THE EFFECT OF TRUNK STABILITY AND LEG STRENGTH TRAINING ON VERTICAL TAKE-OFF VELOCITY IN ATHLETES

Summary of M.Sc. Thesis

Scott Butcher, M.Sc., B.Sc. (P.T.)

Attaining the best possible performance is a goal of all athletes. Athletes, coaches and sport scientists are constantly striving to find better, more efficient ways of achieving optimal performance. Abdominal muscle training is an integral component of many training programs (Norris, 1993); however, the specific mechanism of action of the abdominals to enhance performance is poorly understood.

Trunk stability is a popular concept in the areas of sport training and physical therapy. Trunk stability can be defined as the ability to maintain active control of spinal and pelvic posture and position during dynamic loading and movement conditions. This control can be combined with increasing the intra-abdominal pressure, the tension on the thoracolumbar fascia and the segmental stiffness of the spine to optimize trunk stability (Cholewicki et al., 1997). These methods are proposed to occur through co-contraction of the deep abdominal muscles (transverse abdominis and internal oblique) and multifidus in a neutral spine posture (O'Sullivan et al., 1997). Trunk stability, then, is a combination of trunk control and trunk muscle strength.

There is reason to investigate the effects of trunk stability training on performance enhancement. For optimal force production of a particular muscle to occur, a stable base must be provided (Kisner and Colby, 1990). Stability of a proximal body segment is essential before effective movement of an adjacent body segment can occur. Therefore, in dynamic movements such as vertical jumping, the pelvis and spine must be stable to prevent uncontrolled pelvic movement caused by forceful contraction of the hip and knee extensors. The purpose of this study was to determine the effect that trunk stability training and leg strength training have on vertical jump performance.

Fifty-five athletes were randomly assigned to one of four training groups; a trunk stability group (TS), a leg strength group (LS), a trunk stability and leg strength group (TL), and

a control group (CO). The TS group performed a variety of mat exercises including leg lowering, side supports, and quadruped 'superman' exercises. The LS group trained using leg press, leg extension, and leg curl. The TL group performed both training programs and the CO group performed no activity. Subjects trained over a nine-week period and were tested pre training, at three weeks, and post training.

Each subject was tested on vertical take off velocity during a single vertical jump on a force platform, fatigue index during a 30 second repeated vertical jump on a photocell jump mat, predicted 1RM for leg strength using leg press, and relative leg gravitational torque for trunk stability using a modified double straight leg lowering test (DSLL). Relative leg gravitational torque was used in the DSLL because the relative change in difficulty of moving from 70º to 60º is much greater than moving from 20º to 10º, so the test is less sensitive to change at the higher angles. Therefore, the cosign of the angle achieved was used to obtain a percentage of the maximum possible score (100% at 0º).

Analyses of covariance with pre training scores and body mass as covariates were used to determine significant interactions and group differences. Leg strength and trunk stability testing revealed that the training programs were effective in achieving gains in leg strength and trunk stability, respectively. There were no significant interactions found for fatigue index. For vertical jump, at the three-week testing period, only the TS group was significantly greater in vertical take off velocity than the CO group. At the post training test, the TS, TL, and LS groups were all significantly greater than the CO group in vertical take off velocity, but not different from each other. The TL group, however, was the only group to significantly increase in vertical take off velocity between the three-week and post training tests (see Figure 1).

These results indicate that after three weeks of training, trunk stability training will elicit gains in vertical jump more so than leg strength training, or combined training. It is suggested that after three weeks of training, a significant physiological change would not have occurred. Therefore, the gains in vertical jump are likely due to improvements in trunk and pelvic control, rather than due to increases in trunk muscle strength.

Although there were no significant group differences at the post training test, there was a trend indicating that combined trunk stability and leg strength training may produce better results than either group alone. Indeed, only the combined group (TL) increased in vertical jump between the three-week test and the post-training test.

The results of this study have wide implications for athletes, coaches and those involved with training athletes. This is the first known study to provide evidence that trunk stability training using mat exercises will improve sport skill performance. Athletes should incorporate trunk stability training into their training programs, especially in the early phases of training.

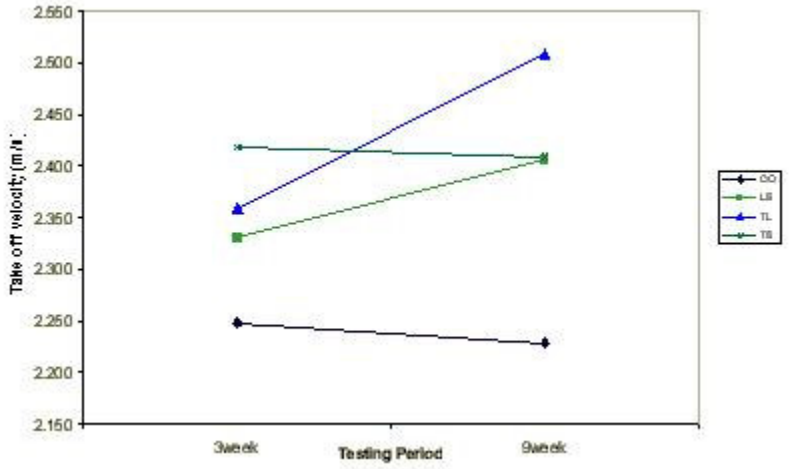

Figure 1
Graph of vertical take off velocity of the adjusted group means measured at the third week and the ninth week testing periods.

REFERENCES

Cholewicki, J., Panjabi, M.M, & Khachatryan, A. (1997). Stabilizing function of trunk flexor-extensor muscles around a neutral spine posture. Spine, 22(19), 2207-12.

Kisner, C., & Colby, L.A. (1990). Therapeutic Exercise: Foundations and Techniques. (2nd ed.). Philadelphia: F.A. Davis Company.

Norris, C.M. (1993). Abdominal muscle training in sport. British Journal of Sport Medicine, 27(1), 19-27.

O'Sullivan, P. B., Twomey, L., Allison, G. T., Sinclair, J., Miller, K. & Knox, J. (1997). Altered patterns of abdominal muscle activation in patients with chronic low back pain. Australian Journal of Physiotherapy, 43(2), 91-98.