

The Effectiveness of Isometric Contractions Compared With Isotonic Contractions in Reducing Pain For In-Season Athletes With Patellar Tendinopathy

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Clinical Scenario: Patellar tendinopathy is a common musculoskeletal disorder affecting the lower-extremities and a difficult condition to manage for athletes that are in season. To facilitate improvement in function and to decrease pain, initial treatment for patellar tendinopathy is typically conservative. Traditional interventions may include eccentric training, cryotherapy, patellar counterforce straps, oral anti-inflammatories, injectable agents, phonophoresis, iontophoresis, orthotics, therapeutic ultrasound, and extracorporeal shockwave. In addition, recent literature suggests that implementing isometric and isotonic contractions may be effective in reducing patellar tendon pain. **Focused Clinical Question:** How effective are isometric contractions compared with isotonic contractions in reducing pain for in-season athletes with patellar tendinopathy? **Summary of Key Findings:** Implementation of isometric and isotonic exercises statistically reduced pain levels in the short term of 4 weeks for in-season athletes; however, isometric contractions provided statistically greater pain relief immediately for up to 45 minutes post-intervention compared with isotonic contractions. **Clinical Bottom Line:** Current evidence supports the use of isometric and isotonic contractions to reduce pain for in-season athletes with patellar tendinopathy. Based on the reviewed literature, clinicians should consider utilizing heavy loaded isometrics or progressive heavy loaded isotonic exercises, which showed reduction in pain levels immediately after intervention and at 4-week follow-up for both intervention groups. Isometric contractions appear to provide greater pain relief immediately after intervention. **Strength of Recommendation:** There is Grade B evidence from 2 level 2 randomized controlled trials and 1 level 3 randomized crossover study supporting the use of isometric and isotonic contractions to reduce patellar tendon pain for in-season athletes.

Keywords: physical therapy, isotonic, exercise, load, tendon

Clinical Scenario

Patellar tendinopathy is a common musculoskeletal disorder affecting the lower-extremities and a difficult condition to manage for athletes that are in season.¹⁻³ Pain is a common factor that may negatively affect an athlete's ability to train with optimal volume and intensity and maximize performance for their sport.¹⁻³ To facilitate improvement in function and to decrease pain, initial treatment for patellar tendinopathy is typically conservative. Traditional interventions may include eccentric training, cryotherapy, patellar counterforce straps, oral anti-inflammatories, injectable agents, phonophoresis, iontophoresis, orthotics, therapeutic ultrasound, and extracorporeal shockwave.²⁻⁶ Exercise and tendon loading appear to demonstrate positive effects in histological changes and reduction in pain perception. Eccentric exercises have been widely utilized to treat patellar tendinopathy and are effective in maximizing an athlete's function over time but are typically poorly tolerated due to an increase in pain levels in the first 2 to 4 weeks and have shown either no benefit or worse outcomes for in-season athletes along with poor adherence to exercise regimen due to pain increase.^{2,3} This pain-induced loading technique may lead to cortical reorganization, which, in turn, may contribute to suboptimal motor control, contributing to ongoing tendon pain. In addition, recent literature suggests implementing

isometric and isotonic contractions as these may be effective alternatives in reducing patellar tendon pain for in-season athletes due to better pain tolerance, which may help to optimize their performance for sport.¹⁻³ Isometric exercise has been shown to affect cortical changes with antinociceptive effects including a release of intracortical inhibition, which was associated with pain reduction.¹ Pain during exercise has been a primary contributor to suboptimal performance and limiting training and sport participation for in-season athletes. Therefore, this critically appraised topic was conducted to determine the extent to which current evidence supports the use of isometric contractions compared with isotonic contractions to reduce pain for in-season athletes with patellar tendinopathy.

Focused Clinical Question

How effective are isometric contractions compared with isotonic contractions in reducing pain for in-season athletes with patellar tendinopathy?

Summary of Search, "Best Evidence" Appraised, and Key Findings

- The literature was searched for studies of level 3 evidence or higher that directly compared isometric contractions with isotonic contractions for patellar tendinopathy.
- The literature search returned 4 possible studies related to the clinical question; 3 studies met the inclusion criteria.

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- Two level 2 studies and 1 level 3 study compared the effects of pain levels with isometric contractions versus isotonic contractions among individuals with patellar tendinopathy.
- Three studies reported a statistically significant reduction in pain with isometric and isotonic contractions in the short term of 4 weeks¹⁻³; however, isometric contractions provided statistically greater pain relief immediately, which remained up to 45 minutes postintervention compared with isotonic contractions.¹

Clinical Bottom Line

Current evidence supports the use of isometric and isotonic contractions to reduce pain for in-season athletes with patellar tendinopathy.¹⁻³ Based on the reviewed literature, clinicians should consider utilizing heavy loaded isometrics or progressive heavy loaded isotonic exercises, which showed reduction in pain levels immediately after intervention and at 4-week follow-up for both intervention groups.¹⁻³ Isometric contractions appear to provide greater pain relief immediately for up to 45 minutes after intervention compared with isotonic contractions when utilizing a single-leg decline squat as a pretest and posttest to measure pain response.¹

Strength of Recommendation

There is Grade B evidence from 2 level 2 randomized controlled trials^{2,3} and 1 level 3 randomized crossover study¹ supporting the use of isometric and isotonic contractions to reduce patellar tendon pain for in-season athletes.

Search Strategy

Term Used to Guide Search Strategy

- Patient/client group: *patellar tendinopathy*
- Intervention/assessment: *isometric exercise*
- Comparison: *isotonic exercise*
- Outcome: *pain*

Sources of Evidence Searched

- PubMed
- Google Scholar
- SPORTDiscus
- EBSCOhost
- CINAHL
- MEDLINE
- Additional resources obtained via review of reference list and manual search

Inclusion and Exclusion Criteria

Inclusion

- Level 3 evidence or higher
- Subjects were clinically diagnosed with patellar tendinopathy
- Studies that directly compared isometric contractions to isotonic contractions

- Subjects were allowed to continue their sport during the intervention period
- Limited to English language
- Limited to humans
- Limited to the past 10 years (2009–2019)

Exclusion

- Subjects with other pathological conditions of the lower-extremity
- Subjects with previous surgery to the lower-extremity
- Subjects who received a corticosteroid injection within the past 12 months

Results of Search

Four studies were retrieved; however, only 3 studies that met the criteria requirements were selected for review.¹⁻³ These are summarized in Table 1. All 3 studies compared isometric contractions with isotonic contractions for pain relief for in-season athletes with patellar tendinopathy.

Best Evidence

Three studies were identified as the best evidence for this critically appraised topic (Table 2). Two articles were level 2 randomized controlled trials, and 1 article was a level 3 randomized crossover study based on the Oxford Levels of Evidence 2011.

Implications for Practice, Education, and Future Research

In each of the 3 studies reviewed, in-season athletes with patellar tendinopathy demonstrated statistically significant reductions in pain levels in response to isometric and isotonic contractions immediately after intervention and at 4-week postintervention.¹⁻³ One of the 3 studies' results displayed significant pain reduction that was greater for subjects in the isometric group,³ whereas another study indicated that pain levels remained decreased 45 minutes only after the isometric contractions.¹ Therefore, both isometric and isotonic contractions are an effective intervention to reduce patellar tendon pain to allow athletes to continue play while in-season without modification of current training loads. However, neither study compared these contractions types with other alternative interventions, so the authors cannot determine if they are equally if not more effective.

The etiology of load-induced patellar tendinopathy is multifactorial and involves tendon overload through tension, compression, or friction, which may lead to a series of tendon injury, repair, and inflammation,⁷ which may cause pain and dysfunction.¹⁻⁷ Nonoperative management has typically included the use of

Table 1 Summary of Study Designs of Retrieved Articles

Levels of evidence	Study design	Author
2	Randomized controlled trial	Van ark et al ³ Rio et al ²
3	Randomized crossover	Rio et al ¹

Table 2 Characteristics of Included Studies

	Rio et al ¹	Van ark et al ³	Rio et al ²
Study design	Randomized crossover	RCT	RCT
PEDro score	6/10	5/10	6/10
Participants	<ul style="list-style-type: none"> • 6 volleyball players (M = 6, F = 0; median age = 26.9 y) clinically diagnosed with PT. • Isometric group and isotonic group. • Performed both interventions a week apart. • Intervention was randomized. • Subjects trained twice per week. • Subjects played games once per week. 	<ul style="list-style-type: none"> • 29 volleyball and basketball players (M = 27, F = 2; 16–32 y old) clinically diagnosed with PT. • Randomly assigned to an isometric group (mean age of 22.9 [4.9] y) or an isotonic group (mean age of 23.1 [4.7] y). • Subjects played or trained at least 3 times per week. 	<ul style="list-style-type: none"> • 20 volleyball and basketball players (M = 18, F = 2; between 16 and 32 y old) clinically diagnosed with PT. • Randomly assigned to an isometric group (mean age of 22.9 [4.9] y) or an isotonic group (mean age of 23.1 [4.7] y). • Subjects played or trained at least 3 times per week.
Intervention(s) investigated	<ul style="list-style-type: none"> • Isometric group: 5 sets of 45-s quadriceps contractions at 70% 1RM using Biodex Pro. • Isotonic group: 4 sets of 8 repetitions at 8RM of quadriceps contractions using leg extension machine. • TUT and rest sets matched. • Subjects performed rehabilitation intervention once under supervision. 	<ul style="list-style-type: none"> • Isometric group: 5 sets of 45-s quadriceps contractions at 80% 1RM using leg extension. • Isotonic group: 4 sets of 8 repetitions at 80% 8RM of quadriceps contractions on leg extension machine. • TUT and rest sets matched. • Subjects performed rehabilitation exercises 4 d/wk for 4 wk. 	<ul style="list-style-type: none"> • Isometric group: 5 sets of 45-s quadriceps contractions at 80% 1RM using leg extension. • Isotonic group: 4 sets of 8 repetitions at 80% 8RM of quadriceps contractions on leg extension machine. • TUT and rest sets matched. • Subjects performed rehabilitation exercises 4 d/wk for 4 wk. • Instructions to avoid other quadriceps exercises during the intervention period. • 2.5% progressive overload weekly if able.
Outcome measure(s)	<ul style="list-style-type: none"> • Pain (NRS) during SLDS (measured at baseline, immediately, and 45-min postintervention). • No follow-up occurred after the intervention period. 	<ul style="list-style-type: none"> • Pain (NRS) during an SLDS (measured at baseline and at 4-wk follow-up). • No follow-up occurred after the intervention period. 	<ul style="list-style-type: none"> • Pain (NRS) during an SLDS (measured before and after every intervention session for a total of 4 wk). • No follow-up occurred after the intervention period.
Main findings	<ul style="list-style-type: none"> • Isometric group statistically significant pain reduction immediately after intervention ($P < .004$) and sustained at 45 min ($P < .001$). • Isotonic group statistically significant pain relief immediately after intervention ($P = .04$), however, was not sustained at 45 min. 	<ul style="list-style-type: none"> • After 4 wk, isometric group ($P = .012$) and isotonic group ($P = .003$) statistically significant reduction in pain. • No statistically significant difference in pain between the 2 groups ($P = .208$). 	<ul style="list-style-type: none"> • Isometric group statistically significant pain reduction immediately after each intervention session compared with isotonic group ($P = .001$). • Both groups reduced pain levels immediately.
Conclusion	<ul style="list-style-type: none"> • Isometric exercise: single session of isometric exercises significantly reduced patellar tendon pain immediately after intervention and remained reduced 45 min post. • Isotonic exercise: single session of isotonic exercises significantly reduced patellar tendon pain immediately after intervention but did not remain reduced at 45-min postintervention. 	<ul style="list-style-type: none"> • Isometric exercise: 4 wk of isometric exercises resulted in significant pain reduction for subjects who were in-season with patellar tendinopathy. • Isotonic exercise: 4 wk of isotonic exercises also resulted in significant pain reduction for subjects who were in-season with patellar tendinopathy. • Training and competition loads were unaltered. 	<ul style="list-style-type: none"> • Isometric contractions resulted in a greater reduction in patellar tendon pain immediately after intervention sessions over 4 wk.

Abbreviations: 1RM, 1-repetition maximum; 8RM, 8-repetition maximum; F, females; M, males; NRS, Numeric Pain Rating Score; PT, patellar tendinopathy; RCT, randomized controlled trial; SLDS, single-leg decline squat; TUT, time under tension.

eccentric contractions performed on a decline board,²⁻⁵ injection therapy, and extracorporeal shockwave.³ Patellar tendinopathy is a common pathology occurring in individuals who perform explosive movements that load the quadriceps and is prevalent in jumping sports including volleyball and basketball.²

Exercise and tendon loading are suggested as the best intervention to decrease patellar tendon pain and maximize function; however, the mechanisms are not well understood. Current literature suggests that loading the tendon through exercise affects the tendon matrix³ and reduces pain perception.¹⁻³ In addition, patellar tendinopathy may be associated with nervous system sensitization,^{8,9} which may be addressed through various exercise prescriptions. It is suggested that isometric and isotonic exercises may be better tolerated to still allow tendon adaptation through loading while minimizing pain increase, which may facilitate an athlete's ability to train and maximize their sport performance while in season. For isometric contractions, 5 sets of 45-second repetitions at 70% to 80% maximum voluntary contractions should be performed on a leg extension machine with the knee flexed to 60°. ¹⁻³ Isotonic contractions should be completed with 4 sets of 8 repetitions at the athlete's 8-repetition maximum on a leg extension machine.¹⁻³

Future studies may investigate the therapeutic mechanisms of isometric and isotonic contractions in individuals affected by patellar tendinopathy. Intervention period was 4 weeks or less, therefore, there may be benefit from longer term studies beyond 4 weeks comparing isometric and isotonic contractions. Next, adherence to specific loading programs was not tracked as programs were meant to compliment the athletes' schedules. The authors in the reviewed studies assumed that the athletes consistently adhered to the strengthening programs due to finding improvements in pain levels and function at the end of the testing period. More supervised sessions may allow for program adjustments and further facilitate adherence. Finally, sample sizes were small, which may affect the external validity of implementation of isometric and isotonic contractions, and although these exercises seem to have a role in rehabilitating patellar tendinopathy, the extent of their effects require further study. Due to the apparent benefits of isometric and isotonic contractions for in-season athletes with patellar tendinopathy, future research should consider evaluation

of the impact of isometric and isotonic contractions on other knee pathologies.

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