Effects of Hamstring Stretching on Range of Motion

A Systematic Review Updated

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ABSTRACT

Hamstring stretching is ubiquitous in sports and is widely recommended by sports medicine clinicians, including athletic trainers. This article provides an overview of the evidence supporting that recommendation by reviewing the results of a systematic review published in 2005, then providing a methodologically similar review of studies published since 2005. Identification of the best stretching parameters may not be possible or even necessary. It is clear from the 39 studies considered that hamstring stretching to gain range of motion is effective, regardless of the approach.

Despite the lack of evidence supporting the benefits of stretching to prevent injuries,[1-4] stretching continues to be a ubiquitous part of the sporting world and is widely recommended by sports medicine clinicians, including athletic trainers. In 2005, I was a member of a team that published a systematic literature review about the effects of hamstring stretching on range of motion.[5] That team's goal was to identify the most effective stretching position, technique, and duration to improve hamstring flexibility in asymptomatic populations. Although we were able to conclude that hamstring stretching does favorably affect flexibility, we were not able to single out any particular stretching protocol that provided more benefit than another. This article's purpose is to provide an overview of the evidence regarding the use of hamstring stretching to improve range of motion. To accomplish that, an overview of the results of the 2005 systematic review[5] is provided and supplemented with an updated review (through January 2009) based on the same parameters.

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METHOD

2005 Review

The 2005 article[5] used a classic approach for systematically reviewing the topic. After a literature search, 3 reviewers independently assessed identified manuscripts according to preset inclusion and exclusion criteria. Next, they independently reviewed the included studies for quality. After independent assessment was completed, the group discussed and compared the assessment of each included study. Table 1 details the literature search parameters and the inclusion and exclusion criteria used. The Physiotherapy Evidence Database (PEDro) 10-point scale was used to measure methodological quality (Table 2). We also extracted information about variables of interest to clinicians (eg, study population, stretching parameters, and range of motion outcomes).

2009 Review

The only material differences in the method are new inclusive dates (ie, studies published or indexed from 2004 through January 2009 are included), and that I was the sole reviewer.

TABLE 1

Search and Inclusion Criteria

DATABASES AND SEARCH TERMS
Medline & SPORTDiscus (2004 to January 2009)
Hamstring stretching, lower extremity stretching, contract-relax stretching, ballistic stretching, static stretching, proprioceptive neuromuscular facilitation
INCLUSION CRITERIA
Experimental (randomized controlled trials) and quasi-experimental (ie, prestretching and poststretching) studies
Intervention includes common and clinically used hamstring stretching
Outcome measures include range of motion at the knee or hip
Participants ages 14 to 60 years
Participants healthy (ie, no orthopedic or neurologic issues that would affect ability to gain range of motion)
EXCLUSION CRITERIA
Non-English language studies
Outcome not in (or not convertible to) degrees (ie, sit and reach)
Instrumented stretching
Abstract and unpublished data

RESULTS

Participants

2005 Review. Twenty-eight studies satisfied the inclusion criteria for the previous effort. Included in those 28 publications were 1338 male and female participants. The participants' mean age could not be determined because of reporting variability among the studies.

2009 Review. Eleven studies[6-16] met the inclusion criteria for the current review. The cumulative number of participants in those 11 studies is 348. All but one of the studies[10] specified the gender breakdown of their participants—197 were male. Better reporting of age in these studies allowed determination of the mean age (21.8 years, SD = 2.5) of all but 30 participants. One study[7] reported their participants to be of "college-age," so presumably the mean would not significantly change.

Methodological Quality

2005 Review. The PEDro scores among the 28 studies included in the original review ranged from 2 to 8, with a mean of 4.3 (SD = 1.6). Several factors, both positive and negative, stood out during that review: 93% of the studies reported point measurements and variability (usually means and standard deviations) associated with their results; 86% reported the results of their statistical analyses; 82% assigned participants to intervention groups randomly; only 18% of outcome assessors were blinded to group assignment. Two other criteria, which are significantly related to each other, were also areas of concern. Criteria 8 and 9 regarding the minimum 85% follow-up and intent to treat analysis were satisfied in 57% and 36% of the studies, respectively. It is important to note that satisfaction of these criteria requires explicit reporting related to these items and that reporting was absent; of course, this could mean that there was inadequate follow-up or it could mean that it simply was omitted from the article. One[17] of these 28 studies met or exceeded the 70% methodological score suggested[18] for recognition as a valid clinical trial.

2009 Review. PEDro scores among the 11 studies reviewed for this publication range from 4 to 7, with a mean of 5.7 (SD = 1.1). This reflects improvement in the methodological quality of studies published more recently. Criteria that were satisfied more frequently in the current review include random assignment of participants to groups improved from 82% to 100%; evidence that the groups were similar at baseline improved from 57% to 91%; assessor blinding improved from 18% to 36%; follow-up and intent to treat analysis criteria improved from 57% to 82% from 36% to 82%, respectively. Two[11,15] of these studies met the 70% methodological score mentioned above; clearly 2 of 11 is better than 1 of 28; however, overall quality is still lacking.

Impact of Stretching Position, Technique, and Duration on Flexibility Gains

2005 Review. The clearest finding among the studies was that nonstretching control groups do not gain range of motion. Eleven studies[17,19-28] reported point measurements for their control groups; gains ranged from –3° to 2.7°, and no study reported a significant change from baseline for the control group. A similar general statement can be made referring to the stretching groups—they do gain range of motion. It was impossible to identify the best stretching protocols for most parameters. Highlights from the previous review follow.

Among the 28 studies, hamstring flexibility gains ranged from 5.7° to 33.6°. Whether the hamstring stretch was performed standing, seated, or supine did not appear to make a significant difference in the magnitude of flexibility gained. None of the studies reviewed was specifically designed to compare gains based on stretch position.

However, there were studies in the previous review that directly compared stretching techniques. Two studies[29,30] were designed to compare static and proprioceptive neuromuscular facilitation (PNF) techniques. In the first,[29] static stretchers gained 9° and PNF stretchers gained 12°, a statistically significant finding. However, in the second study[30] there was no difference—static and PNF stretchers gained 8° and 9.5°, respectively. Bandy et al[21] found static stretching to be significantly more effective (11.4°) than a dynamic knee extension exercise (4.3°). Wiemann and Hahn[28] found no significant difference between static (7.8°) and ballistic (8.4°) stretching in a single stretch session.

Stretch duration was a topic of direct comparison in four[19,20,31,32] of the previously reviewed studies. Bandy et al[19,20] have been responsible for 2 studies that have concluded that 30 seconds is an ideal length for stretching, with gains ranging from 10.1° to 12.5° regardless of whether 1 repetition or 3 repetitions are performed. Comparing nine 5-second stretches to three 15-second stretches, Roberts and Wilson[32] found that the 15-second stretch gained more range (7.8°) than the 5-second stretch (4.6°). In another study comparing the effects of overall stretching times, Cipriani et al[31] compared six 10-second (28°) stretches with two 30-second (24.2°) stretches and found no difference.

Another duration variable of interest is the length of the stretching protocol (a single session versus multiple sessions over weeks). Unfortunately, although there was a wide variety of protocols ranging from single sessions[17,22,26,28,33-37] to twice per day for 6 weeks[27] and even as long as 10 weeks,[29] only the method used by Cipriani et al[31] included this comparison; they found that significant gains had been made by 3 weeks (gains continued in the ensuing 3 weeks). A superior protocol could not be gleaned from the 28 studies; all showed gains. The length of benefit (ie, how long the increase in flexibility lasted) was also not commonly studied. DeWeijer et al[17] showed continuing significant improvement 24 hours after a single session of stretching; others showed significant benefits 1 day[38,39] or 2 days[19-21,24] after the end of the stretching protocol.

TABLE 2

PEDro Methodological Quality Criteria

PEDro CRITERIA[a]
1. Eligibility criteria specified (Y/N)[b]
2. Participants randomly allocated to groups (Y/N)
3. Allocation was concealed (Y/N)
4. Groups similar at baseline (Y/N)
5. Participants were blinded to group (Y/N)
6. Therapists who administered therapy were blinded (Y/N)
7. Assessors were blinded (Y/N)
8. Minimum 85% follow-up (Y/N)
9. Intent to treat analysis for at least one key variable (Y/N)
10. Results of statistical analysis between groups reported (Y/N)
11. Point measurements and variability reported (Y/N)

[a] Total score possible is 10.
[b] This criterion is not scored.

2009 Review. From the current review, it can again be concluded that nonstretching control groups did not gain range of motion. Five[10,12-15] of the 11 studies included control groups with range of motion gains ranging from –3.2° to 3.2°. All but two[6,7] of the studies reported range of motion gain as an outcome variable with results ranging from 1.9°[13] to 23.7°.[10] Although most flexibility increases were within the range reported in the previous review, 2 studies had very low, albeit reportedly statistically significant, gains. Cronin et al[9] and Ford et al[13] reported gains between 1.9° and 3.6°, more comparable to gains associated with control groups. Certainly, the clinical significance of gains so minor could be questioned.

Of note, in both studies with relatively small gains, the stretching position used had not been examined in any of the other 37 studies reviewed. Cronin[9] had participants in a lunge-like position with the back of their thigh resting on a padded surface; the stretch involved active knee extension from that start position. Ford[13] had participants sitting in a chair with the leg to be stretched extended in front of them, resting on its heel; the stretch involved assuming an anterior pelvic tilt and leaning forward over the leg. Again, in the current review, no strong conclusions can be made about the effects of stretching position. Among the more recently published studies, 1 study[11] was designed to compare stretching positions. It concluded that there was no difference in range gained whether the static stretch was performed in a standing (9.4°) or supine (8.1°) position.

Three studies[7,10,14] directly compared stretching techniques. Comparisons included static versus ballistic stretching[7] and active, static, and PNF.[10,14] No significant differences were identified in resulting flexibility, although significant differences between control groups and stretching groups were found in the 2 studies that included control groups.[10,14]

Two studies [8,13] were designed to compare stretch duration. One[8] compared 3-, 6-, and 10-second holds during hold-relax PNF stretching. The other[13] evaluated 30-, 60-, 90-, and 120-second holds during static stretching. Neither study identified significant differences in flexibility gained regardless of the stretch hold duration; Ford et al,[13] like Bandy et al,[19,20] concluded that 30 seconds is an adequate stretch time.

None of the studies was designed to compare protocol duration and length of benefit measurements. Only one collected post-stretch data even as far out as 25 minutes,[14] so there is not much to add to the previous review's consideration of the differences that those 2 parameters might create. Three of the studies were designed to assess the effects of associated warm-up[6,16] or modalities.[9] Much like the 2 studies[17,28] in the previous review that included a group that performed the warm-up but no stretching, the 2 studies in the current review concluded that stretching created significantly more range of motion gain than did warm-up alone, and that adding the warm-up to the stretching protocol did not improve gains. The design of one of those studies[6] allowed the conclusion that placement of stretching before or after activity did not affect range of motion gains. Cronin et al[9] found there was no flexibility benefit associated with vibration therapy.

SUMMARY

These 2 reviews of the effects of hamstring stretching on range of motion gain included 1686 study participants. They are largely, though not entirely, college-aged populations. Two general statements can be made fairly reliably regarding the effects of hamstring stretching on range of motion. First, those who do not stretch (eg, control groups) do not gain range of motion. Second, those who do stretch gain range of motion. The amount of range gained varies widely; however, a rough average of the results of 48 stretching groups among the studies reviewed showed a gain of 9.95°, with 28 group findings between 8° and 13°. This review sought to identify differences in stretching effectiveness based on position, technique, duration, protocol length, and benefit length. Only 1 of these 39 studies was designed to compare results based on position; no difference was found. Six studies directly compared technique. Only 1 of 5 designed to compare static to PNF found a significant difference. Static and ballistic stretching appeared to yield similar results in 2 studies. On the question of stretch duration, 3 studies concluded that a 30-second stretch is ideal, although other stretch durations also provide range of motion gains. Studies designed to identify the best length of protocol or length of benefits (eg, how long stretching gains last) are limited and do not provide strong guidance. ■

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