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Research Paper Review

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The effects of eccentric training on lower limb flexibility: A systematic review

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ABSTRACT

Background

Reduced flexibility has been documented in athletes with lower limb injury, however, stretching has limited evidence of effectiveness in preventing injury or reducing the risk of recurrence. In contrast, it has been proposed that eccentric training can improve strength and reduce the risk of injury, and facilitate increased muscle flexibility via sarcomerogenesis.

Objectives

This systematic review was undertaken to examine the evidence that eccentric training has demonstrated effectiveness as a means of improving lower limb flexibility.

Study Appraisal And Synthesis Methods

Six electronic databases were systematically searched by two independent reviewers to identify randomised clinical trials comparing the effectiveness of eccentric training to either a different intervention, or a no-intervention control group. Studies evaluating flexibility using both joint range of motion (ROM) and muscle fascicle length (FL) were included. Six studies met the inclusion/exclusion criteria, and were appraised using the PEDro scale. Differences in the muscles studied, and the outcome measures used, did not allow for pooled analysis.

Results

There was consistent, strong evidence from all six trials in three different muscle groups that eccentric training can improve lower limb flexibility, as assessed using either joint ROM or muscle FL.

Conclusion

The results support the hypothesis that eccentric training is an effective method of increasing lower limb flexibility. Further research is required to compare the increased flexibility obtained after eccentric training to that obtained with static stretching and other exercise interventions.

ANALYSIS

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Background Information

As you know, injuries to the lower limb are common amongst athletes. Because lower limb injury has the potential to create significant consequences for the individual athlete or their team, it is inherently important to examine factors or interventions which could potentially reduce injury risk, and the time interval between the onset of injury and return to sport.

Some evidence states that increasing flexibility with a stretching program may reduce the amount it time it takes for an athlete to heal and return to sport. This concept is controversial however, as other literature states that the main result of such a program is simply an increase in flexibility and not necessarily a reduced risk of injury.

Deficits in flexibility seem to be only one manifestation of an alteration of muscular function. For instance, athletes with less flexible hamstrings appear to have an altered length-tension curve, with a change in the angle of peak torque and moments produced at longer muscle lengths. In addition, these athletes may be exposing their less flexible muscles to possibly damaging lengthening (or, eccentric) forces during their sporting activities.

Eccentric training, in addition to forming sarcomeres in series (called sarcomerogenesis), appears to increase the joint angle at which peak torque is generated, as well as increase the muscle's fascicle length (FL). Using eccentric training to increase flexibility would combine strengthening and stretching of muscles simultaneously. However, there is an absence of evidence regarding the effectiveness for such a model/approach.

Animal models suggest that eccentric training has the potential to increase flexibility via sarcomerogenesis without performing additional stretching exercises. This is inherently significant, considering the natural positive effects eccentric training may have, including power development and injury prevention. The evidence overall is still unclear, however. Therefore, it was the aim of this systematic review to appraise the current evidence from randomized clinical trials (RCTs) to determine if eccentric training results in significant increases in lower limb flexibility.

PERTINENT RESULTS

Six articles met the inclusion criteria, and were included in this review. There was significant variation in the type of eccentric training, the volume of exercise (sets, reps etc.), intensity of training, duration for which the eccentric contraction, frequency of training, duration of individual training days and overall training programs. All articles were rated as 'high' in quality (> 6/10 on the PEDro scale). In 3 of the studies, the patients began their treatment at similar baseline levels, while the other 3 studies included subjects who began at different baseline levels. The results of the latter 3 studies could be explained by the fact that at baseline, the patients were not similar.

Every study included showed evidence that eccentric training increases ROM, fascicle length (FL), or both, no matter which joint or muscle group was studied:

- One study (1) showed significantly greater increase in ankle dorsiflexion, compared with a no-exercise control group. Another study of the ankle using ultrasound measurements showed significantly increased FL at rest after eccentric training, compared to a control group who performed no exercise.
- One study focusing on the hamstrings (2) showed that eccentric training and static stretching significantly increased hamstring ROM compared to the control group who performed no exercise. Another study (3) performed both ultrasound to measure FL and goniometry to measure ROM. It showed that eccentric training significantly increases ROM and FL compared to the non-exercise control group. In fact, in this study, FL increased by a mean of 34%, which was 2x as much as the increase reported by the control group (17%).
- Other studies which examined the effect of eccentric training on the quadriceps showed a ~22% increase in FL after eccentric training which was not evident after a 14-week pre-training monitoring period (4). FL also increased by ~8% in the combination concentric/eccentric group.

CLINICAL APPLICATION & CONCLUSIONS

The current evidence shows that eccentric training is an effective therapy for increasing lower limb flexibility; a change that is consistent among a number of muscle groups and is both structural (fascicle length) and functional (ROM).

The mechanism for this is most likely sarcomerogenesis – an increase in the number of sarcomeres in series – which has been demonstrated in animal models. This adaptation results in greater torque at larger joint angles, which also results in the limitation of the potential for muscle damage.

The increase in flexibility as a result of eccentric training is the most clinically relevant result of this review. In fact, in one of the studies included, eccentric training resulted in similar flexibility gains compared to static stretching. However, it is undoubtedly certain that static stretching does not afford the client/patient the additional benefits of increased power, torque and injury prevention like eccentric training does, which gives eccentric training a performance edge that many athletes would likely prefer.

The exact timeline for gains in flexibility was not specifically outlined in the literature. However, some animal models show that sarcomerogenesis may occur within 10 days of beginning eccentric training, while statistically significant changes occur after 6 weeks of training. It is however, unclear if these positive changes are maintained after stopping eccentric training. Additionally, more research is needed to determine which exercise prescription is ideal for increasing flexibility, and which prescription is best for injured individuals (i.e. frequency, intensity, time, type).

STUDY METHODS

The authors searched the Academic Search Complete, AMED, Biomedical Reference Collection, CINAHL, MEDLINE, Sport Discus and The Cochrane database for relevant material. RCTs comparing the effect of eccentric training on lower limb flexibility were included. The studies included utilized a method for measuring actual muscle length (such as ultrasound, fascicle length etc.) or joint

ROM. Subjects included in the studies had to be adults greater than 18 years of age. Selected studies were limited to those including human subjects, published in English and published after 1999.

Articles were excluded if they solely examined the effects of eccentric training on muscular strength/power or muscle damage, or if they were less than 4 weeks in duration. Conference proceedings were excluded as well.

The methodological quality of each article was rated using the PEDro scale. Quality was rated as 'high' (> 6/10), 'fair' (4-5/10) or poor (< 4/10).

STUDY STRENGTHS / WEAKNESSES

Weaknesses

- Measuring fascicle length is a difficult process, which is subject to significant measurement error. This is especially true in biarticulate muscles, where fascicle lengths are very long and linear extrapolation is required. This measurement error could be the reason why 3 of the 6 studies included groups who were different at baseline, thus weakening the study.
- Due to the inherent heterogeneity of the training protocols, a meta-analysis could not be performed.
- Care must be taken when extrapolating this information to injured populations, as none of the studies included injured subjects.
- The authors were not proficient in the use of the PEDro scale, which could affect their scoring of the articles.
- Most articles included failed to blind the outcome assessor.

Strengths

- A great number of databases were accessed. The search strategy was described very well by the authors, which allows this review to be replicated easily.
- The authors discuss the potential mechanism for the increase in flexibility.

Additional References

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