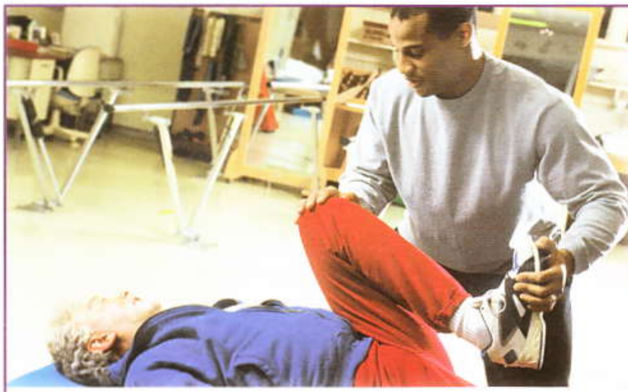
A Professional Courtesy of:

Margaret Dibbini, M.S., P.T.
Director

OPTIMUM
PHYSICAL THERAPY

2150 Central Park Avenue, Suite 207
Yonkers, New York 10710
914-395-3290

Practice provides Physical Therapy and Acupuncture Services



Update on **PHYSICAL THERAPY**™

SUMMER
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Balance Training Improves Postural Control for Chronic Ankle Instability

Ankle sprains are one of the most common musculoskeletal injuries, and those who have experienced a sprain are at the greatest risk for reinjury. While balance training is considered to be an integral component of rehabilitation for persons with chronic ankle instability (CAI), few studies have assessed the effectiveness of training programs on improvements in postural control. Additionally, effectiveness of interventions may be minimized if the balance training programs do not challenge the sensorimotor system. McKeon et al from the University of Kentucky conducted a randomized, controlled trial to assess the benefits of a 4-week supervised dynamic balance training program on static and dynamic postural control and self-reported outcomes in persons with CAI.

Thirty-one active patients with a self-reported history of CAI were randomly assigned to either a control (no treatment) group or a balance training group. Patients in the balance training group participated in 12 sessions at a rate of 3×/week. The program was designed to challenge the patient's ability to maintain single limb stance while performing progressively more difficult dynamic balance activities. An example of these activities is shown in Table 1.

The primary outcome measures included the following:

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1 self-reported symptoms of disability using the Foot and Ankle Disability Index (FADI) and the FADI Sport survey;

2 center of pressure (COP) excursion measures;

3 time-to-boundary (TTB) measures of postural control in single-limb stance with eyes opened and closed; and

4 reach distance in multiple directions using the Star Excursion Balance Test (SEBT).

Both FADI and FADI Sport scores improved significantly following balance training (93.7% vs 85.5% [p = .03] and 85% vs 69.9% [p = .009], respectively). As might have been expected, the control group did not change over the 4 weeks. Static postural control measures with eyes closed changed for the intervention group. TTB, which measures the amount of time an individual uses to make a postural correction to maintain postural stability, improved following training. The authors suggested that the TTB measurement, as compared with more traditional COP-based measures, may be more sensitive to detecting changes in the sensorimotor system following balance training. Reach distance in the posteromedial and posterolateral directions of the SEBT also improved.

Table 1. ***Dynamic balance training session example****

1. Hop to stabilization
2. Unanticipated hop to stabilization
3. Hop to stabilization and reach
4. Unanticipated hop to stabilization (different sequence from #2)
5. Single limb stance eyes open
6. Single limb stance eyes closed

**Each activity contained 7 levels of difficulty through which patients progressed. Balance was also challenged multidirectionally.*

The 4-week balance training program in this study was effective in changing outcome measures for the intervention group. The long-term injury prevention benefits should be the focus of future studies.

McKeon PO, Ingersoll CD, Kerrigan DC, et al. Balance training improves function and postural control in those with chronic ankle instability. Med Sci Sports Exerc *2008;40:1810-1819.*

Aerobic and Eccentric Exercises Beneficial in Patients With Diabetes

Exercise is a universally accepted treatment for enhancing glucose control in persons with type 2 diabetes mellitus (T2DM). Although aerobic exercise has been advocated for improving glucose control, there is increasing emphasis on including resistance exercises with aerobic conditioning. In addition to improving glucose control, resistance exercises, especially high-intensity exercises, may improve muscular strength, endurance and power. Of particular importance may be the benefit of changes in muscle composition and increases in lean tissue mass that may favorably alter metabolism.

Marcus et al from the University of Utah compared the outcomes of a 16-week, supervised program of aerobic exercises with high-force eccentric resistance exercises that included a program of aerobic exercises alone in persons with T2DM. Specifically, these authors wanted to assess the changes in glucose control and physical performance measures.

Fifteen patients with T2DM were sequentially enrolled in either a combined aerobic and resistance exercise (AE/RE) group (7 patients; mean age, 50.7 years) or an aerobic-only (AE) group (8 patients; mean age, 58.5 years). Aerobic exercise progression was based on each patient's age-predicted heart rate (maximum heart rate achieved on a stress test) and rating of perceived exertion. Aerobic equipment included treadmills, stationary bikes, steppers and rowing machines.

For patients in the AE/RE group, a resistance eccentric exercise was added to the aerobic program. This exercise used a recumbent eccentric stepper that required eccentric knee and hip extensor muscle activation. Outcome measures included thigh lean tissue and intramuscular fat, glycated hemoglobin (HbA_{1c}), body mass index (BMI) and 6-minute walk test (6MWT) results.

All patients completed the 16-week supervised program. Both groups were similar in BMI, HbA_{1c} and 6MWT performed at the start of the study. Following the program, both groups showed significant improvements in gly-

Table 2. *Outcomes for glucose control, muscle structure, physical performance, muscle damage and BMI*

	AE/RE group ($n = 7$)			AE group ($n = 8$)		
Variable	Pretraining $\bar{X}$ (SD)	Posttraining $\bar{X}$ (SD)	Within-group difference (95% CI)	Pretraining $\bar{X}$ (SD)	Posttraining $\bar{X}$ (SD)	Within-group difference (95% CI)
HbA_{1c} (%)	7.1 (1.2)	6.5 (1.3)	−0.59 (−1.5 to 0.28)*	6.3 (1.2)	6.0 (1.1)	−0.31 (−0.60 to −0.03)*
Thigh lean tissue (cm^2)	142.9 (33.2)	158.0 (35.2)	15.1 (7.6–22.5)*,†	138.1 (39.3)	132.7 (41.4)	−5.6 (−10.4 to 0.76)*,†
Thigh IMF (cm^2)	32.7 (8.4)	31.6 (7.1)	−1.2 (−2.6 to 0.26)*	32.3 (8.7)	30.2 (9.2)	−2.2 (−3.5 to −0.84)*
6MWT distance (m)	554.5 (59.3)	600.0 (51.9)	45.5 (7.5–83.6)*	520.3 (33.0)	550.2 (55.9)	29.9 (−7.7 to 67.5)*
BMI (kg/m^2)	35.0 (6.0)	33.2 (5.8)	−1.9 (−3.2 to −0.56)*,†	29.8 (4.4)	30.0 (4.2)	0.10 (−0.55 to 0.75)*,†

*IMF, intramuscular fat; CI, confidence interval. *Significant ($p < .05$) time effect; †significant ($p < .05$) interaction (group × time) effect.*

cemic control, thigh composition and physical performance. Additionally, the AE/RE group improved thigh lean tissue and BMI (Table 2).

The findings of this study support the therapeutic benefits of exercises that include both an aerobic and high-force eccentric resistance component for people with T2DM. Increasing lean tissue, especially in the lower extremities, not only may improve functional mobility but may also improve glucose homeostasis.

Marcus RL, Smith S, Morrell G, et al. Comparison of combined aerobic and high-force eccentric resistance exercise with aerobic exercise only for people with type 2 diabetes mellitus. Phys Ther *2008; 88:1345-1354.*

Specific Scapular Exercises for Early Shoulder Rehabilitation

Alterations in scapular position and dynamic control, termed scapular dyskinesia, are often found in shoulder pathologies. As a result, rehabilitation programs emphasize scapular control through selective muscle activation. Ideally, the goal is to restore scapular control so that the shoulder can maintain a position of posterior tilt and external rotation—also called retraction—as a starting point for rehabilitation. To date, studies have focused on exercises requiring muscle activation in positions that may be difficult to achieve for patients in early phases of postoperative rehabilitation or when in acute pain.

In this current study, Kibler et al from the Lexington Clinic Sports Medicine Center, Kentucky, evaluated the muscle activation patterns in patients with and without shoulder pain as they performed 4 specific exercises designed for scapular muscle control. Thirty-nine patients (mean age, 29.6 years) participated. Eighteen patients were asymptomatic for shoulder pain and without scapular dyskinesia. Twenty-one patients had current shoulder pain (impingement, $n = 9$; labral injury, $n = 5$; or rotator cuff tendinopathy, $n = 7$) and altered scapular movement patterns. Electromyography data were collected for

- the upper and lower trapezius,
- the serratus anterior, and
- anterior and posterior deltoid muscles.

Four exercises were studied:

- the inferior glide (IG),
- the low row (LR),
- the lawnmower (LM) and
- the robbery (RB).

These exercises were named after the arm and body positions/motions used in performing them.

All exercises activated the upper and lower trapezius and the serratus anterior in amplitudes ranging between 15% and 32% of maximum voluntary isometric contractions. Ranges between 20% and 40% have been reported as moderate activation and are considered adequate for neuromuscular retraining. However, no differences were found between the groups for the amplitude of muscle activation across the exercises. Particular exercises activated certain muscles to a greater extent and in a different sequence. For example, the serratus anterior was activated first in the LR, but last in the LM and RB; the upper and lower trapezius were activated first in the LM and RB.

The exercises used in this study were effective in generating key scapular muscle activation of sufficient amplitude to be beneficial during the early stages of shoulder rehabilitation. For patients who have range-of-motion restrictions, the IG and LR may be good choices because of the small movements required during the exercises. The LM and RB exercises require larger motions and thus may be better choices for later stages of rehabilitation.

Kibler WB, Sciascia AD, Uhl TL, et al. Electromyographic analysis of specific exercises for scapular control in early phases of shoulder rehabilitation. Am J Sports Med *2008;36:1789-1798.*

Risk Factors and Knee Injury in Runners

Approximately 36 million Americans participate in running each year. Although the health and psychological benefits of running are well known, the incidence of overuse injuries cannot be overlooked. As many as 65% of runners will be required to stop running because of an overuse injury, with the knee being the site most injured.

Both behavioral (e.g., training and injury history) and physiological (e.g., flexibility, alignment, foot structure, strength) factors have been implicated in injury because of their presumed effect on joint loading. In this study, Messier et al from Wake Forest University, North Carolina, proposed to identify the behavioral and physiological risk factors that may contribute to higher knee joint forces and potential injuries in recreational runners.

Twenty runners (7 men, 13 women; mean age, 36 years) who were without injury and ran a minimum of 10 miles/week participated. Medical and training history, isokinetic knee strength, hamstring and quadriceps flexibility, and Q-angle measurements were recorded. Patients ran on an indoor runway to record force and lower-extremity movement data. An inverse dynamics model was used to derive compressive, shear and resultant tibiofemoral joint forces, and patellofemoral compressive force. Knee extension and abduction moments were also evaluated.

The mean peak patellofemoral force was 4.27 × body weight (BW); the mean peak tibiofemoral compressive force was 10.38 BW. Sustained over time and without adequate rest, these high-impact forces may ultimately result in overuse injury. Risk factors found to be significantly linked to the high tibiofemoral compressive forces included BW ($r = 0.48$), higher weekly mileage ($r = 0.62$) and concentric knee extension strength ($r = 0.68$). Higher weekly mileage and concentric knee extension strength were also significantly correlated to patellofemoral compressive force.

Poor hamstring flexibility was associated with greater knee extension moments ($r = -0.47$). During running, this higher knee extension moment contributed to greater patellofemoral and tibiofemoral forces. In addition to increasing the compressive loads at the knee, poor hamstring flexibility may contribute to increased joint stiffness and poor shock absorption.

Although this was a small sample of runners, the findings of this study identified risk factors that potentially could be modified during training or rehabilitation to reduce knee joint loads and thus lower the risk of injury.

Messier SP, Legault C, Schoenlank CR, et al. Risk factors and mechanisms of knee injury in runners. Med Sci Sports Exerc *2008;40:1873-1879.*

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Management strategies for chronic midportion Achilles tendinopathy

Resistance training and lower extremity biomechanics during running