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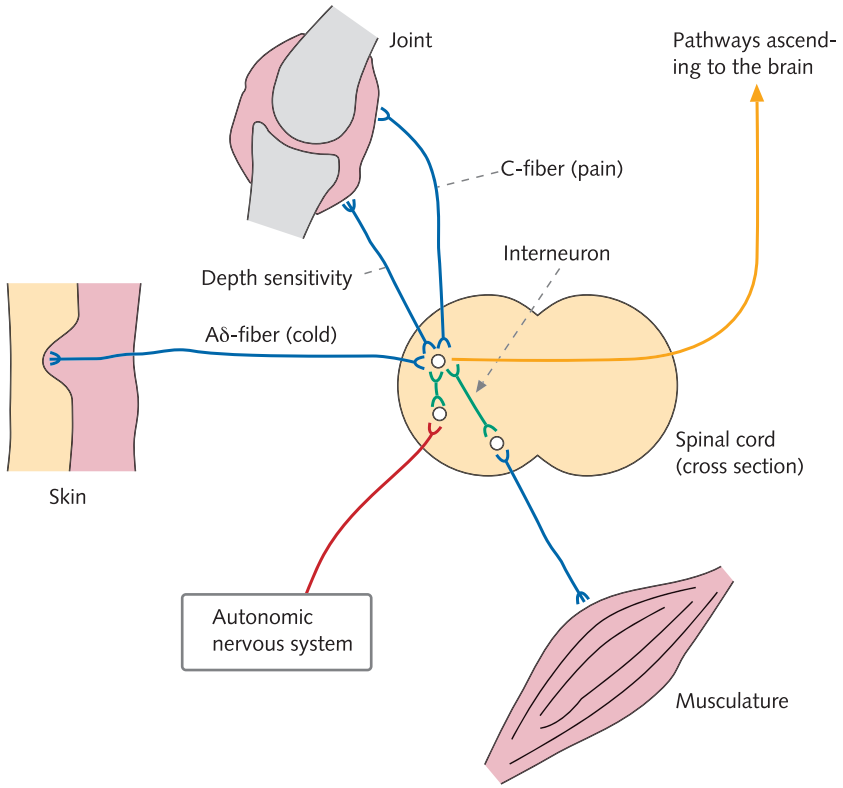

Fig. 3.3 Afferent pathways from the cold sensors and their connections in the spinal cord

pletion of a short and severe cold action. After that the proper value for the normal skin temperature then rematerializes.

Cold sensors are endings of the Aδ-nerve fibers of the peripheral nervous system. These fibers serve as skin afferents for temperature, i.e. they guide the neural stimuli that result from sensory cold stimulation to the spinal cord, and in so doing in the direction of the brain (figure 3.3).

For the effects of whole body cryotherapy it is now of key importance that these signals arriving in the spinal cord are fed into other neural functional circuits, i.e. those of a motor, algesic, vegetative and proprioceptive nature. Such networking causes a modification in such functional circuits that, as we shall see later, can explain some of the therapeutic effects of cold. This impacts on their influence on pain states, inflammatory processes, the

tensile state and the blood supply of the musculature and the function of the locomotory and support apparatus. In addition, afferents resulting from the effects of cold on the skin, but also in higher located structures of the central nervous system such as the brain, become active and intervene in a regulatory manner in peripheral cold effects by modifying efferent pathways that descend from the brain via the spinal cord. The influence on mental activity levels, cardiovascular functions and hormonal feedback loops should also be considered as central (i.e. brain-mediated) effects of cold.

The effect of whole body cold therapy depends on the degree to which skin surface temperature is lowered [43]. For chronic inflammatory joint diseases, chronic pain and fibromyalgia in particular, a lowering of the skin surface temperature to values of around 5 °C should be sought. Within an endurable exposure time of three minutes [54], this temperature can be reached without any problem in a cryotherapy chamber (icelab, Zimmer Medical Systems) within which a constant treatment temperature for the entire body surface of -110 °C is ensured. With a chamber temperature of -80 °C such a reduction cannot be reached within an endurable exposure time [43].

3.2 Pain inhibition

In order to understand how cold action on the skin can intervene in pain, it is first necessary to consider a number of anatomical, physiological and also pathophysiological principles.

Pain origin, perception and processing are very complex processes occurring within neural structures. Both the peripheral nervous system (the neural pathway of the periphery, where the pain stimulus was induced, up until the spinal cord) as well as, and indeed primarily, the central nervous system (spinal cord and brain – in several regions) are involved in this (figures 3.3 and 3.4).

The specific elements for detecting pain stimuli are the nociceptors (pain receptors). They occur both in the skin and joints as well as in the musculature and in the inner organs. They react to mechanical, thermal and also specific chemical stimuli. They also respond to the severe cold stimulus during the stay in the cryotherapy chamber and can signal a pain. Just like cold sensors, nociceptors are also free nerve endings of either C-nerve fibers or Aδ-nerve fibers, as we have already become acquainted with as stimulus conductors for thermal stimuli. The nociceptors feature different sensory thresholds. As such, many of them are only activated when they are sensitized by diseased alterations in the tissue, e.g. by inflammation. Activation

3.10 Summary

In this chapter it was not possible to avoid delving into the theoretical basics of whole body cryotherapy, particularly with regard to the neuronal, hormonal, metabolic and cardiovascular aspects. Without knowledge of such associations, however, any description of the indications for whole body cryotherapy in the following chapters would barely be understandable.

What knowledge do we therefore have to take with us in the coming chapters?

Whole body cryotherapy is based on neuroreflexive as well as neurohumoral processes and effects on central control functions that are induced by the strong, short-term cold stimulus that is applied over almost the entire body surface. Only in this way can it be explained that it has clear therapeutic and stimulating effects not only in the area where it penetrates, but also at deeper-lying tissue that remains inaccessible even to a three-minute application of extreme cold.

Whole body cryotherapy is primarily pain-alleviating and anti-inflammatory. It also affects the tensile state (neuronal activation), blood circulation and metabolism in the skeletal muscles. It intervenes in a regulatory manner in disrupted central activity levels, and it is effective at modulating certain areas of metabolism and the vascular system. It plays a certain role in modulating a number of hormonal feedback loops and reveals a performance-optimising effect which is now explained in much more detail as regards cardiovascular function, the energy balance, muscular metabolism, and stress-related problems in the blood and muscles in a separate chapter, namely "Whole body cryoapplication in competitive sport" (figure 3.16).

1. Pain relief, pain elimination
2. Inflammation inhibition / immunomodulation
3. Effect on skeletal musculature (regulation of tone, improvement in circulation and metabolism, modification of neural activation)
4. Functional improvement of the joints
5. Regulation of the central activity level, psycho-physical performance enhancement, improvement of well being
6. Economization in the cardiovascular system and the energy budget

Fig. 3. 16 Active components of the whole body cryotherapy

4. Indications for whole body cryotherapy

Based on theoretical knowledge, clinical studies and experience the indication list for whole body cryotherapy has been increasingly justified and indeed expanded over the last years.[44] The opinions regarding some indications, however, are far from unanimous amongst the various cryotherapy centers.

The indication list prepared for this book (figure 4.1) includes on the one hand diseases for which whole body cryotherapy has been adequately proven, such as inflammatory-rheumatic disease, osteoarthritis (degenerative-rheumatic diseases) and chronic pains of various cause, and on the other diseases or health problems for which positive treatment results have been obtained clinically, but different assessments have been arrived at.

1. Inflammatory-rheumatic diseases with primary manifestation at the joints (rheumatoid arthritis, Bekhterev's disease)
2. Degenerative-rheumatic diseases (osteoarthritis of large and small joints, also before and after endoprosthetic treatment, postoperative edemas)
3. Cervical and lumbar vertebral-syndrome (discopathies, lumbago, ischia syndrome), also pre- and postoperatively
4. Tendopathies (tennis elbows, inflammation of the achilles tendon, heel pain)
5. Chronic pain states, also primary headaches, pain and stress processing defects (fibromyalgia)
6. Disrupted regulation of muscular tone (spastic) with infantile cerebral palsy, multiple sclerosis, muscular strains and hardening
7. Blunt traumas of the joints and the musculature
8. Psoriasis without and with joint participation
9. Atopic dermatitis (neurodermatitis), bronchial asthma
10. Signs of muscular fatigue
11. Disruptions of equilibrium, disruptions in movement coordination
12. Disruptions in central activity levels (central signs of fatigue, burn-out syndrome, sympathicotonic, parasympathicotonic and depressive reaction states, non-organic and pain-conditioned chronic sleep disorders)
13. General psycho-physical deterioration in performance and ability
14. Immune reaction disorders, caused by extreme muscular demands, age or stress-dependent functional constraints of the immune system
15. Primary hypotonic circulation disorders

Fig. 4.1 Indications for whole body cryotherapy

the icelab, however, such a reaction has never been observed and has not yet been reported in the literature to my knowledge. The reactions of the cardiovascular system to the strong cold stimulus described in chapter 6 suggest instead that the blood vessels of the heart are widened.

6. Whole body cold application in athletic sports

The clinical indications for whole body cryotherapy, including those such as postoperative states, inflammatory processes and blunt tissue damage, have inevitably led sportsmen to use whole body cold increasingly for therapeutic purposes. Reports on their use in this context have now been published. Furthermore it has been pondered how the regulation of central activity levels seen after whole body cryotherapy, the economization in the cardiovascular system and the muscular effects can be utilized for athletic sports. A number of cryotherapeutic centers have already made some capacity available for the use of sportsmen, while some sports clubs have also started purchasing -110 °C cryotherapy chambers and sport-medical rehabilitation centers have also included whole body cold in their therapeutic spectrum. Cold applications have become "the most important form of passive physical therapy in sports medicine" [42].

It can already be forecasted that this highly effective physical therapy shall become a firm component of sports therapy, rehabilitation and regeneration programs. Regarding our own experiences, observations on the whole body cryotherapy of general traumas after competitions and in postoperative rehabilitation, their application during training and the results of currently published research, the following problems shall be discussed in this chapter:

1. Sport injuries as indications for whole body cryotherapy,
2. improvement of physical performance and acceleration of regeneration through application of cold,
3. effect of whole body cryoapplications on physiological parameters and
4. incorporation of whole body cold exposure in training and competition.

6.1 Sports injuries as indications for whole body cryotherapy

In order to be able to recognize the possible applications of whole body cryotherapy after sports injuries as well as after injury-conditioned surgical interventions, we shall first turn to the pathophysiological processes listed in figure 6.1 that are worthy of discussion at this point and which progress after tissue damage. The severity and therapeutic influencing of these processes largely determine the times for which athletes must refrain from training and competition as well as any long-lasting impairments of athletic performance.

The inflammatory reaction in the injured/operated area via the individual damage components (such as impairment of local blood supply and

7. Whole body cold exposure for primary disease prevention, in the spa industry, in programmes for generally promoting health and wellbeing, as well as in relation to naturopathic procedures

7.1 Basics

Whole body cold exposures at temperatures ranging from -100 °C to -110 °C are no longer restricted to purely therapeutic exposures. They are now applied more and more for preventive medicine as well as in many spa institutions renowned for their prophylactic and therapeutic facilities. Against the backdrop of other natural and preventive procedures, the general health beneficial and performance-optimising effects of cryoapplications have resulted in their increasing use to promote general wellbeing, often combined with the desire of optimising one's abilities to work in their chosen profession. People these days are asking what they themselves can contribute to promote their own health, and what role their mental and physical wellbeing plays in this respect. From such generally outlined reasons, it now seems appropriate to ask the role which whole body cold exposures can play in this process. In addition, and this should not be overlooked, exposure to cold can now be accomplished in the icelab in a very comfortable form and environment, a fact which has contributed greatly to its acceptance, even in situations where its necessity is not dictated by a pathological indication (e.g. a painful inflammatory condition), and it is much rather intended to prevent disease, improve well-being or improve overall performance.

What determines the use of whole body cryoapplications in this respect? At this point we can refer briefly back to the effects described in other chapters of this book. Let's start with the systemic effects that are triggered via neuronal reflex mechanisms. This is almost certainly the main reason why whole body cold exposures enjoy benefits over locally employed physical applications. Rather than inducing reactions which are either locally restricted or confined to individual organs, whole body cold exposures elicit complex responses that affect both the physique and the psyche. These can occur in the central and autonomic nervous systems, in the cardiovascular and respiratory systems, in hormonal regulation, with immune functions, in metabolism as well as in muscular and skin functions (figure 7.1).

Concerning the effects of whole body cold applications on the central nervous system, only their influence on the control of chronic inflammatory

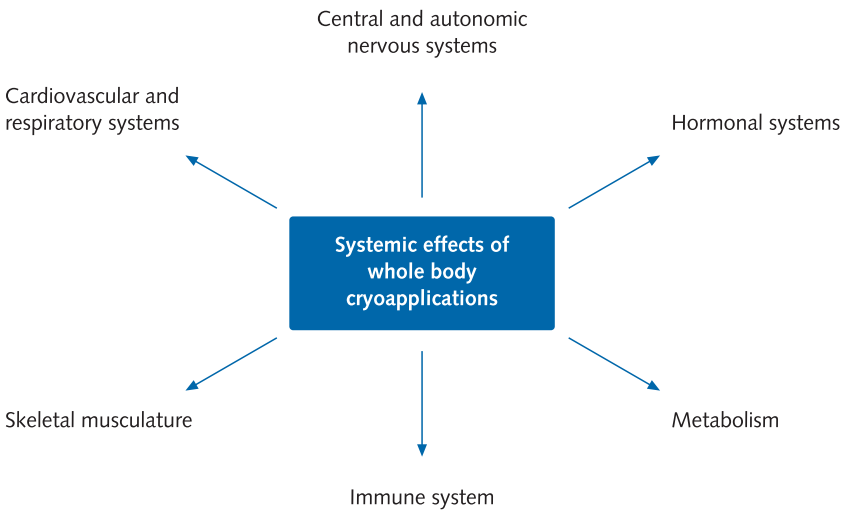

Fig. 7.1 Targets of action for whole body cryoapplications

processes [22, 23, 43] and the perception of pain [31, 66] by the brain initially played a role in the many studies and discussions about this topic. Now, however, many years of more recent clinical experience and scientific research [71, 76, 77, 78] have allowed us to abandon this what now seems unilateral approach. In general terms it can be said that whole body cryoapplications modulate activity levels in the brain. They contribute towards bringing about a balanced mental state. From a symptomatic viewpoint this is actually quite easy to establish since we know that sleeping patterns can improve, stress management can become more effective, overstrain syndromes can be manageable and the treatment of reactive depressive states can be effectively assisted. The mutual interactions between the central nervous system and the autonomic nervous system also play a role. The autonomic nervous system reacts differently to the effects of cold on the body surface in a way that depends largely on what the initial situation might be. With an excessively high level of agitation or arousal, i.e. when the sympathetic nervous system predominates, it is mainly the parasympathetic nervous system which becomes activated, especially via the effects of the cold on the facial skin, and it is this wing of the autonomic nervous system which actually reduces the levels of agitation or arousal. If on the other hand the general state of activity in the nervous system is too low,