

## Fatigue

Everyone can relate to the experience during the last few kilometres of a race. The coordination and precision of your paddling strokes and leg drive are highly reduced, your shoulders and core collapse, the paddle is splashing hard onto the water surface. You feel almost like a beginner in handling your seemingly tippy boat. After the time trial you are incapable of any fine motoric for a couple of hours (tried to open that bottle, get the car keys into the keyhole or just open the package of food?) Luckily your shift as a dentist is over.

The effects of fatigue are only short-term but multifactorial. Some of the reasons are:

- Electrolyte depletion in the muscle due to high frequency of muscle innervation.
- Drop in pH in the muscle due to lactate build up. Activity of metabolic enzymes is reduced in an acidic environment.
- Depletion of muscle glycogen, the energy storage in your muscle.
- Pathologic increase of muscular & inner core temp that impacts metabolic enzyme activity significantly.
- Dehydration causes drop in blood pressure, reduced volume of blood is pumped through the system, leading to reduced perfusion of muscles and brain.
- Blood glucose is the major source of energy for the nervous system. A drop in blood glucose is not only affecting performance of skeletal muscles but particularly neural innervation and even motivation (mental fatigue due to hypoglycaemia).

## Exhaustion

Exhaustion sets in when we operate in the state of fatigue for too long (acute exhaustion during a race) or willingly reduce recovery times in between intense physical activities (chronic exhaustion at the end of a racing season). This state of maximal fatigue will lead to decrease in performance or in an extreme case to involuntary stop of physical work (body collapse).

Acute exhaustion is not uncommon in any sport and of minimal risk in healthy people if enough rest is granted afterwards. To gain performance a mild form of acute exhaustion is even necessary to trigger physiological adaptations in the body. However, please be aware that acute or chronic exhaustion can lead to serious ill-effects in people with pre-existing conditions of the musculoskeletal and cardiovascular system.

## Recovery

Recovery occurs when physical activity is discontinued, reduced or replaced with other types of activities. Fatigue slowly disappears and performance increases again. Elements of recovery are the relatively quick restoration of metabolic (energy) depletion but also the slower healing processes of structural damage such micro lesions in the muscles and tendons, inflammatory processes that can occur with intensive physical activity.

**Overtraining** obviously leads to acute or chronic exhaustion. It can lead to specific vegetative symptoms such as insomnia or cardiac pain but most of all to a reduced performance. Chronic exhaustion occurs if the recovery times are repeatedly insufficient. It can lead to significant physical impairment, weeks and even months of perceived tiredness and musculoskeletal damage. The reasons for that are complex and lie in the central-nervous system (hypothalamic-pituitary activity, adrenal gland and metabolic stress responses) and in insufficient healing processes, respectively. Incomplete healing of micro-injuries can eventually lead to chronic damage of the musculoskeletal system (including tendons, ligaments and joints). Most common injuries such as tendinitis, meniscal ruptures, bursitis, arthritis of the elbow and shoulder are accumulative damage caused by anatomically adverse movements (bad technique) and overtraining.

It takes discipline to train and it takes discipline to recover. Recovery is an important element in a successful training plan