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Update on **PHYSICAL THERAPY**™

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Strength Deficits Linked to Hamstring Injury

Hamstring injuries are common in sprinters. Previous studies have suggested that these injuries occur during late swing and early contact phases of running. However, those studies that have assessed muscle strength deficits or imbalance as causative factors have focused on strength comparisons associated with knee joint movements and have been retrospective in design. Moreover, findings of previous investigations vary so much that no relationship can be established between muscle strength—due to either muscle imbalance between the quadriceps and hamstrings, or side-to-side deficits—and hamstring injury.

Although eccentric hamstring activity has been implicated in hamstring injury mechanisms, the role of the hamstrings as hip extensors has not been studied. In this prospective cohort study, Sugiura et al from Yokohama City University, Japan, assessed 30 male elite sprinters who had no history of hamstring injury. Isokinetic strength measurements were recorded for the hip extensors (hamstrings), knee extensors (quadriceps) and knee flexors (hamstrings). Concentric and eccentric torques were measured at 3 different velocities (60°, 180° and 300°/second). Participants were followed for 1 year as they continued their training or competition, and the occurrence of hamstring injury was recorded.

Hamstring injuries were diagnosed by local tenderness, reduced range of motion in the straight leg exam, pain and re-

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duced strength with resisted knee flexion. An "incident" of hamstring injury was defined as one that caused the athlete to miss at least 1 week of training or competition.

Hamstring injury occurred in 1 lower limb of 6 participants (10% incidence) during the study period. Isokinetic testing at the speed of 60°/second showed significant weakness during eccentric action of the hamstring muscles and during concentric action of the hip extensors in the injured limb compared with the noninjured limb (Figure 1).

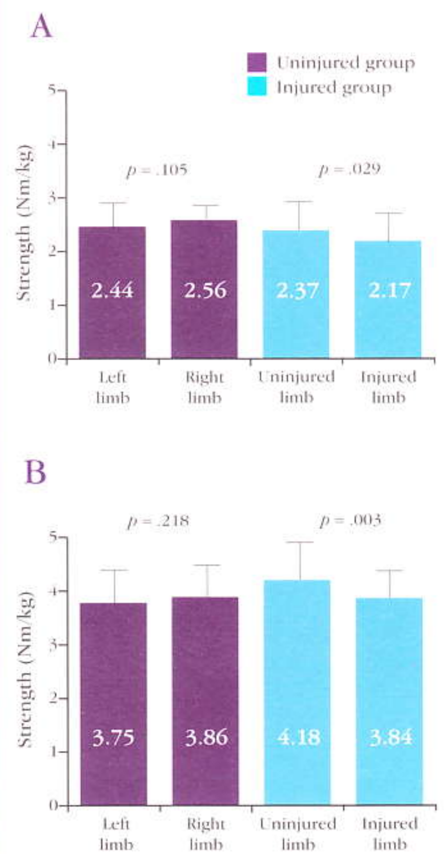

Figure 1. (A) Knee flexors eccentric strength and (B) hip extensors concentric strength (mean ± SD) tested at 60°/second for sprinters who did not ($n = 24$) and who did ($n = 6$) experience a hamstring injury in the year following testing.

When ratios between injured and uninjured legs in these participants were computed (knee flexors eccentric to knee extensors concentric; hip extensors concentric to knee extensors concentric; hip extensors concentric to knee extensors eccentric), each ratio showed a significant difference between uninjured and injured lower limbs.

Typically, the focus of strength-training programs is directed to knee flexion exercises, such as leg curls. Only recently has hip joint extension been emphasized as an integral component of training.

The findings of this study suggest that athletes (runners) with unilateral weakness of the hip extensors and knee flexors may be at higher risk for hamstring injuries. Concentrating training on these muscle groups may help to reduce the incidence of hamstring injuries. More studies are needed.

Sugiura Y, Saito T, Sakuraba K, et al. Strength deficits identified with concentric action of the hip extensors and eccentric action of the hamstrings predispose to hamstring injury in elite sprinters. J Orthop Sports Phys Ther *2008;38:457-464.*

Footwear and Plantar Forces During Running

Running shoes frequently employ a "motion-control" design using materials with different deformation rates in the midsole of the shoes that prevents excessive foot pronation. However, studies have shown that many runners' injuries result from increased plantar loading. While plantar pressure measurements are used in a variety of clinical populations to assess the efficacy of shoe inserts and loading on the plantar aspect of the foot, evaluation of plantar pressure using sports footwear is less common.

The purpose of this study by Cheung and Ng from the Hong Kong Polytechnic University, China, was to compare plantar pressure measurements before and after a brief treadmill running session with 2 different types of footwear:

- a motion-control shoe (Adidas Supernova Control) and
- a neutral shoe (Adidas Supernova Cushion).

The study included 25 women (mean age, 23.5 years) who had been recreational runners (regularly run at least once a week) for ≥1 year. All women had clinical appearance of overpronation (≥6° in the neutral shoe). An insole measured plantar force using 99 sensors, covering the whole plantar surface, as the participants ran on a treadmill at a speed of 10 km/hour for 9 minutes. Isometric inversion strength was measured before and after the treadmill run.

Participants exhibited approximately 30–40% reduction in invertor muscles maximal voluntary contraction strength following the 1.5-km treadmill assessment using both shoe types. Peak plantar force varied between the 2 shoe conditions. There was no change in the magnitude or distribution patterns of plantar forces with the motion-control shoes. However, participants wearing neutral shoes had a 15% increase in peak force in the medial midfoot region and an 8% increase in peak force over the first metatarsal head region. Participants wearing motion-control shoes showed similar plantar force among all regions measured.

Although the participants were not conditioned runners, the changes in loading under the medial midfoot and first metatarsal head may have implications for injuries. The relationship between weakness of the invertor muscle group and increased loading warrants further investigation. These factors also need to be considered when making footwear recommendations.

Cheung RTH, Ng GYF. Influence of different footwear on force of landing during running. Phys Ther *2008;88:620-628.*

Neuromuscular Training for High-risk Maneuvers

Female athletes are more likely to suffer noncontact anterior cruciate ligament (ACL) injuries than male athletes. Although the cause of this discrepancy remains unclear, some have suggested that altered motor control strategies may be a contributing factor. New emphasis has been directed to neuromuscular (NM) training programs that may improve movement patterns associated with high-risk maneuvers, such as cutting tasks, cross-cutting tasks and combined "land-and-jump" tasks. However, only 1 study has compared the kinetics and kinematics of athletes before and after completing an NM training program.

Chappell and Limpisvasti, private practitioners from Raleigh, North Carolina, and Los Angeles, California, respectively, assessed the kinematics and kinetics of these tasks and assessed the effects of an NM training program on changes in performance. The authors hypothesized that a 6-week NM training program could decrease dynamic knee valgus moments, as well as increase knee and hip flexion angles during the jump and performance tasks.

Thirty women players from the National Collegiate Athletic Association Division I basketball or soccer (mean age, 19 years) who were free of knee injury completed the study. Hip and knee kinematic and kinetic variables were assessed during a drop jump, a vertical stop jump, maximum vertical jump and timed single-limb hopping tasks. An NM training program (the Kerlan-Jobe Orthopaedic Clinic NM Training Program) was then introduced that combined a total of 10 exercises for

- core strengthening,
- dynamic joint stability,
- balance training,
- jump training and
- plyometric exercises (Table 1).

Table 1. *NM training program consisted of 10 exercises*

Exercise	Frequency
Abdominal crunches	20 repetitions
Cross crunches	20 repetitions
The plank	60-second hold
Lunges	10 repetitions each leg
Single-leg chest pass	20 passes each side
Single-leg, forward-bend pass	20 passes each side
Single-leg figure 8	20 repetitions each leg
Line jumps	20 repetitions
Lateral shuffle	20 slides to each side
Bounding	20 jumps

A licensed physical therapist initially demonstrated and taught the training program to the athletes. The program was designed to be performed daily and to take 10–15 minutes to complete. Each athlete performed the exercises 6 days/week, for 6 weeks.

Variable responses were found for the different tasks. The kinematic results showed movement patterns resulting in a significantly increased mean knee flexion angle at foot strike (5.2°; $p = .003$) and for the maximum knee flexion angle (5.6°; $p = .006$) during stance phase of the drop jump. No significant differences were observed in hip or pelvic kinematics. For the kinetic variables, there was a significant decrease in the maximum knee flexion moment (from 0.74 to 0.58 Nm; $p = .04$) during the drop jump. Additionally, a decrease in maximum knee valgus moment was observed for the stop jump (from 0.86 to 0.73 Nm; $p = .04$).

Inadequate knee flexion angles and increased knee valgus moments have been proposed as "at-risk" movement patterns for noncontact ACL injuries. Although the responses to this short intervention training program in this study were mixed, they may be considered favorable for the athlete in terms of minimizing risk of injury.

Future studies are needed that assess duration and/or intensity of the NM training program in larger sample sizes. Additional benefits may be realized if programs can be targeted to specific kinematic and kinetic deviations observed during these tasks.

Chappell JD, Limpisvasti O. Effect of a neuromuscular training program on the kinetics and kinematics of jumping tasks. Am J Sports Med *2008;36:1081-1086.*

Strain Changes Associated with Forearm Support Bands

Lateral epicondylalgia can afflict people who perform repeated resisted forearm rotation, wrist and hand motions, and affects 1–3% of the general population. The condition, which is most commonly found in individuals 20–60 years of age, is believed to occur in response to repetitive forces transmitted to the proximal origin of the wrist extensor tendons on the lateral epicondyle, particularly the extensor carpi radialis brevis (ECRB) tendon.

The first choice for treatment is usually conservative physical therapy management. To reduce passive and active stresses to the ECRB tendon, therapy frequently includes a forearm support band. The effects of this band have been reported in previous in vivo studies as they relate to changes in electromyographic activation and grip strength. Takasaki et al from Sapporo Medical University, Japan, measured the influence of forearm support band location on strain at the origin of the ECRB, when applying passive tension to the ECRB.

Eight previously frozen cadaver arms were tested. A strain gauge was inserted in the center of the ECRB origin, 1.0 cm distal to the lateral epicondyle of the humerus. The forearm support band used had a solid ethylene vinyl alcohol resin pad held in place by a Velcro® strap.

Strain measurements were initially made without applying tension to the distal ECRB tendon at 20%, 30%, 40%, 50%, 60%, 70% and 80% of the forearm length measured from the wrist joint. Strain measurements were then taken at the same distances from the wrist joint while applying a traction force of 21.5 N, applied to the distal ECRB. The tension was held constant on the forearm band at 19.6 N.

When there was no traction on the tendon, strain changes in the ECRB were negligible. When the distal tendon was loaded at 21.5 N, the mean strain in the tendon was 2.40%. Mean strain in the ECRB decreased inversely with distance from the wrist, becoming significantly lower than the no-band condition at 80% (0.85%; $p < .05$). No significant changes in strain were measured with the band in the more distal locations.

Although this study was performed on cadaver specimens, the findings offer new insight into the best placement of forearm support bands. The results suggest a recommendation for placing the band at a location over muscle fibers, rather than the distal tendon. The location found to best reduce strain was at 80% length from the wrist.

Takasaki H, Aoki M, Oshiro S, et al. Strain reduction of the extensor carpi radialis brevis tendon proximal origin following the application of a forearm support band. J Orthop Sports Phys Ther *2008;38:257-261.*

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Manual physical therapy and exercise improve mechanical neck pain

Effects of stretching duration on muscle stiffness