

REGENERATION IN FOOTBALL - effects of the BARO-Trainer and CO2 dry bath

Introduction

The 2020/2021 season of the 3rd Bundesliga was characterized by numerous English weeks due to the corona pandemic and the postponed European Football Championship. For all players, this meant an enormous increase in performance from training and games. However, even the adjustment of the substitution rule with five players per game could not significantly reduce the burden on the players.

It is known that the risk of injury during training and games increases with increasing stress. The body systems, which are almost permanently working under full load, also reach their limits here. The metabolism and its regulation by the autonomic nervous system are of central importance here [1].

Against this background, the regeneration of athletes is becoming increasingly important in the prevention concepts of professional sports. Training concepts individually tailored to the players with the support of athletic trainers are certainly one of the essential building blocks. However, complementary possibilities of regeneration have received little attention and research so far.

This amount deals with combining the physical treatment method with carbonic acid, which has been known for centuries and stimulating the vegetative nervous system with an innovative training device, the BARO-Trainer.

The autonomic nervous system (ANS)

Practically all life processes in our body are controlled by the vegetative nervous system, primarily outside our conscious perception. The two components, sympathetic and parasympathetic, act as opponents. The sympathetic nervous system is considered the "motor" of the competition. Metabolism, respiration, cardiac output and vascular regulation are practically brought to maximum performance to secure the stressed muscles' energy requirements. In return, bodily functions that are not immediately required (e.g. digestion) are reduced to a minimum.

Just as an engine cannot be used continuously at full throttle, the body's "drive systems" also need a phase of regeneration to replenish their energy reserves. Here the parasympathetic increases its activity.

The focus is on the digestive system to replenish the used energy stores. The performance of an athlete's body depends on the perfect coordination of these two components. In addition, there are interactions between consciousness and the autonomic nervous system. Visually or emotionally perceived dangerous situations bring the body into a "fight mode" by activating the sympathetic nervous system, easily recognisable by the increased heart rate [2].

Long-term stressful situations result in a lack of regeneration and, thus, an increased risk of injury and illness. Some examples of such impairments include states of exhaustion, lack of concentration, performance deficits, and abnormality of the cardiovascular system.

However, the controlling effect of the sympathetic and parasympathetic nervous systems on heart function also offers the possibility of determining the activity of both components using modern measurement technology. First, the heart rate variability is measured. Simply put, the intervals between heartbeats are never the same in a person. Even at rest, the intervals between the individual heartbeats differ by a few milliseconds. Therefore, a high heart rate variability is an expression of increased activity of the parasympathetic nervous system in regeneration mode.

VNS measuring systems record the intervals between the heartbeats for a specific number of heartbeats or a defined period. Depending on the measuring system and analysis algorithm, the activity of the autonomic nervous system can be visualised with different diagrams.

Physiology of CO2 baths

The healing effects of carbon dioxide have been known and proven since the 19th century. Sources containing CO₂ were used, and CO₂ obtained from combustion was used in special "incense boxes" to treat individual body parts. Therapy systems that function according to this principle were still used a few years ago.

Currently, CO₂ treatment is still used in three forms of application in hospitals and rehabilitation clinics. Classic as a CO₂ bath using sources containing carbonic acid. Mixtures of sodium bicarbonate and crystalline organic acids also release carbonic acid as a bath additive. The third application is CO₂ dry baths. Body sections to be treated are placed in treatment covers, which are filled with warmed carbonic acid gas after the internal air has been sucked out [3,4,5].

The Bohr effect describes the mechanism of gas exchange in the tissue. By lowering the pH value and increasing the CO₂ concentration, the affinity of haemoglobin for oxygen decreases. It is then released into the tissue. Under normal physiological conditions, the CO₂ concentration increases with the increased metabolic activity of the tissue (e.g. muscle activity), which intensifies this effect. In addition, as a metabolic metabolite, CO₂ has a vasodilating effect. Therefore, it is an essential regulatory mechanism for metabolically active organs such as the brain, heart or skeletal muscles [2].

The carbon dioxide that diffuses through the skin during the carbonic acid bath lowers the pH value in the dissolved form and increases the CO₂ concentration in the tissue. The result is vasodilatation and increased oxygen release into the tissue, positively affecting the healing of injuries and regeneration.

Our scientific studies could clinically and with modern measuring technology prove the significant effect of the carbonic acid dry baths. Furthermore, there are indications that CO₂ therapy also positively influences regeneration by stimulating the parasympathetic nervous system. Against this background, it makes sense to use the CO₂ treatment for injuries and regeneration after intense physical exertion.

How the BARO-Trainer works

The BARO-Trainer (HYPOXI Produktions- und Vertriebs GmbH - manufacturer) is a training device that combines diagnosis and active regeneration in one device. It is a positive-negative pressure chamber for the lower half of the body, in which a bicycle ergometer is installed.

Before starting the regeneration training, the vegetative status of the trainee is first determined. Then, the tailor-made training program is selected using software that considers the determined vegetative status and the parameters of gender, age, body weight and general fitness level.

The athlete completes the ergometer's 15 - 30-minute regeneration training with an RPM of approx. 50 at extremely low power levels, depending on the program specifications. During training, overpressure and under-pressure phases alternate in the device according to the previously determined training parameters. The pressures, which change at intervals of 20 to 30 seconds, directly affect the capillary blood flow in the lower extremities. In overpressure mode, these are compressed. Accordingly, the vegetative nervous system tries to counter-regulate to ensure a sufficient blood supply for the active muscles. Conversely, a suction effect occurs in the negative pressure phase, facilitating the capillary flow. In addition to stimulating the vegetative nervous system, alternating pressure treatment and light physical activity promote circulation and regenerative metabolism.

The use of the BARO-Trainer in individual high-performance sports for several years has confirmed the stimulating effect of this regeneration method. However, so far, there is little

experience with team sports. This article reports on the first results of the regeneration concept in football.

Can regeneration be measured?

The topic of regeneration is treated as a secondary issue in clinical research. It is also not surprising since maximum physical stress is not associated with illnesses or injuries. However, some clinical pictures, some of which are serious, are associated with a malfunction of the autonomic nervous system. The most impressive example to be mentioned here is the clinical picture of Morbus Sudeck (alternatively CRPS), which has not yet been thoroughly researched. Here, a minor injury (e.g. bruise) can quickly trigger a severe vegetative derailment of the affected body region combined with pain, malfunctioning and disrupting tissue and bone metabolism.

To date, sports science has not found any recognised parameters by that effective regeneration can be measured. Various influences, such as age, gender, body weight, hormonal status, individual performance demands, and external circumstances, affect personal regeneration. Therefore, a daily "immediate measurement" is practically impossible. On the other hand, the consequences of overtraining are undisputed, with an increased risk of injury, a weakening of the immune system and effects on the athlete's psyche. Accordingly, effective regeneration can be recognised based on several criteria. In addition to physical performance tests, performance monitoring (e.g. polar measurement during training and games) and the assessment of the mental situation as relatively quick markers, the frequency of injuries and illnesses, long-term performance development and permanent mental stability are considered essential factors for assessing effective regeneration [6].

Own investigations

Complementary CO₂ treatment with the CAT system (Carbon Acid Therapy, Unitronic – Medical Control Units GmbH) was already being used by some players at the end of the 2019/2020 third division season. Furthermore, similar to the treatment of injuries, a hyperspectral measurement (Tivita[®] Diaspective Vision GmbH) demonstrated an improvement in blood circulation and oxygenation in the tissue.

These first results allowed a more intensive scientific look at the topic of regeneration options. In addition to the use of carbonic acid baths, the BARO-Trainer, which was specially developed for regeneration, was also included in the investigations.

Initial preliminary investigations were carried out as part of a master's thesis from the Faculty of Biomedical Engineering at the WHZ Zwickau. During the second half of the 2020/2021 season, the influences of CO₂ use and the BARO-Trainer were examined.

Due to the required application times, the devices used were limited.

Three pairs of players were formed for the investigations. Group 1 - no additional regenerative measures. Group 2 – complete CO₂ application. In group 3 - the BARO-Trainer and the CO₂ application were combined. These took place after the regular training sessions.

Immediate effects could be demonstrated in groups 2 and 3 by hyperspectral measurement (improvement of the oxygen supply) and the VNS analysis (VNS analysis, Commit GmbH) with an increase in the activity of the parasympathetic nervous system.

The performance data recorded during the league games were evaluated as additional parameters. In addition to general performance data and deployment times, the distance covered by the players in speed zone 4 (running at a speed of 19.80 - 25.19 km/h) was specifically considered.

Furthermore, the data of the groups among themselves and the values of the respective players' first half series were considered.

Group 1 showed no change. However, in groups 2 and 3, significant increases in the running distance in speed zone 4 could be determined, with the most substantial effects being observed in group 3. Likewise, the subjective evaluation of the regeneration measures, also by the players who were not included in the investigations, was consistently positive.

Conclusion

It is undisputed that the topic of regeneration is becoming increasingly important as performance increases. Complementary measures for regeneration are another vital approach in addition to the already established concepts. Of course, a correct differentiation from illegal performance enhancement through doping must also be made here. In contrast to doping, where an intervention in the body systems is intended to improve performance without additional training effort, regeneration measures aim at rapid body recovery after competition or training. The carbon dioxide treatment, with its different forms, is a recognized application in rehabilitation and spa facilities and has been known for centuries. New research also shows its effectiveness in treating injuries by reducing healing times. From this, the approach can be derived as a possible building block for rehabilitation. The BARO-Trainer has already proven itself in individual high-performance sports. The previous studies in football show that the combination of CO₂ application and the BARO-Trainer, in particular, has positive effects on the regeneration of the players. Further investigations with more significant case numbers are recommended to support these results.

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