

In recent years there has been an increased emphasis on recovery following bouts of heavy training or competition, and the possible means by which recovery can be enhanced. There are a number of situations where enhancing recovery can be helpful for the athlete.

The athlete may have to perform again in a few hours time, such as running a heat of an event in the morning and then the final later in the day. Occasionally in tournaments, individuals or teams have to compete twice in one day. A tennis player may have to play a singles match and then a doubles match a few hours later, or a team sport athlete may have a number of games in a day as part of a weekend round robin tournament. Even though playing another high-intensity competition the same day is the exception rather than the rule, it is not uncommon to have to play on consecutive days or at least two or three times a week. Full recovery is obviously very important.

Even for those playing weekly, it is important to be fully recovered as quickly as possible to enable the athlete to train effectively during the week. In all these situations, recovery from exhaustive activity is important and coaches and conditioning staff have, in recent times, implemented post-game programs to enhance recovery.

Overall the aim is to maximize performance and minimize potential for injury at the next event. There are a number of specific objectives in the recovery process:

- restoration of function
- neuromuscular recovery
- tissue repair
- resolution of muscle soreness
- psychological recovery.

Unfortunately there is limited research into the various recovery methods. Current research has a number of limitations:

- poor study design:
  - often not randomized
  - lack appropriate control populations
- small numbers:
  - increased likelihood of chance findings
  - difficulty finding statistical benefit
  - confusing statistical and clinical benefit
- optimum regimen unknown for most techniques
- sports have different requirements
- underlying mechanisms unclear/speculative
- indirect outcome measures.

A number of methods are commonly used to hasten the recovery process. These include warm-down (active recovery), the use of ice baths, contrast baths, whirlpools or spas, and soft tissue massage, as well as nutritional and psychological techniques.

## Ensuring adequate recovery

### *Warm-down or active recovery*

Most serious athletes perform a warm-down or active recovery following the conclusion of intense exercise. The length of warm-down generally varies with the level of the participant's activity but ranges from 5 to 15 minutes. This is usually followed by stretching of the muscles used in training or competition.

Active recovery has been shown to remove lactate from the circulation more quickly than does passive recovery.<sup>1</sup> The clearance of lactate appears to be related to the intensity of the exercise performed in the warm-down up to about 50% of maximal oxygen uptake

( $VO_{2max}$ ), which is a higher intensity than routinely practiced by most sportspeople. The warm-down appears particularly important if the next bout of activity is within 2–4 hours.

The benefits of warm-down on muscle soreness and performance after 24–48 hours are not clear from current research. Dawson et al. compared immediate recovery procedures to next-day recovery training (25 minutes of pool exercise) and found no difference in recovery of muscle soreness, flexibility and power at 48 hours after an Australian football match.<sup>2</sup>

### **Deep-water running**

Deep-water running involves ‘running’ in the deep end of a swimming pool using a buoyancy vest. This technique can be used to maintain fitness during recovery from lower limb injury (Chapter 12), and as a form of cross-training to reduce impact with the aim of reducing overuse injuries (Chapter 6). Its use has also been advocated as part of the recovery program either immediately after the bout of strenuous exercise or the following day. Reilly et al. showed that a regimen of deep-water running for three consecutive days after intense exercise reduced muscle soreness and appeared to speed up the restoration of muscle strength.<sup>3</sup>

### **Ice immersion, contrast baths, whirlpools and spas**

The use of ice immersion, contrast baths, whirlpools and spas has become common among athletes attempting to enhance the recovery process. Despite this, there is little evidence for their efficacy. Most of the research has looked at the effect of these various treatments in delayed onset muscle soreness (DOMS)—one of but by no means the only feature of muscle damage following intense exercise.

Cryotherapy has long been used to treat musculoskeletal injury (Chapter 10) due to its effect on reducing the hemodynamic response to injury. Decreasing tissue temperature results in constriction of local blood vessels, thus reducing the accumulation of edema. Through predominantly vascular effects, cold application is thought to diminish the edema response to musculoskeletal trauma and decrease metabolism in injured tissues, thus lowering the oxygen requirement and limiting the inflammatory response in the tissues. It is thought that cold application has various other effects on injured tissues, such as reduction of muscle spasm and slowing of nerve conduction velocity, thus altering perceived pain.<sup>4</sup>

There is much variation in the preferred method of ice or cold application. Research has thus far failed to show convincing evidence for a positive effect from ice massage,<sup>5,6</sup> crushed ice,<sup>7</sup> ice water immersion<sup>8–12</sup> or contrast water immersion.<sup>2,13</sup>

There are currently two common methods used. The simplest and easiest method involves use of an ice bath (2–10°C). Although no specific protocol exists, in current practice the regimen commonly used involves the athlete standing waist deep in the ice bath for 1 minute followed by a minute out of the bath. This is repeated two or three times. The second common technique is the contrast bath, alternating warm and cold baths for a minute each, repeated three or four times. Despite the lack of scientific evidence, these techniques are widely used and may have a significant placebo effect. Anecdotally, players invariably report that they believe these techniques help their recovery.

The use of whirlpools and spas appears to improve the recovery process. These baths may have both a physiological effect on muscle and other soft tissue as well as a psychological effect by decreasing arousal.

### **Soft tissue massage**

Regular soft tissue massage contributes to soft tissue recovery from intense athletic activity. Intense training causes prolonged elevation of muscle tone in both the resting and the contractile states. This is often felt as muscle ‘tightness’ by athletes and occurs particularly during periods of adaptation to increased volume and intensity of training.

It is thought that hard training and ‘abnormal tone’ have numerous effects. These may impair the delivery of nutrients and oxygen to the cells and slow the removal of metabolites. They may contribute to biomechanical abnormalities, particularly if muscle tightness is asymmetrical. Increased tone also limits the extensibility and shock absorbency of soft tissue and thus predisposes the tissue to strain. Fatigue associated with hard training also impairs proprioceptive mechanisms and may directly trigger nociceptors.

Intense training also causes irritation of previously inadequately treated soft tissue lesions. Repetitive microtrauma of these lesions may cause bulky connective tissue to develop, which further compromises muscle function and flexibility. Fascial tissue may become less pliable due to cross-linkages developing. Active trigger points that result from heavy training may reduce muscle strength. These problems can impair training and competition and can progress to injury if they are not resolved.