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Continuing education course for shock waves by DIGEST (Deutschsprachige Internationale Gesellschaft für Extrakorporale Stosswellentherapie)
Trigger point shock wave therapy

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Introduction: Trigger point shock wave therapy takes advantage of a less well-known property of the muscle: that of a central pain organ.
As this has been an empirical therapy until now, the following descriptions of therapy modalities are to be seen as recommendations of an experienced therapist.

History: From a historical perspective, this therapy is a recent development. The first publications on this topic cited in MEDLINE were published in the late 90s. These publications reported reduction in pain (Kraus M. et al., 1999) as well as reduced muscle tone (Lohse-Busch H. et al., 1997) after the application of low-energy focused shock waves to the muscle.
In the field of orthopaedics, trigger point treatment only begun when radial pressure wave devices were introduced, which were originally developed for the classical shockwave indications (treatment of tendons and calcifications). Based on the experiences of trigger point therapists, which indicated that firm pressure on the muscle nodes caused them to disappear or become less painful, radial pressure wave devices were used "off-label" to treat muscles using mechanical pressure.
In additional to the above-mentioned treatment of local pain and reduction of muscle tone, treatment of clinically-variable referred pain became a primary objective. This was based on the extensive publications of Travell and Simons in the 80s.

Pathophysiology of muscular trigger points: Based on the investigations performed by Simons and Travell, trigger are sarcomere contractures in the µm range which, if a large number of them occur in the same area, can lead to locally painful and palpable nodes with cord-like contractures in muscle.
The causes for triggers can include trauma or overexertion, leading to dysfunction at the end plate with an overriding muscle contraction. An energy crisis due to ischemia and the release of vasoneuroactive substances then starts a vicious circle. The temporary contraction becomes a long-lasting contracture that can not be relieved without an external influence, thus establishing itself as an autonomous illness (Simons DG, Travell J, 1999).
The characteristic referred pain for trigger points is due to the activation of one spinal neuron by two or more different peripheral nociceptive afferent neurons in different muscles (Mense S., 1990). Muscles do not have 1-to-1 neural connections, meaning that pain is not correlated to a specific muscle.

Clinical consequences: The autonomous trigger points often cause complications if left untreated for long periods: Due to weakness, spasm and coordination problems, the musculature often suffers additional injury. The long-term muscle contracture leads to therapy-resistant insertion tendinosis. Trigger points can also lead to central pain chronification (Mense S., 2001).

Therapy planning: The patients' description of their pain regains significance for therapy planning, as reported pain patterns that would seem illogical from a neurological perspective often exactly correlate with referred pain from affected muscles. The muscles that are suspected causing the problems are palpated for local nodes and referred pain elicited by pressure. In ideal cases, this pain correlates with the pain described by the patient. A focused shock wave is even more effective for provoking referred pain. An examination for muscle contractures and the information regarding the activities that could be causing overexertion are also valuable for determining the localisation of trigger points.
Therapy is started at the clinically-relevant active trigger, followed by the satellite and secondary triggers and finally the triggers in the muscle chain.

Radial pressure waves: In our experience up to this point it has been shown that the radial pressure waves produced by projectile impact are highly effective, although their physical properties are only partially correlated with the trigger point theory. The pressure waves are neither point-shaped nor do they radiate from the skin into muscle in a radial fashion. They also do not reach into the deep layers of thick muscle groups due to their maximum penetration depth of 30 mm.
Nevertheless, they can be used to treat muscle nodes and reduce muscle tone in thin muscles eliminating local and referred pain. They present the advantage of being suitable for treating large muscle areas.
Possible mechanisms of action currently under discussion for superficial pressure wave therapy include: PAIN MODULATION caused by anti-irritation effects of excitation of a-delta nociceptors in and below the skin, stimulation of high-frequency MUSCLE OSCILLATIONS and THREE-DIMENSIONAL EFFECTS within sarcomers.
Additional hypothetical mechanisms of action for pressure and shock waves include: Elimination of ISCHEMIA and MODULATION OF VASONEUROACTIVE SUBSTANCES (two major causes of trigger pathophysiology) and MECHANICAL TRANSDUCTION as a cellular response to external stimulation. DESTRUCTION OF DAMAGED MUSCLE FIBRES by shock waves (Mense S, 2001) does not appear likely, as I have never observed enzyme elevation following therapy.

Based on these mechanisms of action, wide-area shock transmitters of 15, 20 and even 35 mm in diameter are increasingly being used with shock frequencies of 15 Hz and more. Lower shock frequencies have the disadvantage of increased pain during treatment. Shock transmitters with a diameter of less than 10 mm can produce enormous peak pressures, which often lead to haematomas and skin lesions.
During treatment, several hundred shocks are first applied locally to each of the identified trigger areas using a punch technique. After this, the muscle is treated over a wide area using long strokes. The total number of shocks per muscle is between 500 and 4000, depending on the size of the muscle. The treatment pressure selected in each case ranges near the pain threshold and varies between 1.0 and 3.5 bar, depending on the muscle thickness. The pressure is increased from treatment to treatment. The treatment frequency is between 4 and 8 treatments once or twice weekly.
After this, complaints should improve by 80%. If results are significantly lower than this value, extended diagnostics are indicated for finding underlying disorders that are continuously irritating the muscle.

Focused shock waves: As the effects of radial pressure waves are limited to a superficial area, focused shock waves have been used increasingly in recent years. These waves have a penetration depth of more than 5 cm, making it possible to reach deeper triggers, such as those in the gluteal muscles. Their small focus also allows for point-shaped therapy. This often provokes referred pain, which is rarely possible using radial pressure waves.

For this reason focused shock waves are also suitable in diagnostic terms for precise localisation of trigger points.
After diagnostic triggering of referred pain, local treatment is performed with 200 to 500 shocks per trigger node. Unlike radial pressure waves, the shock frequency should not exceed 4 Hz. Research performed by NEULAND regarding mechanical transduction indicate that this is due to the refractory period of the cells. The energy flux density is between 0.05 and 0.25 mJ/mm² and is selected depending on the pain intensity during treatment.
In this case complaints should also have improved by 80% after a maximum of 6-8 treatments (1-2/week).

Combination of radial pressure waves - focused shock waves: The most recent development is that the combination of both types of waves during treatment has been found to be helpful. After localisation of the painful trigger points by causing referred pain with the focused shock wave, local treatment is performed with the focused shock wave in the described manner. The trigger point is then treated with several hundred shocks of radial pressure waves and the entire muscle is relaxed using long strokes over a wide area.
The results of combined treatment are better than either of the respective individual therapy methods alone.

Clinical example 1: Acute and chronic pseudoradicular low back pain
The investigation of trigger points is imperative in cases of irradiating lumbar pain without paresis. Irradiation of pain into the gluteal region can be caused by trigger points in the extensor muscles at the thoracolumbar transition as well as in the quadratus lumborum muscle. These muscles are located in the cranial subcostal region and directly above the distal region of the iliac crest.
In contrast, true irradiation into the lower extremity is often caused by deep trigger points in the gluteal muscles, particularly in the gluteus minimus. Patients often describe additional dysesthesia of the heel and toes as well as unstable gait due to a loss of control over the muscles of the lower extremity. All of these symptoms are reversible with the combined application of shock and pressure waves.

Clinical example 2: Acute and chronic cervical spine pain, cervical spine pain with headache and cervical/brachial pain
The trigger-related irradiation of pain from the cervical spine is often felt as a headache. A typical muscle that can cause this is the middle part of the trapezius muscle. The pain is described as hood-shaped and extends to the temporal region and behind the eyes. In this case the best results are also achieved with combined application of shock and pressure waves.
Other muscles that can be responsible for headache include the splenius muscles, the semispinalis capitis muscles and the sternocleidomastoid muscles. The levator scapulae muscle is more often responsible for local pain at the lateral base of the neck with associated limitation of rotation.
Brachial pain can be caused at the cervical spine due to problems with the scalenus anterior and medius muscles. All other muscles responsible for brachial pain are located in the shoulder and thorax.

Clinical results:
With accurate diagnostics, significant pain relief (VAS < 2) can be achieved in 80% of cases and lasts for at least 6-12 months, if not permanently.
No improvement is possible in 20% of all cases, and increased pain is observed in 2% of the patients.
An increased range of motion at the cervical spine was also achieved, which remained constant after 3 months: +20° of rotation, +16° of anterior and posterior flexion and +17° of lateral flexion. These increases in range of motion are identical for patients of middle age (40 years) and older age (60 years).

Complications:

Complications are minimal with correct usage of the devices. In addition to haematomas caused by radial pressure waves, primarily when used on the gluteal musculature, the patient should be advised of a temporary increase in pain lasting 1-2 days.
For treatment of the cervical spine, headaches and temporary worsening of existing tinnitus may occur.

Resistance to therapy: Insufficient or only short-term improvement was seen with the following underlying conditions:
chronic nerve compression without neurological deficits (spinal or foraminal narrowing, large protrusions, post-operative fibrosis or radiculitis), psychovegetative exhaustion, severely poor posture, inflammatory rheumatoid diseases, fibromyalgia, hormonal disorders with involvement of muscle metabolism (hypothyroidism, hyperparathyroidism) and long-term inadequate ergonomics.

Contraindications: Treatment over the lung using focused shock waves with an excessively deep focus and high energy is absolutely contraindicated.
Relative contraindications include diseases in the above-mentioned group of therapy-resistant diseases, medication with anticoagulants and treatment over the thoracic spine, lumbar spine or abdomen in pregnant women.

Summary and outlook: Based on the current state of knowledge, shock waves function by stimulation of the muscle and not by damaging it. As a result of research carried out by Neuland (2006), it is known that focused shock waves can cause a migration of mesenchymal stem cells, the extent of which depends on the treatment parameters. Excessive impulse counts have led to poorer results.
This research and personal clinical experience indicate that the selection of treatment parameters is of decisive importance for therapeutic success.
For the future, we should strive to determine the best parameters for energy, number of shocks, shock frequency, treatment frequency and the type of wave source with regard to the ability of the treated tissue to respond to therapy.