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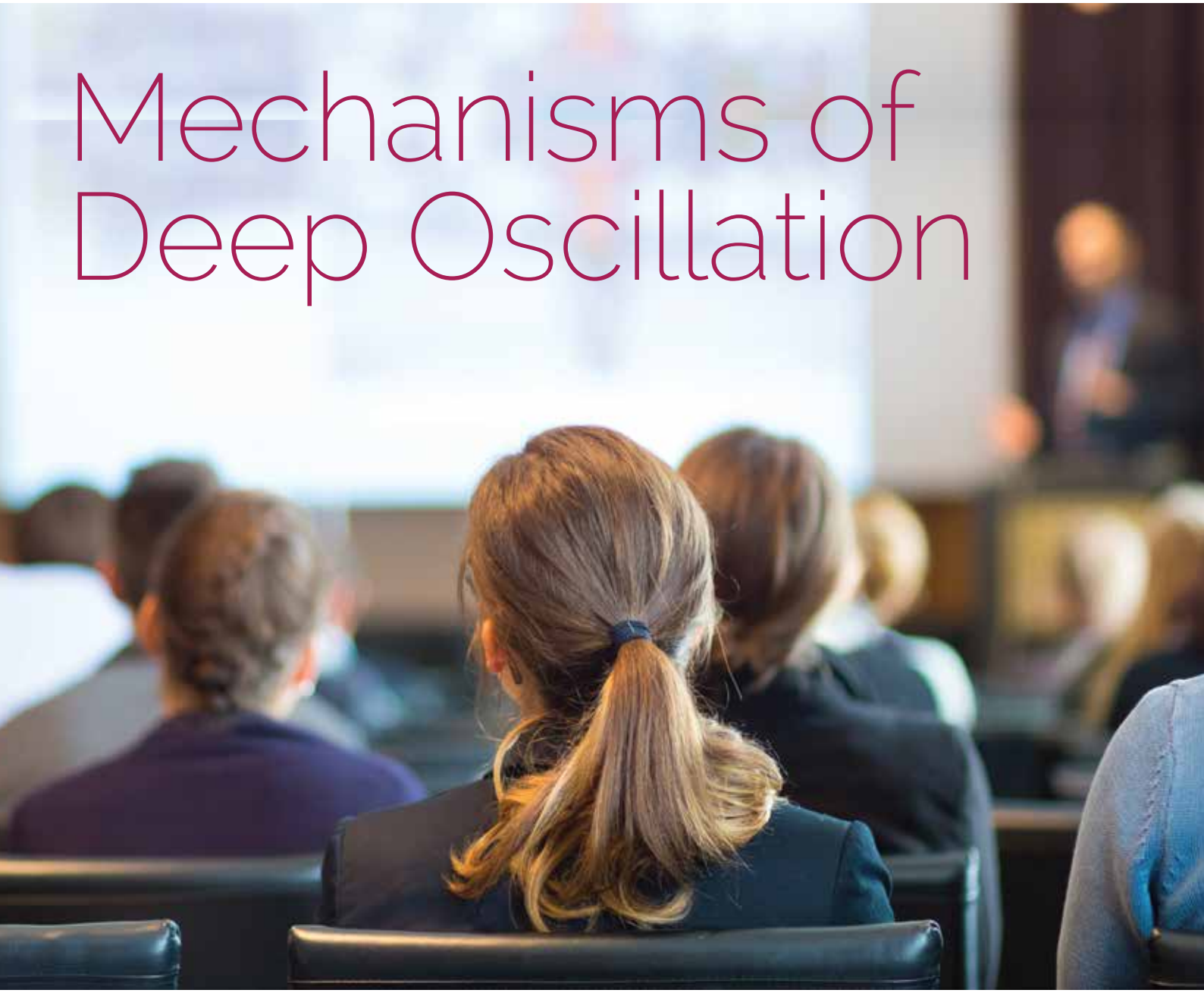
Mechanisms of Deep Oscillation



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Keeping Manual Lymphatic Drainage in Safe Hands

Mechanisms of Deep Oscillation

By Dr Jens Reinhold,
CEO PHYSIOMED Elektromedicin AG

FOREWORD

DEEP OSCİLLATİON® also known as HİVAMAT® 200 therapy, arrived in the UK and Ireland back in 2006 via exclusive distributors PhysioPod® UK Limited. This article, explaining the mechanism of Deep Oscillation with scientific references, has been written exclusively for MLDuk by Dr Jens Reinhold of PHYSİOMED, the German manufacturers. Deep oscillation is now used effectively by many MLD DLT Practitioners & Lymphoedema Therapists enhancing results and reducing pressure on their own hands. İn 2012, the therapy became recommended by The Wittlinger Clinic and the Dr Vodder Academy İnternational and PhysioPod became authorised NHS Suppliers. Lymphoedema, Lipoedema and Chronic Oedema sufferers are now able to self manage at home via the personal unit.

BACKGROUND

Deep oscillation refers to an electromechanical therapy method in which electrostatic attraction and friction, produced by the use of a glove or hand-held applicator, create resonance vibrations in treated tissue. These have a gentle and deep-acting effect on all tissue components to an 8 cm depth [1].

Because of the non-invasive, non-traumatic nature of this modality, there are very early possibilities of application: following injury and from Day One post operatively, in acute pain and in wound healing, also.

Deep oscillation has been successfully applied therapeutically for more than two decades and concomitantly examined scientifically with respect to its tissue effects and clinical results. Currently there exists a substantial number of randomised controlled trials (RCTs), pilot studies, case studies, field reports and studies (several in PubMed-indexed international journals) to provide a medical evidence base for deep oscillation. This article explains well-established clinical effects of deep oscillation and models underlying physiological mechanisms of action, each with references to the relevant literature.

CLİNİCAL EFFECTS

The athermal mechanical mode of action of deep oscillation can induce the following clinically documented effects in treated tissue:

- Strong analgesic effect. This applies to acute traumatic phase as well as to chronic pain conditions [2-11].
- Anti-inflammatory effect [12, 13].
- Prevention and reduction of secondary and primary lymphodema, as well as reduction of oedema in lipoedema [2, 4, 6, 14-17].
- Prevention of fibrotic remodelling processes, reduction of fibrosis [2, 14, 15, 18].
- Muscle relaxation, fascial mobilisation, functional improvement and improved range of motion (ROM) [4, 7, 18-20].
- Support of wound healing processes [1, 21, 22].
- Normalisation of haemodynamic parameters of the skin, correction of aesthetic-neurotic problems and influence on biological ageing through preventive effects on premature ageing [23].
- Accelerated recovery after intensive physical workout [24, 25].
- Decongestion and functional improvement in obstructive pulmonary conditions [26, 27].

PHYSİOLOGİCAL MECHANİSMS OF ACTİON

Below, physiological effects that underlie the respective clinical

effects of deep oscillation are experimentally explained:

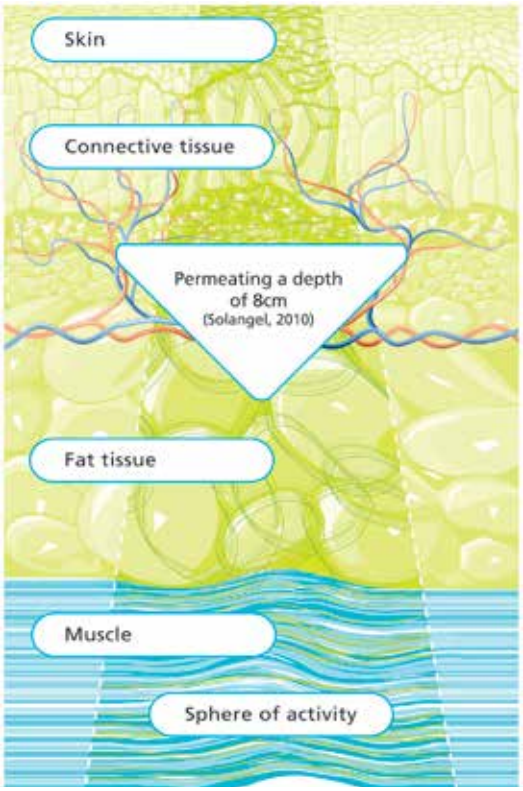
Pain-alleviating effect

• Ex vivo, reduction in the expression (number) of TRPV1 pain receptors on sensory cells confirms a statistically significant pain-alleviating potential of deep oscillation [12]. The results could be based on reduction of the noxious stimulus potential (inflammatory process in general, including calor, tissue acidosis and prostaglandin [cyclooxygenases]) for TRPV1, caused by mechanical distribution and intensified interstitial drainage due to deep oscillation. On the other hand, the therapy might directly affect TRPV1 receptors, e.g. by cell-modulating or inflammation-mediator-related effects in terms of a "cell information therapy" [28].

• Reduction in the tissue content of the cytokine İL-8 by deep oscillation [12] suggests an approach involving inflammation mediators. The authors conclude that an anti-inflammatory effect can be ascribed to the treatment process. Since İL-8 reduces histamine release from basophils as well [29], at least partial contribution of a pain-modulating effect involving mediators may be deduced.

• The mechanical resonance vibrations of deep oscillation and their effects on afferent neurons can have an analgesic effect by influencing the gate control mechanism [30, 31].

• İn hypertonic muscular states, e.g. resulting from trauma, a muscle-relaxant property of high frequencies of deep oscillation may also contribute significantly to pain reduction. Persistent contraction is ascribable to above-threshold influx of nociceptive afferents. As causes, e.g. myogeloses are suspected that lead to spontaneous muscle spasms ("muscle protein congeals") via chemical disturbance of the muscle metabolism [32]. Deep oscillation can counteract myogeloses, by its mechanically dissolving and distributing effects and its promotion of interstitial lymphatic drainage, rehabilitatively, but even already preventively. This also explains the strong analgesic effect in fibromyalgia syndrome and the antifibrotic effect of deep oscillation. The pain-spasm-pain theory assumes that increased excitability of ¥ neurons caused by muscle nociceptors is what underlies the hypertonicity. This results in higher discharge rates of muscle spindle afferents and – in a vicious circle – increased activation of a motor neurons. İschaemic contractions caused by muscular vessel compression result. Vasoactive and analgesic substances are released, oedema formation and venous congestion occur, which in turn lead to activation of nociceptors [33]. Here again, anticongestive effects of deep oscillation can consecutively exert muscular-relaxing and analgesic effects. The same applies to the micro-trauma hypothesis with mechanical nociceptor activation as a result of trauma, pain-inducing cascades and increase in the permeability of capillaries, venous congestion, oedema formation, ischemia, and subsequently increased muscle tonicity [33].



İnflammation-suppressing effect

• Reduction of the tissue content of the pro-inflammatory cytokine interleukin-8 by deep oscillation (see above).

• Mikhalchik et al. [13] experimentally (whole blood) found inhibition of oxygen radical production by deep oscillation and deduce an anti-inflammatory effect.

Prevention and reduction of secondary and primary lymphoedema, reduction of oedema in lipoedema

• Mikhalchik et al. [21] (animal studies), Jahr et al. [4] (breast lymphoedema), Boisnic und Branchet [12] (periorbital puffiness and formation of dark circles), Teo et al. [16] (lymphoedema and lipoedema of the extremities) and Nourollahi et al. [17] (lipoedema) could each demonstrate, using objectively quantifiable methods, significant reduction in oedema after intervention with deep oscillation.

• Boisnic and Branchet [12] furthermore determined ex vivo a significant reduction of dermal oedemata (semi-quantitative evaluation = score; percentage of dilated capillaries, planimetric measurement of the surface of dilated capillaries in groupwise comparison to the control). The study results suggest a vasomodulating effect in terms of moderate vasoconstriction of capillaries as an anti-oedematous sub-mechanism of the effects of deep oscillation.

• İncreased and accelerated reduction of oedemata by deep oscillation may furthermore be explained by two mechanisms. Mechanical stimuli from deep oscillation may have dissolving effects on (hardened) oedemata, haematomata and seromata and thus make soluble contents transportable. This can support mixing of lymphatic substances (cell debris, protein bodies, etc.) with lymph, improve their distribution in the interstitial space and thus increase the reabsorption area. As a result, this may reduce the noxious stimulus potential and tissue acidoses (see above). Furthermore, the mechanical impulses may constitute deforming forces on collagenous fibre structures of the interstitial space, which exert, via anchoring filaments, tensile forces on the endothelial structure of initial lymph vessels (lymph capillaries and pre-collectors). They could thus bring about opening of junctions or anastomosis in the endothelial structure for entry of liquids and intensify the interstitial

drainage mechanism on this basis. The issue is particularly relevant in situations in which – e.g. due to pain-related immobilisation or relieving posture – the effect of the muscle pump cannot or can only partially come to fruition (activation of anchoring filaments by skeletal muscles located above the traumatised localisation) [34].

• Medina (2015) visualized tissue effects of deep oscillation by simultaneous ultrasound imaging in hemarthrosis as well as in muscle [35].

Prophylaxis of fibrotic remodelling processes, reduction of fibrosis

• Causes of secondary fibrosis are exogenous (e.g. radiogenic) or endogenous (e.g. inflammation, circulatory disorders) injuries. Haematomata and seromata are likewise regarded as precursors for induration and fibrosis, especially postoperatively [2]. Improved values of the circumferences and thickness of the subcutaneous tissue, as well as improvement in the tissue situation by the treatment, suggest an antifibrotic effect of deep oscillation [15, 18]. The prophylactic effect of deep oscillation in incipient fibrosis may be attributed to dissolving effects and the increased and accelerated resorption of haematomata, oedema and seromata (see above).

Muscle relaxation, promotion of physical activity, mobilisation, functional improvement and improved ROM

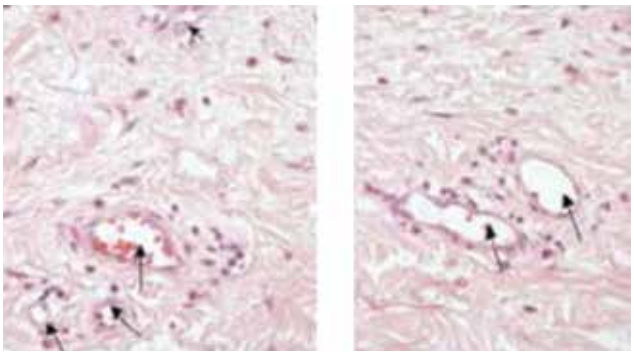
• Particularly in traumatic conditions and degenerative diseases of the musculoskeletal system, the pronounced promotion of physical activity and mobilisation by deep oscillation can be ascribed to pain-alleviating effects (see above) ("self-mobilisation in areas relieved of pain"). As described above, muscle-relaxing effects can be explained by anti-congestive action of deep oscillation with consecutive reduction of the hypertonicity.

Support of wound healing processes

• An animal test [21] and clinical pilot studies on second-degree burns [1] and side effects following conservative therapy of breast carcinoma [2] (both randomised and controlled) yielded significant and also impressive results with regard to acceleration and qualitative improvement of wound healing by deep oscillation. The same has been reported from observational studies concerning secondary wound healing [6, 22] and keloids. Possible mechanisms in oedema-induced wound healing disturbances can be explained by results concerning reduction of oedemata by deep oscillation (see above).

• Another approach consists in adequate tensile and compressive stimuli exerted on fibroblasts by deep oscillation, in particular in indications in which these stimuli are fully or partially absent for longer periods due to immobilisation (pain-related relieving posture or impaired movement). For example, in experimental studies it was demonstrated that cyclic mechanical stimuli have a stimulating effect on the proliferation of fibroblasts [36], as well as a modulating impact on the secretion of growth factors such as TGF-β from fibroblasts [37]. Varani et al. [38] showed that the collagen synthesis by fibroblasts by cell-cell contact decreases in correlation to the intensity of mechanical stimulation. Deep oscillation might provide necessary mechanical stimuli for sufficient cell-cell contact.

Since 1991 deep oscillation has been an adjuvant treatment modality from Day One post operatively after mastectomy. ©Photo: Hernandez Tápanes, S.

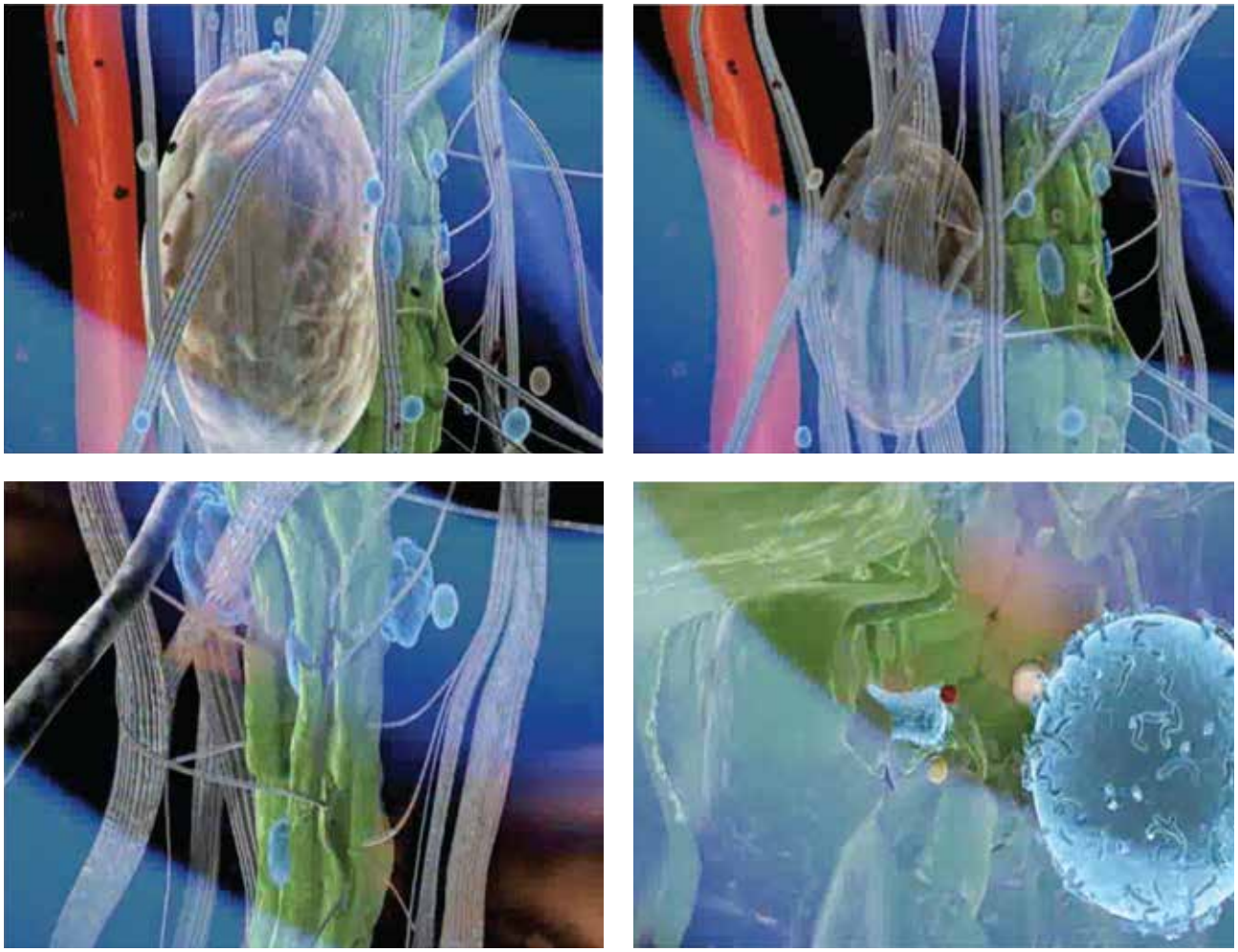


Analysis of vasodilation after colouration with haematoxylin-eosin (x400): Untreated skin model (left). Vasoconstriction of dermal capillaries after two treatments with deep oscillation (right). ©Boisnic and Branchet [12]

• Boisnic [39] could demonstrate ex vivo by immunohistochemistry, in each case in comparison to control groups, significant increases in the mitotic index of epithelial cells, in the elastin synthesis of fibroblasts and in collagen synthesis by deep oscillation. A variety of further mechanisms relevant to wound healing are also conceivable.

Prevention of premature ageing processes

• A randomised and controlled clinical trial by Turova et al. [23] demonstrated a significantly positive impact on different ageing-relevant biomarkers in the treatment of the nape region. The authors take these results as an opportunity to recommend deep oscillation with the objectives of normalising haemodynamic parameters, mitigate aesthetic-neurotic problems and influencing biological ageing through preventive effects on premature ageing.



Schematic representation of interstitial oedema. Resonant vibrations by deep oscillation have a dissolving effect. Lymph and lymphatic ingredients (protein bodies, cell debris, etc.) are mobilised, whirled up and distributed (above). Via anchoring filaments, deep oscillations act on junctions in the endothelial structure of initial lymph vessels (bottom left). Opening of septa thus induced favours resorption of lymph and ingredients (interstitial drainage; Interior view of initial lymph vessel; bottom right). ©PHYSIOMED.

Accelerated recovery after physical workout

• Deep oscillation accelerates regeneration after intensive physical workout (regeneration of the previous performance level in isokinetic maximum strength test (legs) of football players). This reflects the sportsmens´ subjectively perceived exertion, which was significantly reduced by deep oscillation. The results show a tendency for blood parameters creatine kinase, myoglobin and C-reactive protein in the deep oscillation group [25].

• Mechanisms for accelerated regeneration can be explained by anti-congestive properties of deep oscillation in microtrauma with consecutive reduction of the hypertonicity as well as local metabolic elimination and improved alimentation in all tissue layers. Furthermore it can be ascribed to pain-alleviating effects on the aching muscles, promotion of physical activity and mobilisation. Trybulski et al. [24] underline the importance of the lymphatic system in this context.

Decongestive effect and functional improvement in chronic obstructive pulmonary disease (COPD)

• Case studies (e.g. [27]) report decongestive effects in obstructive conditions.

• In an RCT [26] adjuvant deep oscillation in the complex treatment of COPD revealed a fall in both systolic and diastolic arterial blood pressure, as well as a definite reduction in heart rate, which indicates the transition to improved cardiac functionality. Deep oscillation also improved bronchial patency and had a favourable effect on pulmonary function parameters Full Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), FEV1/VC ratio, and allowed for a reduction in bronchodilator intake.

• Mechanisms for these effects can be attributed to anti-congestive (mucolytic) and (respiratory) muscle relaxing properties (see above), with consecutive hemodynamic and functional adaptations. The RCT authors mention 'de-tension', i.e. to release airway spasms, to remove phlegm/secretions and to ease breathing in COPD patients.

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