TRIGGER POINT SHOCK WAVE THERAPY TST®

W. Bauermeister MD PhD

Disclaimer

This Treatment Guide is based on the personal experiences of Wolfgang Bauermeister, MD PhD and the personal experiences of other physicians using the Dornier *Aries* who were trained by Dr. Bauermeister.
Neither Dornier MedTech nor Dr. Bauermeister take any responsibilities or provide any warranty or guarantee for the success of a treatment regarding the treatment procedure and parameters proposed in this document.
The described treatment procedure and parameters should be used as an orientation. However, the guidelines are not intended to replace or substitute the physician's professional judgment and responsibility to treat and give the best possible medical care in any way.
When treating with the Dornier *Aries*, it is recommended to adjust the parameters to the patient and his clinical situation individually starting with the lowest recommended shock wave parameters (intensity or energy level respectively and frequency).

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1 Introduction

Figure 1: Dr. Wolfgang Bauermeister

Wolfgang Bauermeister MD PhD is a physiatrist specializing in Sports- and Pain Medicine. He received a German medical degree and PhD from the University of Hamburg Medical School and a second medical degree in the USA.

In the US he gained experience in pain clinics where he took care of athletes and chronic pain patients. After a residency at Tufts New England Medical Center – Tufts University Boston USA – in the specialty of Physical Medicine and Rehabilitation he got certified by the American Board of Physical Medicine and Rehabilitation.

When he returned to Germany in 1988 he became familiar with shock wave lithotripsy. He found that some patients, who had suffered from low back pain and sciatica, were pain free after lithotripsy. They had severe bruising at the site of entrance of the shock waves, which coincided with typical trigger point areas responsible for low back pain and sciatica. Through his observations the idea was born, that shock waves could remove myofascial trigger points.

It took several years before shock waves made their way into the orthopedic field. After careful evaluation of the potential of this technology Dr. Bauermeister started to train physicians and therapist in the year 2000. Since then he has published several articles and books and by now Dr. Bauermeister's **T**rigger Point **S**hock Wave **T**herapy **TST**® is a generally accepted and widely used medical approach.

Driven by the need to make trigger points visible Dr. Bauermeister started to work with Ultrasound Elastography, which was used for the diagnosis of prostate tumors in 2001. He found that not only tumors, but also myofascial trigger points could be visualized. It took him several years to obtain a suitable device, which would enable him to acquire high definition elastography images of myofascial trigger points. Now the technology is generally available and is well suited not only to diagnose trigger points but to monitor the effects of shock waves in soft tissue which help to formulate optimal treatment approaches.

2 Dornier *Aries*, One for All – All in One

The Dornier *Aries* is a multipurpose shock wave device, which generates low, medium, and high energy shock waves. This novel system can be used for all **E**xtracorporeal **S**hock **W**ave **T**herapy (**ESWT**) applications covering all indications of unfocussed and focused technologies.

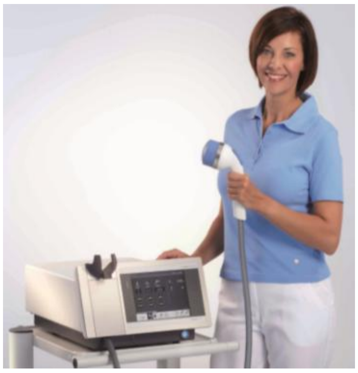


Figure 2: Dornier *Aries*, small table top device

Perfect for Trigger Point Treatment

The special design of the Dornier *Aries* allows continuous treatment workflow without changing applicators or gel pads. Therefore the therapist's best attention can be given to the patient and the treatment.

Figure 3:
Ergonomic applicator with Smart Focus therapy channel

The ergonomic low weighted hand piece allows a comfortable and relaxed single-hand operation. The cap of the applicator has an optimized shape, size and material to support convenient coupling for all treatment areas. The adjustment of penetration depth is done by simply increasing or decreasing the energy level over integrated buttons in the applicator.

The therapeutic reason why the Dornier *Aries* is ideal for treating trigger points is its unique Smart Focus technology. For the treatment it is important to reach simultaneously as many trigger points in superficial, intermediate and deep muscles as possible. This is provided using an optimum field of focus, also referred to as "therapy channel" with high precision and ease of use.

a. **Focused shock waves** (SW) are produced by systems with electro hydraulic, piezoelectric or electromagnetic shock wave sources. Focusing is done by the shape of the reflector or by an acoustic lens. This leads to higher peak power, higher penetration depth – depending on type of focused shock waves. Characteristics:
   - Sharp and high level energy concentration on a focal spot
   - Depth variation realized by using standoff pads

b. **Non focused** pressure waves are produced by ballistic systems which generate radial waves with relatively low peak power and low penetration depth. Pressure waves have slower rise time and longer duration compared to focused shock waves. Characteristics:
   - Lower penetration depth due to divergence of the wave
   - Energy density maximum on the skin surface

c. Dornier **Smart Focus** technology generates weakly focused shock waves to deliver high effective peak power combined with wide range of penetration – from superficial surface to deeper tissue areas. With the especially tailored therapy channel a broad variety of indications can be supported. Characteristics:
   - Narrow beam profile from surface and to the depth
   - Large treatment area – therapy channel
   - Adjustable length of the therapy channel

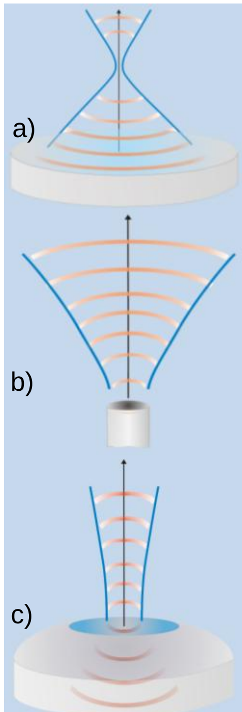


Figure 4:
a) Focused SW
b) Non focused SW
c) Smart Focus

3 The Myofascial Pain Syndrome

Most musculoskeletal pain problems are caused by myofascial trigger points, which are the underlying pathology of the **M**yofascial **P**ain **S**yndrome (**MPS**). **Tr**igger **P**oint**s** (**TrPs**) developed through minor muscle injury caused by overuse in sports, at work or at home. Chronic pain syndromes develop when trigger points are not diagnosed and treated early enough.

TrPs can be visualized macroscopically with Ultrasound Elastography and microscopically. They can be generated experimentally and they have a specific neurobiochemistry.

3.1 Microscopic Studies

Several muscle biopsy studies report about significant changes in the microscopic appearance of the muscle fibers. Even though there is no sufficient statistical evidence for the validity of the findings, there appears to be regions (Figure 5) of shortened (Figure 5 region 1) and enlarged sarcomeres surrounded by elongated (Figure 5 region 2) ones as if they are being pulled apart.

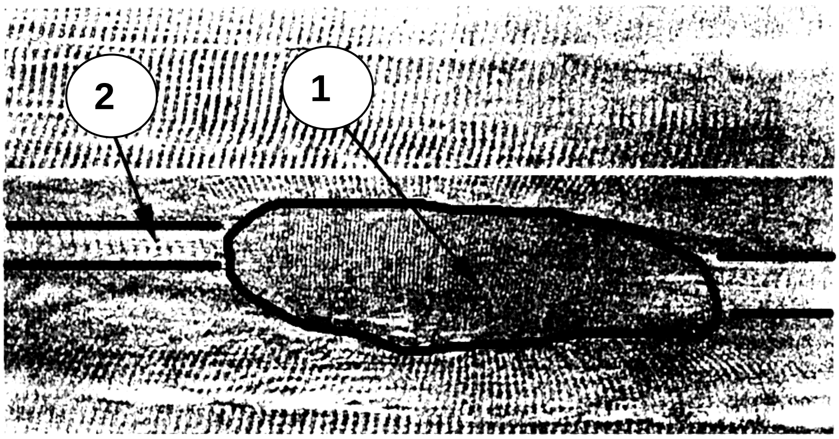


Figure 5: Microscopic view of a trigger point (Simons et al.[1])

3.2 Experimental Studies

In experimental studies Mense et. al.[2] were able to demonstrate the development of myofascial trigger points in rats after 45 minutes of induced muscle contraction.

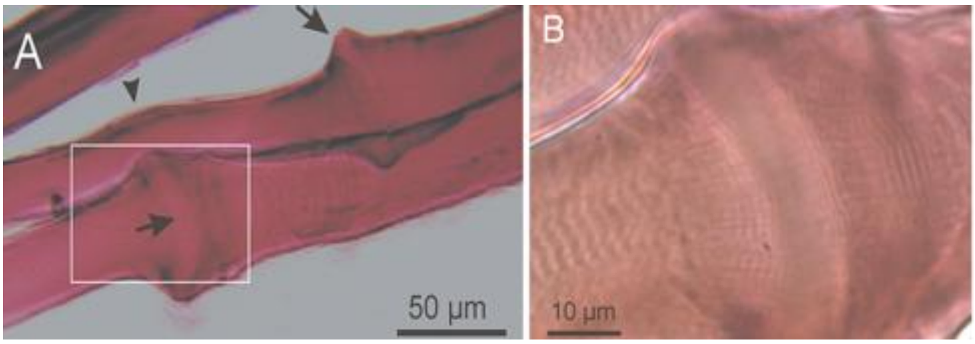


Figure 6: Mense et. al.[2]
A: Muscle fiber with sarcomere contractions
B: Enlarged discoid shaped sarcomeres contractions

[1] Simons DG, Stolov WC (1976): Microscopic Features and Transient Contraction of Palpable Bands in Canine Muscle; Am J Phys Med 55: 65-88

[2] Mense S., Simons DG., Hoheisel ,U., Quenzer , B. (2003): Lesions of Rat Skeletal Muscle After Local Block of Acetylcholinesterase and Neuromuscular Stimulation; J Appl Physiol, VOL 94 (JUNE 2003), URL: www.jap.org

Mense et. al.[2] describe (Figure 6):
"A: contraction disks (arrows) cause marked bulging of the sarcolemma that can impinge on adjacent muscle fibers and distort their sarcomere pattern (arrowhead). The widely spaced curved lines to the right of the lower contraction disk show that the arrangement of sarcomeres, which is normal to the left of the disk, is completely out of register. B: enlarged view of the boxed area in A. Note the abnormally contracted regions flanking the hyaline center of the disk compared with the normal A band spacing seen in the uppermost fiber in A."

3.3 Trigger Point Complex

Central **Tr**igger **P**oints (CTrP) are located in a taut band within the muscle.
Attachment **Tr**igger **P**oints (ATrP) are located at the attachments sites of the muscles.
Many sarcomere contraction knots build a palpable **Tr**igger **P**oint (TrP).

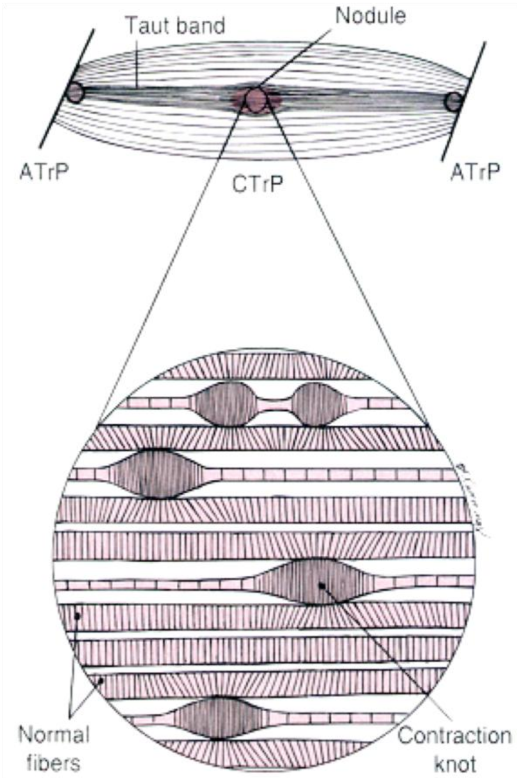


Figure 7: Central TrP (CTrP) within a taut band showing contraction knots of sarcomeres. In the periphery attachment trigger points (ATrP)[3] are located.

3.4 Neurobiochemistry of Trigger Points

Shah et. al.[4] studied the neurobiochemistry of trigger points in the Trapezius muscle with micro analytical techniques. In active trigger points they found a significantly higher concentration of cytokines compared to latent trigger points and to normal muscle tissue. The pH was extremely low with pH 4.3.

[3] Mense S, Simons DG, Russell IJ. (2001): Muscle Pain, Understanding its Nature, Diagnosis and Treatment; 1st ed., p. 251, Philadelphia: Lippincott Williams & Wilkins.

[4] Shah JP, Phillips TM, Danoff JV., Gerber LH. (Jul 2005): An in-vivo microanalytical technique for measuring the local biochemical milieu of human skeletal muscle; J Appl Physiol, Vol. 99 (5), pp. 1977-1984

Trigger point cytokines are:

- Substance P (SP)
- Calcitonine-Gene-Related-Peptide (CGRP)
- Bradykinin (BK)
- Serotonin (5-HT)
- Norepinephrine (NE)
- Tumor-Necrosis-Factor-α (TNF-α)
- Interleukines (IL-1β, IL-6, and IL-8)

After a therapeutic intervention with dry needling the pathologic concentration of the cytokines dropped significantly and the pH went up.
The pro- inflammatory cytokines cause a peripheral sensitization of the nociceptors with subsequent central sensitization and the development of referred pain.

3.5 Peripheral Sensitization

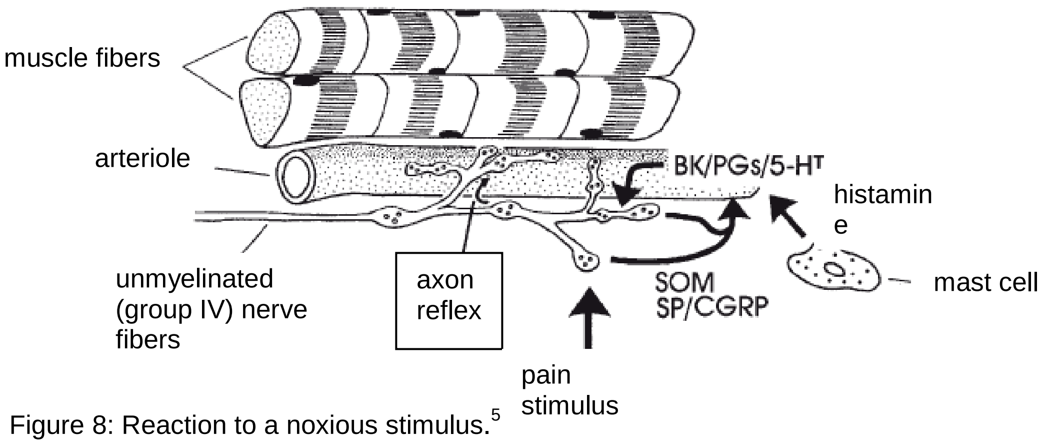


Figure 8: Reaction to a noxious stimulus.[5]

As a reaction to a noxious stimulus, the trigger point nociceptors release Substance P (SP), Calcitonine-Gene-Related-Peptide (CGRP) and Somatostatin (SOM). The surrounding tissue releases Prostaglandins (PG), Serotonin (5-HT) and Bradykinin (BK). Axon reflexes stimulate the release of Cytokines in adjacent nociceptors, which leads to a continuous spread of the sensitized areas. These processes cause a peripheral sensitization of the nociceptors resulting in an abnormal pain response to normal stimuli (Allodynia) like standing, sitting, walking, running, muscle stretch or muscle contraction.

3.6 Central Sensitization

Ongoing input from the sensitized nociceptors of the trigger points activates ineffective (dormant) synapses in the spinal cord. They build AMPA–receptors, which now can react with Glutamate, the most prevalent pain neurotransmitter. Ineffective synapses connect multiple spinal levels instead of just two or three, as it is the case under normal conditions. The brain cannot trace back the painful stimulus originating from the sensitized trigger point nociceptors. It misinterprets the stimulus as pain coming from some other part of the body.

[5] Mense S. (2000): Neurobiologie des Muskelschmerzes - Neurobiology of Muscle Pain; Deutsche Zeitschrift für Sportmedizin, Jahrgang 51, Nr. 6, pp. 190-195

3.7 Referred Pain

The peripheral sensitization, which leads to a central sensitization results in musculoskeletal or visceral pain with its origin in trigger points outside the pain site. A typical example would be lateral epicondylitis pain caused by trigger points in the deltoid muscle, or mid thoracic pain from TrPs in the levator scapulae muscle. TrPs causing low back pain source can be in levator scapulae, mid thoracic back muscles, quadratus lumborum or glutei. Knee pain can arise from trigger points in the upper rectus femoris muscle. Sciatica type of pain radiating even into the foot and toes can originate in the gluteus medius or minimus muscle.

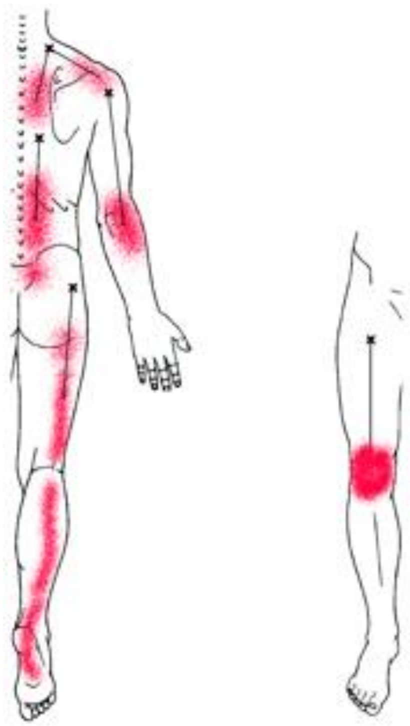


Figure 9: Referred pain pattern:
x = TrP,
Red area = referred pain

Trigger points (x) as seen in Figure 9 shorten the muscles and refer pain to other parts of the body.
To alleviate myofascial pain it is necessary to treat the cause of the pain – the myofascial trigger points – above or below the pain site.

4 Diagnosis of Trigger Points

Trigger points can be detected in superficial muscles through palpation they can be visualized by **U**ltra**s**ound **E**lastography – Us-E or diagnosed by shock wave application. In deeper muscles – where most trigger points are located – Us-E or shock waves can be used only. To define a region where trigger points are located the measuring the range of motion method can be used.

4.1 Palpation

TrPs can be best palpated in superficial muscles, but it requires a lot of experience and studies show a very low inter rater reliability.

4.2 Ultrasound Elastography

Us-E is the only method, which allows, visualizing trigger points in daily practice. With conventional diagnostic methods like x-ray, MRI, and ultrasound trigger points cannot be visualized. Us-E however can show the trigger points in vivid colors. They appear depending on the color scale chosen as reddish-brown spots indicating hard tissue compared to the softer more yellow to blue appearing surrounding tissue. The typical diameter of TrPs is usually 1.5-2.0mm.[6] [7] [8] [9]

4.2.1 Case 1

Patient complains about right-sided sciatica type of pain. In the Us-E (Figure 10) the red-brown spots indicate trigger points, which can be seen even at a depth of 8 cm. The Us-E image (Figure 11) of the same patient shows only a few TrPs and clinically only minor pain on the left side.

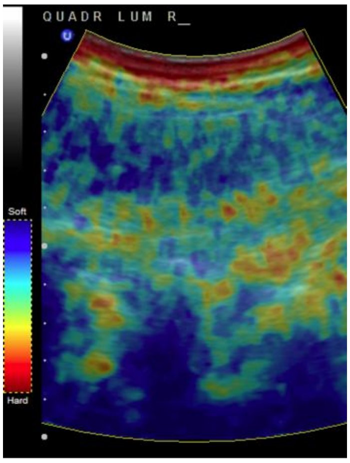


Figure 10: Right quadratus lumborum area, maximum exploration depth is 10 cm.

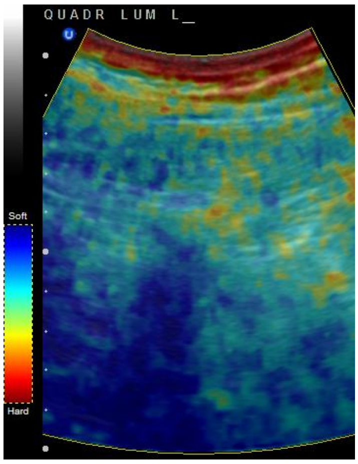


Figure 11: Left quadratus lumborum area, maximum exploration depth is 10 cm.

[6] Bauermeister W., (2002): Das Rückenfit Programm; SüdWest Verlag

[7] Sikdar, S., Shah JP., Gebreab T., Yen, R.-H., Gilliams E., Danoff, J., Gerber, LH. (2009): Novel Application to Visualize Myofascial Trigger Points and Surrounding Soft Tissue; Arch Phys Med Rehabil., 90 (11): 1829–1838.

[8] Bauermeister W. (2011): Ultrasound Elastography, a Novel Method for the Diagnosis of Trigger Points and a Tool to Evaluate the Efficacy of Shock Waves in the Treatment of Myofascial Pain Syndroms; 14th congress of the International Society for Medical Shock Wave Treatment

[9] Bauermeister W. (2012): Ultraschall-Elastographie zur Diagnose Myofaszialer Schmerzsyndrome; Abstract,
23. Deutscher interdisziplinärer Schmerz- und Palliativkongress

4.2.2 Case 2

Figure 12 and Figure 13 show an Us-E of the left and right upper leg of a patient with left knee pain showing a significant number of trigger points in the left vastus intermedius muscle compared to the right side.

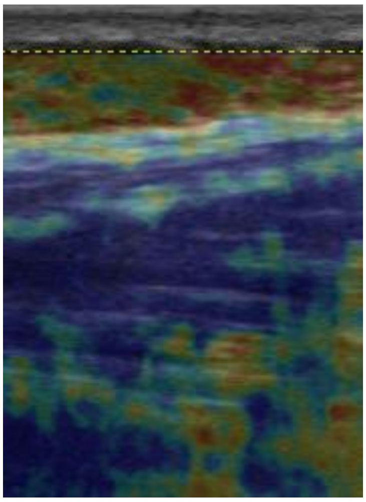


Figure 12 Left vastus intermedius muscle of the symptomatic side

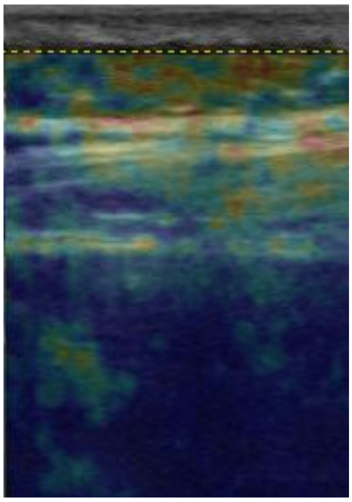


Figure 13 Right vastus intermedius muscleof the asymptomatic side

4.3 Shock Wave Diagnosis

Shock wave stimulation of muscles helps to locate trigger points. When shock waves reach the nociceptors around the trigger points the patient experiences local pain. When the trigger points are "active" the patient feels a referred pain besides the local pain.[10] [11] [12]

4.4 Range of Motion Measurement – Localization of Treatment Area

Treating myofascial trigger points can be very challenging, because the trigger point site and pain site are not identical. Trigger points of various muscles can refer pain to the same site, therefore all relevant muscles need to be examined and treated.

To narrow down the possible number of muscles which need to be examined for trigger points it is best to measure the **R**ange **O**f **M**otion (ROM) of the large joints and the spine. Since trigger points shorten the muscles, the range of motion is reduced. By applying the principles of functional anatomy it becomes clear to the examiner which muscles need be examined for trigger points.

A total body exam consists of the Range of Motion of the cervical- and lumbar spine with the **C**ervical-**ROM** (C-ROM) and the **B**ack-**ROM** (B-ROM) device using compass goniometers and the evaluation of the shoulder-, hip-, knee- and ankle joint with a universal gravity goniometers.

[10] Bauermeister W. (Bauermeister W. (2004): Trigger-Stoßwellen-Diagnostik und Trigger–Stoßwellen-Therapie; Osteoporose & Rheuma aktuell 2/04

[11] Bauermeister W. (2004): The Diagnosis and Treatment of Myofascial Trigger Points Using Shock Waves; Journal of Musculoskeletal Pain, Vol. 12, Supplement Number 9, iSSN: 1082-6025

[12] Bauermeister W (2004): The Diagnosis and Treatment of Myofascial Trigger Points Using Shock Waves in Patients With Idiopathic Low Back Pain Journal of Musculoskeletal Pain, Vol. 12, Supplement Number 9, iSSN: 1082-6025

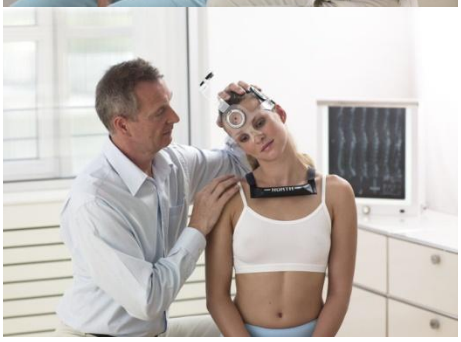
Following examples show the range of motion measurements of the spine and the joints.

Assessment of Range of Motion - ROM:

1. ROM of the cervical spine with the C-ROM:
   - Rotation
   - Flexion
   - Extension
   - Lateral flexion

2. ROM of the shoulder joint with the universal goniometer
   - Internal rotation
   - External rotation
   - Abduction

3. ROM of the lumbar spine with the B-ROM
   - Rotation
   - Lateral flexion



4. ROM of the Hip
   - Internal rotation
   - External rotation
   - Flexion
   - Extension

5. ROM of the lumbar knee
   - Flexion

6. ROM of the ankle
   - Dorsiflexion

5 General Therapy Information

When treating orthopedic conditions you have different options: pain site treatments and trigger point treatments outside the pain area. Typical examples of pain site treatments are tennis and golfer elbow, where exactly the pain area is targeted. Trigger points are usually treated in a certain distance from the painful site, since trigger points refer pain into other parts of the body. The principles of trigger point treatment are the same in all muscles. So the general treatment information can be applied to all treatments.

5.1 Number of Sessions and Intervals

Treatments can be done depending on the problem daily, every other day, twice or once a week. The frequency of treatments depends on the complexity of the problem and the general condition of the patient. Patients with trigger points in the upper and lower half of the body require more treatments. The treatment should focus on one area per visit but two or more areas can be treated if the patient is in a good physical condition. Well-trained athletes can tolerate more treatments than a chronic, deconditioned pain patient.

5.2 Energy Level and Number of Shock Waves

In one treatment session you would typically apply approximately 2000 impulses to one muscle or a muscle group. Always start with low energy level. Look for trigger points by moving the applicator over the target area. Increase the energy level step by step until the patient feels moderate local and/or referred pain.

When shock waves hit a trigger point the patient experiences:

- Local or unfamiliar referred pain when shock waves stimulate nociceptors of a “latent” trigger point.
- Local and familiar referred pain when the shock waves stimulate active trigger point.

All active trigger points should be treated. Latent TrPs require treatment if they cause significant shortening of the muscle. Continue treating the trigger point until the pain decreases significantly.
In subsequent treatments of the same area the energy level chosen can be usually higher compared to the first treatment. This is a clear indication that the peripheral sensitization has been reduced.
The treatment can be terminated when a further increase of the energy level does not result in pain either local or referred pain. But this usually happens during subsequent treatments of the same area but not in the first.

5.3 Pain During Trigger Point Treatment TST®

During the treatment the patient feels pain. The induced pain should not exceed 3-5 on the Visual Analog Scale – VAS.
Higher pain levels are stressful to the patient and they might cause pain for days or even up to a week after the treatment. Even though patients believe that the more pain they endure the more benefit they will reap, this is not necessarily true. Too much pain can cause fainting, especially when treating the neck and/or shoulder area.

5.4 Anesthesia

The treatment focuses on the active trigger points, which often lie outside the pain area.
Do not use local anesthesia, but treat within the comfort zone of the patient.
With the Dornier *Aries* trigger points can be treated and all muscle groups from head to toe as outlined in the treatment guidelines without anesthesia.

6 Indications and Contraindications

The MPS can present with pain in localized areas, but it can spread throughout the body as chronic widespread pain. Many common diagnoses are actually related to myofascial TrPs and represent only one other symptom of a MPS.

6.1 Indication

In surface adjacent soft parts of the postural and musculoskeletal system, shock wave treatment with the Dornier *Aries* can be administered for trigger points.

Trigger point related conditions are:

- Pain of the shoulder (e.g. supraspinatus tendinitis, calcific tendinitis)
- Heel spur and plantar fasciitis
- Lateral and medial epicondylitis
- Proximal iliotibial band friction syndrome
- Tibial edge syndrome
- Trochanter irritation
- Patella tendinitis

Other conditions are:

- Morton's neuroma
- Induratio penis plastica (IPP)
- Dupuytren's contracture

When applying shock waves in combination with other therapeutic methods the user's responsibility is to verify the patient's tolerance.
The user conducting the treatment is obligated to make herself/himself familiar with the medical state-of-the-art for ESWT, and has to adapt the relevant application and treatment procedure accordingly.

6.2 Contraindications

Before applying a shock wave treatment, the attending user must check for possible contraindications and make an appropriate treatment decision relative to the risks presented by alternative treatment methods.

Contraindications are:

- Coagulation disorders
- Use of anticoagulants
- Thrombosis
- Pregnancy
- Acute inflammations in the shock wave area
- Air filled organs in the shock wave area
- Tumors in the shock wave area
- Aneurysm in the shock wave area
- Unclear pathological changes in the shock wave area
- Pacemaker or defibrillator in the shock wave area

6.3 Relative Contraindications

Relative contraindications are:

- Epiphysial cartilage in the shock wave area during growth
- Polyarthritis
- Polyneuropathy like in diabetes mellitus

The user conducting the treatment is obligated to make herself/himself familiar with the contraindications in the latest medical publications. For patients who have a cardiac pacemaker or defibrillator, it must be carefully verified if an ESWT can be done without any danger, based on the criteria in the most recent literature.

6.4 Personal Experiences

In my experience when working with the Dornier *Aries* certain contraindications like using anticoagulants or treating over air filled organs do not present an absolute contraindication.

6.4.1 Treatment Over Air Filled Organs or Bowels

Many trigger points are located directly over the lungs, which cannot be excluded from the treatment. Direct exposure to the alveoli using a sharply focused shock wave zone can cause bleeding caused by cavitation. The Dornier *Aries* has its focus at the surface of the patient's body close to the applicator cap. Also the shock waves have a flat distribution with moderate peak energy flux densities. Therefore, cavitation in the depth of the body is unlikely especially in low energy levels. I have done several thousand treatments with the Dornier *Aries* in the vicinity of the lungs or the bowels, without ever having experienced any problems. On the other hand, there have been reports of bleeding and coughing up blood after treating the upper trapezius muscle with sharply focused shock waves. Therefore my recommendations regarding the treatment over air filled areas pertain only to the Dornier *Aries* and no other shock wave device.

6.4.2 Anticoagulation

It is my personal experience when using the Dornier *Aries* those patients on anticoagulants do not suffer hematoma. Prior to the treatment I make sure, that the medication is in the appropriate therapeutic range and I constantly move over the treatment area instead of applying shock waves over one small area.

6.4.3 Treatment of Attachment Trigger Points

When I treat tendon insertions – attachment trigger points – I move over the points towards the muscle belly and back continuously. I avoid staying on one spot in order to avoid strong pain and skin reactions.

7 Treatment Reactions

In general orthopedic shock wave therapy has little or no side effects. It is important to minimize the pain during the treatment, to avoid stress reactions of the autonomic nervous system. Skin reactions can be minimized or avoided by constantly moving over the treatment area.
Nevertheless following reactions on trigger point treatment are described[13]:

7.1 Reactions When Treating Attachment Trigger Points

Possible reactions are:
- Exhaustion for hours and sometimes days
- Local pain in the treated area
- Pain in other areas of the body
- Swelling
- Reddening
- Hematomas
- Petechiae
- After previous cortisone therapy skin lesions can occur.
- Arrhythmias especially in patients who already have arrhythmias

7.2 Reactions When Treating Central Trigger Point

Possible reactions are:
- Exhaustion for hours and sometimes days
- Local pain in the treated area
- Pain in other areas of the body
- Arrhythmias especially in patients who already have arrhythmias

7.3 Personal Experience to Reactions of Trigger Point Treatment

On the first visit I only treat one area and ask the patient to closely monitor the reactions. It is normal to feel immediately better after the treatment and to experience more pain the next day. Thereafter patients feel more freedom of motion and often a certain reduction of pain.

Caution:
Once patients feel an improvement they start to test how much activity they can tolerate and usually overdo with an increase of pain. Most patients are not aware of it and they need to be questioned thoroughly to make them understand, that they need to watch their physical activity. Once they feel consistently better, they can start to become more active.

[13] http://www.udel.edu/PT/clinic/journalclub/old/sojournalclub/02_03/nov02/haake.pdf

8 Treatment Procedure

The treatment with the Dornier *Aries* is a very different experience for the patient compared to other orthopedic shock wave devices. By gliding over the treatment area instead of staying over one TrP at a time, the procedure is much more comfortable for the patient and the therapeutic effect is better. Patients mostly experience an immediate relief after the treatment.

8.1 Coupling of Shock Waves

Shock waves need to be coupled with the skin by using ultrasound gel. Without or too little gel the shock wave energy dissipates without entering the tissue. Keep close contact with the body surface so that the sound emanating from the shock wave applicator is dull. When you hear a high pitched snapping sound you are not in full contact with the body.

Figure 14: Treatment of the quadratus lumborum area.

Figure 15: Treatment of the hamstring area.

8.2 The Trigger Point Treatment

Depending on the type of shock wave device you can treat one trigger point after the other or glide over the muscle or muscle group. When working with the Dornier *Aries*, I found that it is better to glide over the muscles. You can work with higher energies meaning that you penetrate deeper into the muscles and reach more trigger points simultaneously because the patient feels less pain during the procedure.

When you just stay over one trigger point area you have to reduce the energy level, otherwise the treatment is too painful. Gliding over the muscles gives faster and better results as opposed to treating one trigger point after the other.

8.3 Energy Level and Total Number of Impulses

For one treatment I usually use 2000 impulses. In the first session I start with the lowest energy level. The starting level can increase in the following sessions. I always try to increase the energy level during the treatment going at least 3 steps higher compared to when I started. In very sensitive or thin muscles I have to work with lower energy level settings, which might require using more than 2000 impulses until you are able to increase the energy level setting. When I treat insensitive or very thick muscles using high energy level settings I might use only 1500 impulses per treatment area.

9 Results of TST®

The results of a successful treatment can be felt immediately. Patients mostly experience pain relief for hours, days or weeks. The range of motion is improved and the eventual pain during or at the end of the range of motion is reduced.
On palpation the treatment area is softer and less painful to pressure. The referred pain is decreased or totally absent. With Us-E the efficacy of the treatment can be monitored objectively.

9.1 Ultrasound Elastography

The efficacy of the TST® can be monitored easily with the Us-E and adjusted accordingly. The treatment recommendations are based on Us-E and a positive clinical outcome.

9.1.1 Case 1

Patient with left sided low back pain and a significant number of TrPs in the quadratus lumborum area. Evaluation was repeated after the application of 1000 and after 2000 shock wave impulses.

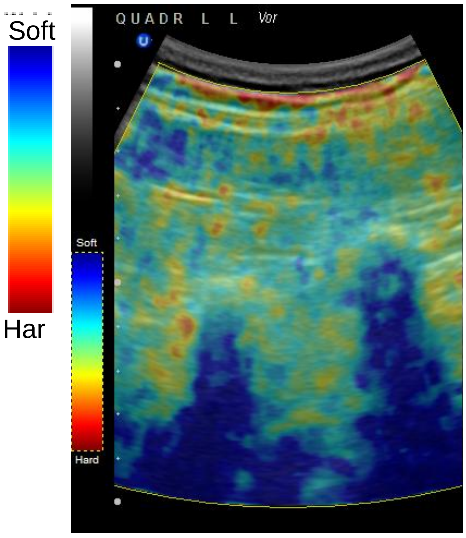


Figure 16: Left quadratus lumborum area The red-brown spots indicate trigger points before treatment.

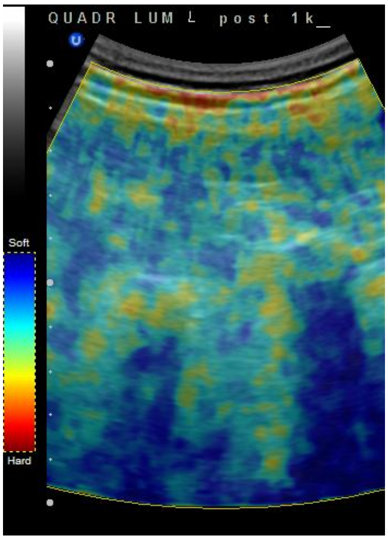


Figure 17: After the application of 1000 shock waves the trigger points start to fade.

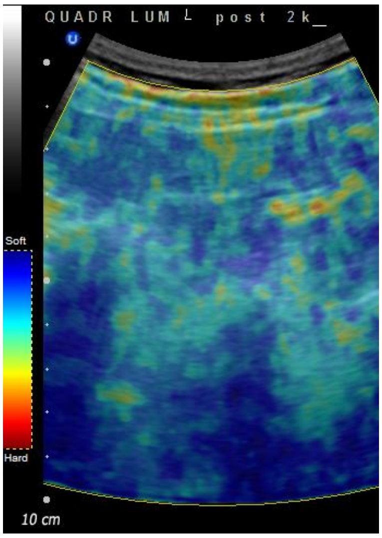


Figure 18: After the application of 2000 shock waves only very few trigger points remain.

9.1.2 Case 2

Patient with right sided sciatica type of pain. The elastograms show the right quadratus lumborum area before and after treatment. After the treatment the pain was reduced and the Us-E after one week showed no significant TrPs.

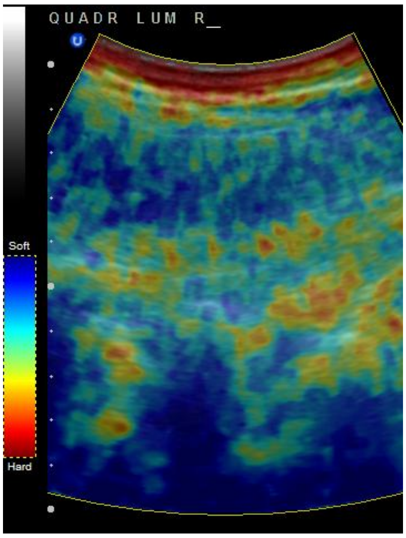


Figure 19: Right quadratus lumborum area. The red-brown spots indicate trigger points which can be seen even at a depth of 8 cm.

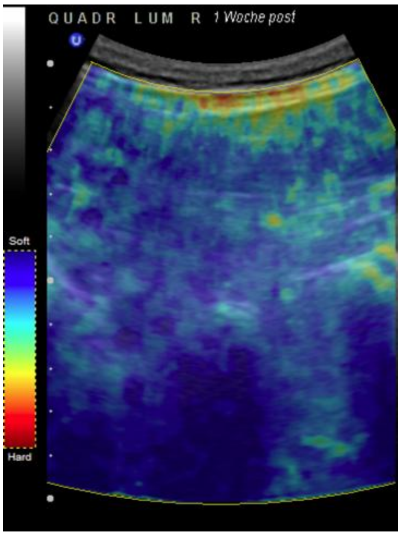


Figure 20: Right quadratus lumborum area one week after a treatment.

9.1.3 Case 3

Figure 21 and Figure 22 show Us-E of a patient with knee pain caused by TrPs in the rectus femoris muscle area. After 1500 shock wave impulses only few TrPs remained.

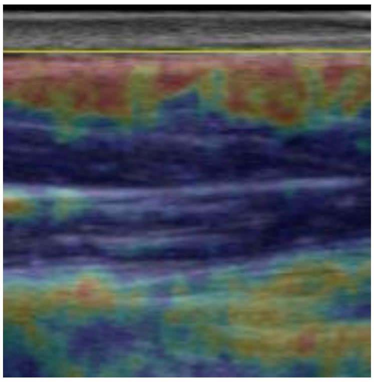


Figure 21: Left: vastus intermedius muscle before treatment. The red-brown areas and spots indicate trigger points

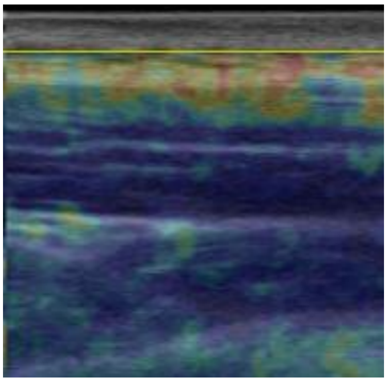
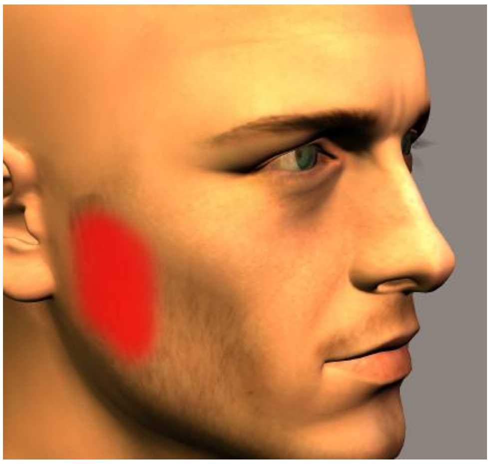


Figure 22: Right: vastus intermedius muscle after treatment

9.2 Effect on the Range of Motion

An efficient treatment results not only in a visible decrease of TrPs, but also in a significant improvement of the ROM and a reduction of eventual pain during and at the end of the ROM.

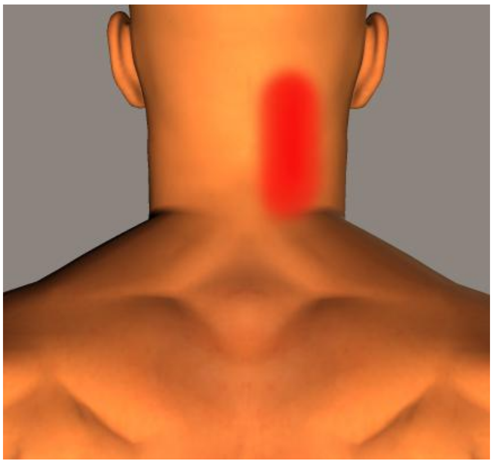
10 Head – masseter



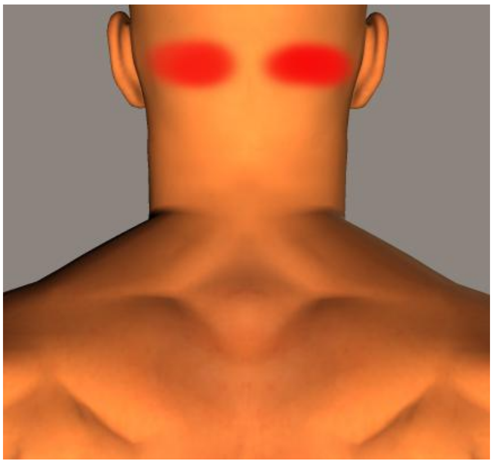
Indication:	Pain in: toothache of unknown cause, inner and outer ear pain Temporomandibular joint (TMJ) problems and sensitivity to heat or cold of the teeth
Patient position:	Sitting
Energy Level:	2-10
Impulses:	1000
Most sensitive area:	Insertions
Caveat: Use low energy level on the muscle insertions because of intense referred pain into the jaw. When the pain decreases the energy level can be increased.	

11 Neck

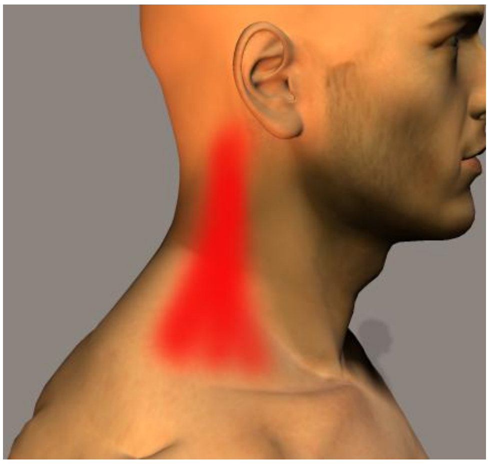
11.1 Neck – posterior	
Indication:	Pain in: neck, shoulder and headache Vertigo
Patient position:	Sitting
Energy level:	3-20
Impulses:	1500
Most sensitive area:	Sub occipital region
Caveat: Coughing and tickling of the throat may occur. Reduce the energy level to make it more bearable for the patient.	



11.2 Neck – sub occipital	
Indication:	Pain in: neck, shoulder and headache Vertigo
Patient position:	Sitting
Energy level:	3-9
Impulses:	1000
Most sensitive area:	Near mastoid process
Caveat: Work with low energy level in patients with tinnitus when you treat near the mastoid process. Tinnitus may increase for a day or two, but reverts back to normal. Don't treat patients with a history of combined sudden hearing loss and tinnitus.	

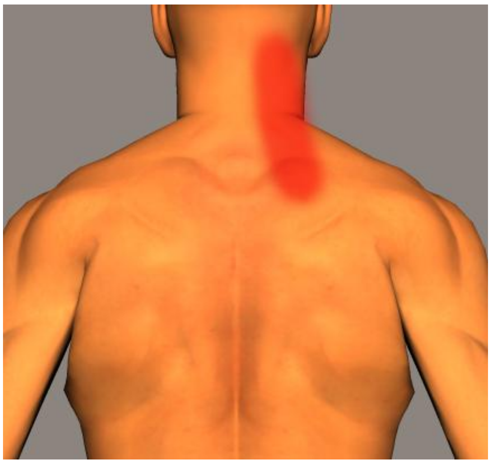


11.3 Neck – lateral, scalene	
Indication:	Pain in: neck, shoulder, chest, upper extremity, mid thorax and headache Vertigo
Patient position:	Sitting
Energy level:	2-14
Impulses:	1500
Most sensitive area:	Near mastoid process
Caveat: Coughing and tickling of the throat may occur. Reduce the energy level to make it more bearable for the patient. After a while the coughing will decrease and you can slowly increase the energy level. Work with low energy level in patients with tinnitus when you treat near the mastoid process. Tinnitus may increase for a day or two, but reverts back to normal. Don't treat patients with a history of combined sudden hearing loss and tinnitus.	

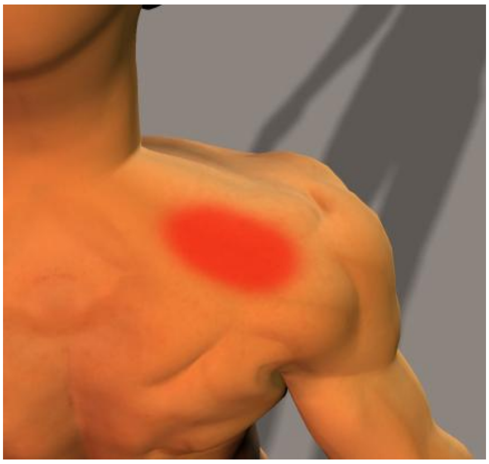


12 Shoulder

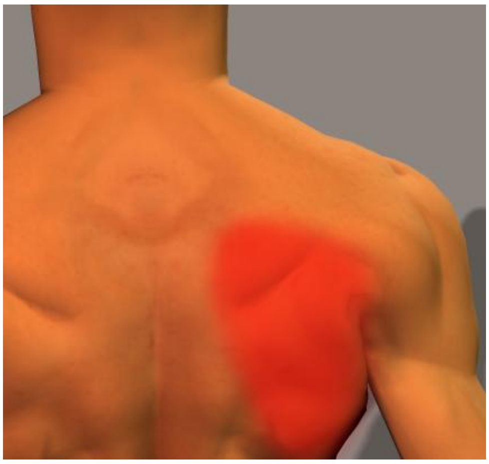
12.1 Shoulder – levator scapulae	
Indication:	Pain in: neck, shoulder, chest, upper extremity, mid thorax, lower back and headache Vertigo
Patient position:	Sitting
Energy level:	4-15
Impulses:	2000
Most sensitive area:	Upper neck, insertion of levator scapulae.
Caveat: Coughing and tickling of the throat may occur. Reduce the energy level to make it more bearable for the patient and slowly increase the energy level.	



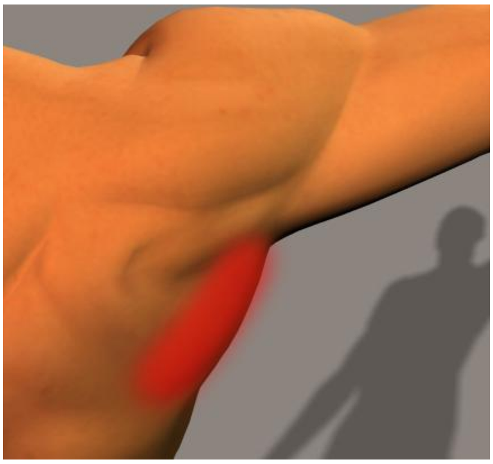
12.2 Shoulder – supraspinatus	
Indication:	Pain in: neck, shoulder and arm
Patient position:	Sitting
Energy level:	4-9
Impulses:	350
Most sensitive area:	Lateral aspect



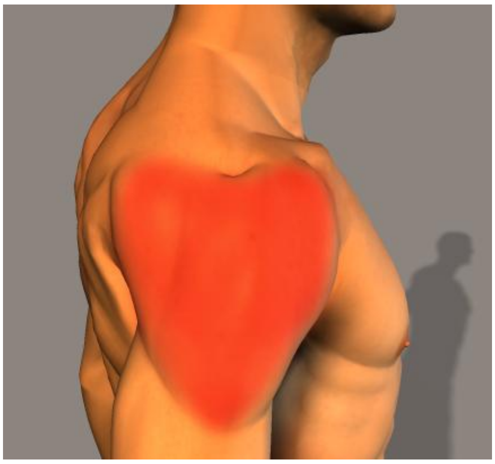
12.3 Shoulder – infraspinatus	
Indication:	Pain in: neck, shoulder, arm, upper extremity, mid thorax and lateral chest
Patient position:	Sitting or prone
Energy level:	3-12
Impulses:	1400
Most sensitive area:	Posterior insertion of deltoid



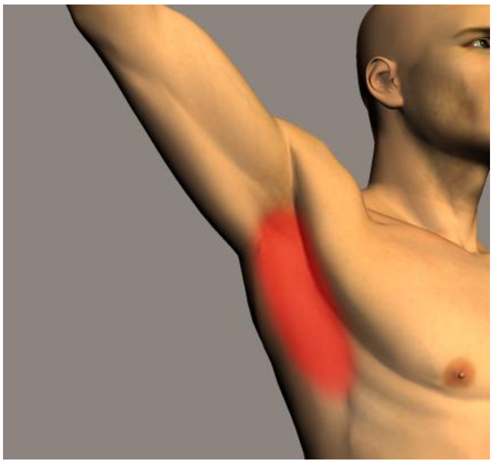
12.4 Shoulder – teres major	
Indication:	Pain in: shoulder, arm and lateral chest
Patient position:	Sitting or prone
Energy level:	4-7
Impulses:	1000
Most sensitive area:	None



12.5 Shoulder – deltoid	
Indication:	Pain in: neck, shoulder, upper extremity and headache Lateral epicondylitis
Patient position:	Sitting
Energy level:	2-17
Impulses:	1800
Most sensitive area:	Insertion and attachments areas.



12.6 Shoulder – subscapularis	
Indication:	Pain in: neck, shoulder, arm, mid thorax, chest
Patient position:	Supine
Energy level:	4-14 (20)
Impulses:	1800
Most sensitive area:	Upper medial and lateral insertion.

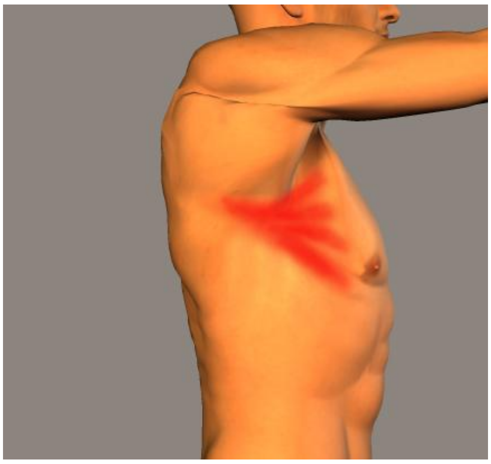


13 Pectorals

Indication:	Pain in: shoulder, arm and chest
Patient position:	Supine
Energy level:	3-11 (20)
Impulses:	2100
Most sensitive area:	Humerus area and lateral part at the rib insertion

14 Serratus anterior

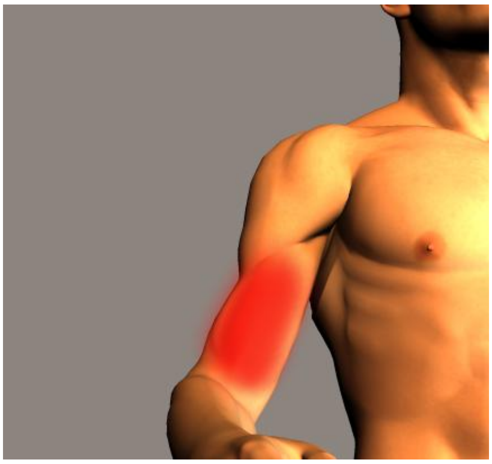
Indication:	Mid the racket pain
Patient position:	Side or sitting
Energy level:	3-9
Impulses:	1800
Most sensitive area:	Tip of the scapula and the rib insertions



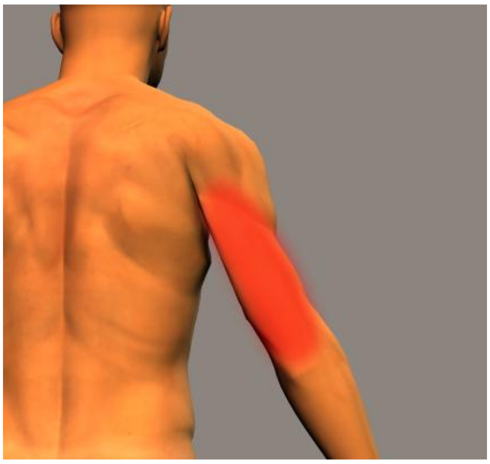
15 Arm and Hand

15.1 Upper Arm

15.1.1 Upper Arm – biceps brachii	
Indication:	Pain in: shoulder, upper and lower arm
Patient position:	Sitting or supine
Energy level:	2-15
Impulses:	1700
Most sensitive area:	Insertion

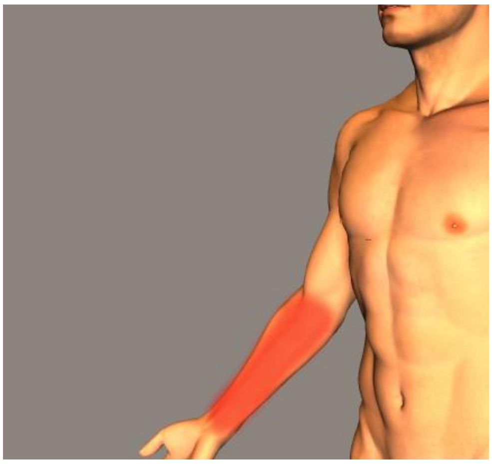


15.1.2 Upper Arm – triceps brachii	
Indication:	Pain in: shoulder, upper and lower arm
Patient position:	Sitting or prone
Energy level:	3-20
Impulses:	1800
Most sensitive area:	Insertion

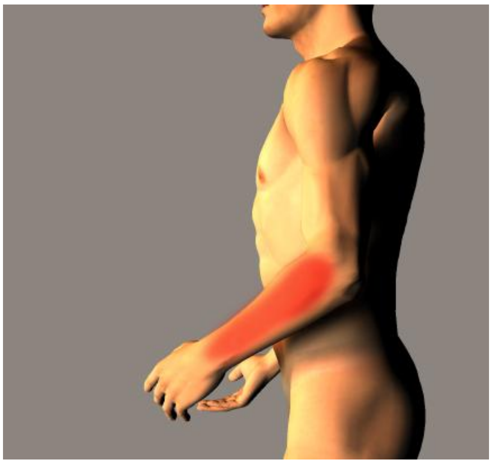


15.2 Lower Arm

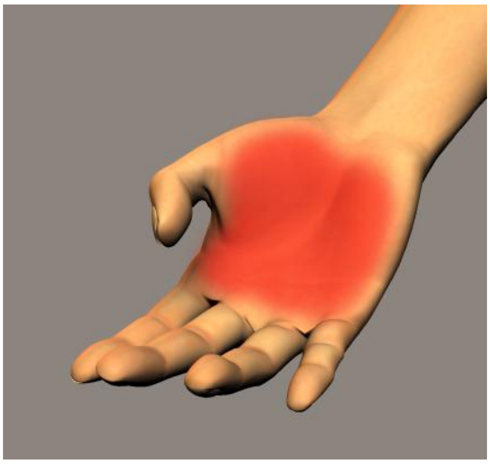
15.2.1 Lower Arm – flexors	
Indication:	Pain in: shoulder, upper and lower arm, wrist, hand and finger
Patient position:	Sitting or supine
Energy level:	4-12
Impulses:	1500
Most sensitive area:	Insertion



15.2.2 Lower Arm – extensors	
Indication:	Pain in: shoulder, upper and lower arm, wrist, hand and finger
Patient position:	Sitting or prone
Energy level:	4-12
Impulses:	1500
Most sensitive area:	Insertion



15.3 Hand – palmar	
Indication:	Pain in: wrist, hand and finger
Patient position:	Sitting or prone
Energy level:	2-8
Impulses:	1000
Most sensitive area:	None



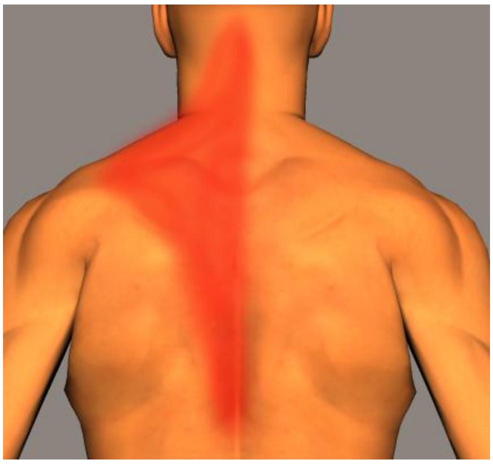
16 Abdomen

Indication:	Pain in: abdomen and thorax Bowel dysfunction, bladder dysfunction, dysmenorrheal and chronic nonbacterial prostatitis
Patient position:	Supine
Energy level:	5-14 (20)
Impulses:	1800
Most sensitive area:	None
Caveat: Include the origins of the abdominal muscles on the ribs.	

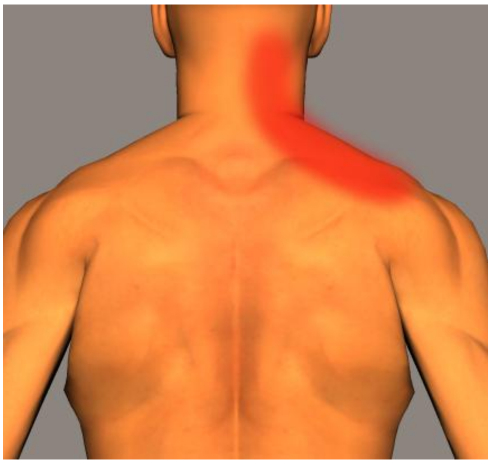
17 Back

17.1 Upper Back

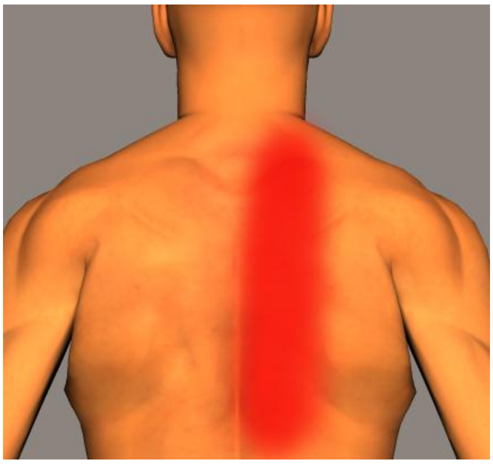
17.1.1 Upper Back – trapezius, total	
Indication:	Pain in: neck, shoulder, arm, thorax, lower back, scapular and headache
Patient position:	Sitting
Energy level:	2-19
Impulses:	1800
Most sensitive area:	Sub occipital region, lateral Supraspinatus region, medial boarder of scapula
Caveat: Coughing and tickling of the throat may occur, especially when you work in the neck area. Reduce the energy level to make it more bearable for the patient and slowly increase the energy level.	



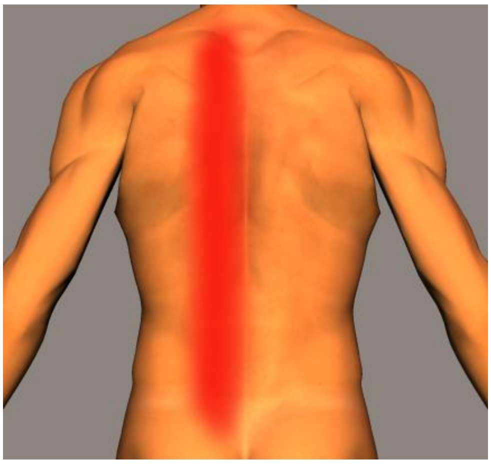
17.1.2 Upper Back – upper trapezius	
Indication:	Pain in: neck, shoulder, arm, thorax, lower back, scapular, anterior chest and headache
Patient position:	Sitting
Energy level:	2-18
Impulses:	1200
Most sensitive area:	Sub occipital region, insertion of levator scapulae, lateral supraspinatus area.
Caveat: Coughing and tickling of the throat may occur. Reduce the energy level to make it more bearable for the patient and slowly increase the energy level.	



17.1.3 Upper Back – T1 – T12	
Indication:	Pain in: neck, shoulder, arm, mid-thorax, scapula, chest, lower back and headache Breathing difficulties, exertional asthma and vertigo
Patient position:	Sitting or supine
Energy level:	2-20
Impulses:	1400
Most sensitive area:	Medial aspect of shoulder blade

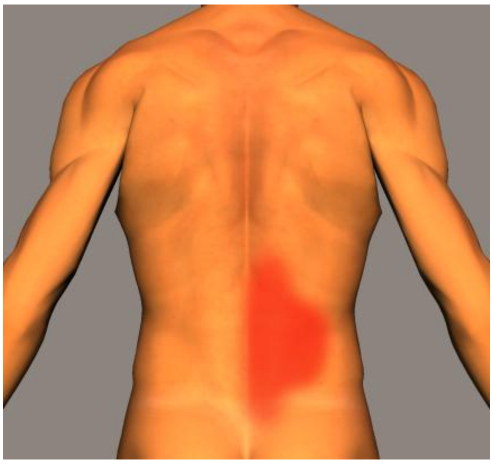


17.2 Back – erector spinae	
Indication:	Pain in: upper, middle and lower back, hip, knee, lower extremity, chest, abdomen and pelvis
Patient position:	Sitting or supine
Energy level:	3-20
Impulses:	2500
Most sensitive area:	Medial aspect of shoulder blade, lumbar area 1-3, sacral area



17.3 Lower Back

17.3.1 Lower Back – quadratus lumborum	
Indication:	Pain in: upper, middle and lower back, sacroiliac joint, hip, knee, lower extremity, abdomen, pelvis and sciatica
Patient position:	Sitting or supine
Energy level:	2-20
Impulses:	1800
Most sensitive area:	None
Caveat: The quadratus lumborum area requires high energy level because trigger points can be located in the ventral psoas.	



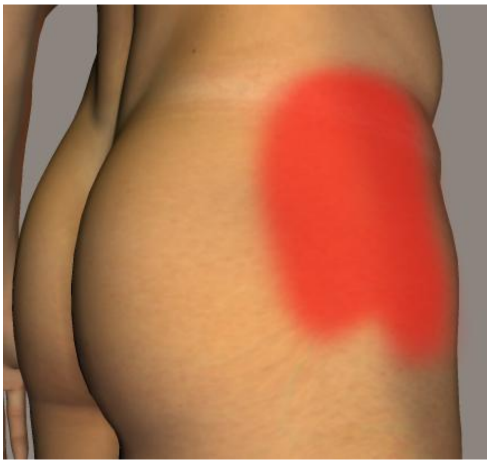
17.3.2 Lower Back – sacrum	
Indication:	Pain in: lower back, iliac crest, hip, lower extremity, pelvic and sciatica
Patient position:	Sitting or supine
Energy level:	2-19
Impulses:	1200
Most sensitive area:	Above the sacroiliac joint area

18 Hip

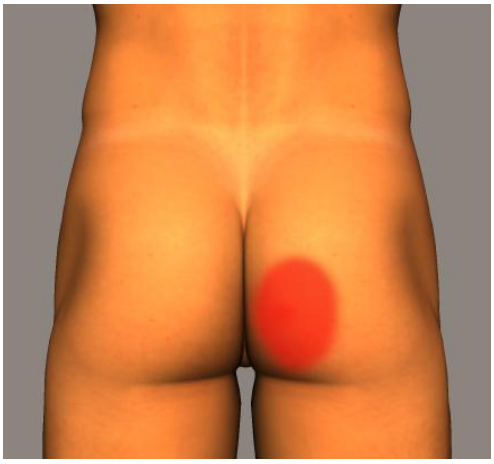
18.1 Hip – total	
Indication:	Pain in: lower back, sacroiliac joint, hip, , trochanter, groin, knee, lower extremity, Achilles tendon, ankle, plantar fascia and sciatica Bursitis
Patient position:	Supine
Energy level:	1-20
Impulses:	2000
Most sensitive area:	Muscle insertions around the trochanter major, quadratus femoris area, lateral hip, sacrotuberous ligament area

18.2 Hip – medial	
Indication:	Pain in: lower back, sacroiliac joint, hip, , trochanter, groin, knee, lower extremity, Achilles tendon, ankle, plantar fascia and sciatica Bursitis
Patient position:	Supine
Energy level:	5-20
Impulses:	1100
Most sensitive area:	Muscle insertions around the trochanter major, quadratus femoral area, sacrotuberous ligament area

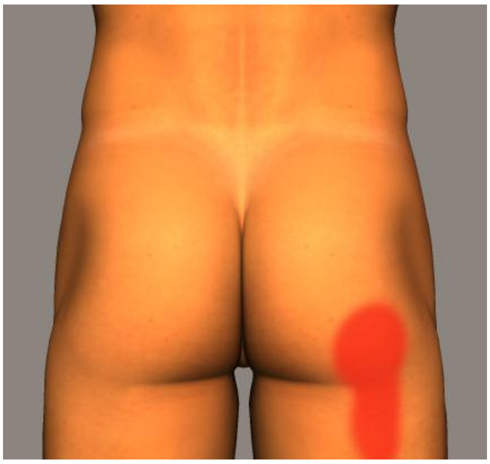
18.3 Hip – lateral	
Indication:	Pain in: lower back, sacroiliac joint, hip, trochanter, groin, knee, lower extremity, Achilles tendon, ankle, plantar fascia and sciatica Bursitis
Patient position:	Supine
Energy level:	10-20
Impulses:	1800
Most sensitive area:	Upper Ilium, near the iliac crest, around the trochanter major



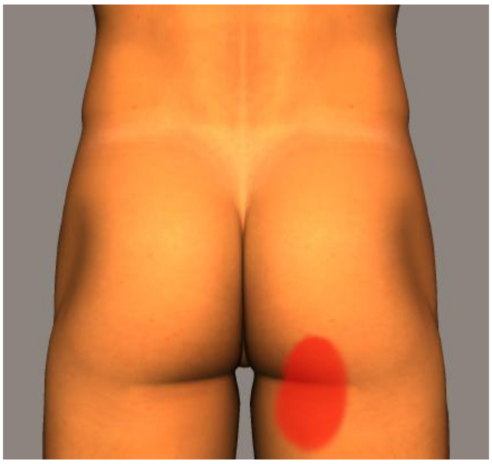
18.4 Hip – sacrotuberous ligament	
Indication:	Pain in: pelvis, rectum, hip, groin and lower back Chronic abacterial prostatitis
Patient position:	Supine
Energy level:	4-17
Impulses:	1200
Most sensitive area:	None



18.5 Hip – quadratus femoris	
Indication:	Pain in: hip, sciatica, knee and lower extremity
Patient position:	Supine
Energy level:	4-13
Impulses:	1500
Most sensitive area:	None
Caveat: The Quadratus femoris area is extremely sensitive and refers pain to the groin and down the leg into the foot	



18.6 Hip – ischial tuberosity	
Indication:	Pain in: lower back while sitting, hip, knee, foot and sciatica Insertional tendinitis
Patient position:	Prone
Energy level:	4-10
Impulses:	1400
Most sensitive area:	None

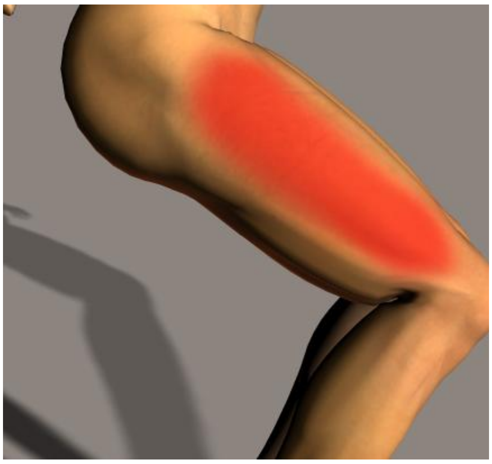


19 Leg and Foot

19.1 Upper Leg

19.1.1 Upper Leg – quadriceps femoris	
Indication:	Pain in: knee, groin, Achilles tendon, plantar fascia, hip, lower back, upper back and cervical
Patient position:	Supine
Energy level:	2-20
Impulses:	2300
Most sensitive area:	Close to the anterior iliac spine, the lower 3rd of the quadriceps muscle, vastus lateralis

19.1.2 Upper Leg – vastus lateralis	
Indication:	Pain in: trochanter, adductor, hip, knee and sciatica
Patient position:	Supine or side
Energy level:	2-18
Impulses:	1900
Most sensitive area:	Lower 3rd of the muscle, near and on the trochanter major, over the tensor fasciae latae



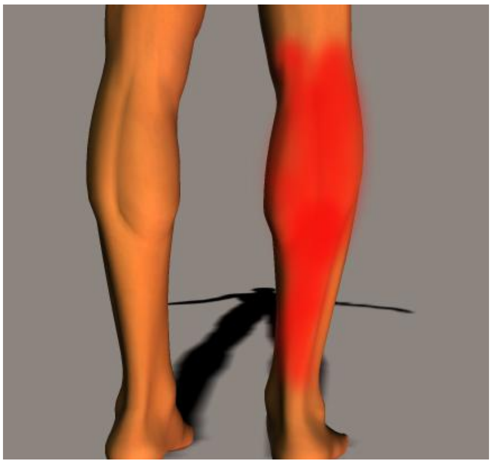
19.1.3 Upper Leg – tensor fasciae latae	
Indication:	Pain in: hip, groin, trochanter, knee, abdomen and sciatica
Patient position:	Supine or side
Energy level:	1-16
Impulses:	1600
Most sensitive area:	None

19.1.4 Upper Leg – hamstrings	
Indication:	Pain in: hip, knee, groin, lower back, upper back, cervical and sciatica
Patient position:	Prone
Energy level:	2-20
Impulses:	2000
Most sensitive area:	Ischial tuberosity, quadratus femoris area, lateral part of hamstrings, lower 3rd of the hamstrings

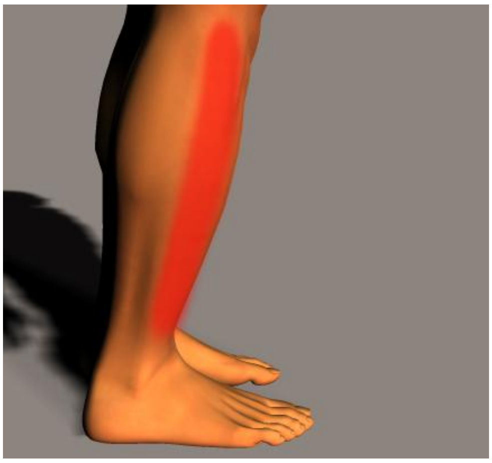
19.1.5 Upper Leg – adductors	
Indication:	Pain in: hip, knee, groin, low back, upper back, cervical, abdomen, pelvic and rectum Abacterial prostatitis and interstitial cystitis
Patient position:	Supine
Energy level:	3-20
Impulses:	2600
Most sensitive area:	none
Caveat: Look for strong muscle twitch reaction at the origin of the muscle near the pubic bone	

19.2 Lower Leg

19.2.1 Lower Leg – gastrocnemius	
Indication:	Pain in: knee, calf, ankle and medial tibia (shin splints) Achilles tendinitis and plantar fasciitis
Patient position:	Prone
Energy level:	3-18
Impulses:	1700
Most sensitive area:	Lateral part of gastrocnemius, medial and lateral origin at the knee joint, soleus and Achilles tendon



19.2.2 Lower Leg – peronei	
Indication:	Pain in: knee, calf, medial tibia (shin splints) and ankle Achilles tendinitis and plantar fasciitis
Patient position:	Supine
Energy level:	4-12
Impulses:	1200
Most sensitive area:	At origin and insertion



19.2.3 Lower Leg – tibialis anterior	
Indication:	Pain in: medial tibia (shin splints), ankle and foot
Patient position:	Supine
Energy level:	4-16
Impulses:	1200
Most sensitive area:	None

19.2.4 Lower Leg – Achilles tendon	
Indication:	Pain in: calf, ankle and foot Retro calcaneal bursitis, plantar fasciitis and Achilles tendinitis
Patient position:	Prone
Energy level:	2-18
Impulses:	2000
Most sensitive area:	None

19.3 Foot – plantar fascia	
Indication:	Pain in: dorsal and plantar foot and toe Plantar fasciitis and Morton's neuroma
Patient position:	Supine or prone
Energy level:	4-12
Impulses:	1500
Most sensitive area:	None

20 Reference List

[1] Mense S., Simons DG., Hoheisel , U., Quenzer , B. (2003):
Lesions of Rat Skeletal Muscle After Local Block of Acetylcholinesterase and Neuromuscular Stimulation
J Appl Physiol, VOL 94 (JUNE 2003), URL: www.jap.org

[2] Mense S, Simons DG, Russell IJ. (2001):
Muscle Pain, Understanding its Nature, Diagnosis and Treatment
1st ed., p. 251, Philadelphia: Lippincott Williams & Wilkins.

[3] Shah JP, Phillips TM, Danoff JV., Gerber LH. (Jul 2005):
An in-vivo Microanalytical Technique for Measuring the Local Biochemical Milieu of Human Skeletal Muscle
J Appl Physiol, Vol. 99 (5), pp. 1977-1984

[4] Mense S. (2000):
Neurobiologie des Muskelschmerzes - Neurobiology of Muscle Pain
Deutsche Zeitschrift für Sportmedizin, Jahrgang 51, Nr. 6, pp. 190-195

[5] Bauermeister W., (2002):
Das Rückenfit Programm
SüdWest Verlag

[6] Sikdar, S., Shah JP., Gebreab T., Yen, R.-H., Gilliams E., Danoff, J., Gerber, LH. (2009):
Novel Application to Visualize Myofascial Trigger Points and Surrounding Soft Tissue
Arch Phys Med Rehabil. 90 (11): 1829–1838.

[7] Bauermeister W. (2011):
Ultrasound Elastography, a Novel Method for the Diagnosis of Trigger Points and a Tool to Evaluate the Efficacy of Shock Waves in the Treatment of Myofascial Pain Syndromes
14th congress of the International Society for Medical Shock Wave Treatment

[8] Bauermeister W. (2012):
Ultraschall-Elastographie zur Diagnose Myofaszialer Schmerzsyndrome
Abstract, 23. Deutscher interdisziplinärer Schmerz- und Palliativkongress

[9] Bauermeister W. (2012):
Ultraschall-Elastographie zur Diagnose Myofaszialer Schmerzsyndrome
Abstract, 23. Deutscher interdisziplinärer Schmerz- und Palliativkongress

[10] Bauermeister W. (2004):
Trigger-Stoßwellen-Diagnostik und Trigger–Stoßwellen-Therapie;
Osteoporose & Rheuma aktuell 2/0411

[11] Bauermeister W. (2004):
The Diagnosis and Treatment of Myofascial Trigger Points Using Shock Waves;
Journal of Musculoskeletal Pain, Vol. 12, Supplement Number 9, iSSN: 1082-6025

[12] Bauermeister W (2004):
The Diagnosis and Treatment of Myofascial Trigger Points Using Shock Waves in Patients With Idiopathic Low Back Pain;
Journal of Musculoskeletal Pain, Vol 12, Supplement Number 9, iSSN: 1082-6025

[13] http://www.udel.edu/PT/clinic/journalclub/old/sojournalclub/02_03/nov02/haake.pdf

21 Further Readings

Bauermeister W. Fries HH.:
Trigger Osteopractic a Novel Approach for the Treatment of Tennis Related Injuries Tennis Science & Technology Edited by. S.J. Haake, A. Coe Blackwell Science Ltd. ISBN 0-632-05638X

Simons DG, Travell JG, Simons LS. (1999):
Travell and Simons Myofascial Pain and Dysfunction: The Trigger Point Manual Volume 1, Upper Half of Body. Ed. 2. Williams and Wilkins, Baltimore.

Travell JG., Simons DG. (1983).:
Myofascial Pain and Dysfunction: The Trigger Point Manual, Volume 1, Upper Half of Body Ed. 1. Williams and Wilkins, Baltimore.

Bauermeister W. (1999).:
Trigger-Osteopraktik
Physikalische Therapie in Theorie und Praxis, 20 (8), 487-490.

Bauermeister W. (2004):
Trigger–StoßwellenTherapie: Ergebnisse Dreier Prospektiver Studien an Patienten mit Nacken-Schultergürtel-, Schulter-Arm-Schmerzen, Lumbalgie und Lumboischialgie
Extrakorporale Stoßwellentherapie, Schwerpunkt Radiale Technologie Grundlagen Klinische Ergebnisse, L. Gerdesmeyer iSBN 3-8334-1088-4

Stierle T. (2004):
Methode Swiss Dolorclast
in: Gerdesmeyer L (Hrg). Extrakorporale Stosßwellentherapie. Books on Demand, Norderstedt, 2004:100-9.

Maier M., Averbeck B., Mizs, Refior HJ., Schmitz C. (2003):
Substance P and Prostaglandin E2 Release After Shock Wave Application to the Rabbit Femur
Clin Orthop; 406:237-45

Chen YJ., Kuo YR., Yang KD., Wang CJ., Chen S-MS., Huang HC., Yang YJ., Yi-Chih S., Wang FS. (2004):
Activation of Extracellular Signal-Regulated Kinase (ERK)and p38 Kinase in Shock Wave-Promoted Bone Formation of Segmental Defects in Rats
J Bone 2004;34:466-77

Cavalieri E., Amelio E., Russo S., Marlinghause E., Suzuki H., (2003):
Effect of Shock Wave on Endothelial NO Synthase in HUVEC
in: Maier, Giillesberger (Hrg). Abstracts 2003 zur Muskuloskelettalen Stoßwellentherapie, Kongressband des 3. Drei-Ländertreffens der Österreichischen, Schweizerischen und Deutschen Gesellschaften für Extrakorporale Stoßwellentherapie. München-Großhadern. Books on Demand GmbH, Norderstedt, 2003.

Bauermeister W. (2005):
Diagnose und Therapie des Myofaszialen Triggerpunkt Syndroms durch Lokalisierung und Stimulation Sensibilisierter Nozizeptoren mit Fokussierten Elektrohydraulischen Stoßwellen
Medizinisch Orthopädische Technik 5, 65-74

Bauermeister W. (2007):
Myofasziales Triggerpunkt-Syndrom Diagnose und Therapie durch Stoßwellen, Extracta Orthopaedica Ausgabe 5, 12-19

22 Acronyms and Abbreviations

5-HT	Serotonin
AMPA	α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid
ATrp	Attachment Trigger Point
BK	Bradykinin
B-ROM	Back Range of Motion
CGRP	Calcitonine-Gene-Related-Peptide
C-ROM	Cervical Range of Motion
CTrP	Central Trigger Point
ESWT	Extracorporeal Shock Wave Therapy
IL-1β, IL-6, and IL-8	Interleukins
NE	Norepinephrine
PG	Prostaglandins
ROM	Range of Motion
SOM	Somatostatin
SP	Substance P
SW	Shock Wave
TMJ	Temporomandibular Joint
TNF-α	Tumor-Necrosis-Factor-α
TrP	Trigger Point
TrPs	Trigger Points
TST®	Trigger Point Shock Wave Therapy
Us-E	Ultrasound Elastography
VAS	Visual Analog Scale

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Author:

Dr. Wolfgang Bauermeister
Toni-Schmid-Straße 45
81825 München

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Dornier MedTech Europe GmbH
Argelsrieder Feld 7
82234 Wessling

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