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Comparison of the different types of shockwaves and the use of alternating treatment modes

Shockwave therapy is a highly effective and gentle method to treat a range of disorders of the musculoskeletal system such as calcium deposits in the shoulder as well as tennis elbow and heel spurs. In the last few years many other indications have been added by changing the therapeutic parameters. These range from the treatment of sports injuries, pseudarthrosis and poorly healing wounds to acupuncture using shockwaves and cosmetic skin treatments such as cellulite reduction.

In the field of shockwave therapy, three different types of shockwaves are generally used. In every case shockwaves are produced by the different physical generators and directly transferred to the painful area of the body to exert their therapeutic effect and stimulate the self-healing process. The main difference is the angle at which the shockwaves are transmitted through the body. These types also differ in their depth of penetration, energy and the shape of the shockwave itself. These types are explained in detail below.

In **Focused Shockwave Therapy** (f-ESWT) all the shockwaves are directed to the focus point. They reach the focus point at the same time where they generate the highest energy flux density. This point can penetrate to different depths in the body (up to 8 cm). The pressure profile of a focused shockwave is characterised by a rapid rise in pressure (10 nanoseconds) to create a shockwave. Focused shockwaves can be generated by three different technical methods: electrohydraulic, electromagnetic and piezoelectric. The effects are very similar.

Focused Shockwave Therapy (f-ESWT) can be used for non-invasive treatment of orthopaedic conditions such as tendinopathies and myofascial pain syndromes, especially when high energy and depth of penetration are required.

The second type is **Radial Shockwave Therapy** (r-ESWT) in which shockwaves are normally generated pneumatically. Unlike focused shockwaves, the maximum point of energy is at the tip of the device. These waves then disperse radially away from the tip of the device with rapid energy

attenuation. The depth of penetration of radial waves varies based on energy input but can reach up to 2.5 cm in human tissues.

The r-ESWT indications are superficial indications, such as plantar fasciopathy, Achilles tendinopathy, medial tibial stress syndrome and wound healing.

A third and different type of shockwave therapy is **Wide Focus Technology (WFT)**. The shockwaves are again generated with a pneumatic system, but this type converts a rapid pressure increase into a significant energy flux density of up to 0.88 mJ/mm^2, resulting in a wide focus. This means that a concentrated energy channel delivers the shockwaves in parallel deep into the body for optimal treatment.

Wide Focus Technology (WFT) combines Focused Shockwave Therapy (f-ESWT) and Radial Shockwave Therapy (r-ESWT). It is very efficient on the surface, taking advantage of r-ESWT, and by generating high energy it can reach deeper tissues, similar to focused shockwaves. All the indications described above for the other two types of shockwave can also be treated with this method. It does not require the complicated exact positioning of the device as with f-ESWT. There is also no need to estimate the depth of the cells to be treated. With these advantages, the success of the treatment is very high.

The following figure shows a sketch of the different types of shockwaves for a better understanding.

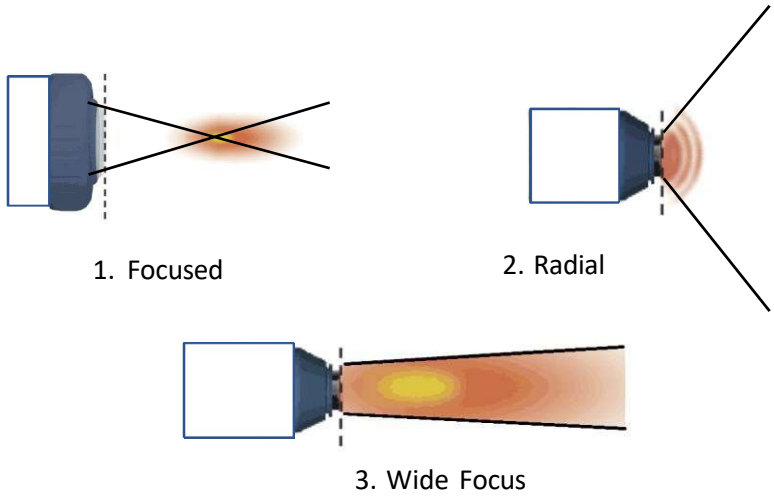

Figure 1: Shockwave types

To understand the different types more precisely, devices of each type were measured. For this

purpose, the shockwaves were directed into a water tub. The energy and path of the shockwave were measured with a piezoelectric hydrophone model 113B22. The x-axis shows the penetration depth into the body, the y-axis shows the lateral spread of the shockwave, and the colours indicate the pressure of the shockwave. It can be clearly seen here how Wide Focus Technology (WFT) combines the advantages of both the other types.

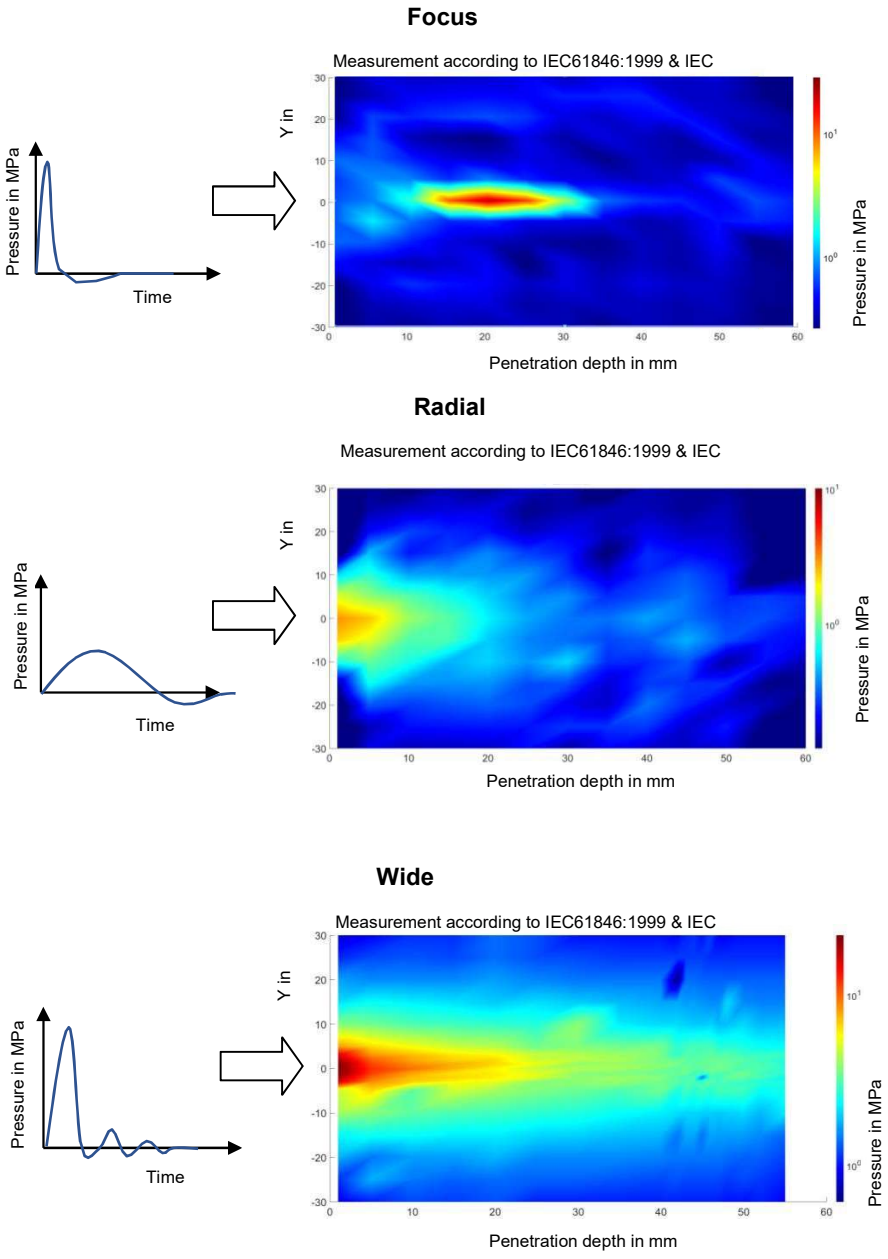

Figure 2: Measurement of the three shockwave types in comparison

WFT is a very effective shockwave treatment method. To fully optimise this method, an **alternating treatment mode** should be used. This automatically changes the frequency and intensity between defined limits. After adjusting the ideal energy and frequency at the beginning

of a treatment, it is possible to convert the shockwave generation into the special modes of the system (Fig 3).

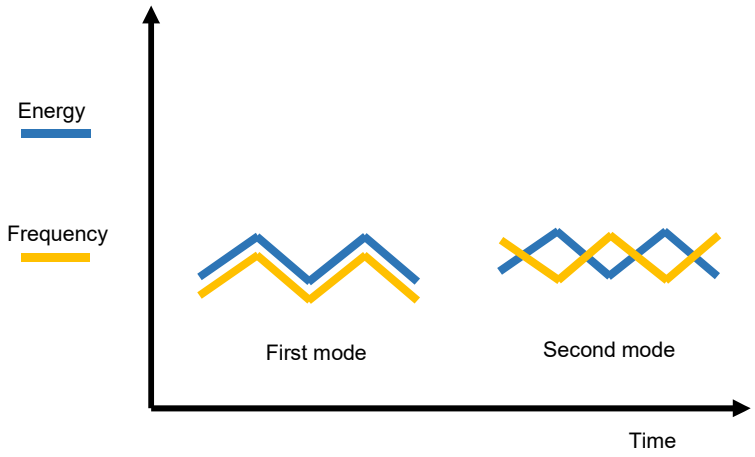

Figure 3: Alternating modes

This special technology is of particular importance. The intelligent and cell-protective application, which automatically varies the intensity and frequency during the treatment between well-defined turning points, can be adapted to the patient's perception of pain. The cells reached by the different therapies can recover. At higher frequencies and energies, the therapy is more effective, while the patient can briefly recover at the simultaneous minimum of frequency and energy (Fig 3, first mode). There are two possibilities with this technology as shown in Fig 3: the frequency and intensity can be varied simultaneously (first mode) or the frequency and energy change in opposite directions as in the second mode.

This optimal energy and frequency range is so important because shockwave therapy is virtually ineffective at low energies but on the other hand cell destruction may have already begun at higher energies. This intelligent coupled shockwave application has been developed to provide this mid-range energy and frequency range, which is adjusted for each therapy and patient.

Patients usually benefit immediately from this very protective process with pain reduction. Treatment with this technology is generally found to be pleasant and well-tolerated, even when applying higher energies, so that healing can begin more quickly and treatment is much more efficient.

It is not advisable to shorten the duration of treatment (number of sessions) by increasing the number of shocks within a session. In addition, very high energies and frequencies are counterproductive for three main reasons:

1. In our own biochemical investigations with fibroblasts, we have shown that high energy levels lead to cell destruction.
2. At higher frequencies noticeable cavitation occurs. This process, which occurs when a void or bubble in a liquid rapidly collapses, creates high flows of liquid that can cause mild side effects in the treatment area, such as exacerbation of pain, redness, swelling and haematoma.
3. The patient feels pain, which may lead to discontinuation of therapy.

The risks and side effects of the treatment are comparatively very low, so this therapy can be considered the gold standard intervention.

In summary, the advantages of Wide Focus Technology (WFT) with its use of alternating treatment modes are:

- accurate localization of the treatment area
- exact depth of penetration is not needed
- high pressure on the tissue leads to mechanotransduction, which produces the biological effects
- cell metabolism is highly improved
- stimulation of the self-healing process of the body and the activation of stem cells, which leads to the regeneration of the damaged tissues
- the most efficient, cost-effective and patient-friendly approach for treating the above conditions.

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