CAUSE & EFFECT

→ SWISS DOLORCLAST® METHOD

lat. Capsicum annuum

> Red chili peppers contain capsaicin. At first this substance overwhelms the so-called C nerve fibers responsible for transmitting pain but then disables them for an extended period of time. Everybody knows the feeling – first, the mouth is on fire, then it feels completely numb

> Research has indicated that shock wave therapy works the same way[1]. When activated, the C nerve fibers release a specific substance (substance P) in the tissue as well as in the spinal cord. This substance is responsible for causing slight discomfort during and after shock wave treatment. However, with prolonged activation, C nerve fibers become incapable for some time of releasing substance P and causing pain[2]

> Less substance P in the tissue leads to reduced pain, but there is more: less substance P also causes so-called neurogenic inflammation to decline[3]

> A decline in neurogenic inflammation may in turn foster healing – together with the release of growth factors and the activation of stem cells in the treated tissue[4]

1 Maier et al., Clin Orthop Relat Res 2003; (406):237–245.

2 In addition, shock waves activate the so-called Aδ nerve fibers (sensory afferent nerve fibers from the periphery) via receptors in the tissue. According to the gate control theory of Melzack and Wall (Science 1965; 150:971–979) these activated Aδ fibers then suppress the conduction of pain in the second-order neuron of the sensory pathway in the dorsal horn of the spinal cord.

3 The release of substance P, CGRP (calcitonin gene-related peptide) and other inflammation mediators from afferent nerve fibers is generally referred to as "neurogenic inflammation" (Richardson and Vasko, J Pharmacol Exp Ther 2002; 302:839–845). It is also linked to the pathogenesis of tendinopathies such as tennis elbow and plantar fasciitis (Roetert et al., Clin Sports Med 1995; 14:47–57; LeMelle et al., Clin Podiatr Med Surg 1990; 7:385–389).Shock wave treatment causes a drop in substance P and CGRP in the tissue (Maier et al., 2003; Takahashi et al., Auton Neurosci 2003; 107:81–84).

4 Shock waves in the treated tissue lead to a stronger expression of growth factors such as BMP (bone morphogenetic protein), eNOS (endothelial nitric oxide synthase), VEGF (vascular endothelial growth factor) and PCNA (proliferating cell nuclear antigen) as well as to an activation of stem cells (Wang CJ, ISMST Newsletter 2006 Vol 1 Issue 1; Hofmann et al., J Trauma 2008; 65:1402–1410).

SHOCK WAVES ACT ON MUSCULOSKELETAL TISSUE AND THE SKIN THROUGH VARIOUS MECHANISMS

These mechanisms result in both short-term and long-term effects and bring pain relief and healing to the musculoskeletal system

	PAIN RELIEF	HEALING
MAIN SHORT-TERM EFFECTS	Depletion of presynaptic substance P in C nerve fibers[1]	Improved blood circulation[3]
MAIN LONG-TERM EFFECTS	Blockade of neurogenic inflammation[1] Improved tendon's gliding ability[2]	Activation of mesenchymal stem cells[4] New bone formation[5]

[1] Maier et al., 2003. [2] Zhang et al., 2011. [3] Application of shock waves usually results in reddening of the skin, which indicates increased blood supply.
[4] Hofmann et al., J Trauma 2008;65:1402-1410. [5] Radial ESWT: Gollwitzer et al. (2013); focused ESWT: Tischer et al. (2008), among many others.

BOTH THE POSITIVE AND THE NEGATIVE PHASE OF A SHOCK WAVE MAY CONTRIBUTE TO THESE MECHANISMS

> Dr. John Ogden (Atlanta, GA, USA) and colleagues were most probably, first to address this issue in 2001, stating that "a significant tissue effect is cavitation consequent to the negative phase of the wave propagation" (Ogden et al., 2001). However, they did not specified what this "significant tissue effect" actually is. In 2013 Dr. Camilo Perez (Seattle, WA, USA) and colleagues wrote that exact knowledge of the positive and negative pressure fields of ESWT devices "may have important consequences for therapy, depending on whether the positive (associated with stress) or negative (associated with cavitation) component is responsible for therapeutic bioeffects" (Perez et al., 2013).

> The contribution of cavitation to the therapeutic effects of ESWT on the musculoskeletal system has been a long-standing question for more than a decade. First indications in this regard came from research conducted by Dr. Gustav Schelling (Munich, Germany) and colleagues, who in 1994 exposed in vivo explanted frog sciatic nerves to focused ESWT, either in normal frog Ringer solution or in polyvinyl alcohol, a medium with low cavitation activity (Schelling et al., 1994). Based on results from electrophysiological recordings of the sciatic nerves the authors concluded that "bioeffects of shock waves on nervous tissue appear to result from cavitation. It is suggested that cavitation is also the underlying mechanism of shock wave-related pain during ESWL in clinical medicine" (Schelling et al., 1994).

> Very recently, Dr. Christoph Schmitz (Munich, Germany) and colleagues demonstrated for the first time that cavitation actually contributes to therapeutic effects of ESWT on the musculoskeletal system in vivo. To this end the scientists exposed Caenorhabditis elegans worms (C. elegans) in the lab to radial shock waves generated with the Swiss DolorClast®. It was found that increased exposure to radial ESWT resulted in decreased mean speed of movement of the worms (analyzed under the microscope similarly to gait analysis of patients) while increasing the proportion of worms rendered paralyzed (Angstman et al., 2015). Reduction of cavitation by exposing worms to radial ESWT in polyvinyl alcohol resulted in reduced effect. Specifically, worms exposed to radial ESWT in polyvinyl alcohol demonstrated statistically significanctly higher average worm speed than controls in S-medium immediately following application of radial ESWT (Angstman et al., 2015).