Treatment of Infrapatellar Tendinitis:  
A Combination of Modalities and Transverse Friction Massage Versus Iontophoresis

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The purpose of this study was to compare an established protocol of modalities and transverse friction massage (MOD & TFM) with iontophoresis of dexamethasone and lidocaine (IONTO) in the treatment of patients with infrapatellar tendinitis. Thirty cases with infrapatellar tendinitis were randomly assigned to either the MOD & TFM or the IONTO intervention. Subjects still symptomatic after six sessions of intervention received the alternate treatment protocol. Four measures were used to assess patient status: a functional index questionnaire, a visual analog pain scale, a rating of tenderness with palpation of the involved tendon, and the number of step-ups needed to elicit pain. In response to the MOD & TFM intervention, only the number of step-ups performed to elicit pain showed significant improvement. All status measures improved significantly with the IONTO intervention. The results suggest that iontophoresis may be more effective and efficient in decreasing pain, reducing inflammation, and promoting healing in patients with infrapatellar tendinitis.

Participation in sport and physical activity has increased over the past several decades. Furthermore, there has been an increase in the incidence of overuse injuries. Patellar tendinitis, an overuse injury of the knee extensor mechanism, is the most prevalent painful extra-articular condition affecting the knee (19).

The diagnosis and treatment of overuse injuries remain a challenge to sports medicine practitioners (31). A diagnosis of patellar tendinitis or ‘‘jumper’s knee’’ is based on history and clinical examination (3, 10). Typically, the patient reports anterior knee pain during or after participation in a repetitive activity such as jumping, running, cycling, climbing, or kicking. Occasionally, direct trauma or one strong quadriceps contraction initiates symptoms (13, 32).
Clinical findings include tenderness with palpation to the involved site, and painful resisted knee extension (11, 12, 25). The tenoperiosteal junction at the inferior pole of the patella is most commonly affected, but the body of the tendon or its distal attachment to the tibial tubercle can also be involved (30). At times, localized swelling and quadriceps weakness are present (25, 32).

Contrary to earlier belief, patellar tendinitis is not self-limiting and may progress to a state of chronic inflammation, degeneration, and necrosis (16, 27, 32, 37). Classification systems have been developed that describe the progressive phases of patellar tendinitis in terms of symptoms and functional impairment (4, 11, 32) and histopathological changes (19). These classification systems have been advocated as a basis upon which to determine appropriate treatment intervention. Conservative treatment is almost universally recommended as an initial approach to the management of patellar tendinitis, especially during the early phases of involvement (14, 25, 27).

Specific recommendations for conservative management are numerous and include rest, ice, nonsteroidal anti-inflammatory medications, and physical therapy (27, 29, 32, 37). Physical therapy modalities such as heat, phonophoresis, and ice have been widely advocated as means to achieve the initial treatment goals of relieving pain, reducing inflammation, and promoting healing (25, 30, 31, 34). Two other physical therapy interventions, transverse friction massage (TFM) (6, 8, 13) and iontophoresis (3, 14), also appear among recommended treatments for infrapatellar tendinitis.

James Cyriax described TFM in the 1940s. He claimed TFM has two therapeutic effects in chronic inflammatory conditions: production of a traumatic hyperemia, and mobilization and softening of fibrous adhesions (12). Case studies of treatment regimes that included TFM have reported relief of symptoms (38) and return to sport (19, 22) in patients with tendon lesions of the ankle, shoulder, and knee. Similar success was reported in achieving analgesia in patients with various soft tissue injuries (6).

In contrast to these case reports, controlled investigations of athletes with iliotibial band friction syndrome (33), patients with extensor carpi radialis tendinitis (35), and rabbits with induced knee sprains (36) reported no treatment effect attributable to the use of TFM. Clearly, the specific conditions under which TFM can be effective require further substantiation.

Steroid injection, Cyriax’s alternative to TFM (12), is generally no longer recommended for use in cases of infrapatellar tendinitis (14, 37), primarily due to evidence linking steroid injection with subsequent tendon rupture (16, 17, 32). However, recent investigations have failed to attribute any detrimental changes in traumatized tendons to the use of steroid injection (26, 28). Thus, controversy persists over the safety of treating tendinitis with steroid injection.

Iontophoresis, the use of a continuous direct current to move ions through the skin, is an alternate, noninvasive procedure for the local administration of anti-inflammatory medications (20). Iontophoresis of corticosteroids yields local tissue concentrations that are lower than those achieved with injection but greater than those achieved with oral administration, and therefore is considered to be both safe and effective (21).

Investigators have reported increased range of motion, improved function, and decreased pain in patients treated with iontophoresis for various musculoskeletal inflammatory conditions (2, 5, 15, 23, 24). Less favorable results
for iontophoresis were reported in a study of patients with “extensor mechanism disorders” (1). It is important to note that all of these clinical studies of iontophoresis drew conclusions solely from descriptive statistics. Clearly, further study is warranted to document definitively the therapeutic benefits of iontophoresis.

For over 12 years, our group of orthopedic and sports medicine clinics has used a combination of modalities, similar to the program outlined by Gross (22), to achieve the initial treatment goals of relieving pain, reducing inflammation, and promoting healing. The purpose of this study was to compare our established protocol of moist heat, transverse friction massage, phonophoresis, and ice with iontophoresis of dexamethasone and lidocaine in patients with infrapatellar tendinitis.

Method

Subjects

Seventeen men and 9 women with infrapatellar tendinitis, 4 with bilateral involvement, participated in this study after providing written, informed consent. Four inclusion criteria were used: (a) anterior knee pain with resisted knee extension, (b) painful palpation of the infrapatellar tendon, (c) no prior surgery involving the infrapatellar tendon, and (d) a Cyriax knee examination (12) negative for ligament or meniscal injury. Subjects ranged in age from 14 to 43 years old (mean age = 20.5 years) with duration of symptoms ranging from 3 days to 10 years (median duration of symptoms = 5.5 months). Table 1 characterizes the individual cases of infrapatellar tendinitis using Curwin and Stanish’s “classification of patellar disorder according to pain” (11). Participants were instructed to avoid activities that elicited knee pain. Cases were randomly assigned to the two treatment protocols.

Table 1 Cases of Infrapatellar Tendinitis Characterized by Curwin and Stanish’s “Classification of Patellar Disorder According to Pain” (11)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Number of cases⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No pain</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Pain with extreme exertion only, does not hinder sports performance and disappears when activity stops</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Pain with exertion, remains 1 to 2 hr afterward</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Pain during any athletic activity, lasts 4 to 6 hr afterward, increases throughout activity; performance level decreased</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Pain that starts immediately after activity commences, causes withdrawal from activity</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Pain during daily activities; patient unable to participate in any sports</td>
<td>4</td>
</tr>
</tbody>
</table>

⁴Classification level missing for 2 cases.
Treatment Protocols

The two treatment protocols were (a) iontophoresis (IONTO) and (b) a combination of modalities and transverse friction massage (MOD & TFM). Iontophoresis of one part dexamethasone sodium phosphate (4 mg/ml) with two parts lidocaine hydrochloride (4%) was performed using the Phoresor® II (IOMED, Inc., Salt Lake City, UT), in accordance with manufacturer's guidelines. The drug delivery electrode was placed over the most tender part of the patellar tendon, with the length of the electrode perpendicular to the tendon. The Ioflex™ (IOMED, Inc.) iontophoretic electrode was used in treating the first 5 cases. However, with the development of a polymer gel electrode, the TransQB™ (IOMED, Inc.) was adopted for use as the drug delivery electrode for all subsequent cases. A maximum of 80 mA-min and 40 mA-min was delivered when using the Ioflex™ EL 502 electrode and the TransQB™ electrode, respectively.

The MOD & TFM protocol consisted of (a) moist heat to the anterior aspect of the knee for 15 min; (b) transverse friction massage to the infrapatellar tendon as described by James Cyriax (13) for 12 min; (c) phonophoresis of 10% hydrocortisone cream coupled with ultrasound transmission gel at 1.5 W/cm², continuous, to the infrapatellar tendon for 6 min; and (d) cold pack to the anterior aspect of the knee for 15 min. The phonophoresis component of the MOD & TFM protocol was not administered to subjects under 17 years old as a precaution against any adverse effects that ultrasound might have upon growing epiphyses.

Several practice sessions were held in which two investigators standardized application of all treatment techniques. A test was conducted to determine the intertherapist reliability of administering TFM. Each investigator applied her palpation and friction massage techniques to the infrapatellar tendon of 10 asymptomatic volunteers. Participants were asked to consider both pressure and sweep in rating the techniques as about the same or noticeably different. Nine of the 10 participants rated the friction massage applied by the two therapists as about the same. When a third investigator joined the project, practice sessions again were held to review standardized application of treatment techniques. Additionally, all three investigators had demonstrated both written and practical expertise in the Cyriax approach to orthopedic medicine as evidenced by earning certificates of "Advanced Accomplishment in Orthopedic Evaluation and Treatment."

Status Measures

Four measures were used to assess patient status:

**Functional Index Questionnaire (FIQ).** Patients assessed their function by completing an FIQ, adapted from Chesworth and coworkers (9) and depicted in Figure 1. The seven items on the questionnaire were scored as unable to do = 0 points, can do with problems = 1 point, and no problems = 2 points, for a possible maximum score of 14 points.

**Palpation.** As the examiner palpated the affected portion of the tendon, patients rated any tenderness elicited. The categories not painful, somewhat painful, or very painful were scored as 1, 2, and 3, respectively.

**Step-Ups.** A standard clinic stool of 9 in. height was used to perform step-ups at an approximate rate of 20 steps per minute. Patients were instructed
Today, do you or would you have any problem in your _____ knee at all?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Unable to do</th>
<th>Can do with problems</th>
<th>No problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Walking as far as 1 mile</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. Climbing up two flights of stairs (16 steps)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3. Squatting (15 repetitions)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>4. Jumping rope for 5 min</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>5. Climbing up four flights of stairs (32 steps)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>6. Running a short distance, say 100 m (approximately the length of a football field)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>7. Running as far as 1 mile</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Figure 1 — Functional index questionnaire used to assess patient status.

to do as many step-ups as they were able, up to a maximum of 30 repetitions, indicating when knee pain started and whether the pain became severe.

**Visual Analog Scale (VAS).** Patients were asked to indicate the greatest level of pain experienced during the preceding 24 hr by making a slash on a 10-cm line with endpoints labeled *no pain at all* and *pain is as bad as it could possibly be* (9).

**Procedure**

Following the evaluation and the patients’ admission to the study, initial status measures were obtained. Six sessions of the assigned treatment protocol were administered, two to three times per week, but not on consecutive days. Status measures were repeated on the seventh visit. If a patient was still symptomatic, a six-session course of the alternate treatment protocol was initiated. Status measures were administered a third time on the visit that followed completion of six sessions of the alternate treatment protocol.

Exercise was added to the rehabilitation program on an individualized basis, with care taken to avoid eliciting or exacerbating anterior knee pain. The exercise program typically included lower extremity stretching, hamstring strengthening, progressive quadriceps strengthening such as modified straight-leg raising, eccentrics, and functional activities specific to the patient’s sport or recreational activity. Frequently, patients underwent lower extremity biomechanical evaluation, at times resulting in a recommendation for orthotic intervention.

**Data Analysis**

The Systat statistical package, Version 5.0 (Systat, Inc., Evanston, IL), was used to analyze the study data. A *t* test was used to compare the means of age and
duration of symptoms, and the Mann Whitney U test was used to compare classification level and pretest scores between the initial IONTO and MOD & TFM treatment groups. The Wilcoxon signed ranks test was used to compare pretreatment and posttreatment scores on status measures within each protocol, regardless of order of application.

Results

Twenty-four of the 30 cases of infrapatellar tendinitis provided sufficient data for inclusion in the statistical analysis. The 6 excluded cases were dropped for the following reasons. One patient was asymptomatic after one treatment session. One patient sustained an injury to the involved knee after inclusion in the study but before completion of the study protocol. Two cases were lost when the referring physician of a patient with bilateral involvement refused to consent to his patient receiving iontophoresis. One patient failed to return for scheduled treatment visits. One patient with concurrent patellofemoral dysfunction required intervention beyond the scope of this project.

Of the 24 cases included in the data analysis, 13 started with the MOD & TFM protocol and 11 started with the IONTO protocol. Nine of the MOD & TFM cases and 9 of the IONTO cases crossed over to receive the alternate treatment protocol. Of the 4 MOD & TFM cases that did not cross over to receive the IONTO protocol, 1 underwent an operative procedure to the involved knee, and 3 were unable to keep scheduled physical therapy appointments. Of the 2 IONTO cases that did not cross over to the MOD & TFM protocol, 1 was asymptomatic after the initial six sessions and returned to track-and-field competition; the other patient was unable to keep scheduled physical therapy appointments. Therefore, a total of 42 trials (22 MOD & TFM, 20 IONTO) were available for statistical analysis.

The initial treatment groups, 13 MOD & TFM cases and 11 IONTO cases, did not differ significantly (p > .05) in age, classification level, duration of symptoms, or pretest scores for the four status measures. In response to the MOD & TFM protocol, only the number of step-ups performed to elicit pain differed significantly (p < .05) between pretest and posttest. All status measures improved significantly (p < .05) over the course of treatment with the IONTO protocol. Table 2 lists results for each of the two treatment protocols on all four status measures. Patient ratings of tenderness with palpation of the infrapatellar tendon pre- and posttreatment are depicted in Figures 2 and 3, for MOD & TFM and IONTO, respectively.

Discussion

For over 12 years, the MOD & TFM protocol was the primary approach in our clinics to treating patients with tendinitis, sprains, and strains. In this study of infrapatellar tendinitis, the IONTO protocol was associated with greater improvement in pain and function than the MOD & TFM protocol.

Combining modalities with TFM limits our ability to generalize about the specific effects of each of the individual components of the protocol. In administering phonophoresis, we used 10% hydrocortisone (HC) in a cream base.
Table 2  Pre- and Posttreatment Scores and Results of Wilcoxon Signed Ranks Tests for the Two Treatment Protocols

<table>
<thead>
<tr>
<th>Status measure</th>
<th>Pretreatment Median</th>
<th>Range</th>
<th>Posttreatment Median</th>
<th>Range</th>
<th>z score</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modalities and TFM protocol</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIQ</td>
<td>8</td>
<td>4–14</td>
<td>8.5</td>
<td>4–14</td>
<td>1.29</td>
<td>.196</td>
</tr>
<tr>
<td>PALP</td>
<td>2.5</td>
<td>2–3</td>
<td>2</td>
<td>1–3</td>
<td>−1.41</td>
<td>.157</td>
</tr>
<tr>
<td>STEP</td>
<td>5</td>
<td>1–30</td>
<td>13.5</td>
<td>1–30</td>
<td>3.01</td>
<td>.003</td>
</tr>
<tr>
<td>VAS</td>
<td>3.4</td>
<td>0–9.3</td>
<td>2.6</td>
<td>0–7.1</td>
<td>−1.34</td>
<td>.181</td>
</tr>
<tr>
<td><strong>Iontophoresis protocol</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FIQ</td>
<td>8.5</td>
<td>3–13</td>
<td>9.5</td>
<td>5–14</td>
<td>2.79</td>
<td>.005</td>
</tr>
<tr>
<td>PALP</td>
<td>2</td>
<td>2–3</td>
<td>2</td>
<td>1–3</td>
<td>−2.45</td>
<td>.014</td>
</tr>
<tr>
<td>STEP</td>
<td>9.5</td>
<td>1–30</td>
<td>26</td>
<td>3–30</td>
<td>3.18</td>
<td>.001</td>
</tr>
<tr>
<td>VAS</td>
<td>3.3</td>
<td>0.2–7.1</td>
<td>1.4</td>
<td>0–6.4</td>
<td>−2.58</td>
<td>.010</td>
</tr>
</tbody>
</table>

Note. FIQ = Functional index questionnaire; PALP = palpation; STEP = number of step-ups performed to elicit pain; VAS = visual analog scale.

Figure 2 — Patient ratings of tenderness with palpation to the infrapatellar tendon pre- and posttreatment with modalities and TFM.
Since the completion of our data collection, Cameron and Monroe (7) have reported that 10% HC cream is a poor transmitter of ultrasound. In practice, we now use dexamethasone and lidocaine mixed with ultrasound gel. However, the ultrasound medium used during this project is now of questionable therapeutic benefit.

Further research is needed to determine the most efficient, effective treatment for tendinitis. Based on our findings, iontophoresis should be considered in developing the treatment plan for patients with infrapatellar tendinitis. One question that several of our colleagues have posed, and which warrants investigation, is whether a treatment plan combining TFM and iontophoresis offers more benefit than either treatment administered separately. Another important issue unanswered by this project is the long-term effect of these treatment interventions on recurrence rates and return to sport.

We acknowledge several limitations in drawing conclusions from the results of this clinical project. Ethical considerations resulted in at least two decisions that favored the best interest of our patients over a stronger experimental design. One issue not determined by this study was the reliability of the selected status measures. With our first subjects, we collected two sets of pretreatment scores, one following initial evaluation and a second on the subsequent visit. However, implementing this plan delayed the initiation of actual treatment for 2 or 3 days. Most of our subjects (20 of 26) were high school students active in athletics. Eager to return to competition as soon as possible, they found the delay in treatment unacceptable. Therefore, the plan was modified such that only one set of pretreatment scores was collected, and treatment was initiated the same day the patient was accepted into the study.
Although we were not able to assess reliability of our status measures, there is support in the literature for their use. The VAS and a similar FIQ were found to be valid measures of clinical change in patients with patellofemoral syndrome (9). Also, the VAS has been shown to be a valid measure of symptoms, both in patients who have undergone knee surgery and in patients presenting for initial assessment of knee pain (18).

A second limitation of this study is the lack of control over the exercise programs that were designed on an individual basis with the primary goal of restoring prior level of activity. The effect of differences in individual exercise programs upon posttreatment status scores is unknown.

A third limitation to this study was the small sample size. To maximize the number of cases receiving each protocol, patients were crossed over to the alternate intervention if still symptomatic after completing their initial course of six sessions. We made within-group comparisons using scores from cases that completed each protocol, regardless of order of administration. Thus, the results of this study do not consider carryover or order effects.

Considering our findings, we recommend iontophoresis as the initial approach to the treatment goals of decreasing inflammation, promotion healing, and relieving pain. The use of iontophoresis has at least two additional benefits beyond the therapeutic gains reported in this project. First, administration of iontophoresis using the Iomed Phoresor is a 10-min treatment program. Our established program of moist heat, friction massage, phonophoresis, and ice is a 48-min treatment. The shorter time required to administer the IONTO protocol leaves more treatment time for exercise, biomechanical assessment, and functional training. Second, treatment with iontophoresis may represent a cost savings for patients and their insurers. In our clinics, the charge for the MOD & TFM protocol is twice that for the IONTO protocol.

The numerous treatment options suggested in the literature for the conservative management of tendinitis probably reflect the difficulty of treating overuse tendon lesions. The difficulty in resolving infrapatellar tendinitis is highlighted further by the fact that many of our patients were not asymptomatic after 12 treatment sessions. We defined infrapatellar tendinitis as a collection of symptoms, namely pain elicited with resisted knee extension and with palpation of the infrapatellar tendon in an otherwise negative clinical examination. Those patients who failed to improve substantially may have advanced beyond the early stages of tendinitis to tendinosis.

Tendinosis, characterized by the histopathological processes of degeneration and necrosis, cannot be distinguished from tendinitis on clinical examination (30). Inflammation is a necessary part of the healing process, and the administration of anti-inflammatory modalities may only temporarily quell symptoms. The ability to distinguish between various stages of a tendon lesion may be the key to determining stage-specific treatment interventions that result in quicker resolution of symptoms. Clearly, more research is needed to optimize treatment outcomes in cases of infrapatellar tendinitis.

**Conclusion**

The results of this study and clinical considerations suggest that iontophoresis may be more effective and more efficient than a combination of modalities
and TFM in the treatment of infrapatellar tendinitis. Further study, however, is warranted before definitive conclusions can be drawn.

References

Infrapatellar Tendinitis


Acknowledgments

The authors gratefully acknowledge Richard Bohannon, EdD, PT, NCS, for his guidance and support throughout this project, and John Ogilvie, PhD, for his comments on several drafts of this manuscript. Also, thanks to IOMED, Inc., for supplying the equipment used in this study.