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Trigger point shock wave therapy: An Overview

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Introduction:

Trigger points are clinically characterised by 2 properties: *muscle pain* (local or referred pain) and *dysfunction* (contractures, reduction of strength and coordination). Classic trigger point therapies such as infiltrations, dry needling, stretching, friction massage has little significance in orthopaedics, in contrast to the frequency of myofascial pain.
The rapid expansion in trigger point treatment with shock waves during recent years indicates the greater efficiency of this method. The recommended treatment methods are based on empiricism.

Chronology:

The first publications in MEDLINE on this topic 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 muscles.
In the field of orthopaedics, trigger point treatment only began later when radial pressure wave devices were introduced, which were originally developed for the treatment of tendons and calcifications. Based on the experience of trigger point therapists, they have indicated that firm pressure on muscle nodes caused them to disappear or become less painful, radial pressure wave devices were used "off-label" to treat muscles using increased mechanical pressure.
In addition to the treatment of local pain and reduction of muscle tone, treatment of clinically-variable referred pain developed into the 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, triggers 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 no longer be relieved without an external influence, thus establishing itself as an autonomous problem (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 perception is not correlated to a specific muscle.
Once the trigger point has been created, it can continue even after its cause has disappeared and can become an autonomous secondary problem that has to be treated separately.

Clinical consequences:

Triggers often cause complications if left untreated for long periods: Due to weakness, spasms and coordination dysfunction, the musculature often suffers additional injury. The long-term muscle contracture leads to therapy-resistant insertion tendinopathies. Triggers can also lead to a chronic central pain (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 muscles affected with triggers. The muscles that are suspected to be causing the problem are palpated for local nodes and referred pain triggered by pressure. In ideal cases, this pain will correlate with the pain described by the patient. A focused shock wave is even more effective for provoking referred pain. A search for muscle contractures and information regarding 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:
Our experience up to this point has shown that the radial pressure waves caused by projectile impact are highly effective, although their physical properties only partially correlate with the trigger point theory. The pressure waves are not point-shaped and penetrate 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 as well as 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 and wide-based 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 OF SARCOMERES.
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.

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, pain should decrease by 80%. If results are significantly lower than this value, extended diagnostics are indicated for finding hidden illnesses that irritate the muscle continuously.

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 triggers 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 until pain disappears. The energy flux density is between 0.05 and 0.35 mJ/mm^2 and is selected depending on the pain intensity during treatment.
Under this treatment pain should also decrease by 80% after a maximum of 6-8 treatments (1-2/week).

Planar shock waves
They are the most recent development. Focused shock waves are defocused with geometric changes to the shock wave head, resulting in parallel waves that enter the muscle. The objective is to reach a trigger point located at a depth in the muscle that cannot be measured, and to reach it with a greater degree of certainty than has been possible with the spatially restricted focus.

Combination of radial pressure waves – focused/planar shock waves:
The combination of both shock waves has been found to be helpful in practice. After localisation of the painful trigger points by provoking referred pain with the focused shock wave, local treatment is performed 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 the individual therapy methods alone.

Clinical examples
1.) Acute and chronic pseudoradicular low back pain
The investigation of trigger points is imperative in cases of radiating lumbar pain without paresis. Radiation of pain as far as the gluteal region can be caused by triggers in the extensors at the thoracolumbar transition as well as in the quadratus lumborum muscle. These muscles are located in the cranial sub costal region and directly above the distal region of the iliac crest.
In contrast, referred pain into the lower extremity is often caused by deep triggers 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.

2.) Acute and chronic cervical spine pain, cervical spine pain with headache and cervical/brachial pain
The trigger-related radiation 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.

Results:
With accurate diagnostics, significant pain relief (VAS from 7 to < 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).

3.) Achillodynia, plantar fasciitis, forefoot pain
Contractures of the calf muscles are a primary risk factor for the aforementioned overexertion syndromes. Shock wave therapy can significantly increase the active elasticity of the calf, leading to a reduction in tension in the overstressed tendons and fascias.

4.) Periarthritic shoulder pain
The important muscles in terms of function include the subscapularis, infraspinatus, deltoideus, trapezius, latissimus dorsi and pectoralis major muscles. Trigger points in these muscles are created by acute overloading in sport and as phenomena associated with structural shoulder lesions. Clinically, the most significant effects are rotation restrictions and local as well as referred pain in the elbow and hand.

5.) Acute muscular overexertion
Tension in forearm extensors and flexors, tibialis anterior and peroneal muscles are well suited to shock wave therapy. Only 1-3 treatments are required if treatment is started in the early stages.

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 up to 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 disease, fibromyalgia, hormonal disorders with involvement of muscle metabolism (hypothyroidism, hyperparathyroidism) and long-term inadequate ergonomics.

Contraindications:
Treatment over the lungs, main vessels, nerves using focused shock waves with a deep focus and high energy is absolutely contraindicated.
Relative contraindications include illnesses 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:
Our experience of trigger shock wave therapy up to this point has shown that it represents an enrichment of conservative orthopaedics.
The future task should be 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.