Training with eccentric exercise to prevent hamstring strains

U. Proske[1], P. Percival[2] and D.L. Morgan[2], [1]Department of Physiology, and [2]Department of Electrical and Computer Systems Engineering, Monash University, Clayton, VIC 3800, Australia.

Eccentric exercise, where the contracting muscle is lengthened, is distinct from other forms of exercise because in someone unaccustomed to it, their muscles become stiff and sore next day. It is believed that the soreness is the result of microscopic damage to muscle fibres, leading to an inflammatory response and sensitisation of nociceptors. The soreness persists for about a week. A second period of eccentric exercise, a week after the first, is followed by much less soreness, the result of an adaptation process accompanying repair of the damage.

An indicator of muscle damage, present immediately after a period of eccentric exercise, is a shift of the muscle's length-tension relation in the direction of longer lengths (Jones *et al.*, 1997). It is believed that this is due to the presence of disrupted, non-functioning sarcomeres in series with still functional sarcomeres, and this produces an increase in whole-muscle series compliance. The shift reverses within 1–2 days. A second, sustained shift in the length-tension relation is apparent a week later. It persists for several weeks. This is the adaptation response of the muscle which is thought to involve the incorporation of additional sarcomeres into the repaired muscle fibres. As a result of this secondary shift, less of the muscle's working range lies on the descending limb of the length-tension relation, the region where disruption and damage is most likely to occur (Morgan, 1990).

Hamstring strains are the most important soft-tissue injury in the Australian Football League (AFL). There is evidence that hamstring strains occur while players are carrying out eccentric contractions during rapid knee extensions in sprinting and kicking a ball. We have recently proposed that the microscopic damage from eccentric contractions can, during repeated contractions, act as a point of weakness for development of a more major tear injury, involving many muscle fibres (Brockett *et al.*, 2001). The group at greatest risk of a hamstring strain are previously injured players. We have shown that optimum angles for torque in previously injured hamstrings were at shorter muscle lengths than for uninjured muscles, making them more susceptible to damage from eccentric exercise and therefore more prone to injury. This is because with a short optimum length more of the muscle's working range is on the descending limb of the length-tension curve, the potential region for damage. The reasons for the shorter optimum remain uncertain, but may include factors such as a player's natural predisposition, the development of scar tissue during healing and insufficient eccentric exercise during rehabilitation.

It is possible to provide protection against the damage from eccentric exercise by means of a controlled program of eccentric training. Such a program would be designed to keep all damage at the microscopic level, yet produce an adequate shift of the optimum angle, so that less of the muscle's working range included the descending limb of the length-tension relation. We are therefore proposing a strategy of regular testing of optimum angles together with a program of mild, targetted eccentric exercise as a means of reducing the incidence of hamstring strains, indeed, of strain injuries in all susceptible muscles.

Brockett, C.L., Morgan, D.L. & Proske, U. (2001) *Medicine and Science in Sports and Exercise,* 33:783-790.

Jones, C., Allen, T., Talbot, J., Morgan, D.L. & Proske, U. (1997) *European Journal of Applied Physiology and Occupational Physiology,* 76:21-31.

Morgan, D.L. (1990) *Biophysical Journal*, 57:209-221.