Focused Shock Wave Therapy in the Treatment of the Spine

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Non-invasive treatment of herniated discs by focused shockwave therapy (F-SWT)

In orthopaedic practice a number of pathologies result in surgical treatment, which is necessary because of the inefficiency of traditional conservative therapy. This is particularly true of diseases of the spine such as protrusion, herniated disc, low back pain, osteoporosis and spondylitis. At present, there are non-surgical treatments for these diseases - manual therapy, skeletal traction, epidural blockade, physiotherapy etc.

The disadvantages of these methods is that their application eliminates only symptoms (soft tissue swelling, inflammatory and infiltrative reaction and pain), but the problem (actually a herniated disc) remains unchanged and continues to progress.

The technical results achieved with focused shock wave therapy (F-SWT) have shown that this is a highly efficient treatment, allowing outpatient treatment, no scarring, no postoperative complications and a low likelihood of a recurrence of the herniated disc. The technical results claimed are achieved by implementing a method of treating morphological and anatomical abnormalities of the intervertebral discs in three stages.

The first stage of treatment is at least one course of adjuvant therapy, aimed at maximising the softening of the herniated disc (determined by MRI), suppressing inflammation and relieving pain. The combined therapies at the first stage involve microwave heating of muscles and ligaments in the affected area, phonophoresis, electrical muscle stimulation and anti-inflammatory drug therapy.

Microwaves are electromagnetic radiation between radio waves and infrared, between 1m and 1cm, at a frequency of 30 MHz 300 MHz. In medicine three microwave frequencies are used: 2450 MHz (12.245 cm), 915 MHz (32.79 cm) and 433.9 MHz (69.14 cm). In Europe all three are used in frequency microwave therapy, in the U.S. only the first two. The physiological effects of microwave exposure therapy in a living organism are to improve the metabolic activity of cells, reducing the viscosity of fluids, increase the extensibility of collagen and increase blood flow. The therapeutic effect of microwave radiation is shown as an anaesthetic (due to directly effecting the pain gate, rapid removal of irritants and increasing blood flow, reduced muscle spasms, sedation), the reduction of muscle spasms, the acceleration of recovery by increasing metabolic activity, which has an impact on post-traumatic process, and for a chronic infectious process, the softening of the collagen tissue, scar tissue and other fibrosis and treatment of muscle tissue by increasing intramuscular blood flow.

Drug phonophoresis is based on a combination of the physiological effect of direct current in combination with drugs. In general, this mechanism can be represented as follows: pain gates have an effect on A-delta (fast) and C (slow) pain fibres in the posterior horns of the spinal cord by the stimulation of mechanoreceptors (A-beta). A high-fibre low-intensity electric shock in combination with selected drugs produces a morphine effect on the C-fibre system for the production of stimulation A-delta fibre pain receptors, resulting in changes around the ionic balance of cells, accelerating the healing of skin wounds and bone, fibrous tissue is restored, cellular metabolism increases and cell membrane potential is restored, increasing microcirculation.

Interferential current therapy passes two different mid-field pulses simultaneously through the same thing. As a result, the tissues form a new current. The amplitude of the new current is composed of two amplitudes of the electric current flows. If the amplitude of the currents is directed in opposite directions the new current is formed. As both frequencies and the current flow combined, so if the frequency of one of the threads 4000 Hz, and the other is 4100 Hz the frequency of the new current will be 4050 Hz. Midrange currents are much easier to pass through the skin and have less resistance to the use of short pulses. At a frequency of 4000 Hz each individual phase lasts 0.125 ms, which corresponds to a very high intensity stimulation of the nerves. This increases the effect which is never reached by low-frequency therapy and stimulation. This thread is much easier to pass through the flesh as it is midrange and nerve stimulation provides modulation amplitudes. The analgesic effect of interferential current is provided: the activation mechanism of the gate pain is due to the stimulation of large diameter, low threshold excitability nerve fibres by high frequency - about 100 Hz, the activation threshold of A-delta and C fibres. Activation of their production takes place below a current frequency of 10-25 Hz; high frequency (50 Hz) causes a block in the endings of fibres and the local increase of current fluid output and tissue fluid as a result of moderate muscle contraction and stimulation of the autonomic nervous system, these contribute to the exit of the nerve chemicals that block pain impulses conduct.

Anti-inflammatory therapy performs a paravertebral blockade of the affected disk using analgesics and/or homeopathic drugs - Discus compositum, Traumeel, Placenta compositum etc. If necessary, in the case of acute inflammatory response, the intramuscular treatment of non-steroidal anti-inflammatory drugs (Voltaren 75mg) is increased to once a week. In exceptional cases, we can recommend the application of small doses of corticosteroids (5 mg Diprospan) at 0.25-0.5 mg for paravertebral blockades on the condition that the total quantity of the substance does not exceed 1.5 mg (1\3 ampoules) per

week. In the treatment of the thoracic spine doses of medication can increase by 25-30% compared to the above and in treatment of the cervical and lumbar spine the dosage is increased by 10-15%.

The success of the first phase of treatment is determined by examining repeated magnetic resonance imaging (MRI) images of the affected disk, looking at the dynamics of the consistency of the disc hernia. In some cases, you may need to enhance the contrast of the MRI images.

In the second phase at least one session of F-SWT is applied directly to the area of pathological focus - the hernia (protrusion) of the intervertebral disc. The number of sessions depends on the anatomical and physiological characteristics of the herniated disc

A short (0.1-0.3 sec) burst of F-SWT applies focused high-impact low-frequency sound waves, which improve local blood circulation, loosening the calcium deposits and fibrotic lesions which cause inflammation and pain. One of the major effects of the shock waves is to stimulate the development of a new microvascular subject area.

A theoretical aspect of F-SWT is based on creating a shock wave with a high flux density, which focuses on a limited target area. This is to ensure that the shock wave will develop full energy only in the selected treatment area, without harming surrounding tissues. The hyperbaric effect of F-SWT is based on the ability of acoustic vibrations to form cavitations in the tissues as the liquid changes into a gas and leaves. This component of F-SWT treatment is crucial in the treatment of the protrusion and hernia of intervertebral discs.

Stabilisation of the microcirculation around the cavities: F-SWT produces massage, which is very important in the treatment of oedema. In acute inflammation, shock waves help to remove histamine from the tissues and prevent the formation of other risk factors in the cells, which is associated with an increase in the diffusion of calcium ions across the cell membrane. The outcome of this process is to reduce the intensity of inflammation in the tissues. In the granulation phase of the inflammatory process the formation of fibroblasts for a new vascular network is stimulated, as well as collagen and a new capillary system of the vascular network.

Thus, the different effects produced in the tissue may lead, for example, to the reversible deformation of cell membranes due to mechanical impact or shock waves stimulating the healing process through the intensification of metabolic processes, such as in the cases observed in the orthopaedic practice in the treatment of inflammatory degenerative changes of intervertebral discs. The parameters that determine the success of extracorporeal therapies are mostly energy and energy flux density. These parameters depend on the characteristics of the disc hernia and are determined individually for each patient.

The mechanical or acoustic energy of the shock wave is determined by pressure amplitude and duration, the acoustic properties of the medium (density and acoustic velocity) and the spatial distribution of the shock wave.

In order to achieve a noticeable effect in the tissue, the energy of the shock wave should focus on just a limited target area, where it

Surgical treatment	F-SWT
1. In-patient treatment (from 4 to 45 days), requiring hospitalisation for a period of treatment*	1. Outpatient treatment allows the patient to maintain their lifestyle for the duration of treatment
2. Scarring of the operated tissues, leading in the long-term to compression of the nerve plexus	2. No scarring, no postoperative complications
3. Relatively high rate of relapse (38%) *	3. Relatively low rate of relapse (less than 4%) *
4. High levels of postoperative complications (8%), including complications from anaesthesia*	4. Absence of postoperative complications
5. The outcome of invasive intervention is relatively less dependent on compliance with post-operative mode	5. The outcome of therapy is largely determined

* According to statistics obtained 'Pain Clinic Unique methods of medical treatment'

exceeds the threshold value and produces a therapeutic effect. It is believed that shock waves are effective when the pressure reaches 50 bar (5 MPa) or more. This zone corresponds to the so-called 5 MPa focus. This takes into account only the positive component of the amplitude of the shock wave and the negative component (stretching waves) is neglected.

Extracorporeal shock wave therapy is performed at threshold energy, selected from a range of 3-12 MPa. The best time to perform a course of focused extracorporeal shock wave therapy is when the hernia is reduced by 0.2-0.3 mm. As shown by studies a similar effect in the treatment of the cervical spine disc hernia can be achieved with an optimal threshold value of energy at the focus of 3-5mPa, with the thoracic spine the threshold is increased to 6-8 MPa, and for the lumbosacral spine it is increased to 10-12 MPa. The energy settings and the pulse frequency (from 2 to 8 Hz) during the F-SWT session is determined by the doctor, depending on the dynamics of the effectiveness of the therapy.

If the patient begins to experience pain even with a properly focused stream of shock waves, it is necessary to reduce the energy to 1.0-1.4 MPa. You can also reduce the frequency of the pulses to 1-2 Hz. Practice shows that in most cases this is enough for a relatively small decrease in the effectiveness of the therapy. For maximum penetration of waves through the tissues of the body it is desirable to use the gel agents, such as conductive gel used for ultrasound therapy/diagnosis. At the same time the head of the F-SWT emitter should be tightly pressed against the surface of the body, slowly moving across the surface so as to focus the radiation in the area of the damaged disc.

As mentioned above, the rate of F-SWT consists of a large number of sessions. To reduce the size of a herniated disc by 1mm, from 3 to 6 treatments are required. It is absolutely necessary to perform control magnetic resonance imaging (MRI) of the spine to be treated every 10-15 sessions to manage the process of regression. Completion of the second phase must also be accompanied by a final MRI study.

The third stage is the final treatment and serves to consolidate the results and restore the damaged nerves, which includes electrical muscle stimulation, massage and exercise. Experience shows that the number of procedures in the third stage is determined by the degree of pre-compression of the nerve and can be 3-15 sessions. In the third phase intramuscular injections of vitamin B12 and of homeopathic remedies, such as Neurology 1.0 and 2.0 of 1 ml, can be introduced 2-3 times a week.

The table below compares the traditional invasive methods of treatment for hernias of intervertebral discs (disc prosthesis, endoscopic aspiration or coagulation) and the focused shock wave therapy method:

Thus, the advantages of focused shock wave therapy compared with invasive treatment are high efficiency, physiology and a smaller number of complications (including long-term).

These conclusions were based on 15-years of experience with 27,000 patients with different pathologies concerning intervertebral discs. Some of the patients underwent surgery in different hospitals in Israel. Another part of the course was focused extracorporeal shock wave therapy.

By a combination of factors - the effectiveness of treatment, number of complications, the presence of the indications and contraindications - the effectiveness of F-SWT was 97% compared with surgical treatment - 42% - and endoscopic intervention - 83%. Thus, the above examples demonstrate the high efficiency of the proposed method of non-invasive treatment for pathologies of intervertebral discs, allowing its use in cases where previously invasive intervention would have been performed.