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Update on
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**Effectiveness of Eccentric Training
1 Year After ACL Reconstruction**

Significant quadriceps muscle atrophy and weakness develop following anterior cruciate ligament (ACL) reconstruction. Muscle volume losses up to 30% have been reported in the involved limb. Thus, the 3-month period following surgery is believed to be the most critical time for restoring muscle function. In a previous study, Gerber et al from the United States Military Academy, New York, reported that a 12-week progressive, high-force eccentric training program resulted in significantly greater improvements in muscle volume, strength and function when compared with a standard rehabilitation program following ACL reconstruction.

Although these findings were positive, the effect of this exer-

cise intervention was studied only after the 12-week period. Given that the typical recovery period following ACL reconstruction exceeds 1 year, assessment of longer-term benefits is critical to the evaluation of exercise interventions.

In a follow-up study, the same authors evaluated the effects of the eccentric training on muscle volume, strength and function at 1 year after ACL reconstruction. Forty patients (mean age, 29.3 years) had undergone ACL reconstruction and were randomized to either an eccentric training group or a standard rehabilitation training group.

Both groups followed a protocol that emphasized weight-bearing, functional and resistance training, and early knee motion. The eccentric group also completed a

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resistance program focusing on negative, or eccentric, work of quadriceps and hip extensors using a recumbent cycle ergometer. The standard rehabilitation group completed an exercise regimen of similar intensity but with a focus on positive or concentric work.

Seventeen patients in the eccentric group and 15 patients in the standard group returned for the 1-year follow-up. Magnetic resonance images of the thigh were compared with values obtained 3 weeks following ACL reconstruction. Knee laxity, strength and functional assessment were also evaluated.

At follow-up, quadriceps femoris and gluteus maximus muscle volumes were significantly greater in the eccentric exercise group. Quadriceps and gluteus maximus muscle volume improved 23.3% and 20.6%, respectively, in the eccentric group, compared

with 13.4% and 11.6% in the standard rehabilitation group (Figure 1). Quadriceps muscle strength and hop distance were also significantly better at 1 year in the eccentric group. No differences were found between the groups for knee laxity or functional outcomes.

At 1 year, patients who followed the progressive eccentric intervention program after ACL reconstruction had muscle strength and volume changes that exceeded the improvements found in the patients who had followed the standard program. These findings highlight the importance of this type of exercise intervention as part of a comprehensive rehabilitation program following ACL reconstruction.

Gerber JP, Marcus RL, Dibble LE, et al. Effects of early progressive eccentric exercise on muscle size and function after anterior cruciate ligament reconstruction: a 1-year follow-up study of a randomized clinical trial. *Phys Ther* 2009;89:51-59.

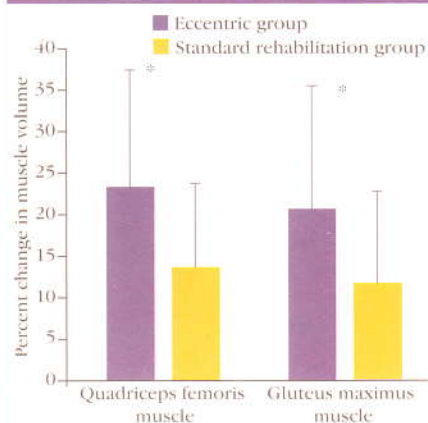


Figure 1. Quadriceps femoris and gluteus maximus muscle volume improvement of the involved lower extremity from 3 weeks to 1 year after surgery. *Indicates that statistical differences in muscle volume improvement were observed between the eccentric exercise and standard rehabilitation groups ($p \leq .05$).

Comparison of Different Interventions for Achilles Tendinopathy

Chronic Achilles tendinopathy is a common overuse injury that affects the general population. Although >20 different treatment interventions have been proposed in the literature, few randomized clinical trials exist to guide management of this challenging condi-

tion. Recent evidence has shown both eccentric training and shock-wave therapy (SWT) to be effective in symptom reduction, with success rates >50–60%. In this study, Rompe et al from the OrthoTrauma Evaluation Clinic, Germany, assessed whether the combined use of these modalities would lead to even better results in symptom reduction.

Sixty-eight patients with chronic recalcitrant Achilles tendinopathy of >6 months duration were randomly assigned to either

- 1 an eccentric loading exercise group or
- 2 an eccentric loading exercise + SWT group.

Eccentric training targeted both the gastrocnemius and soleus, and progressed from 1 set/10 repetitions to 3 sets/15 repetitions, 2×/day. Exercises progressed to weight resistance when there was no pain or discomfort. In group 2, patients began with the same eccentric training. After 4 weeks, they continued with the eccentric training program and were also given 3 sessions of SWT. The area of maximal tenderness was treated, and no local anesthesia was applied. Outcome measures included the

- Achilles tendon-specific VISA-A (a visual analogue score to assess pain and activity) questionnaire,
- the Likert scale (1–6) for ratings of self-reported improvement and
- a numerical rating (0–10) pain assessment scale.

Table 1. Outcome assessment at 4-month follow-up

Outcome measure	4-month mean		
	Group 1 eccentric loading mean	Group 2 eccentric loading + SWT mean	Group 1 vs group 2 difference
VISA-A score (0–100)	73.0	86.5	–13.5; $p = .0016$
Likert scale (1–6)	2.9	2.1	0.8; $p = .035$
Load-induced pain, NRS (0–10)	3.9	2.4	1.5; $p = .0045$

NRS, numerical rating scale.

Outcomes were assessed prior to randomization and at 16 weeks after baseline assessment.

At 4 months from baseline, the VISA-A score increased in both groups, indicating improvement in pain, function and activity. Both groups improved by >20 points from baseline measurements (group 1 improved from 51/100 to 73/100; group 2 improved from 50/100 to 87/100). Fifty-six percent of patients in group 1 and 82% of patients in group 2 rated themselves to be either completely recovered or to be much improved on the Likert scale. The numerical pain assessment scale also showed improvements for both groups. For each of these outcome assessments, patients in group 2 (combined eccentric training with SWT) scored significantly better than patients in group 1 (Table 1).

In this study, both treatment groups improved from baseline value. Greater improvements occurred for the group that received eccentric training + SWT, with a demonstrated success rate of 82%. In clinical environments where SWT is not a feasible option to combine with eccentric training, eccentric training

still provides an effective intervention for management of chronic Achilles tendinopathy.

Rompe JD, Furla J, Maffulli N. Eccentric loading versus eccentric loading plus shock-wave treatment for midportion Achilles tendinopathy. Am J Sports Med 2009;37:463–470.

Hip Resistance Training Alters Lower Extremity Movement Patterns

Nearly 75% of runners will sustain an overuse injury that requires a temporary halt in their running regime. One of the factors linked to lower extremity (LE) injuries relates to the inability to control abnormal movement patterns in the frontal and transverse planes. Hip muscle weakness has been implicated in LE injuries that include

- ankle sprains,
- patellofemoral pain syndrome and
- noncontact anterior cruciate ligament injury.

The abnormal movement patterns associated with hip dysfunction include hip adduction

and internal rotation, knee abduction, tibial internal rotation and foot pronation.

Traditionally, attempts to control LE movement patterns with the goal of reducing injury risk have involved interventions directed at the foot. Although recent biomechanical studies have emphasized the importance of the hip in controlling LE position, the effect of hip strengthening on the change in LE mechanics has not been studied. In this investigation, Snyder et al from the University of Northern Iowa assessed the effects of a 6-week hip strengthening program on LE mechanics during running.

Fifteen healthy women (mean age, 21.9 years) participated. Isometric hip strength measurements (external rotation and abduction) and 3-dimensional biomechanical analyses were collected before, at midpoint and following completion of a 6-week, 3×/week strengthening program. The hip strengthening program included a series of closed-chain hip abduction and rotation exercises using a cable-column for resistance. Resistance was progressively increased over the 6-week period.

The study results showed that the training program increased isometric hip abduction and external rotation strength by 13% and 23%, respectively. Changes in the LE movement patterns during running included a significant reduction in foot eversion range of motion ($p < .05$) and a trend toward a reduction in hip internal

rotation. Joint moments were also significantly reduced for rearfoot inversion ($p < .01$) and knee abduction ($p < .05$).

Although the participants in this study were without LE pathology, the findings support the concept that hip strengthening may have a significant, positive impact on the alteration of movement patterns that are considered detrimental. Programs that focus on the hip musculature should not be overlooked in the prevention and/or treatment of LE overuse injuries.

Snyder KR, Earl JE, O'Connor KM, Eber-sole KT. Resistance training is accompanied by increases in hip strength and changes in lower extremity biomechanics during running. Clin Biomech 2009;24:26-34.

Enhancing Exercise Programs for Chronic Neck Muscle Pain

Neck pain originating from the upper trapezius muscle (myalgia) is common in office workers and others involved in similar repetitive work tasks. Recent investigations have shown that high-intensity strength training for painful neck and shoulder muscles markedly reduced pain in women with trapezius myalgia.

The aim of this study from Andersen et al from the National Research Centre for the Working Environment, Denmark, was to compare the electromyography (EMG) responses of 5 different exercises believed to be effective

in activating the neck and shoulder muscles. The goal of the study was to identify the exercises that would best target the upper trapezius muscle.

Twelve women, aged between 30 and 60 years, with a clinical diagnosis of trapezius myalgia, participated. Surface EMG was recorded from the upper trapezius and deltoid muscles during 5 different strength exercises. These exercises were

- 1 shrug (SHR),
- 2 one-arm row (ONE),
- 3 upright row (UPR),
- 4 reverse fly (REV) and
- 5 lateral raise (LAT).

The maximal voluntary static contraction (MVC) of the upper trapezius and deltoid muscles was first obtained. Peak EMG during the exercises was then compared with the MVC values for each muscle as the patients performed each exercise.

For the majority of exercises, the level of muscle activation exceeded 60% MVC. Upper trapezius activation was greatest with SHR (102% MVC), followed by LAT (97% MVC) and UPR (80% MVC; Figure 2). The latter 2 exercises (LAT and UPR) require less training load to achieve activation levels similar to those of SHR, and may be considered as alternative options for patients with chronic neck myalgia when SHR is difficult to complete.

It is important to note, however, that while these exercises may be beneficial for rehabilitation programs targeted to upper trape-

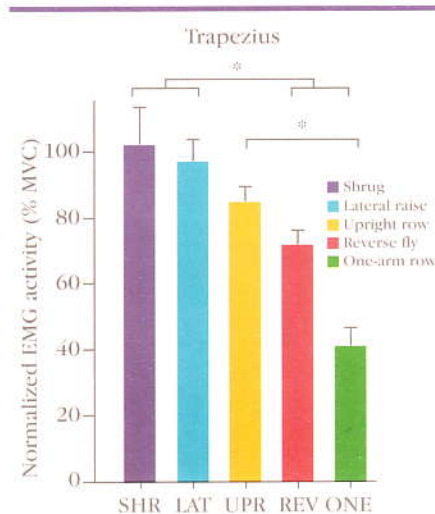


Figure 2. Normalized EMG activity. The highest levels of activation for the upper trapezius were found in the SHR and LAT exercises. *Indicates significant difference in normalized EMG between exercises ($p < .01$).

zius activation, they may aggravate symptoms of shoulder impingement because of the added resistance to the muscles of the rotator cuff. Careful monitoring of patient feedback will enable modification of the exercises if needed.

Andersen LL, Kjaer M, Andersen CH, et al. Muscle activation during selected strength exercises in women with chronic neck muscle pain. Phys Ther 2008;88:703-711.

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Elastic resistance exercises improve balance for lateral ankle sprains

Proprioception vs strength training in knee OA

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