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2767 Geryville Pike
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Update on PHYSICAL THERAPY™

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Timeline for Sports Return Following ACL Reconstruction

The anterior cruciate ligament (ACL) is the most frequently reconstructed structure in athletes' knees. Even with surgery, however, many athletes have difficulty returning to preinjury activity levels, and the ability to return to sports after reconstruction ranges from 43% to 92%. There is evidence to suggest that preoperative strengthening interventions may improve postoperative outcomes. In this study, Hartigan et al from the University of Delaware assessed the effects of 2 different preoperative protocols (employing strength training and perturbation training) on strength, functional outcomes and the athlete's readiness to return to sports at 3, 6 and 12 months following surgery.

Forty athletes ranging between 13 and 55 years of age (mean age, 28 years) who had sustained an ACL rupture within the past 10 months and were considered candidates for ACL arthroscopic reconstruction (noncopers) were randomized into 2 groups:

- a strength-training exercises-only (STR) group
- a perturbation training and strength-training exercises (PERT) group

Strength training consisted of high-intensity, low-repetition exercises; progressive step-downs for neuromuscular control; and an isokinetic spectrum protocol. In addition to the strengthening protocol, the PERT group performed exercises to elicit selective and purposeful muscle reactions while the perturbations were being

IN THIS ISSUE

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applied. Each patient received 10 preoperative exercise sessions.

All patients underwent surgery by the same orthopedic surgeon. Both groups received similar postoperative training. Outcome measures included quadriceps strength relative to the non-involved limb, hop indices, and 2 self-reported questionnaires on knee function and symptoms.

Although the authors anticipated that the PERT group would exhibit improved scores postoperatively, the findings of this study showed that functional outcomes were no different between the groups, and mean scores for each functional outcome met return-to-sports criteria at 6 and 12 months postoperatively. The only differences found were that patients in the STR group hopped faster at 12 months and that patients in the PERT group self-rated their knee function more favorably at 6 months.

This study also found considerable individual variability in the athletes' ability to pass return-to-sports criteria; 6 patients continued to have clinically meaningful deficits in quadriceps strength postoperatively that prevented their return to high-level sports participation. These outcomes point to the need to evaluate athletes on an individual basis rather than by using a time-based criterion for safe return to sports.

Hartigan EH, Axe MJ, Snyder-Mackler L. Time line for noncopers to pass return-to-sports criteria after anterior cruciate ligament reconstruction. J Orthop Sports Phys Ther *2010;40:141-154.*

Real-time Visual Feedback and Running Injuries

Of the 12 million people who run regularly for exercise in the United States, up to 16% (1.9 million) of these runners will sustain a stress fracture of the foot or leg. Impact loading—the loading that occurs as the foot makes contact with the ground—is believed to play a major role in stress fractures. Recent studies have linked tibial stress fractures to greater tibial accelerations and vertical force loading rates during the early stance phase of running. Based on this information, if the mechanics of a runner can be modified to reduce tibial acceleration and vertical loading rates, it may be possible to reduce that individual's risk of developing a stress fracture.

In this study, Crowell et al from the U.S. Army Research Laboratory—Human Research and Engineering Directorate, Maryland, assessed the effect of real-time visual feedback on a runner's ability to modify impact loading. Five female runners (mean age, 26 years) who ran ≥32 km/week and were experienced treadmill runners participated. A uniaxial accelerometer was placed on each participant's right tibia as she ran on a treadmill instrumented with force transducers. A visual display indicated the real-time peak positive accelerations (PPA) of the tibia during running. Participants were instructed to "run softer" and to keep their PPA below a horizontal line placed on the monitor that indicated a 50% reduction of the PPA. This feedback was given for 10 minutes, after which the runners ran without any feedback for an additional 10 minutes.

Data were collected at 3 different time periods:

- at the end of a 5-minute warm-up period
- after feedback was given
- after the no-feedback period

Within a single session of training, 3 of 5 runners were able to significantly reduce their PPA while they received feedback,

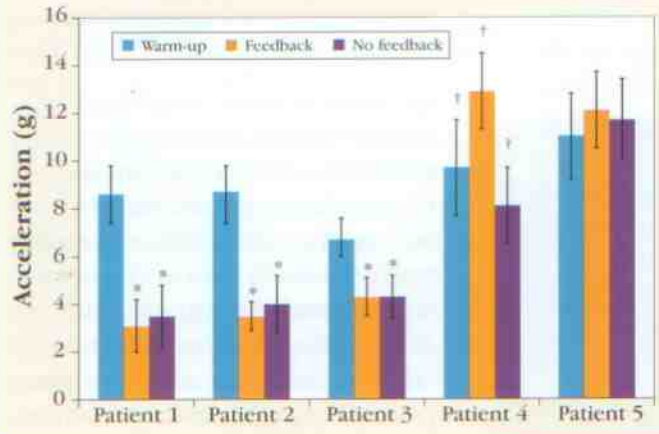

Figure 1. PPA in units of acceleration due to gravity (g) for each participant during the warm-up, feedback and no-feedback periods. Error bars represent ±1 SD. *Significantly different from the warm-up period ($p \leq .05$). †Significantly different from each of the other 2 periods ($p \leq .05$). SD, standard deviation.

and 4 of the 5 runners were able to keep their PPA values reduced from the warm-up period after feedback ended (Figure 1). Other variables measured

- impact peak
- average loading rate
- instantaneous loading rate

These variables also indicated a reduction in impact loading.

Although this was a small sample of runners monitored for a short time period, these changes were demonstrated after only a single session of training. If these changes could be maintained such that impact loading could be decreased, then it may be possible to train individuals to run in a way that reduces the risk of stress fractures. Longer-term studies with larger numbers of runners would help to answer these questions.

Crowell HP, Milner CE, Hamill J, Davis IS. Reducing impact loading during running with the use of real-time visual feedback. J Orthop Sports Phys Ther *2010;40: 206-213.*

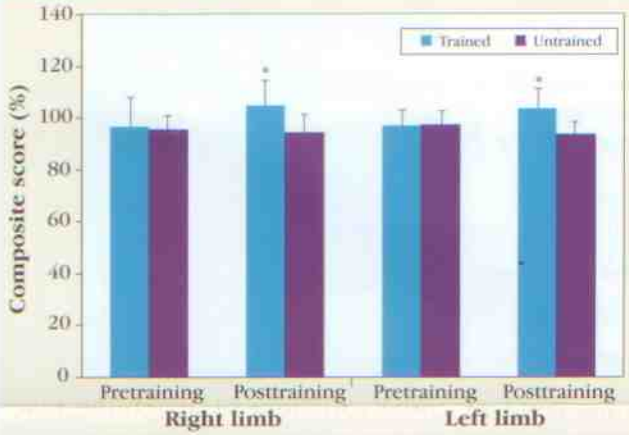

Figure 2. SEBT composite score on both limbs following the neuromuscular training program. Error bars are ±1 SD. *Significantly higher SEBT composite score ($p \leq .05$). SD, standard deviation.

Neuromuscular Training Improves Dynamic Stability in Young Female Athletes

Every year, >3 million female adolescents participate in American high school sports. Soccer ranks as 1 of the 5 most popular sports for female athletes. Of concern, however, is that nearly 72% of female soccer players will experience at least 1 injury over a 2-year period. This increased incidence of injury has been linked to poor core stability and decreased muscular synergy of the trunk and hip stabilizers, resulting in a lack of control of the center of mass.

In this study, Filipa et al from the Cincinnati Children's Hospital Medical Center, Ohio, evaluated the effect of an 8-week neuromuscular training program (NMTP) on lower extremity coordination, balance, flexibility and strength. Twenty healthy and active female soccer players (mean age, 15 years) participated. Thirteen of these players were assigned to the experimental group and 7 to the control group.

The experimental group participated in a biweekly NMTP consisting of agility drills, lower extremity and core strengthening, and static and dynamic stretches. Participants were required to maintain proper techniques during the exercises. The exercises gradually improved lower-extremity strength and core stability by incorporating exercises that increased lateral trunk perturbations. The control group continued their participation in soccer but did not receive NMTP training.

The star excursion balance test (SEBT) was used to assess dynamic stability prior to and following the 8-week intervention period for both groups. The SEBT is a functional screening tool developed to assess lower-extremity dynamic stability and identify neuromuscular deficits in athletes at high risk for injury. Prior to the training, both groups performed similarly on the SEBT. Following NMTP, the SEBT composite score significantly improved for both lower limbs in the training group compared with the control group (Figure 2). Improvements were primarily noted in posterolateral and posteromedial directions.

Controlling movement deviations that move the center of mass away from the base of support may help decrease abnormal forces on the lower extremities and ultimately reduce the risk of injury. Further study is needed to determine if improved performance, as demonstrated on the SEBT, can carry over to reducing

in-season injury rates in female athletes.

Filipa A, Byrnes R, Paterno MV, et al. Neuromuscular training improves performance on the star excursion balance test in young female athletes. J Orthop Sports Phys Ther *2010;40:551-558.*

Ankle Power Training Improves Movement Time in Older Persons

Loss of ankle muscle strength and power has been linked to a decline in function among older adults. Activities such as getting up from a chair, climbing stairs or walking quickly are especially problematic because they require fast movements and high rates of ankle torque generation. Power training has been beneficial for improving strength, endurance, balance and walking speeds in older adults. However, the majority of studies have focused on larger muscle groups of the lower limb, or they have required resistance training equipment primarily found in fitness centers.

In this study, Webber and Porter from the University of Manitoba, Canada, assessed the effects of ankle power training on foot movement time, strength and power in a group of mobility-impaired older women. The authors compared training using elastic resistance bands with training using traditional weight-resistance equipment.

Fifty women (age range, 70–88 years), met for 45 minutes, 2×/week for 12 weeks. They were randomized into 1 of 3 groups as follows:

- Weight-training group participants used weight-training machines as part of a strengthening program for ankle dorsiflexion (DF) and plantarflexion (PF). Loads were increased every 2–3 weeks while participants maintained the speed of contraction.
- Elastic resistance–training group participants used bands to perform resistance exercises for DF and PF. Band resistance was increased every 2–3 weeks.
- Control group participants performed flexibility exercises for the shoulders and neck.

Participants in both training groups were told to perform the exercises as quickly as possible in the concentric phase.

Table 1. *Pre- and posttraining movement time and reaction time values (mean ± SD, % change and effect size)*

		Weights	Bands	Control
Movement time (ms)	Pre-	191 ± 48	188 ± 41	181 ± 43
	Post-	177 ± 52	164 ± 39	175 ± 36
	Change (%)	8	12	2
	Effect size	–0.28	–0.60	–0.17
Reaction time (ms)	Pre-	366 ± 41	360 ± 34	347 ± 43
	Post-	359 ± 39	363 ± 39	351 ± 46
	Change (%)	2	1	1
	Effect size	–0.17	0.09	0.09

The results showed significant improvements in foot movement time for the elastic-resistance group ($p = .003$); movement time decreased by 12% (Table 1). Both weight-training and elastic resistance–training groups showed similar gains in ankle DF strength and power; the weight-training group showed greater gains in ankle PF strength and power.

Elastic-band training that incorporated high-velocity/low loads improved foot movement time for the participants in this study. This improvement may have important implications for minimizing fall risk or improving mobility performance during situations that require rapid ankle torque generation. Elastic bands are also inexpensive and convenient to use in both rehabilitation and home exercise programs designed for older adults with mobility limitations.

Webber SC, Porter MM. Effects of ankle power training on movement time in mobility-impaired older women. Med Sci Sports Exerc *2010;42:1233-1240.*

IN THE NEXT ISSUE

Manipulation vs mobilization for neck pain

Plyometric vs resistive exercises for acute ankle sprain