</p> <p>Warm-up, knee extensors strengthening, proprioceptive training, and agility drills aimed at vastus medialis oblique</p> <p>Exercises with biofeedback to increase in vastus medialis oblique activity</p>	<p>Patellar gliding and tilting, measured with a Vernier caliper</p> <p>Patellofemoral Pain Syndrome Severity Scale: 1-10</p> <p>Isokinetic torque of knee flexion and extension</p> <p>Total work per body weight (J/kg)</p>	<p>Both groups had significant improvement in isokinetic peak torque in work output in patellar alignments</p> <p>No between-group differences</p> <p>Decrease in pain not significant</p>

<sup>a</sup>NMES, neuromuscular electrical stimulation.

no inferential statistics were performed; so, the significance of these changes cannot be determined. The quality of this study was the lowest of all articles reviewed, with a 19 of 100 on the patellofemoral-specific scale<sup>8</sup> and 4 of 10 on the PEDro Scale.<sup>22</sup> Because of the poor quality of the study and the use of an exercise program with the modalities, there is no evidence that any of these modalities are effective in treating PFPS.

### Neuromuscular Electrical Stimulation

Each study postulated that selective strengthening of the vastus medialis using NMES could enhance a standard exercise protocol in reducing the symptoms of PFPS. Studies varied in quality, with a range of 57 to 79 of 100 on the patellofemoral-specific scale<sup>8</sup> and 5 to 6 of 10 on the PEDro Scale.

Three studies showed improvements in several measures of pain and function.<sup>7,11,12</sup> Because the exercise protocol was part of the intervention in these groups, it is not possible to separate the effects of NMES from the known positive effects of exercise on PFPS.<sup>6</sup> The results of these 3 studies suggest that there is no added benefit of NMES when combined with standard physical therapy.

### EMG Biofeedback

Studies on EMG biofeedback varied widely in quality, with a range of 50 to 76 of 100 on the patellofemoral-specific scale of Bizzini et al<sup>8</sup> and 6 to 8 of 10 on the PEDro scale.

Significantly greater short-term improvements in pain and functional measures were reported when exercise was combined with EMG biofeedback and patellar taping, compared with exercise alone.<sup>18</sup> However, at 1 year following the intervention, there were no significant differences between the 2 groups. The decreased number of patients at the 1-year follow-up may have contributed to this lack of significance difference. Unfortunately, the effect of patellar taping cannot be separated from EMG biofeedback.

Differences in pain or functional measures between exercise and exercise combined with EMG biofeedback were not found, whereas increased recruitment of the vastus medialis/vastus medialis oblique was seen.<sup>16</sup> EMG biofeedback may be useful in activation of the vastus medialis oblique, but this may have little impact on pain and function. Similarly, no differences in pain or functional scores were reported for an exercise program as compared with exercise combined with EMG biofeedback.<sup>21,31</sup> Significant improvement in the vastus medialis oblique:vastus lateralis EMG ratio was seen with the EMG biofeedback.<sup>21</sup> EMG biofeedback may be able to affect the relative activation of the vastus medialis/vastus medialis oblique when compared with the vastus lateralis, but when combined with an exercise program, EMG biofeedback has no additional effect in reducing the symptoms of PFPS.

### Electrical Stimulation for Pain Control

One study<sup>5</sup> included TENS in all 3 experimental groups, so the effect of TENS in isolation of other treatments could not be assessed. A second study<sup>13</sup> compared TENS with diadynamic

current therapy, both used in combination with an exercise program, and it found no difference between the 2 pain-reducing electrical modalities. The third of these 3 studies<sup>1</sup> reported that when high-volt monophasic pulsed stimulation was used in combination with an exercise program, compared with the exercise program alone, there was a significant difference between the 2 groups after 3 weeks of treatment, but after 6 weeks of treatment, there were no between-group differences. Conclusions cannot be drawn about the efficacy of electrotherapy for pain control on treating the symptoms of PFPS, because in these studies, electrical stimulation was used with exercise in all groups<sup>13</sup> or included in each intervention.<sup>5</sup> The one study<sup>1</sup> that had an exercise control suggested a short-term advantage to high volt monophasic pulsed stimulation, but at the end of treatment, there was no additive effect in reducing the symptoms of PFPS.

### Low-Intensity Therapeutic Laser

There was no significant difference in any measure for the laser when compared with a sham laser control in the treatment of patients with PFPS.<sup>25</sup> There was a range of variables in the treatments with laser therapy, including wavelength, power, power density, energy, energy density, treatment duration, treatment intervention time postinjury, and method of application (contact mode versus noncontact mode).<sup>30</sup> The effectiveness of laser therapy may be related to these parameters. No conclusions can be reached from this study.

## CONCLUSIONS

None of the therapeutic modalities reviewed has sound scientific justification for the treatment of PFPS.

## REFERENCES

1. Akarcali I, Tugay N, Kaya D, Atay A, Doral MN. The role of high voltage electrical stimulation in the rehabilitation of patellofemoral pain. *Pain Clin*. 2002;14(3):207-212.
2. American Physical Therapy Association. *Guide to Physical Therapist Practice*. 2nd ed. Alexandria, VA: American Physical Therapy Association; 2003.
3. Angoules AG, Balakatounis KC, Panagiotopoulou KA, Mavrogenis AF, Mitsiokapa EA, Papagelopoulos PJ. Effectiveness of electromyographic biofeedback in the treatment of musculoskeletal pain. *Orthopedics*. 2008;31(10):980-984.
4. Antich TJ, Randall CC, Westbrook RA, Morrissey MC, Brewster CE. Physical therapy treatment of knee extensor mechanism disorders: comparison of four treatment modalities. *J Orthop Sports Phys Ther*. 1986;8(5):255-259.
5. Avraham F, Aviv S, Ya'akobi P, et al. The efficacy of treatment of different intervention programs for patellofemoral pain syndrome: a single blinded randomized clinical trial pilot study. *ScientificWorldJournal*. 2007;7:1256-1262.
6. Barton C, Webster K, Menz H. Evaluation of the scope and quality of systematic reviews on nonpharmacological conservative treatment for patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 2008;38(9):529-541.
7. Bily W, Trimmel L, Mödlin M, Kaider A, Kern H. Training program and additional electric muscle stimulation for patellofemoral pain syndrome: a pilot study. *Arch Phys Med Rehabil*. 2008;89(7):1230-1236.
8. Bizzini M, Childs JD, Piva SR, Delitto A. Systematic review of the quality of randomized controlled trials for patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 2003;33:4-20.
9. Bohannon R. The effect of electrical stimulation to the vastus medialis muscle in a patient with chronically dislocating patella. *Phys Ther*. 1983;63(9):1445-1447.

10. Brody LT, Thein JM. Nonoperative treatment for patellofemoral pain. *J Orthop Sports Phys Ther.* 1998;28(5):336-344.
11. Callaghan MJ, Oldham JA. Electric muscle stimulation of the quadriceps in the treatment of patellofemoral pain. *Arch Phys Med Rehabil.* 2004;85(6):956-962.
12. Callaghan MJ, Oldham JA, Winstanley J. A comparison of two types of electrical Stimulation of the quadriceps in the treatment of patellofemoral pain syndrome: a pilot study. *Clin Rehabil.* 2001;15(6):637-646.
13. Can F, Tandogan R, Yilmaz I, Dolunay E, Erden Z. Rehabilitation of patellofemoral pain syndrome: TENS versus diadynamic current therapy for pain relief. *Pain Clin.* 2003;15(1):61-68.
14. Cosca DD, Navazio F. Common problems in endurance athletes. *Am Fam Physician.* 2007;76(2):237-244.
15. Devereaux MD, Lachmann SM. Athletes attending a sports injury clinic: a review. *Br J Sports Med.* 1983;17(4):137-142.
16. Dursun N, Dursun E, Kilic Z. Electromyographic biofeedback-controlled exercise versus conservative care for patellofemoral pain syndrome. *Arch Phys Med Rehabil.* 2001;82(12):1692-1695.
17. Fulkeron JP. Diagnosis and treatment of patients with patellofemoral pain. *Am J Sports Med.* 2002;30(3):447-456.
18. Harrison EL, Sheppard MS, McQuarrie AM. A randomized controlled trial of physical therapy treatment programs in patellofemoral pain syndrome. *Physiother Can.* 1999;51(2):93-100.
19. Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral problems. *Arthroscopy.* 1993;9(2):159-163.
20. Manske RC, Davies GJ. A nonsurgical approach to examination and treatment of the patellofemoral joint: part 2. Pathology and nonsurgical management of the patellofemoral joint. *Crit Rev Phys Rehabil Med.* 2003;15(3/4):253-293.
21. Ng GYF, Zhang AQ, Li CK. Biofeedback exercise improved the EMG activity ratio of the medial and lateral vasti muscles in subjects with patellofemoral pain syndrome. *J Electromyogr Kinesiol.* 2008;18(1):128-133.
22. PEDro Physiotherapy Evidence Database. PEDro Scale. <http://www.pedro.org.au/english/downloads/pedro-scale/>. Updated June 21, 1999. Accessed January 5, 2010.
23. Philadelphia Panel. The Philadelphia panel evidence-based clinical practice guidelines on selected rehabilitation interventions for knee pain. *Phys Ther.* 2001;81(10):1675-1700.
24. Powers C. Rehabilitation of patellofemoral joint disorders: a critical review. *J Orthop Sports Phys Ther.* 1998;28(5):345-354.
25. Rogvi-Hansen B, Ellitsgaard N, Funch M, Dall-Jensen M, Prieske J. Low level laser treatment of chondromalacia patellae. *Int Orthop.* 1991;15(4):359-361.
26. Thomee R. A comprehensive treatment approach for patellofemoral pain syndrome in young women. *Phys Ther.* 1997;77(12):1690-1703.
27. Wilk KE, Davies GJ, Mangine RE, Malone TR. Patellofemoral disorders: a classification system and clinical guidelines for nonoperative rehabilitation. *J Orthop Sports Phys Ther.* 1998;28(5):307-322.
28. Wilson T, Carter N, Thomas G. A multicenter, single-masked study of medial, neutral, and lateral patellar taping in individuals with patellofemoral pain syndrome. *J Orthop Sports Phys Ther.* 2003;33:437-448.
29. Witvrouw E, Bellemans J, Lysens R, Danneels L, Cambier D. Intrinsic risk factors for the development of anterior knee pain in an athletic population: a two-year prospective study. *Am J Sports Med.* 2000;28(2):480-489.
30. Woodruff LD, Bounkeo JM, Brannon WM, et al. The efficacy of laser therapy in wound repair: a meta-analysis of the literature. *Photomed Laser Surg.* 2004;22(3):241-247.
31. Yip SL, Ng GY. Biofeedback supplementation to physiotherapy exercise programme for rehabilitation of patellofemoral pain syndrome: a randomized controlled pilot study. *Clin Rehabil.* 2006;20(12):1050-1057.

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