ESWT/ESWL Team of

RICHARD WOLF

spirit of excellence

ELvation® USA

PiezoWave² VET

PIEZO Shockwave in Small Animal Medicine

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Section 1 - The Technology of shockwave therapy

History of extracorporeal shockwave therapy (ESWT)

ESWT developed from extracorporeal shockwave lithotripsy (ESWL), a technology that has been available for over 30 years. ESWL is a procedure in human medicine which uses acoustic shockwaves to break up kidney stones. Extracorporeal shockwave therapy (ESWT) was derived from ESWL and was initially used to treat human pseudarthrosis (non-unions). The first successful treatment of a human non-union by ESWT was reported in 1988 in Germany. Within two years, multiple clinical studies reported a success rate of 60-90% for healing of pseudarthrosis. Next, ESWT was shown to be successful for treatment of tendinitis calcarea, epicondylitis, and heel spur pain[1]. In human medicine, ESWT became a successful and viable non-surgical treatment for acute and chronic pain of the musculoskeletal system[2]. As the technology evolved, mobile units and therapy sources were developed and shockwave has become a useful solution for thousands of patients[3]. The benefits and impact of shockwave in human medicine have been impressively demonstrated in numerous studies[3,4]. ESWT was first FDA approved for the treatment of plantar fasciitis in 2000. Once ESWT had demonstrated its efficacy in human medicine, the modality began to be used in veterinary medicine. It was originally used in horses for treatment of bone and soft tissue conditions including but not limited to tendinitis, stress fractures/non-unions, back pain, and navicular syndrome[5]. The use of ESWT in small animals began in the late 1990's and has been used successfully for bone, joint, and tendon injuries, as well as osteoarthritic conditions[6.7,8,9].

For the purpose of clarity, the term shockwave will be used throughout this document meaning the equivalent to extracorporeal shockwave therapy, ESWT.

Piezowave^2 VET Edition of the Clax unit trolley for mobile use.

Basic principles of extracorporeal shockwave therapy

Shockwave therapy is a non-invasive procedure used to treat acute and chronic pain of the musculoskeletal system[3]. The source from which the shockwaves are generated is located outside the body (extracorporeal) and the shockwaves are delivered to areas deep inside the body. The focused shockwaves used in ESWT procedures reach their peak pressure precisely in the target tissue.

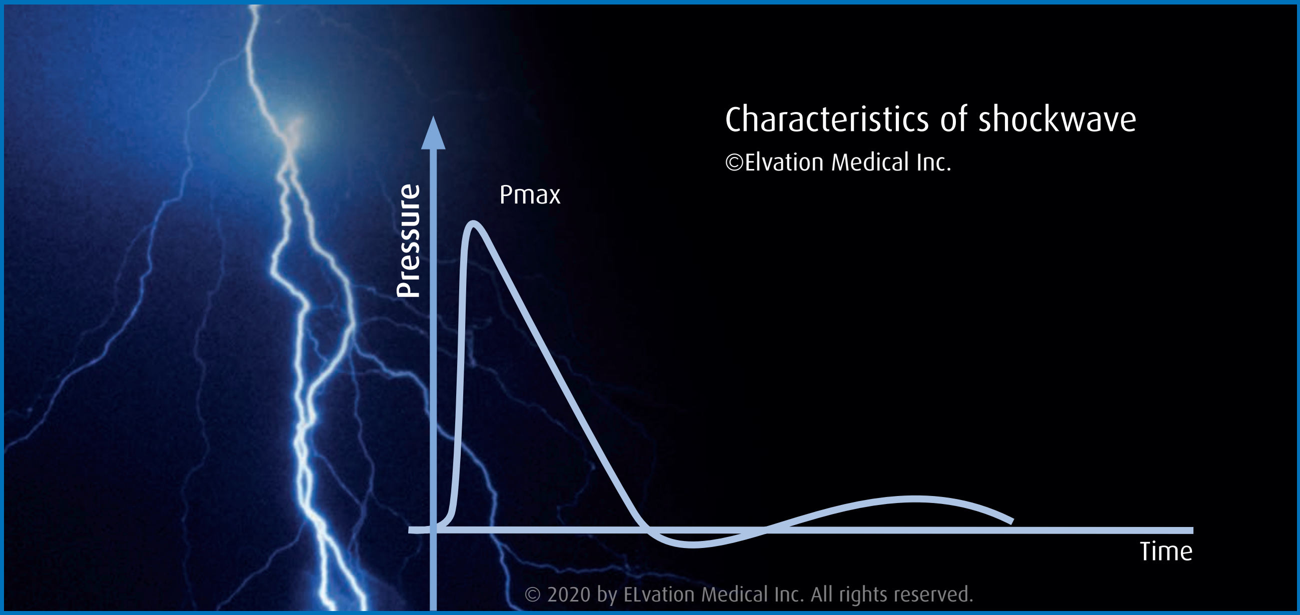


Figure 1 - physical characteristics of a shockwave

Physical characteristics of a shockwave include[10]:

- A single pulse high pressure wave
- High peak pressure, up to and above 100 MPa
- Short rise time and steep slope that occurs in nanoseconds
- Followed by negative pressure, low tensile wave
- Small pulse width, both pressure waves occur over about 5-10 microseconds

Technologies used to generate shockwaves

Focused shockwave

Several different focused shockwave systems are now available; electrohydraulic, electromagnetic, and piezoelectric. They all create true shockwave characteristics (Figure 1). The technologies differ in terms of how the shockwave is generated, and other associated properties such as noise level, focal size, durability of the therapy source, adjustment and focusing of the shockwave, penetration depth, and shockwave intensity.

Electrohydraulic shockwave

Electrohydraulic systems use a spark plug to produce the shockwaves (Figure 2) and reflectors to focus them, thus termed "indirect focusing". The intensity of shockwaves produced by these systems decrease over time making it often necessary to refurbish the therapy sources after around 50 treatments. Electrohydraulic systems also have different shaped therapy sources for different penetration depths. Treatments with this modality are loud, can be painful, and usually require small animal patients to be sedated.

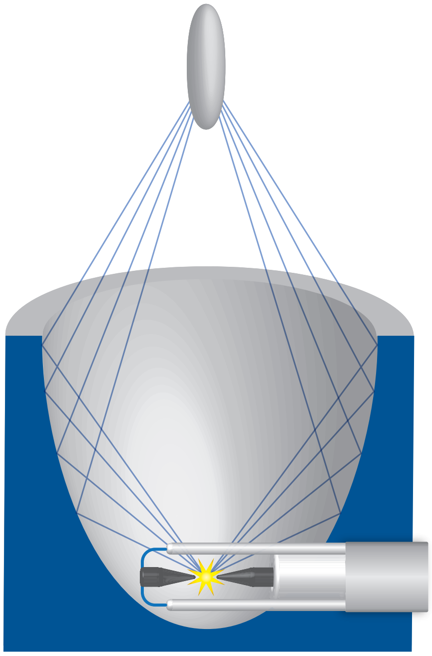


Figure 2 - Electrohydraulic shockwave

Electromagnetic shockwave

Electromagnetic systems utilize an electromagnetic coil with a metal membrane next to the coil. The metal membrane produces acoustic pulses in response to the electromagnetic energy from the coil. The energy is then focused by an acoustic lens, thus termed "indirect focusing". They produce fairly consistent levels of peak energy and are not as loud as electrohydraulic systems. Electromagnetic shockwave systems do require different therapy sources to generate different length focal zones.

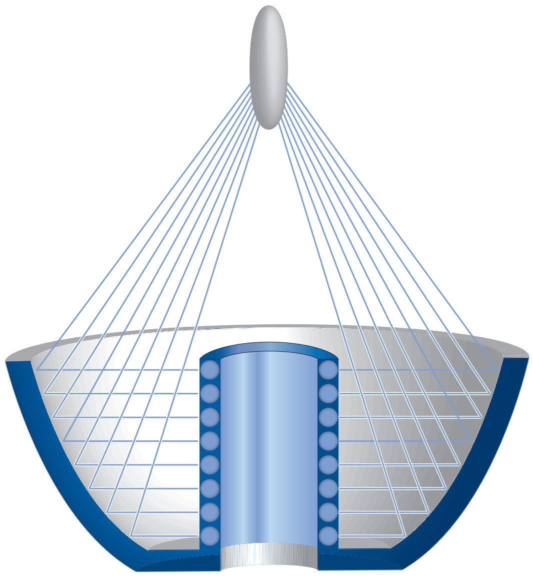


Figure 3 - Electromagnetic shockwave

Piezoelectric shockwave;
The focused piezoelectric principle of the PiezoWave[2]

In a piezoelectric shockwave, a high-voltage pulse is used to excite piezoceramic elements arranged on a concave surface. This concave surface is termed the transducer and is located on the top of the handle of the therapy source for the shockwave. The unique physical characteristic of piezoceramic elements causes them to briefly and simultaneously expand by a few micrometers and create a pressure pulse. The piezo elements are precisely aligned so that each of the individual pressure pulses being produced come together at a defined point in tissue to create a shockwave . Piezo shockwave is the only shockwave method to use "direct focusing;" it does not require an additional reflector. The transducer of the therapy source is flat and compact and provides a precise well-defined focal zone (page 10). Different gel pads are used to adjust the penetration depth within tissues (page 12).

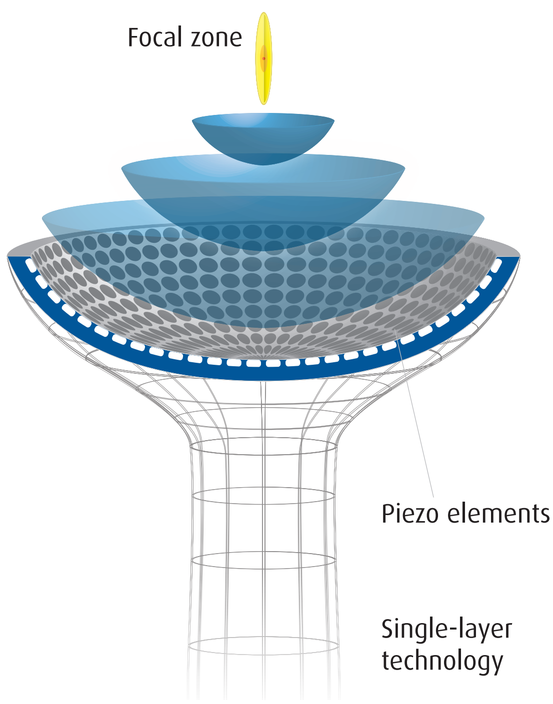


Figure 4 - Piezoelectric shockwave

Piezo shockwave technology is known for its exceptional durability. Piezoelectric therapy sources often have a working life of more than 5,000 treatments, a significantly longer lifespan than both electrohydraulic and electromagnetic systems.

Therapy Source Components

1.1 Therapy Source handle with start/stop button
1.2 Plug connector
1.3 Identification plate with reference and serial numbers
1.4 Cord that transfers high voltage to piezo elements
1.5 Concave transducer that contains the piezo elements
1.6 Twist lock ring to hold gel pad in place
1.7 Gel pad (interchangeable)

Figure 5 - The PiezoWave^2 therapy source

The PiezoWave^2 therapy sources disconnect from the control unit and include: the plug connector, an identification plate with reference and serial numbers, the cord that transfers high voltage to piezo elements, the handle with a start stop button, the concave transducer that contains the piezo elements, and a twist lock ring to hold gel pad securely in place.

Piezo shockwave therapy sources are available with single-layer or double-layer technology. This technology is unique in that it can provide many different possibilities of focal zones including larger and/or different shaped focal volume, and/or deeper penetration.

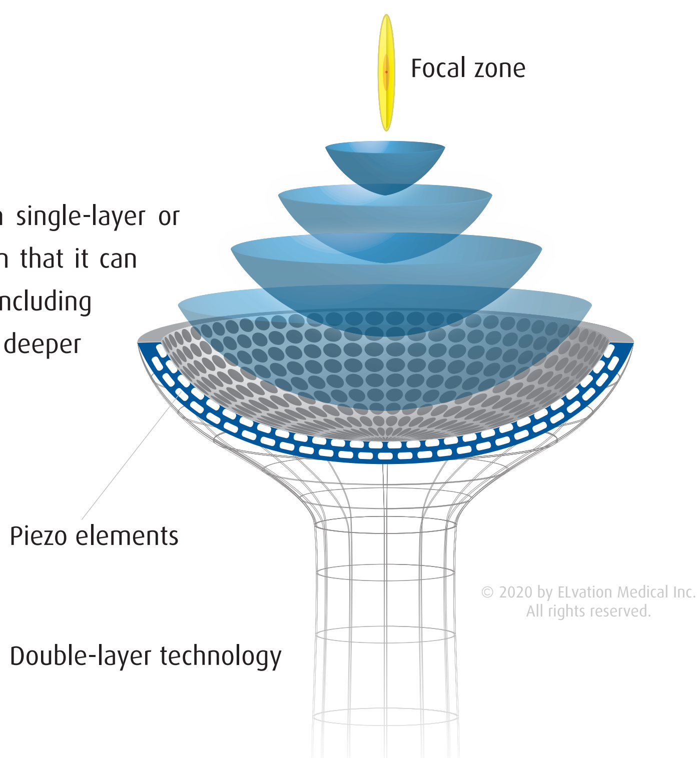


Figure 6 - The double layer therapy source

Radial "shockwave"

Radial shockwave is more appropriately described as radial pressure waves and differs significantly from focused shockwave. Radial pressure waves are ordinary sound waves with only 30 MPa of peak pressure and require a longer time, around 3 microseconds, to reach this peak pressure. The pressure generated by a radial (pneumatic, ballistic) system, spread radially, and create the highest energy flux density at the skin level. The radial pressure waves shape exhibit no steepening and the energy density of the pressure waves rapidly decreases below the topmost layers of the skin[11]. Thus, they are most useful for superficial applications. With radial pressure waves, the penetration depth, intensity, and angle of entry cannot be selected independently. Instead, the penetration depth is coupled to the intensity setting.

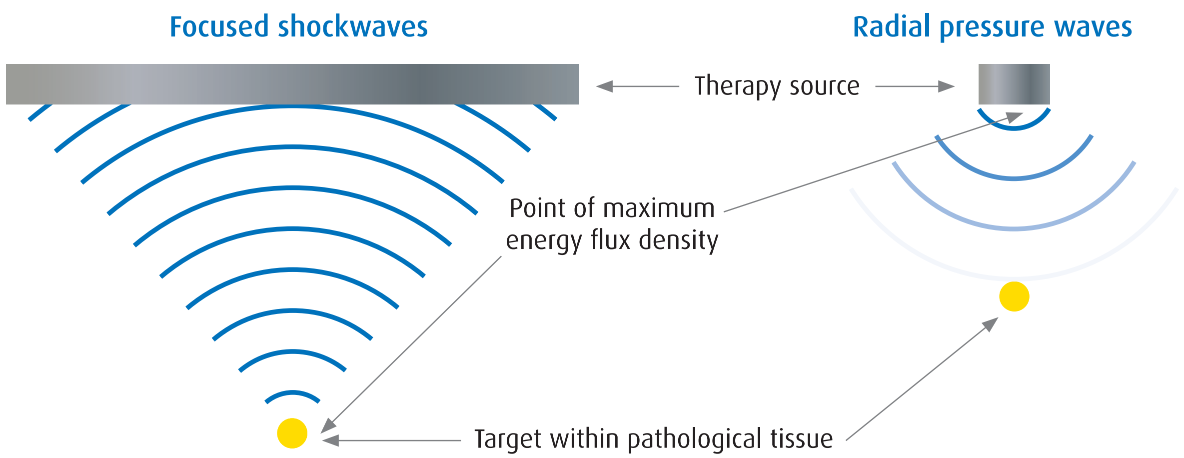


Figure 7 - Point of maximum EFD and Target within tissue:
Focused shockwaves (left) versus Radial pressure waves (right)

Focal zone, focal size, and specifications of PiezoWave[2]

The focal zone is the area in which the slope of the pressure waves steepen to create a shockwave. Because it is necessary for the shockwave to reach the specific location of the damaged tissue, the focal zone plays a key role in shockwave treatments. ElvationUSA provides five different piezo shockwave therapy sources (sold separately). Each therapy source has a different geometric shape, number of layers and arrangement of piezo ceramics in its transducer. It is these specifics that create unique focal zones with different characteristics (Figure 11 and Figure 12). The standard terms used to describe the basics of shockwave and focal size of different shockwave modalities can be confusing and are often used randomly or incorrectly in advertising. It is important to understand these terms and be aware of the standards used to describe focal zones (Figure 8).

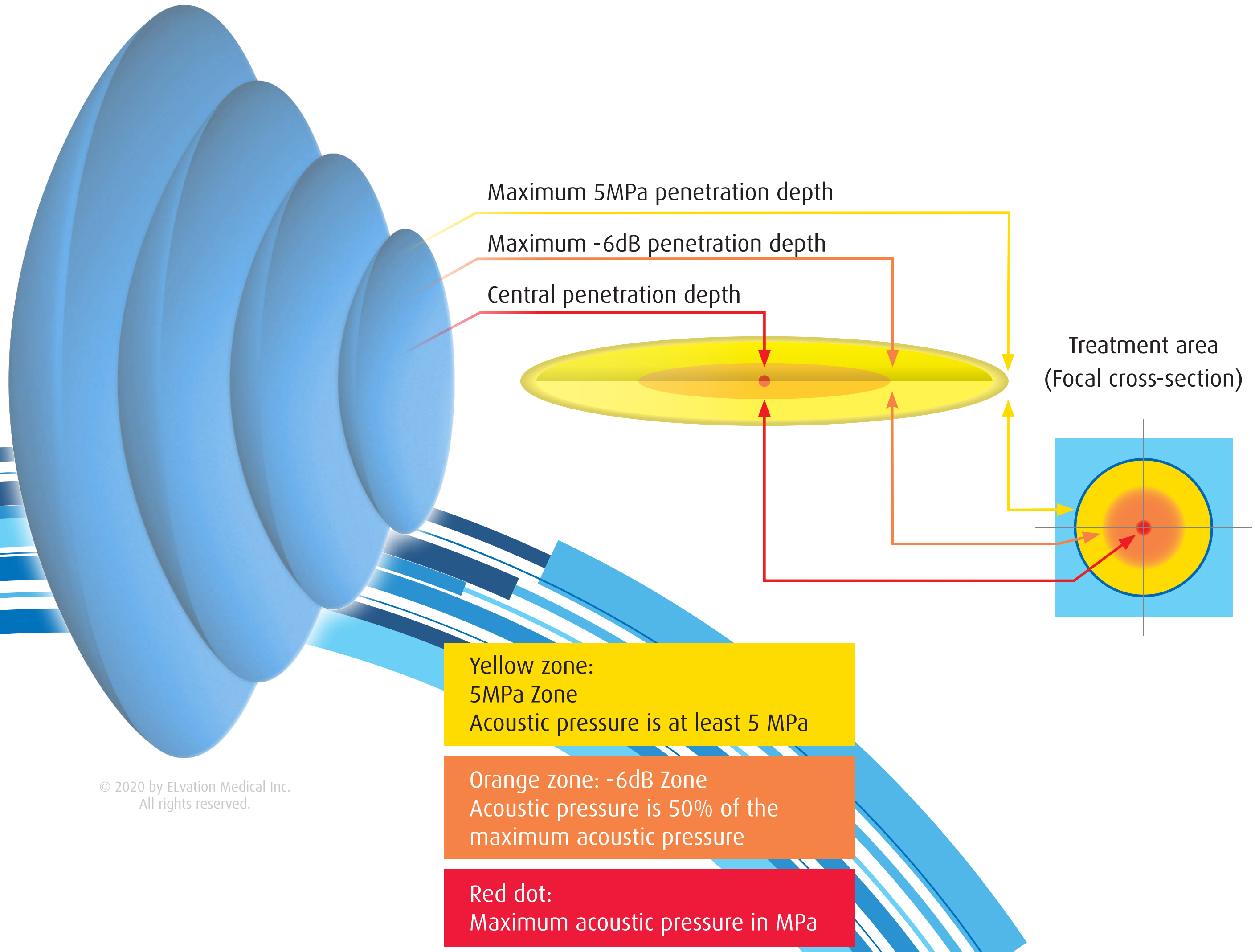


Figure 8 - Description of the focal zone

The -6dB zone, which is often used for comparisons between measurements in studies, refers to the part of the focal zone where the acoustic pressure amplitude is at least 50% of the maximum amplitude achieved at the center of the focus. Based on the assumption that an acoustic pressure amplitude of at least 5MPa is required to achieve a biologic effect in tissue, the 5MPa zone is increasingly considered to be the therapeutic impact zone. The 5MPa zone is defined as the focal area in an acoustic field where the acoustic pressure amplitude is ≥ 5MPa. The central penetration depth is the distance between the skin surface and the point of maximum acoustic pressure when using a gel pad which allows the greatest penetration depth. The distal penetration depth of the -6dB zone or 5MPa zone refers to the distance between the skin surface and the distal "end" of the focal zone when using the gel pad which allows the greatest penetration depth. The penetration depth can be adjusted by using gel pads as spacers.
The maximum applied energy flux density (EFD), a local variable for the acoustic pressure signal measured at the central focal point, is an acoustic field parameter often used to help standardize protocols in clinical practice and scientific studies.

Penetration depth of PiezoWave[2]

Piezo shockwave enables pinpoint and precise energy delivered during diagnosis and treatment because the guidelines 'penetration depth', 'intensity' and 'angle of entry' can be preselected independently of one another. When applying focused shockwaves the greatest pressure is created in the focal zone. Thus, targeted defined penetration depths with independently adjustable energy intensity are important and unique characteristics of focused piezo shockwaves.

Figure 9 - Therapy source penetration depth with different gel pads

PiezoWave[2] therapy sources use exchangeable gel pads to ensure that the pulses reach the desired depth precisely and with as little scattering as possible (Figure 9). They are used as spacers and change the penetration depth in increments of 5 mm and 10 mm. The gel pads are designed to ensure that the virtual extensions of the cone-shaped exterior surfaces intersect precisely at the point of focus.

The central penetration depth ranges from 20 mm to 100 mm, with the distal penetration depth of 30 mm to 172 mm, depending on the choice of therapy source. The numbers on the gel pads show the penetration mm depth of the respective therapy source in mm (Figure 23).

Figure 10 - Gel on transducer under the gel pad (left) and line and dot on gel pad help for positioning (right)

Shockwave gel must be applied to the middle of the therapy source (Figure 10). When positioning the gel pad, any air bubbles can be eliminated by turning the gel pad.

Therapy sources for PiezoWave^2

In veterinary medicine, focal zone ranges are from 20 mm to 100 mm in central penetration depth and 30 mm to 172 mm in distal penetration depth. Treatments can be optimized by choosing the optimal therapy source to allow accurate application to the location of the target tissue.

The three different therapy sources most commonly used for small animal treatment are the F7G3, the F10G4, and the FBL10x5G2. Each has different and unique properties in terms of focal zones and EFD levels (Figure 11). Energy flux density, EFD, is a measurement of energy passing through the central penetration depth of the focal zone. The F7G3 is most commonly used for small animal therapy. It is small, light, easy to manipulate, and usually provides plenty of EFD and depth of penetration for treatment of small animals.

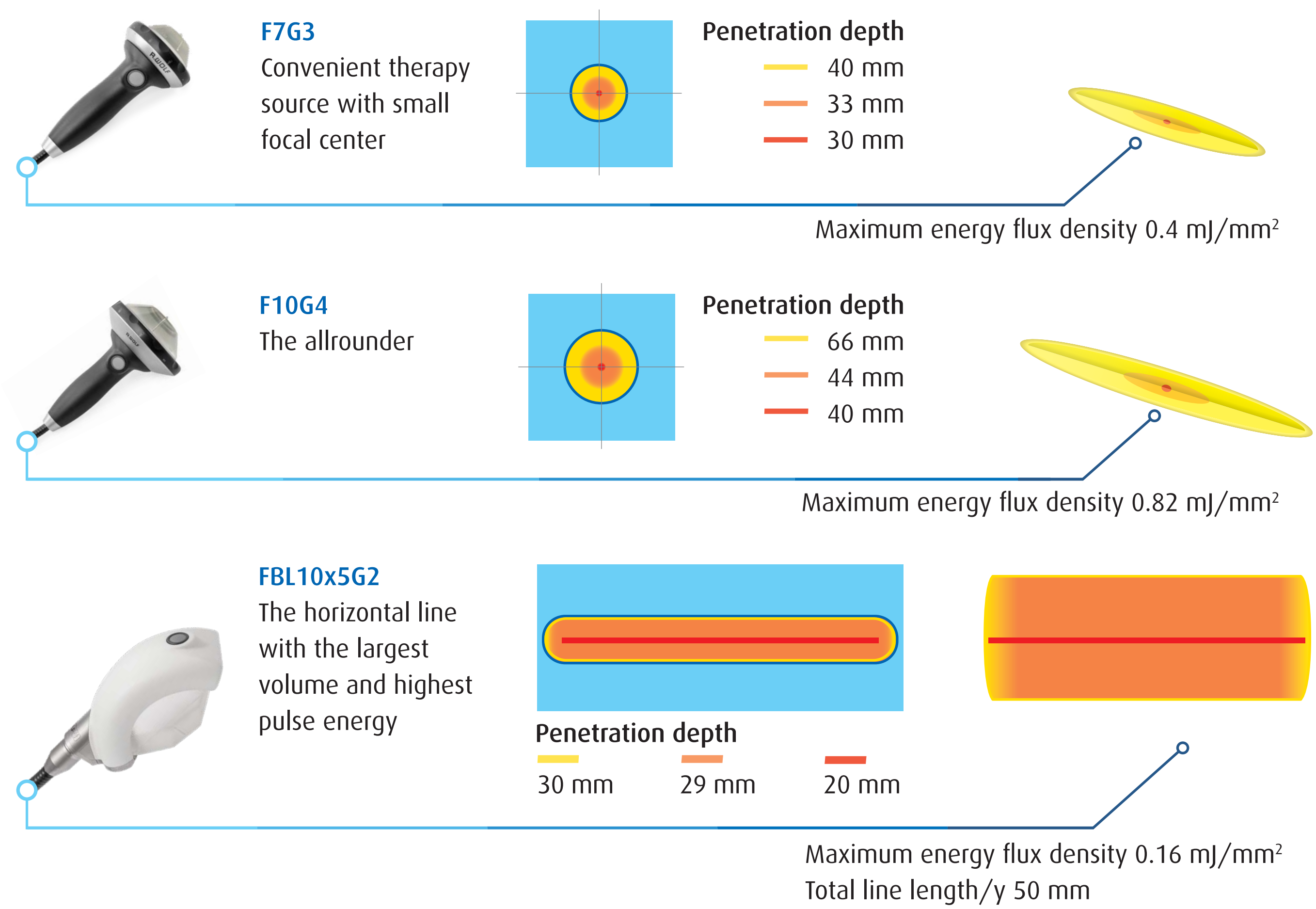
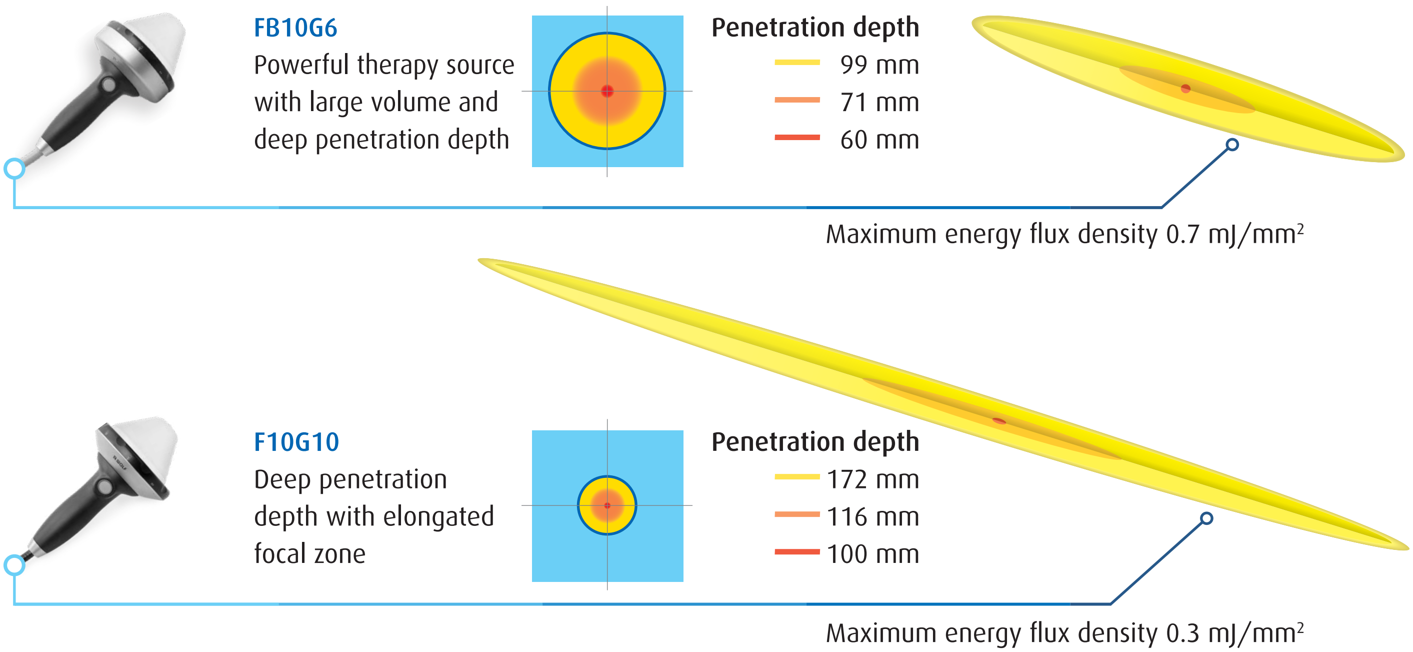


Figure 11 - Therapy sources used in small animal Veterinary medicine

In some cases, if more energy or depth of penetration is required, the larger F10G4 therapy source is an option. The linear-focused, high-volume therapy source, the FBL10x5G2, has a very large focal zone and allows for the treatment of large muscle bodies, or the tendon and muscle, or ligament and bone both to be within the focal zone.

The other two therapy sources for the PiezoWave[2], the FB10G6 and the F10G10 are most often used for large animal therapy (Figure 12). The very deep penetration of the F10G10 makes it useful for treating the caudal neck and the SI joint of horses; whereas, the FB10G6 provides a very high EFD. The linear-focused, high-volume FBL10x5G2 therapy source is also useful for equine distal limb tendon and ligament treatments.



Values may vary, depending on the preset intensity and may be rounded.

Figure 12 - Therapy sources used in large animal veterinary medicine

Richard Wolf Inc. and ELvation Medical have developed "a high-volume, linear-focused piezo shockwave" therapy source, an innovation that is the first of its kind worldwide (figure 13). The aim was to make the application of focused shockwaves faster, more uniform, and more effective. Gel pads are used to adjust the penetration depth to depths between 0 mm and 30 mm (maximal penetration depth). Benefits of this new technology include; ability to treat much larger volume, quicker and more uniform applications, treatment of large anatomical sites (tendon insertions, muscles, wounds ...) and simultaneous treatment of several adjacent areas.

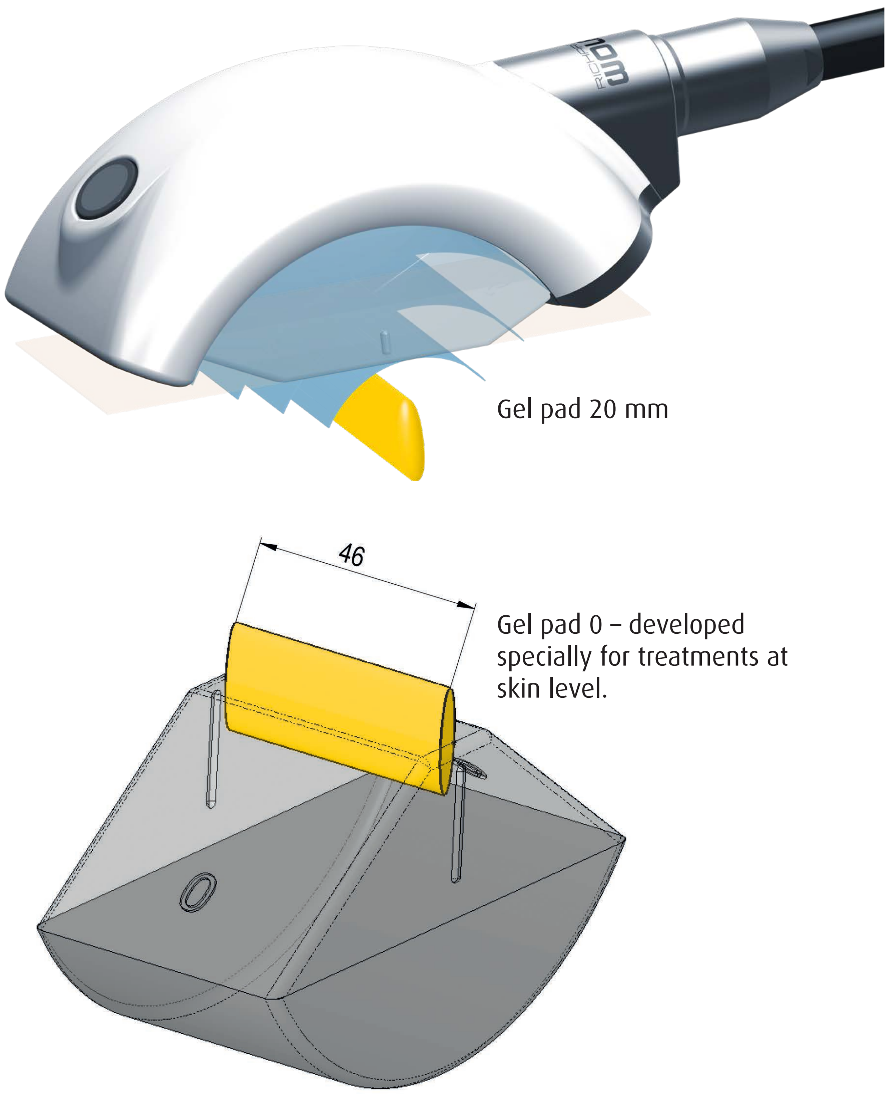


Figure 13 - The high-volume linear-focused therapy source FBL10x5G2

Therapy source: F7G3
Max. central penetration depth:
30 mm

Therapy source: F10G4
Max. central penetration depth:
40 mm

Therapy source: FBL10X5G2
Max. central penetration depth:
20 mm

Energy flux density: therapy sources F7G3, F10G4, and FBL10x5G2

Level	F7/G3 Energy flux density (mJ/mm²)	F10/G4 Energy flux density (mJ/mm²)	FBL10x5G2 Energy flux density (mJ/mm²)
0.1	0.018	0.032	N/A
0.2	0.019	0.039	N/A
0.3	0.022	0.044	N/A
0.4	0.025	0.047	N/A
0.5	0.030	0.054	N/A
0.6	0.031	0.060	N/A
0.7	0.038	0.064	N/A
0.8	0.040	0.072	N/A
0.9	0.045	0.080	N/A
1	0.048	0.092	0.018
2	0.063	0.113	0.021
3	0.073	0.138	0.027
4	0.086	0.153	0.029
5	0.097	0.182	0.034
6	0.110	0.220	0.041
7	0.123	0.238	0.046
8	0.134	0.270	0.051
9	0.154	0.320	0.060
10	0.167	0.351	0.064
11	0.191	0.388	0.069
12	0.210	0.456	0.079
13	0.227	0.478	0.087
14	0.255	0.516	0.097
15	0.272	0.581	0.106
16	0.299	0.601	0.113
17	0.315	0.646	0.126
18	0.346	0.654	0.139
19	0.376	0.770	0.147
20	0.403	0.822	0.160

Table 1 - EFD values for small animal therapy sources

Therapy source: FB10G6
Max. central penetration depth:
60 mm

Therapy source: F10G10
Max. central penetration depth:
100 mm

Energy flux density: therapy sources FB10G6 and F10G10

Level	FB10G6 Energy flux density (mJ/mm²)	F10G10 Energy flux density (mJ/mm²)
0.1	0.027	0.011
0.2	0.029	0.012
0.3	0.032	0.013
0.4	0.037	0.015
0.5	0.043	0.017
0.6	0.046	0.018
0.7	0.052	0.021
0.8	0.055	0.023
0.9	0.062	0.025
1	0.075	0.031
2	0.088	0.035
3	0.111	0.044
4	0.124	0.051
5	0.14	0.058
6	0.168	0.071
7	0.187	0.076
8	0.213	0.085
9	0.242	0.100
10	0.266	0.114
11	0.291	0.121
12	0.341	0.142
13	0.377	0.152
14	0.393	0.168
15	0.461	0.190
16	0.483	0.205
17	0.519	0.231
18	0.599	0.244
19	0.628	0.259
20	0.702	0.323

Table 2 - EFD values for large animal therapy sources

Use of PiezoWave² in small animal veterinary medicine

Shockwaves are mechanical stressors which induce biochemical changes in living tissue[3]. Mechanical stimuli affect almost all cellular functions in living tissue, including growth, cell differentiation, cell migration, protein synthesis, physiological apoptosis, and tissue necrosis[11]. On a molecular level, the biochemical changes ultimately affect the gene expression of cells by eliciting specific tissue reactions[12]. Below is a list of specifically studied effects of shockwave.

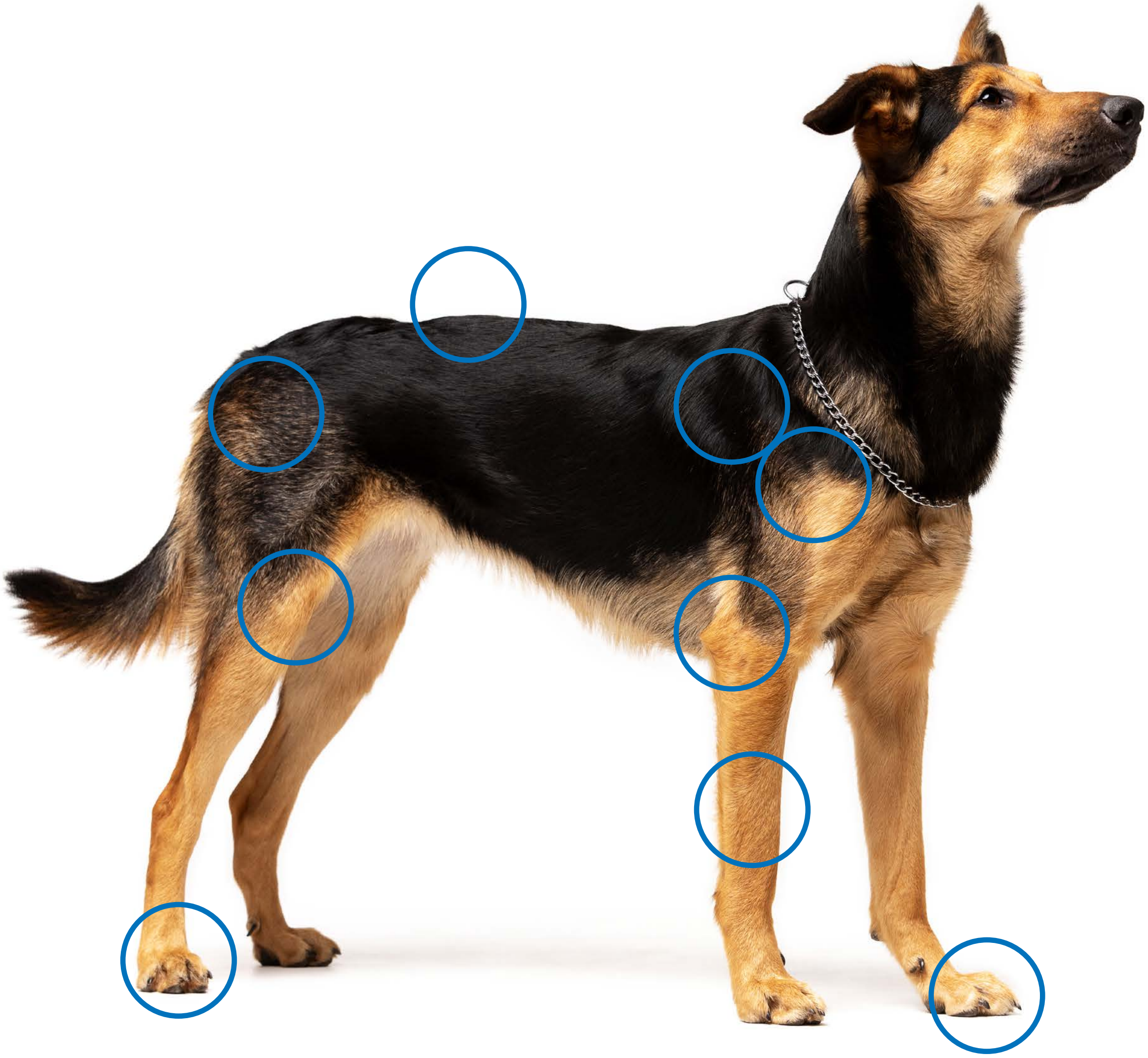
- Stimulates new blood vessel formation [13,14,15]
- Regulates inflammation [16]
- Releases nitrogen monoxide (NO) which contributes to vasodilation, increases metabolic activity and angiogenesis, and exerts an anti-inflammatory effect [13]
- Changes levels of Substance P [17]
- Stimulates bone metabolism [18]
- Releases growth factors; IGF, TGFbeta, VEGFgamma [19,20,21]
- Exhibits chondroprotective effects [22]
- Dissolution of calcified fibroblasts [23]
- Stimulates lubricin production [24]
- Stimulates stem cells [25]
- Antibacterial effects [26]

The treatment of orthopedic disorders plays an important role in small animal medicine. Shockwave is one of the few medical technologies which treats pain syndromes of the musculoskeletal system by repeatedly triggering the body's own self-healing processes[3,12]. There are many studies that describe the use and verify the efficacy of shockwave for healing of both bone and soft tissue in veterinary medicine [5,6,7,8,9,27]. Shockwaves are able to stimulate the endogenous production of lubricin in the tendons and at tendon insertions [24]. Lubricin helps tendons slide within joints and an increased amount of lubricin could provide pain relief and decreased joint erosion and account for some of the clinical success of shockwave when treating chronic osteoarthritis.

The efficacy of shockwave for trigger point treatment and the effectiveness of focused piezo shockwaves has also been studied[28].

A representation of conditions piezoelectric shockwave can be used to treat in small animal veterinary medicine are listed below. More information can be found in the remainder of this document.

- **Shoulder diseases** - Bicipital tenosynovitis, Supraspinatus and Infraspinatus insertional tendinopathy
- **Elbow diseases** - Degenerative joint disease
- **Carpal diseases** - Degenerative joint disease, Tendon/Ligament injuries acute and chronic
- **Intervertebral disc disease & Lumbosacral stenosis**
- **Coxofemoral diseases** - Degenerative joint disease, Iliopsoas trigger points
- **Stifle diseases** - Cranial cruciate disease, Patella luxation, Degenerative joint disease, Patella tendonitis, Medial and lateral collateral ligament inflammation, Long digital extensor tendonitis
- **Tarsal diseases** - Ligament injuries acute and chronic, Achilles tendinopathy
- **Wounds**
- **Osteochondritis dessicans (OCD)**



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Section 2 - Clinical use of the PiezoWave²

Piezo technology - key characteristics

- Direct focusing technology (precisely defined, perfect for localizing and treating pain points)
- Precisely adjustable penetration depth
- Penetration depth and intensity settings can be adjusted independently
- No pain at the interface between patient and device
- Variable intensity settings for improved patient comfort
- High-volume, linear-focused therapy source: perfect for uniform applications
- Very long lifespan
- Quiet and tolerable to minimize the animal's flight instinct and avoid the necessity for sedation in most cases
- Excellent massage effect, even for deep myofascial structures

Safety and adverse effects

Since 1998, thousands of veterinary patients have been treated with focused shockwaves. An initial clinical study for shockwave use in veterinary medicine, Initial Experiences with Extracorporeal Shockwave Therapy for Treatment of Bone Spavin in Horses, was published in 2002[1]. Although it is still a relatively new form of small animal veterinary therapy, shockwave is being used to effectively treat musculoskeletal disorders in small animals safely with limited side effects[2,3,4,5,6,7]. Generally, treatment side effects reported in literature are minimal with some variation based on the type of the shockwave device being used and the intensity of shockwave treatment being delivered. This piezoelectric technology is also used for human therapy and the treatment of acute and chronic musculoskeletal pain[8].

It is important that shockwave be performed by trained veterinary medical professionals that know when and where shockwave should and should not be used. The decision as to whether or not to carry out a planned application is the responsibility of the end-user and must be based on the patient’s current condition.

Basic contradictions include:

- Areas of infection in the focal area
- Malignant tissue in the focal area
- Coagulation disorders (a prior check of the coagulation status may be necessary)
- Use in conjunction with blood-thinning medication
- Pregnancy, fetus near the focal area
- Lung tissue in the focal area
- Brain tissue or spinal cord in the focal area
- Eyes in the focal area
- Epiphyseal growth plate in the focal area

Common clinical conditions treated with PiezoWave[2]

Degenerative joint disease (DJD) or osteoarthritis (OA)

DJD or OA is the progressive deterioration of the articular cartilage of diarthrodial (synovial) joints mainly due to secondary causes such as; trauma, infection, immune-mediated diseases, developmental malformations, joint instability, repeated abnormal activity, etc. DJD is characterized by hyaline cartilage thinning, joint effusion, and periarticular osteophyte formation. Clinical signs of DJD include lameness, pain, joint swelling, muscle atrophy, pericapsular fibrosis, reduced joint range of motion, and crepitation. Treatment goals are to control pain, improve joint function and mobility, delay the progression of disease, and promote the quality of life. Shockwave provides rapid and long-lasting pain relief in DJD patients by regulating proinflammatory cytokines, promoting the proliferation and regeneration of cartilage tissues, and stimulating lubricin production.

Figure 15 - Radiograph of severe stifle OA

Figure 16 - Radiograph of tarsus OA

Intervertebral disc diseases (IVDD)

IVDD is a degenerative disease of the spine characterized by premature calcification of the nucleus pulposus in the intervertebral disc. The disc degeneration is initiated by one or more factors including traumatic injury, chronic overload, spinal hypomobility or hypermobility, age-related deterioration in collagen and cartilage, and developmental malformations. Clinical signs range from back pain and lameness, to paresis with decreased proprioception, to paraplegia. Treatment programs will differ according to degree of IVDD, but are multimodal and focus on pain relief and mobility. Shockwave provides rapid pain relief, as well as promotes nerve healing by stimulating vascular endothelial growth factor (VEGF) expression and angiogenesis in damaged neural tissue. Furthermore, shockwave has shown to decrease secondary damage of nerve tissue (neuroprotective effect) and improves recovery of motor function after nerve injury.

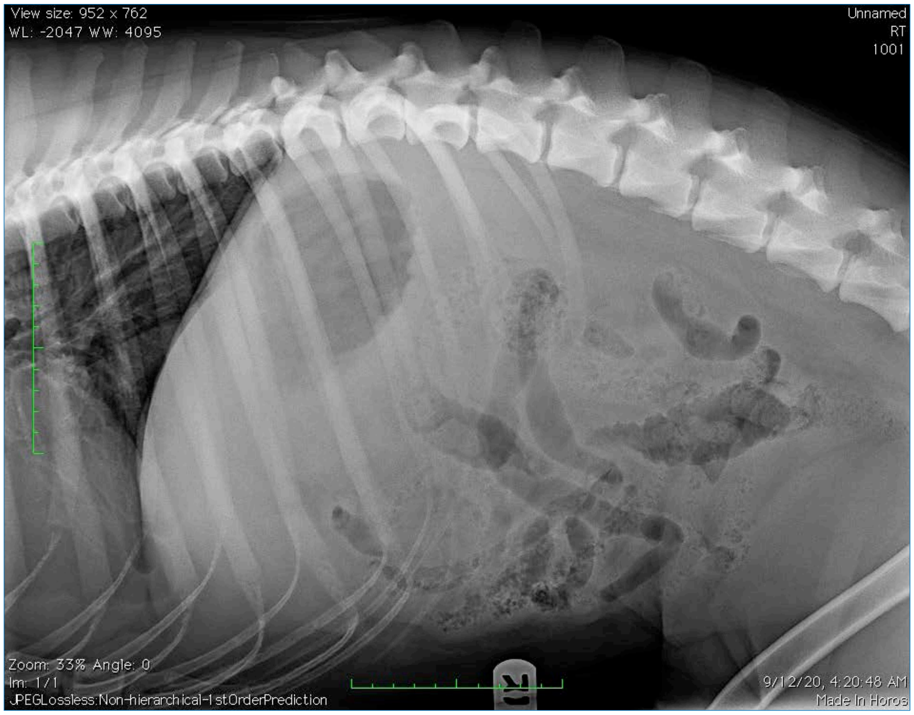

Figure 17 - Radiograph of canine IVDD with disc space narrowing T13-L1

Lumbosacral stenosis or cauda equina syndrome

Lumbosacral stenosis refers to narrowing of the lumbosacral vertebral canal and/or L7–sacral intervertebral foramina, causing compression of L7 sacral or caudal nerves. Cauda equina syndrome implies pain or other clinical signs related to compression and dysfunction of these spinal nerves. The narrowing spinal canal may be caused by: congenital malformation, intervertebral disc degeneration or disease, discospondylitis, spondylosis, trauma, or neoplasia. Common clinical signs of cauda equina syndrome include rear end back pain and weakness. Some dogs will develop progressive hind limb weakness, muscle wasting, and postural reaction deficits caused by L7 and/or sacral nerve dysfunction. Treatment of cauda equine syndrome generally involves conservative multimodal approach with the goals to alleviate pain, improve strength, delay the progression of disease, and promote the quality of life. Shockwave provides rapid pain relief, as well as promotes nerve healing by stimulating vascular endothelial growth factor (VEGF) expression and angiogenesis in damaged neural tissue. Shockwave has also shown to decrease secondary damage of nerve tissue (neuroprotective effect) and improve recovery of motor function after nerve injury.

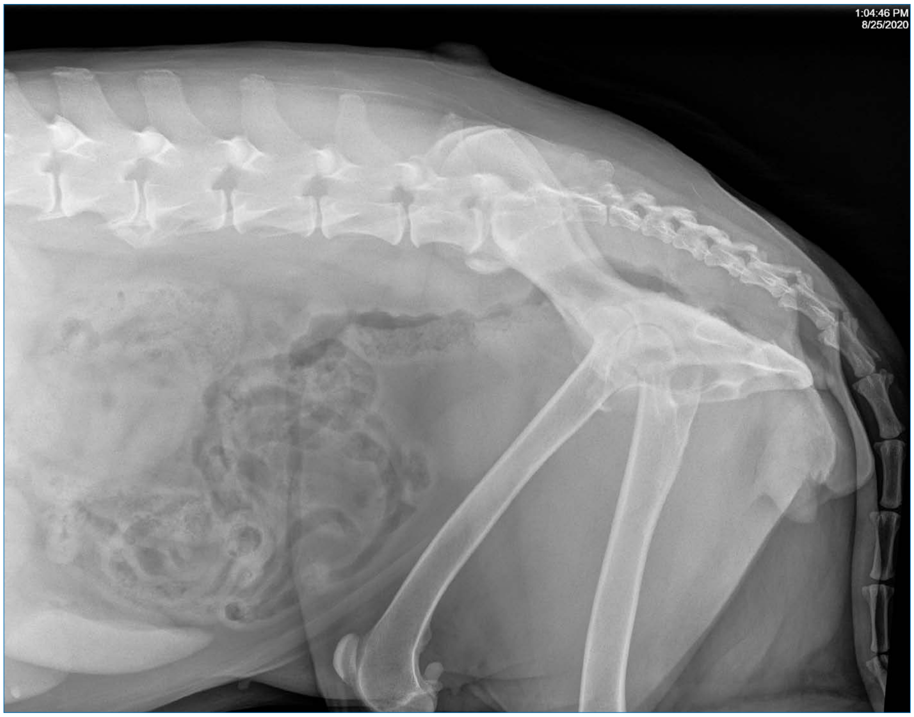

Figure 18 - Radiograph of bridging lumbosacral spondylosis

Tendon disorders

Tendons are tough bands of fibrous connective tissues that connect muscles to bones. Tendon injuries may be caused by acute trauma, repetitive overloading, or gradual wear and tear to the tendon from overuse or aging. Tendinopathy usually causes varying degrees of pain, inflammation, lameness, stiffness, and loss of strength in the affected joint. The affected lesion may be sore, warm, or swollen to the touch. In chronic tendinopathy, fibrotic scarring tissues (fibrosis) may be palpated along the affected tendon. Non surgical management of tendinopathy consists of pain medication, rest, cryotherapy, manual therapy, and eccentric strengthening exercises. The use of therapeutic modalities such as therapeutic ultrasound, laser, acupuncture, and shockwave therapy has been documented to relieve pain, reduce inflammation, increase blood supply, and promote healing in tendinopathy [9,10].

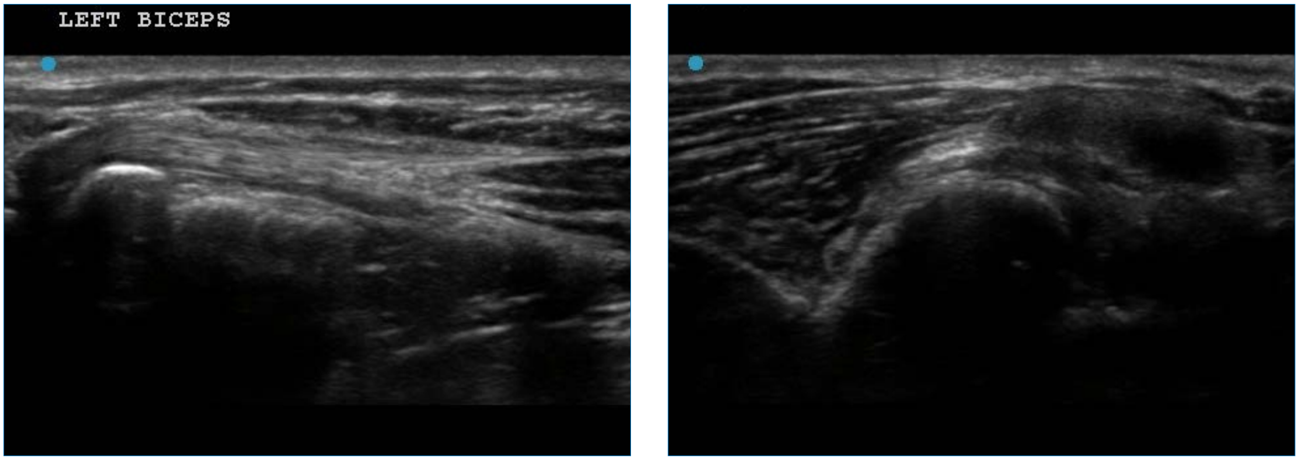

Figure 19 - MSK ultrasound of a healthy biceps musculoskeletal junction (left) and a supraspinatus insertion tendinopathy with hyperechoic debris (right).

Myofascial trigger points

Myofascial trigger points (MTrP) are palpable focal, tender areas of contracture located within a taut band inside the skeletal muscle. Myofascial pain syndrome (or chronic myofascial pain) is a syndrome characterized by chronic pain that persistently radiates from myofascial trigger points and fascial constrictions. The causes of MTrP are not fully understood, but it typically occurs after a muscle has been contracted repetitively from overuse, trauma, osteoarthritis, intervertebral disc disease, neuropathy, mobility dysfunction, poor posture and gait, post-surgery, and prolonged immobility. Therapies such as manual therapy, acupuncture, dry needling, laser, and shockwave are effective in treating MTrP and myofascial pain[11]. Shockwave therapy can physically break up the contracture as well as provide pain relief and increased circulation to the area[11].

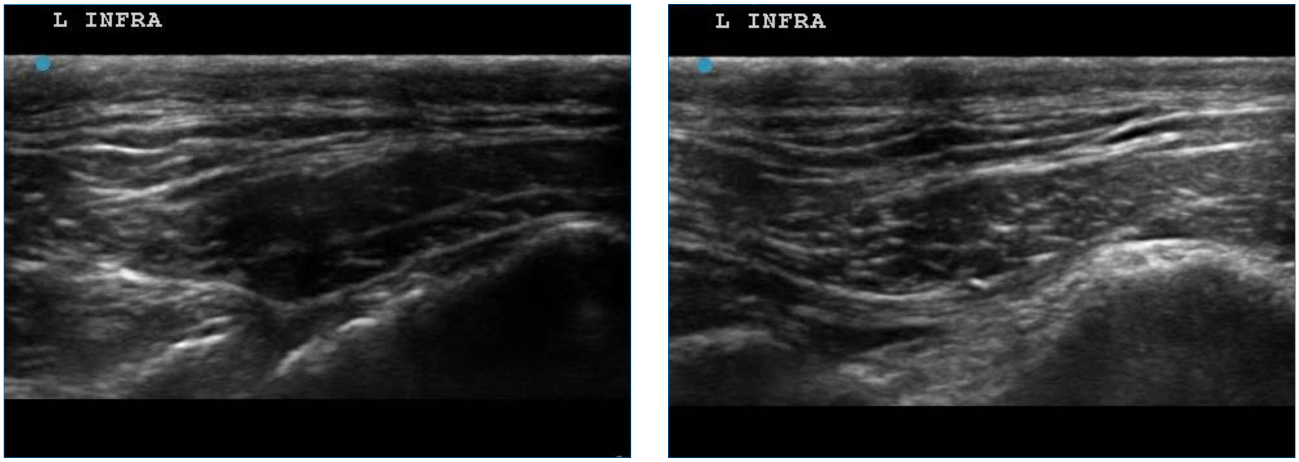

Figure 20 - MSK ultrasound of infraspinatus muscle before PiezoWave^2 (left) and after 4 PiezoWave^2 treatments, 12 days (right).

General treatment information

Patient preparation

The acoustic pulses generated in the transducer of the therapy source require a liquid medium to travel through. This is created by the gel pad, coupling gel, and water. Very long, thick coat hair may need to be trimmed before starting treatment. Moisten the area to be treated generously with water e.g. with the aid of a spray bottle and apply sufficient coupling gel. Avoid excess hair and air bubbles to ensure that the acoustic pulses will be properly transmitted to the target area.

Sedation

PiezoWave² therapy is usually very well tolerated by small animals, making sedation often unnecessary. At the start of every therapy, it is important to gradually accustom the animal to treatment, which means starting at a low intensity and gradually increasing the intensity. It is important to pay attention to any signs of pain or defensive movements by the patient and adjust the intensity accordingly.

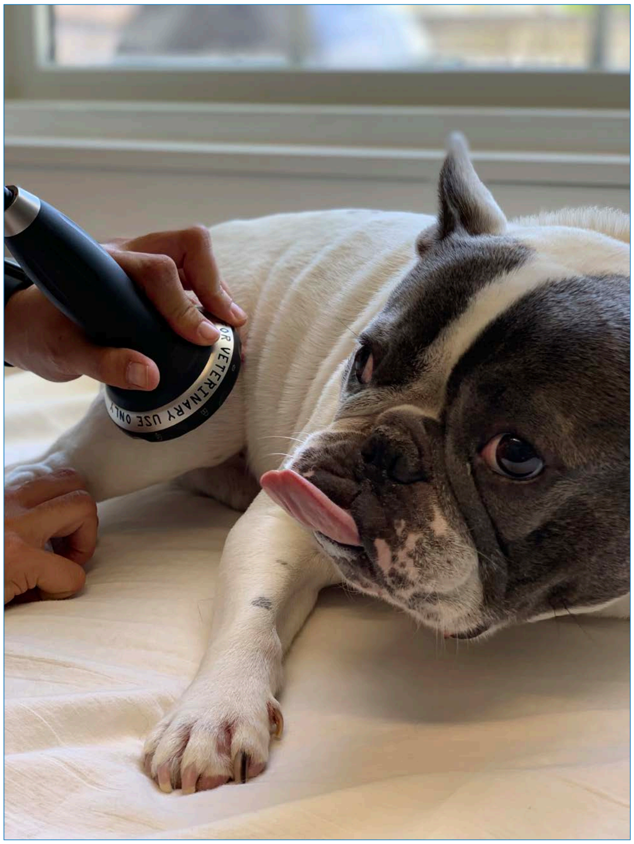

Figure 21 - PiezoWave² as a calm comfortable treatment process

Determining treatment guidelines

Each individual case will require specific treatment guidelines in terms of therapy source, gel pad size, energy intensity (EFD) of the applied therapy, frequency of pulses per second, and total number of pulses administered.

Therapy source

To optimize the therapeutic results, the user should understand the characteristics and choice of the best therapy source for each situation. A review of specific therapy sources is in Section 1 - Therapy sources for PiezoWave[2] (page 14).

Figure 22 - The F7G3 and FBL510x5G2 are the most commonly used therapy sources for small animal therapy

Gel pad

With Piezowave²'s site-specific focused energy, it is important to choose the appropriate stand-off gel pad for the correct depth of penetration (page 12).

Figure 23 - The numbers on the gel pads represent central penetration depth in mm

It is best to use a combination of manual palpations and diagnostic imaging to determine the area of damaged tissue, the depth of penetration required to reach it, and the optimal angle of entry for the therapy source. If imaging is not possible, the correct stand-off gel pad can be chosen based on knowledge of the anatomy, and the ability of the PiezoWave² to scan for and flare pain points that are identified by the patient's bio feedback. When treating different anatomical structures in one session, it may be necessary to use multiple different gel pads.

Pulse frequency

Current literature does not define the biological response to variations of pulse frequency (pulses/second, Hz). Pulse frequency is adjusted primarily to help make the treatment more tolerable for the patient. Starting with a lower setting, such as 4-5, and increasing to tolerance while looking for pain and biologic response is best. In some patients, a higher frequency can be more painful; while in others, a higher frequency is less painful.

Figure 24 - The left plus and minus keys are used to set the pulse frequency from 0 to 8.

Dosing - EFD and number of pulses

Energy flux density, EFD, values are a means to quantify treatment intensity and standardize treatments, especially when comparing energy from different shockwave sources. It is evident that, due to acoustic impedance, different tissue types require different amounts of energy to initiate mechanotransduction and trigger the biological effect of shockwave.

Effective energy levels are patient and injury dependent; therefore, energy levels applied are primarily guided by the patient's treatment tolerance. Variations in injury type, stage of the injury, as well as individual patient pain tolerance result in the ranges of recommended treatment values in this document. Assessing patient outcomes and treatment progression can also guide energy intensity. Patients often tolerate more energy as the healing process progresses.

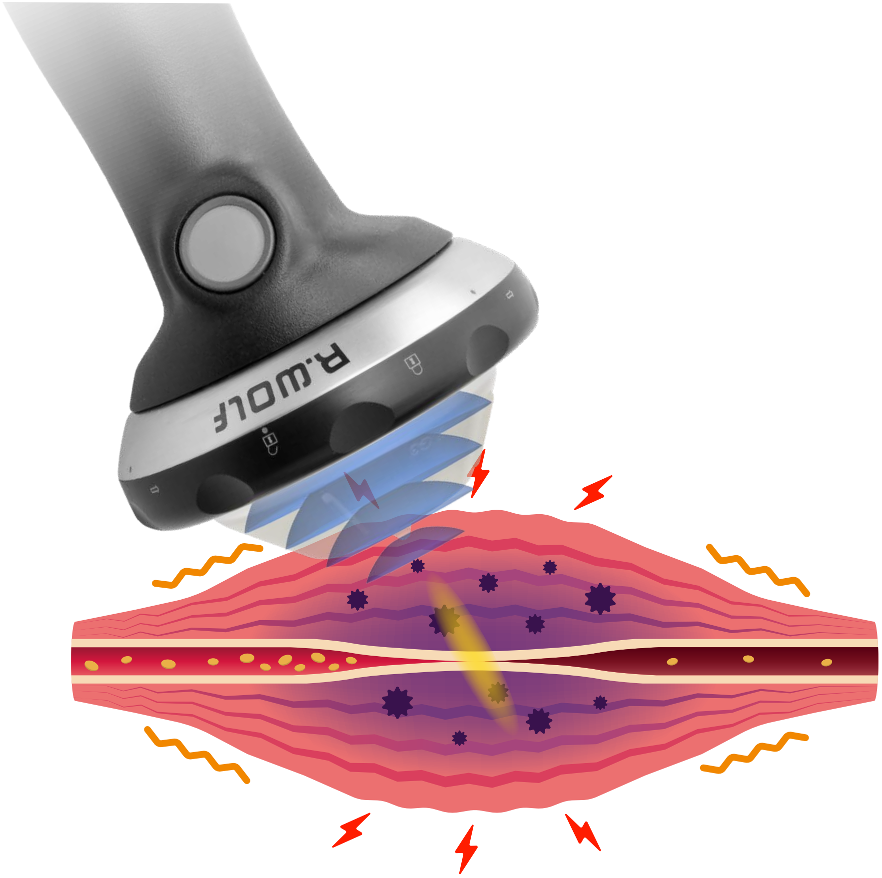

Figure 25 - A representation of the PiezoWave² focal zone within inflamed tissue

When treating similar clinical conditions, individual patients have different sensitivity to the shockwave energy. This document supplies suggested ranges of energy levels with which our users have seen positive results. In general, it is important to start the therapy with low energy (e.g. power intensity of 0.5 to 2 on the control unit with the F7G3 therapy source) and work up according to the patient's tolerance paying attention the animal's cues. The energy flux density tolerated by each patient may also be affected by the method in which the therapy source is being moved and positioned during the treatment session. When the energy engages injured tissue it can become painful to the patient and the operator may need to decrease the power intensity to make the therapy tolerable.

The total number of pulses for treatment of a specific conditions is case dependent. Since the amount of energy needed to create mechanotransduction in the cells of patients has not been defined, the attending veterinary professional should evaluate the patient's response and adjust total number of pulses accordingly.

When determining the total number of pulses and recommended energy levels, it is important to understand that unlike when using lasers, **the energy is not accumulated in the tissue**. Each shockwave impulse triggers the tissue and is then converted into mechanical energy. Therefore, the quantity of pulses and energy flux density used must be enough to mechanically process the tissue.

Treatment schedule

Positive clinical results with the PiezoWave² can be seen after only one or two treatments. But for healing to occur, **a schedule of either once or twice per week for a total of 3-6 treatments** is recommended. Biweekly low energy treatments are useful during the initial therapy of acute injuries. In chronic conditions, after a series of weekly treatments and with the pain under control, the frequency of treatments can be decreased to an as-needed basis. Scheduled re-evaluations should be used to determine if more PiezoWave² therapy is needed.

Figure 26 - Treatment schedules should be case specific with scheduled re-evaluations to monitor progress

Technique for therapy application

It is important that the damaged tissue receives enough energy to stimulate a biologic reaction (mechanotransduction). To get this optimal effectiveness from each treatment session the positioning of the therapy source, the therapist, and the animal are all important.

Movement and positioning of the therapy source should be accurate and precise. It is recommended that the therapist be in a comfortable position next to the pet with their dominant hand on the therapy source and the other hand on the pet feeling the surrounding tissue. The animal should also be in a comfortable position in which they can remain still and relaxed.

If the location of the damaged tissue is clearly identified, a static treatment can be used, and the therapy source is held at the location of the injury or moved a short length along the specific tendon or ligament. A small rocking of the therapy source and changing of the angle of entry can be used to slightly expand the area of treatment.

Figure 27 - A representation of the PiezoWave^2 focal zone with a small rocking of the therapy source

Ultrasonic guidance

If ultrasound imaging is available, it can be used to help determine the positioning of the PiezoWave[2] therapy source. The optimal site and angle of entry for the therapy source is the same as that from which the sonographer receives the best diagnostic image.

PiezoWave[2] as a diagnostic tool

Sometimes the exact locations of pain points, whether the primary injury or secondary due to compensation, are not known. In these cases, the PiezoWave[2] can be used in a diagnostic manner to identify these sites by flaring the pain points. The therapy source is used in a dynamic technique and moved slowly over the suspected area beginning at a low energy intensity while carefully monitoring for the patient's reaction. If no reaction is seen, the intensity is gradually increased and the scan is repeated. When a specific pain point is identified via the animal's bio feedback, the therapy source is held stationary in that position for around 500-1000 pulses. It may be useful to gently rock the therapy source at a specific site to provide a slight increase in treatment area. After therapy on a single point is complete the therapist can continue to slowly scan the area and to locate another pain point and repeat the process. If the patient is not tolerating the energy of the therapy needed to identify the pain point or flare the injured site, in most cases, the intensity level can be lowered to a tolerable level and positive results will still be seen.

The values given for **suggested treatment guidelines in this document are for static application** of the energy unless otherwise noted.

Post treatment care

Early controlled movement acts as a stimulus on the healing areas and is essential for the recovery process. Excessively long rest periods result in structures atrophying, reduced metabolic activity, and can have a significant negative effect on the patient's psyche. A structured rehabilitation plan with a program of specific exercises can have a decisive impact on the successful outcome of therapy. Each patient's follow up care should be designed by a veterinary medical professional with re-evaluations to monitor the patient's progress. It is important to recognize there is an analgesic effect with shockwave and no patient should overstress the affected structures for at least 72 hours post treatment.

Figure 28 - Hydrotherapy is a common component of many rehabilitation plans

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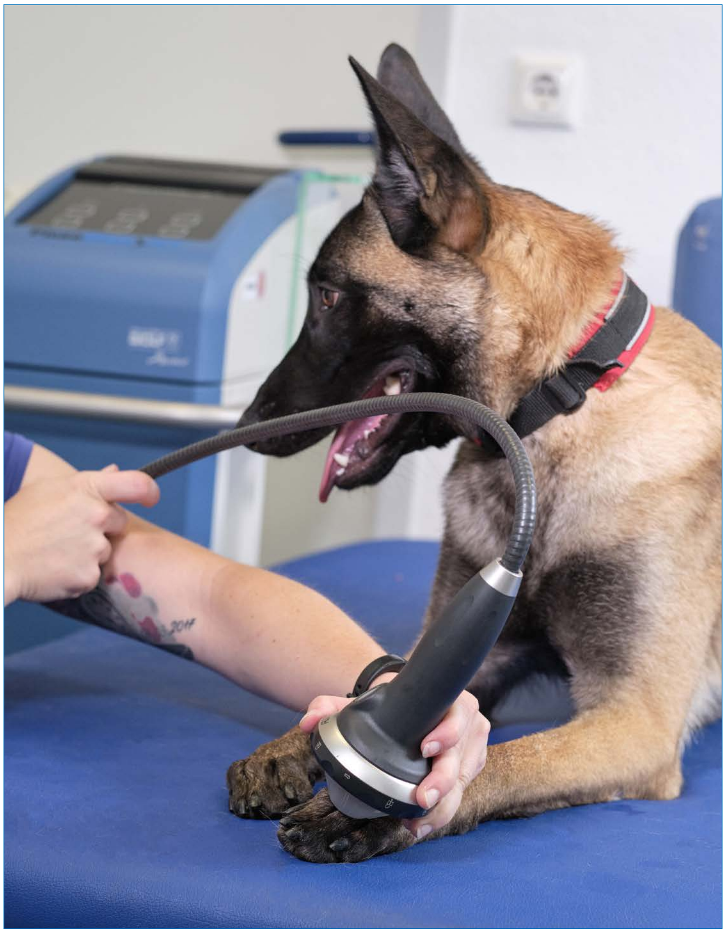
Section 3 - Suggested treatment guidelines

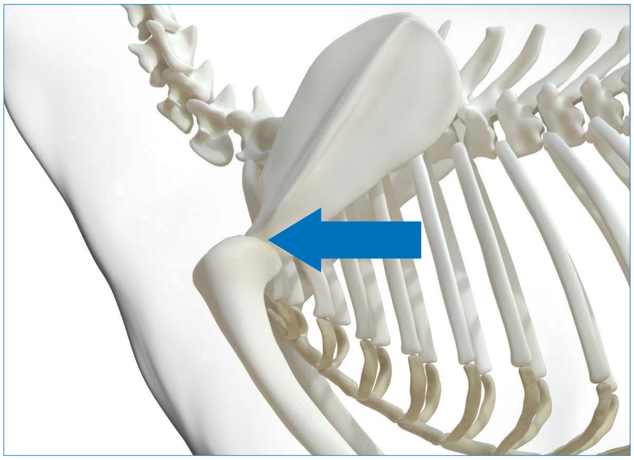


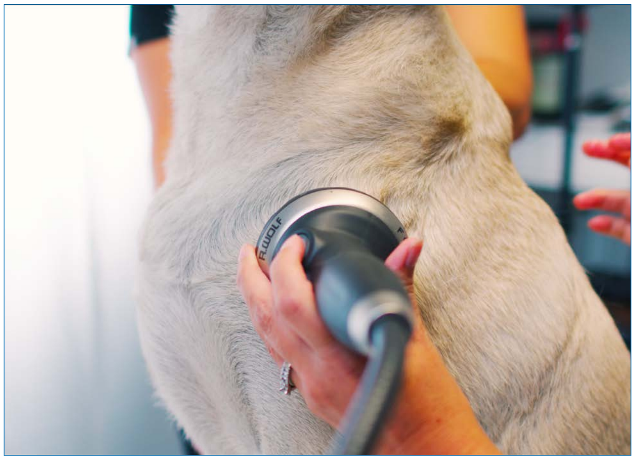
General considerations

- Guidelines and positions are merely suggestions for optimal results, each clinician may have different preferences for specific cases.
- Information is based on the clinical experiences of contributing clinicians. Clinicians utilizing the PiezoWave² report a wide range of guidelines as being effective and other published sources may vary from what is offered here.
- Standoff pad size is selected based on the depth of tissue to be treated.
- It is important the proper therapy source is used and that the end user understands the focal zone, distal and central penetration depth, and specific EFD for said therapy source.
- It is recommended to start low with both EFD and number of pulses and adjust according to patient's biofeedback.
- It is best to monitor the patient's response prior to increasing energy intensity.
- If a response is not seen after several treatments it is recommended to gradually increase the energy intensity.
- A treatment schedule of either once or twice a week for 3-6 treatments is usually recommended.
- The guidelines given are for static application of the energy if working in a dynamic mode they may need to be adjusted.
- Treatment with shockwave should be part of a case specific program determined and monitored by a specialist in the veterinary field and is best paired with a rehabilitation program.

Shoulder diseases

Shoulder degenerative joint disease





Therapy source position

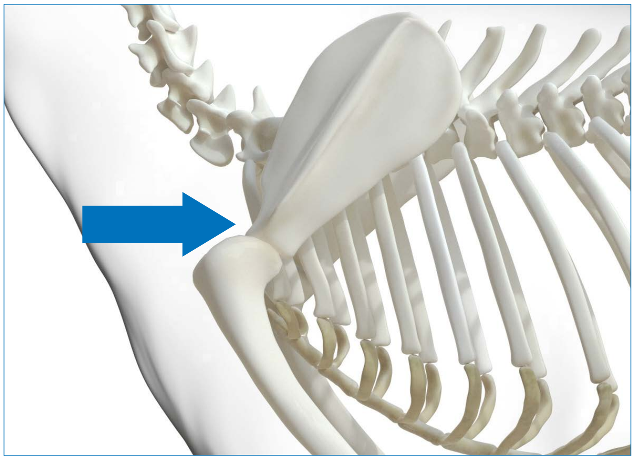
Shoulder degenerative joint disease

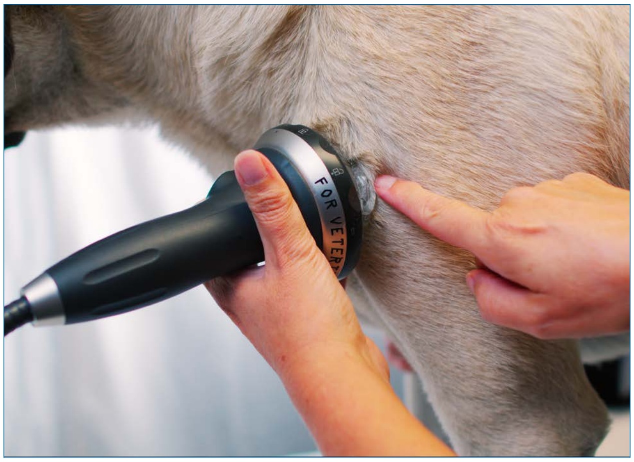
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-20	6-8	800-1500	0.032-0.134	0.6-8	0.1-3	5-18

Position the therapy source on the slightly flexed joint space. Patient can stand or lie down. The shoulder joint space is palpable craniodistal to the acromion process. Place the therapy source along the joint line and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, decrease pain, increase range of motion, vasodilation via upregulation of nitrogen monoxide (NO), angiogenesis, exhibit chondroprotective effects, stimulate stem cell production, dissolution of calcified fibroblasts, stimulate lubricin production, stimulate bone production, activate osteoblasts

Bicipital tenosynovitis





Therapy source position

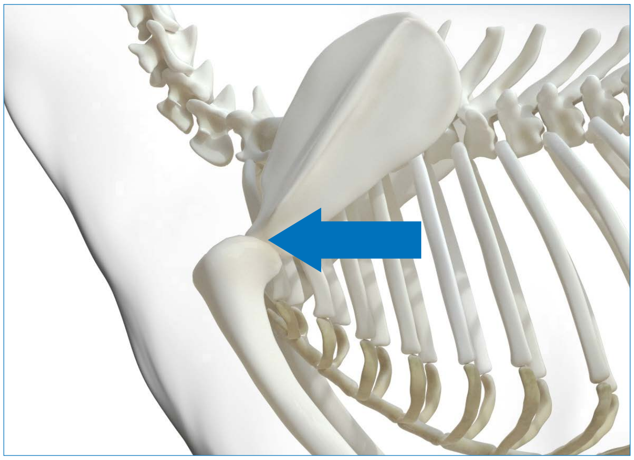
Bicipital tenosynovitis (acute)

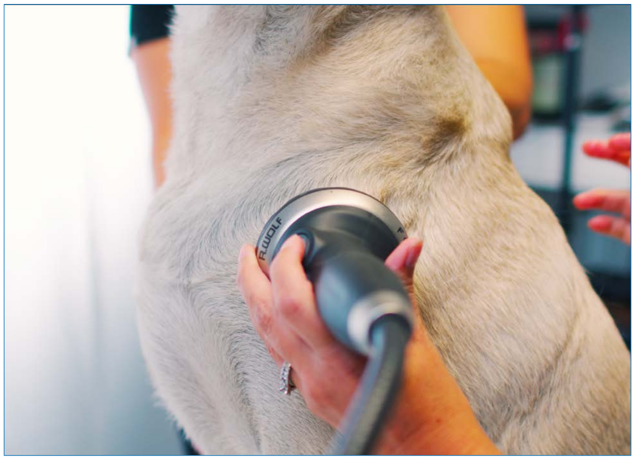
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 aIntensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source on the injured tendon near the musculotendinous junction, this is palpable at the cranial aspect of the shoulder joint. The patient may stand or lie down. Angle the therapy source toward the insertion of the muscle fiber and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen mon-oxide (NO)

Supraspinatus insertional tendinopathy





Therapy source position

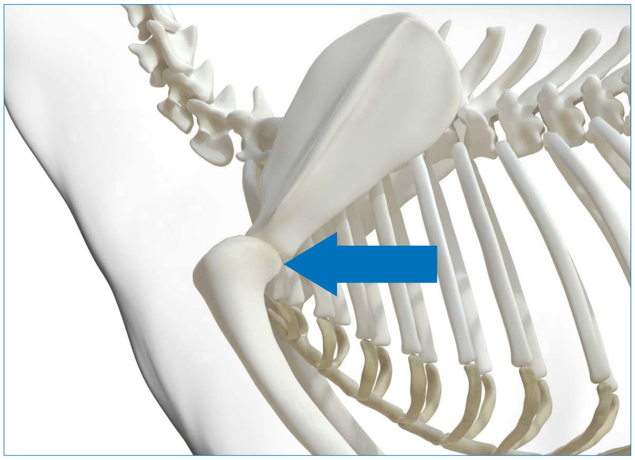
Supraspinatus insertional tendinopathy (acute)

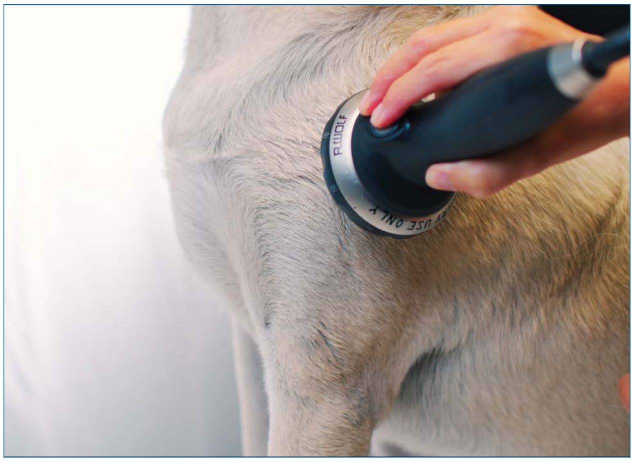
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source on the injured tendon near the musculotendinous junction just craniodistal to the acromion process. The patient can stand or lie down. Angle the therapy source toward insertion of the muscle fibers and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Infraspinatus insertional tendinopathy





Therapy source position

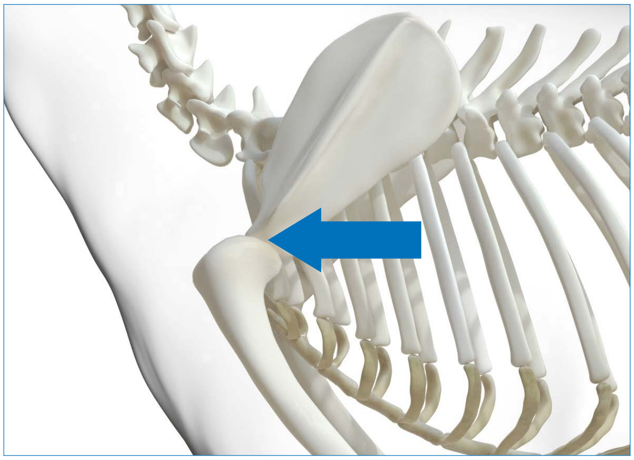
Infraspinatus insertional tendinopathy (acute)

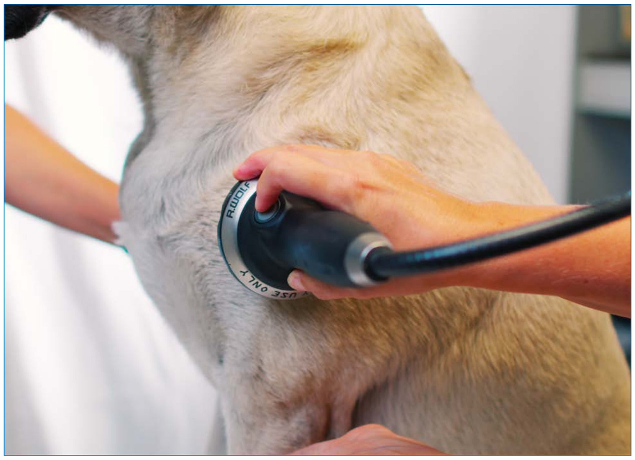
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source on the injured tendon near the musculotendinous junction just caudal to the greater tubercle of the humerus. The patient can stand or lie down. Angle the therapy source toward insertion of the muscle fibers and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Shoulder osteochondritis dissecans (OCD)





Therapy source position

Shoulder OCD (confirm with the radiographs)

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	3000	0.272-0.362	15-18	8-10	NA

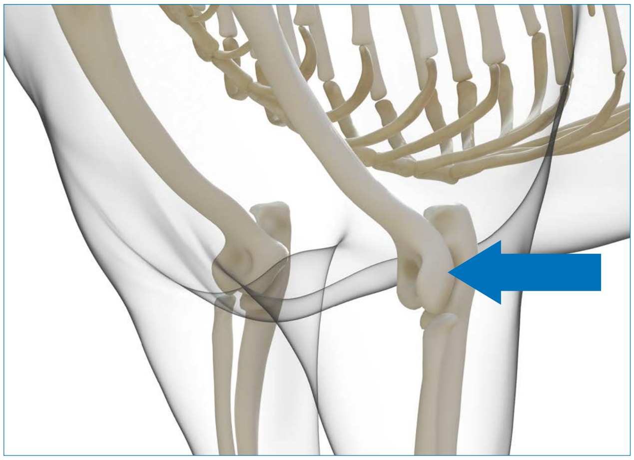
Patient should be sedated for this procedure.

Position the therapy source on the anatomical area of OCD from radiographs on the caudal humeral head. Therapy source should be positioned at an angle that directs the energy to the lesion. The shoulder should be flexed to allow access to the area of interest. Choose standoff pad slightly larger than lesion to incorporate new periosteum.

Goal of therapy: create new bone formation by stimulating osteoblast production and prevent a cartilage flap from separating

Elbow disease

Elbow degenerative joint disease



Therapy source position

Elbow degenerative joint disease (this includes elbow dysplasia as well as acquired osteoarthritis)

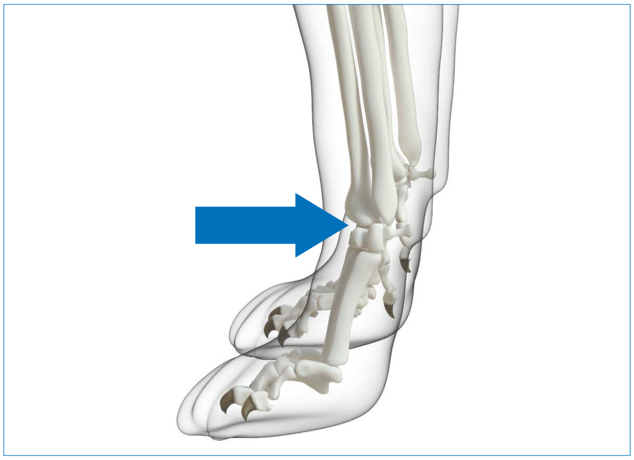
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-20	6-8	800-1500	0.032-0.134	0.6-8	0.1-3	5-18

Position the therapy source on the slightly flexed joint space. Have the pet stand or lie with their elbow partly flexed. Place the therapy source along the joint line and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, decrease pain, increase range of motion, vasodilation via upregulation of nitrogen monoxide (NO), angiogenesis, exhibit chondroprotective effects, stimulate stem cell production, dissolution of calcified fibroblasts, stimulate lubricin production, stimulate bone production, activate osteoblasts

Carpal diseases

Carpal degenerative joint disease



Therapy source position

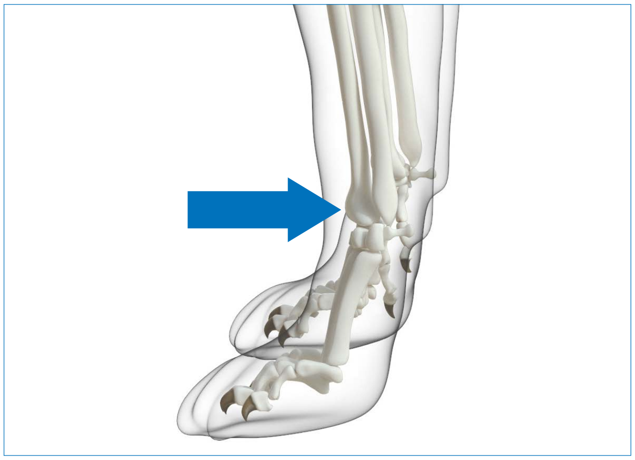
Carpal degenerative joint disease

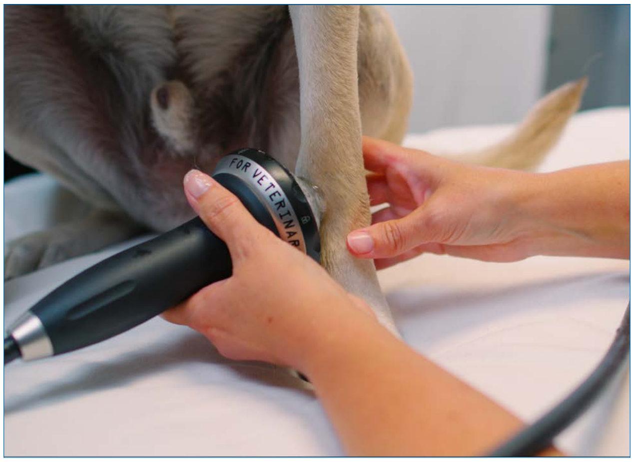
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-20	6-8	800-1500	0.032-0.134	0.6-8	0.1-3	5-18

Position the therapy source on the flexed or slightly flexed joint space. Have the patient stand, sit, or lie with limb supported while flexed. Place the therapy source along joint line and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, decrease pain, increase range of motion, vasodilation via upregulation of nitrogen monoxide (NO), angiogenesis, exhibit chondroprotective effects, stimulate stem cell production, dissolution of calcified fibroblasts, stimulate lubricin production, stimulate bone production, activate osteoblasts

Carpal tendon/ligament injury acute and chronic





Therapy source position

Carpal tendon/ligament injury acute

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Carpal tendon/ligament injury Chronic

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	1000-2000	0.054-0.097	1-5	0.5-1	8-14

Position the therapy source on the injured tendon or ligament. Have the patient stand, sit, or lie with limb supported while slightly flexed. Angle the energy source so the energy reaches the damaged fibers and remain stationary or gently rock <10 degrees in all directions.

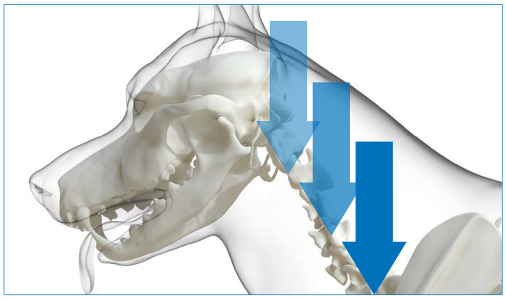
Goals of acute and chronic carpal tendon injuries: Decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Intervertebral disc diseases

Therapy source positioning for:

1. Cervical IVDD
2. Thoracic IVDD
3. Lumbar IVDD
4. Lumbosacral stenosis (cauda equina syndrome)

1.



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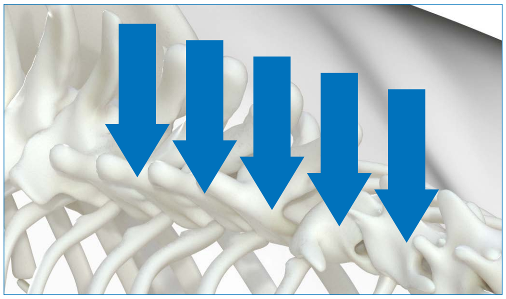

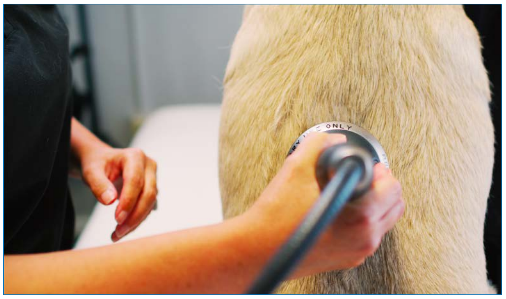

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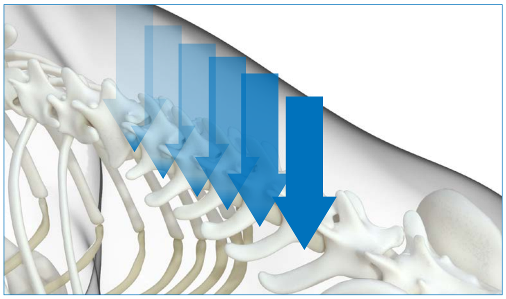
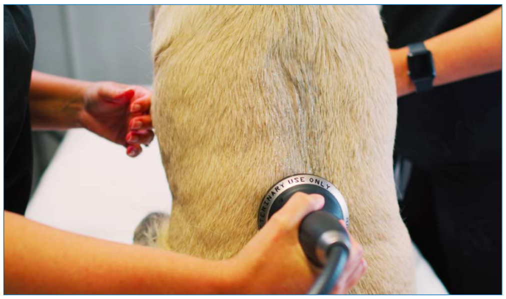




4.

Treatment guidelines for:
1. Acute IVDD (cervical, thoracic, lumbar)
2. Chronic IVDD and lumbosacral stenosis (cauda equina syndrome)

1. Acute IVDD (Cervical, Thoracic, Lumbar)

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	5-8

2. Chronic IVDD (Cervical, Thoracic, Lumbar) and Lumbosacral stenosis

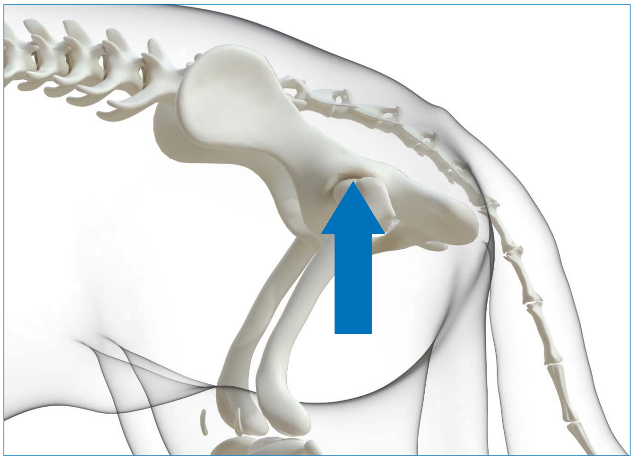
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-20	6-8	800-1500	0.032-0.072	0.6-3	0.1-0.8	5-12

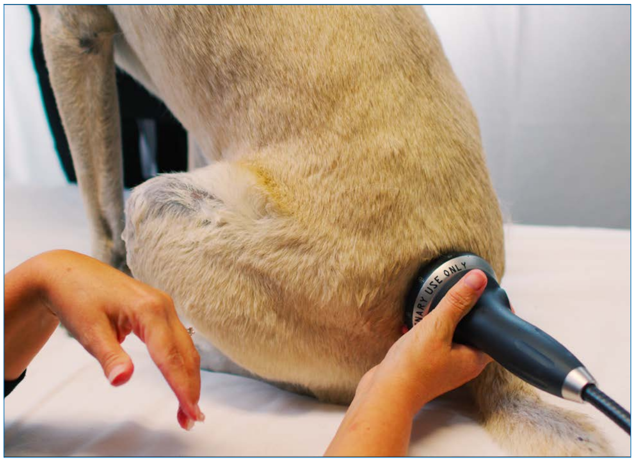
Position the therapy source caudal to the paraspinal processes where the lateral nerve roots exit the spine for the location of the IVDD. Angle the therapy source so the energy reaches these nerve roots. Treat bilaterally.
Caution: do not use over lungs, intestines
Caution: do not use directly over hemilaminectomy site, may be used dorsal over ventral slot

Goals of therapy: decrease inflammation, decrease pain, increase range of motion, vasodilation via upregulation of nitrogen monoxide (NO), angiogenesis, exhibit chondroprotective effects, stimulate stem cell production, dissolution of calcified fibroblasts, stimulate lubricin production, stimulate bone production, activate osteoblasts

Coxofemoral diseases

Coxofemoral degenerative joint disease





Therapy source position

Coxofemoral degenerative joint disease

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-20	6-8	800-1500	0.032-0.134	0.6-8	0.1-3	5-18

Position the therapy source on the slightly flexed joint space. Have the patient sit or lie down to open the joint space. Place the therapy source proximal to the greater trochanter. Place the energy source along the joint line and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, decrease pain, increase range of motion, vasodilation via upregulation of nitrogen monoxide (NO), angiogenesis, exhibit chondroprotective effects, stimulate stem cell production, dissolution of calcified fibroblasts, stimulate lubricin production, stimulate bone production, activate osteoblasts

Legg-calve perthes

Positioning for Legg-calve perthes is similar to Coxofemoral degenerative joint disease (page 56) except patient needs to be sedated.

Legg-calve perthes

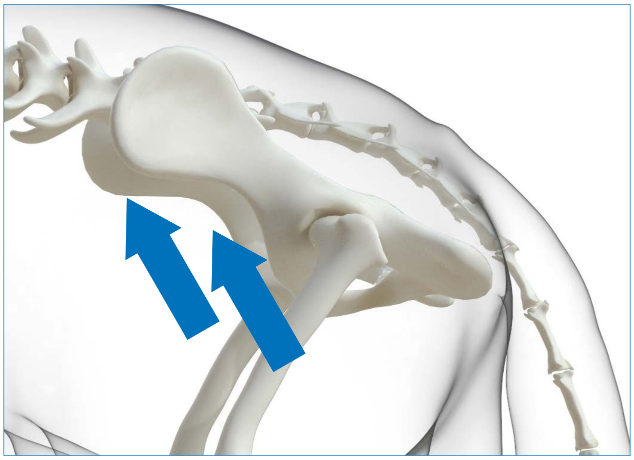
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	3000	0.272-0.346	15-18	8-10	NA

Patient should be sedated for this procedure.

Position the therapy source on the slightly flexed joint space. Have the patient sit or lie down to open the joint space. Place therapy source proximal to the greater trochanter. Place the energy source along the joint line and remain stationary or gently rock <10 degrees in all directions.

Goals of the therapy: neovascularization which improves the blood supply to the femoral head via upregulation of vascular endothelial growth factor (VEGF) and endothelial nitric oxide synthase (eNOS), promotes bone growth through cell proliferation and osteogenesis, relieves pain by hyper-stimulation analgesia with decreased substance P positive sensory nerve fibers and calcitonin related gene peptide (CRGP)

Iliopsoas trigger points



Therapy source position

Iliopsoas trigger points

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-30	6-8	500-1000	0.032-0.134	0.6-8	0.1-3	5-18

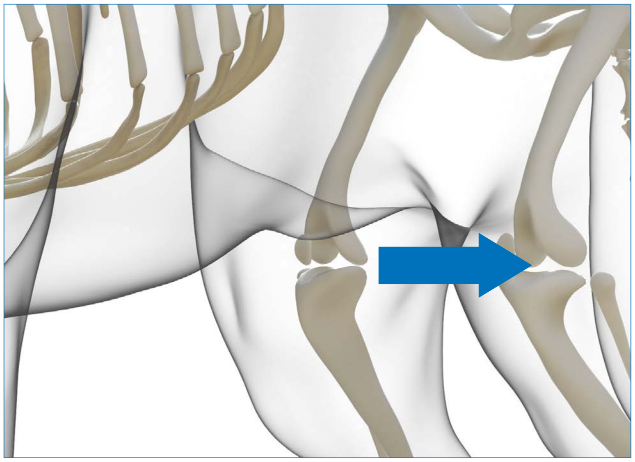
The FBL10x5G2 is very useful for trigger point therapy. If it is not available, dynamic movement of any pin-point therapy source can be used to identify single trigger points that are resolved through static positioning of therapy source.

Place the therapy source on the trigger point in the muscle affected, angle until energy reaches the trigger point and hold in position. If trigger point remains, slightly scan in the direction of the muscle fibers during treatment until trigger point releases. If uncertain where in the muscle belly the trigger point is located, scan with the therapy source until a flare occurs. Focus on the area of the flare. Movement between flared areas is dynamic, static positioning at a single point will require about 500-1000 static pulses to resolve a specific point.

Goals of therapy: release of trigger point, vasodilation via upregulation of nitrogen monoxide (NO), increase metabolic activity, angiogenesis, decrease inflammation

Stifle diseases

Stifle degenerative joint disease



Therapy source position

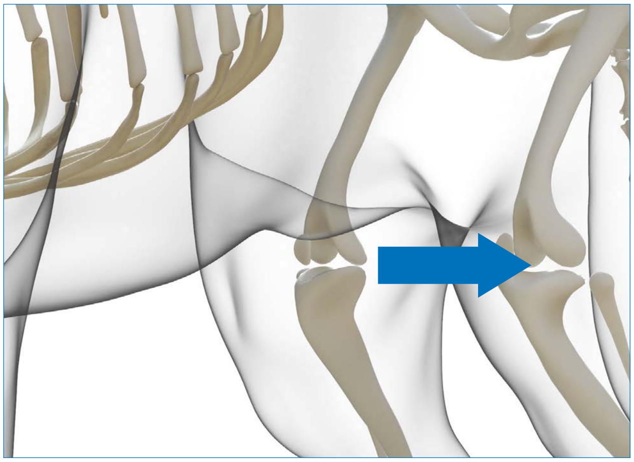
Stifle degenerative joint disease

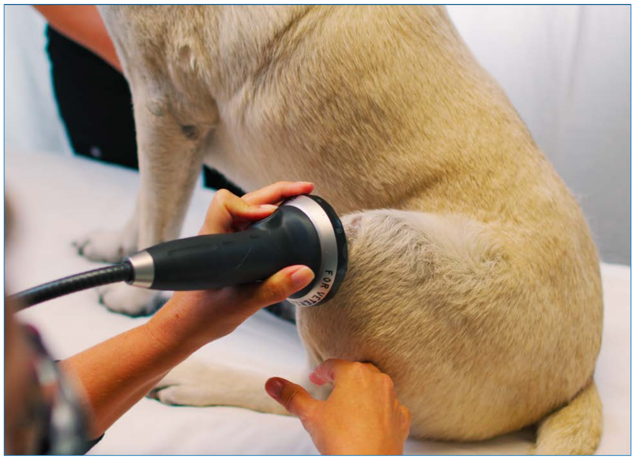
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-20	6-8	800-1500	0.032-0.134	0.6-8	0.1-3	5-18

Position the therapy source on the slightly flexed or fully flexed joint space. Have the patient sit or lie down to open the joint space. Angle the therapy source so that the energy reaches within the joint capsule and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, decrease pain, increase range of motion, vasodilation via upregulation of nitrogen monoxide (NO), angiogenesis, exhibit chondroprotective effects, stimulate stem cell production, dissolution of calcified fibroblasts, stimulate lubricin production, stimulate bone production, activate osteoblasts

Cranial cruciate ligament disease





Therapy source position

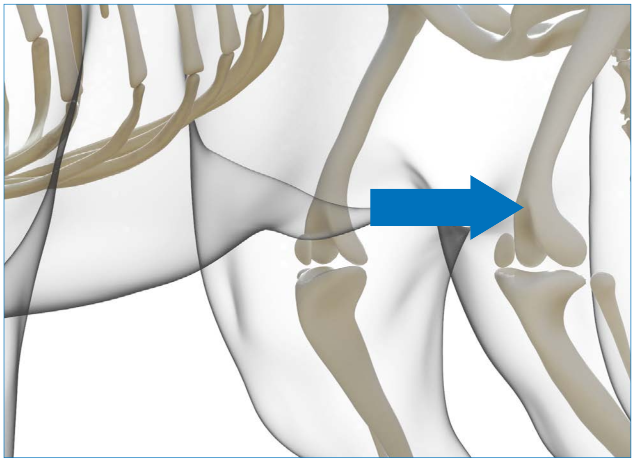
Cranial cruciate ligament disease

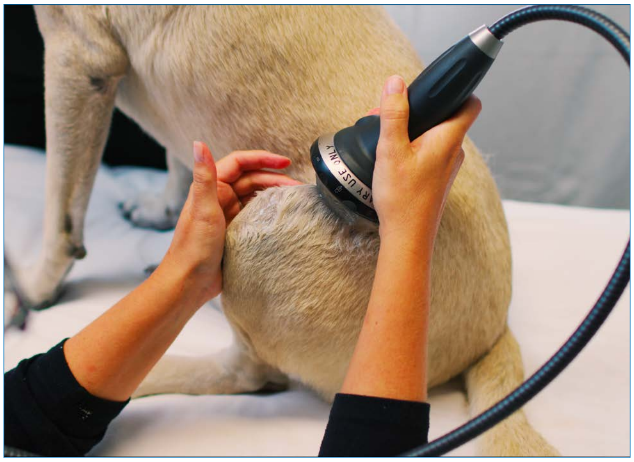
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source on the stifle joint medial or lateral to the patellar tendon with a slightly flexed or fully flexed stifle to open up the joint space. Have the patient sit or lie down. Angle the therapy source so the energy reaches within the joint capsule and remain stationary or gently rock <10 degrees in all directions.

Goals of Therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Medial patella luxation





Therapy source position

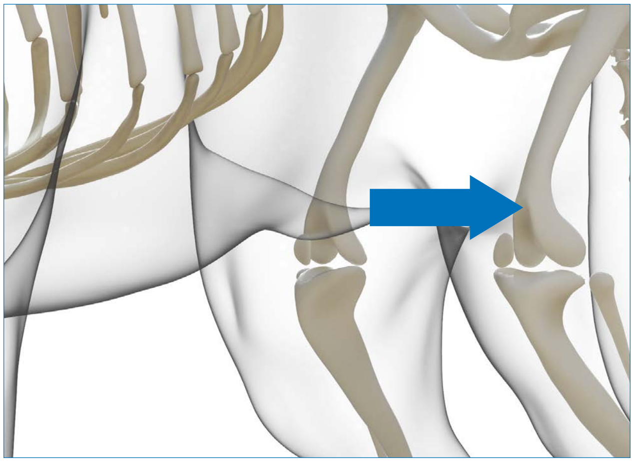
Medial patella luxation

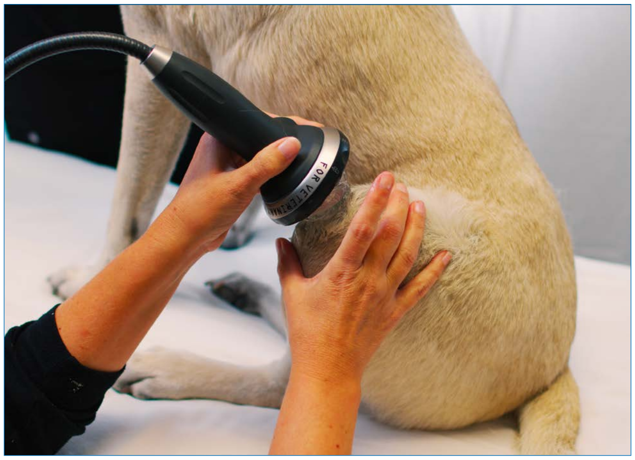
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	1000-2000	0.054-0.097	1-5	0.5-1	8-14

Position the therapy source on medial quadriceps tendon near the musculotendinous junction, proximal to the patella. The patient can be in standing or sitting position. Angle the therapy source so the energy reaches the musculotendinous junction and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: release the tension of the vastus medialis as it joins the patellar tendon, decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Patellar desmitis





Therapy source position

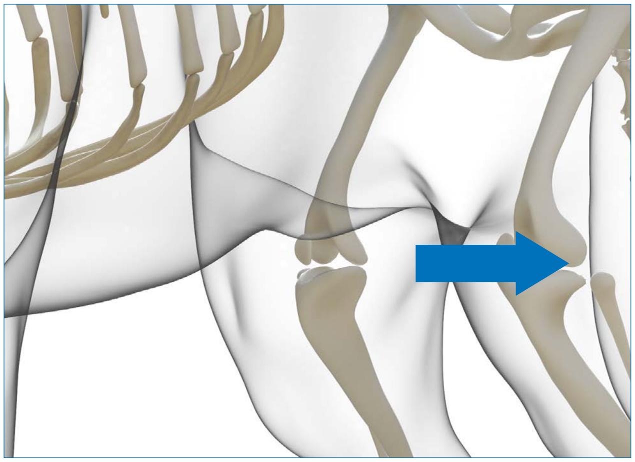
Patellar desmitis

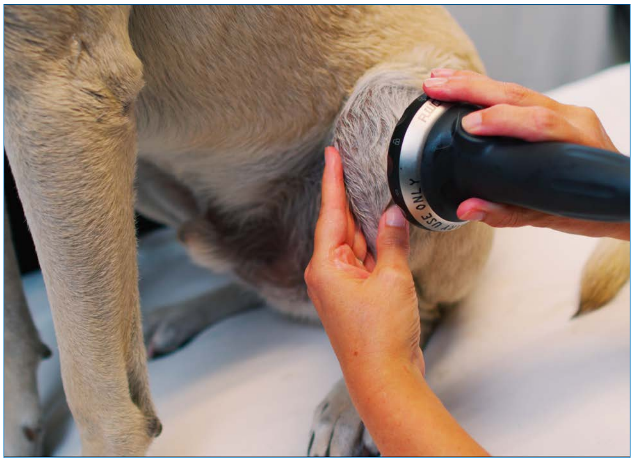
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source distal to the patella on the patellar tendon. The patient can be standing, sitting, or lying down. Angle the therapy source so that the energy reaches the patellar tendon and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Collateral ligament tendinopathy





Therapy source position

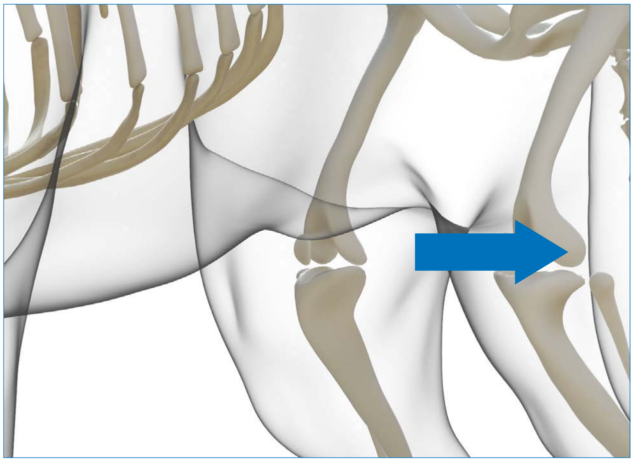
Collateral ligament tendinopathy

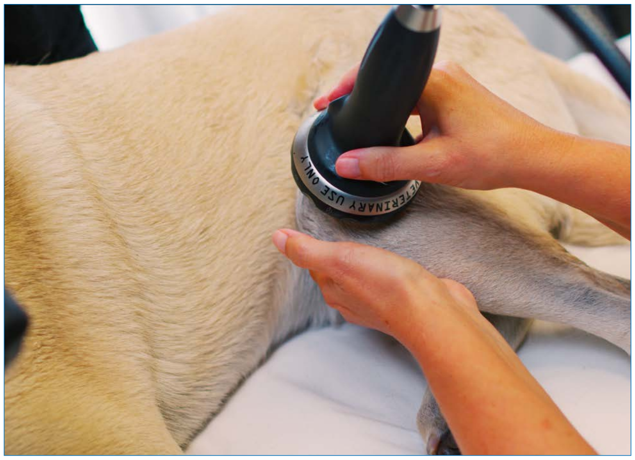
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source on the lateral collateral ligament at the site of swelling. The patient can be standing, sitting, or lying down. Angle the therapy source so the energy is directed at the ligament and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Long digital extensor tendinopathy





Therapy source position

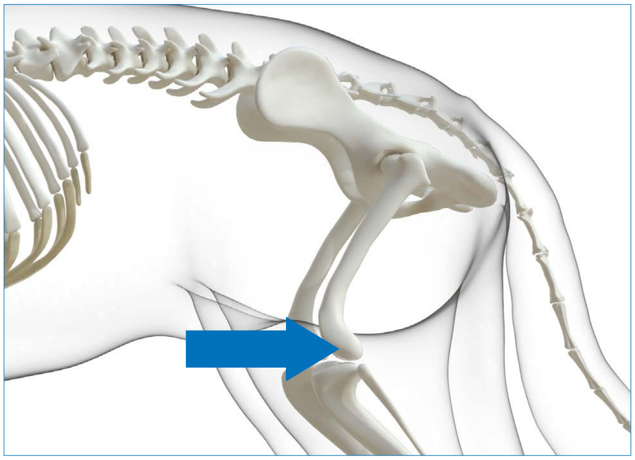
Long digital extensor tendinopathy

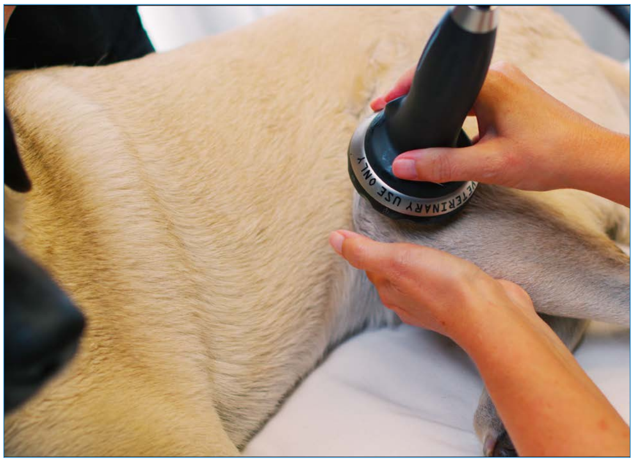
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source on the distal femur over the origin of the long digital extensor tendon. The patient can be standing, sitting, or lying down. Angle the therapy source so the energy reaches the origin of the long digital extensor tendon and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Femoral osteochondritis dissecans (OCD)





Therapy source position

Femoral OCD (confirm with radiographs)

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	3000	0.272-0.362	15-18	8-10	NA

Patient should be sedated for this procedure.

Position the therapy source on the distal femoral condyle angled to the area of OCD from radiographs. Therapy source should be angled for energy to reach the lesion. The stifle should be fully flexed or partially flexed to allow access to the area of interest. Choose standoff pad slightly larger than lesion to incorporate new periosteum.

Goal of therapy: create new bone formation by stimulating osteoblast production and prevent a cartilage flap from separating

Post stifle surgery
Post TPLO (tibial plateau osteotomy)
Post CBLO (CORA-based leveling osteotomy)

Positioning for post TPLO or CBLO surgery is similar as that for Stifle DJD (page 59) but angle of entry for energy is critical so energy reaches the osteotomy site (described below).

Post TPLO or CBLO surgery

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	1500-2000	0.097-0.272	5-15	1-8	14-20

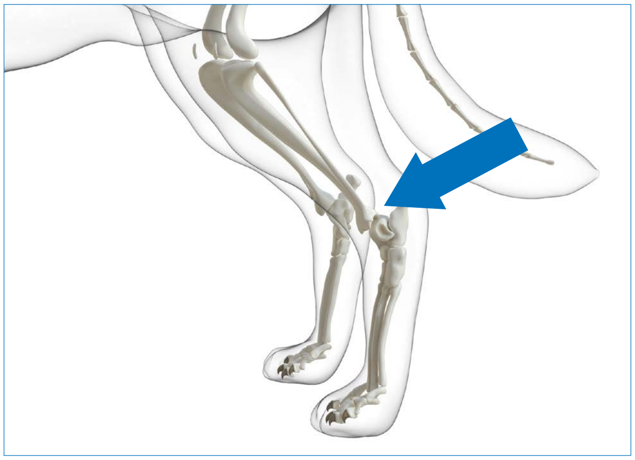
Some patients may need sedation for this procedure.

Position the therapy source on the stifle joint in the neutral position. Have the patient sit or lie down. Angle the therapy source so that the energy reaches four locations around the stifle joint: proximolateral, distolateral, proximo-medial, and distomedial. Treatment is not applied over or directly adjacent to the bone plate.

Goals of therapy: control postoperative pain, decrease inflammation by inhibiting inflammatory cytokine (interleukin 6 and metalloproteinases), stimulate ingrowth of neovascularization and bone growth, promote weight bearing and a faster return to function

Tarsal diseases

Tarsal degenerative joint disease



Therapy source position

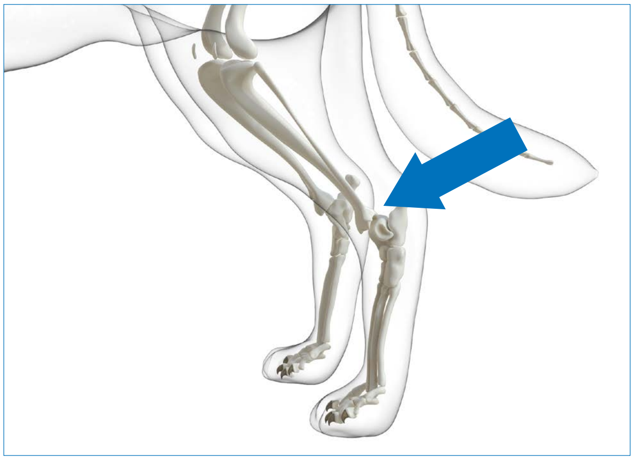
Tarsal degenerative joint disease

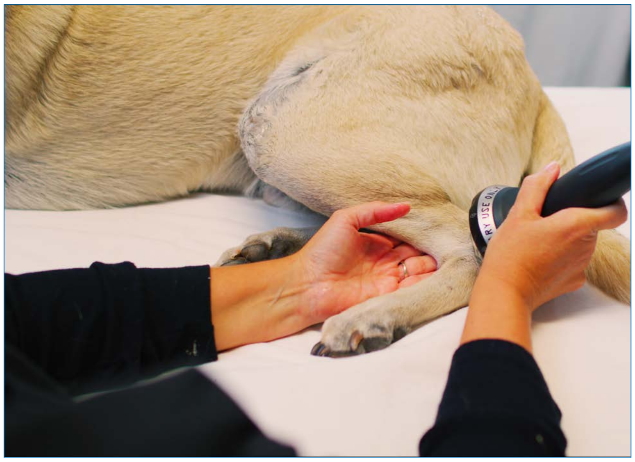
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-20	6-8	800-1500	0.032-0.134	0.6-8	0.1-3	5-18

Position the therapy source on the slightly flexed joint space. Have the patient sit or lie down. Angle the therapy source so that the angle reaches the joint space and remain stationary or gently rock <10 degrees in all directions.

Goals of therapy: decrease inflammation, decrease pain, increase range of motion, vasodilation via upregulation of nitrogen monoxide (NO), angiogenesis, exhibit chondroprotective effects, stimulate stem cell production, dissolution of calcified fibroblasts, stimulate lubricin production, stimulate bone production, activate osteoblasts

Tarsal tendon/ligament injury acute and chronic





Therapy source position

Tarsal tendon/ligament injury - acute

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

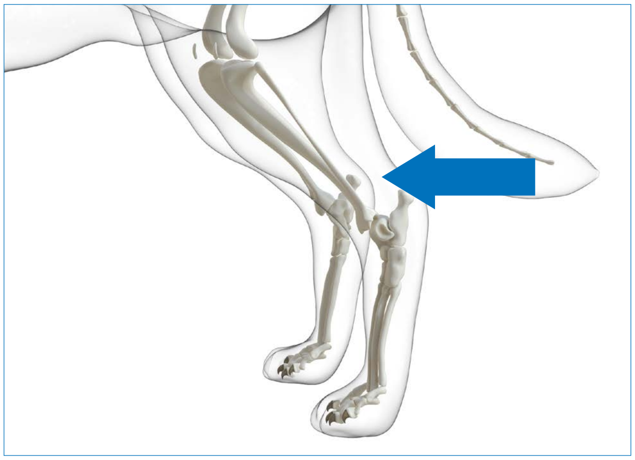
Tarsal tendon/ligament injury - chronic

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	1000-2000	0.054-0.097	1-5	0.5-1	8-14

Position the therapy source on the injured ligament. Have the patient sit or lie down. Angle the therapy source so that the energy reaches the damaged fibers and remain stationary or gently rock <10 degrees in all directions. Monitor patient response to treatment prior to increasing levels.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Achilles tendinopathy



Therapy source position

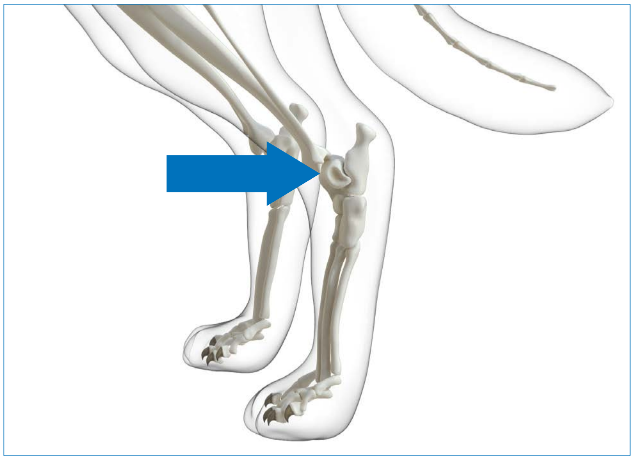
Achilles tendon grade 1, 2 strains

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	750-1000	0.032-0.054	0.6-2	0.1-0.5	4-8

Position the therapy source on the injured tendon usually over the swelling. Angle the therapy source so that the energy reaches the tendon and remain stationary or gently rock <10 degrees in all directions. Monitor patient response to treatment prior to increasing levels.

Goals of therapy: decrease inflammation, promote stem cell release, vasodilation via upregulation of nitrogen monoxide (NO)

Tarsal joint osteochondritis dissecans (OCD)



Therapy source position

Tarsal OCD (confirm with the radiographs)

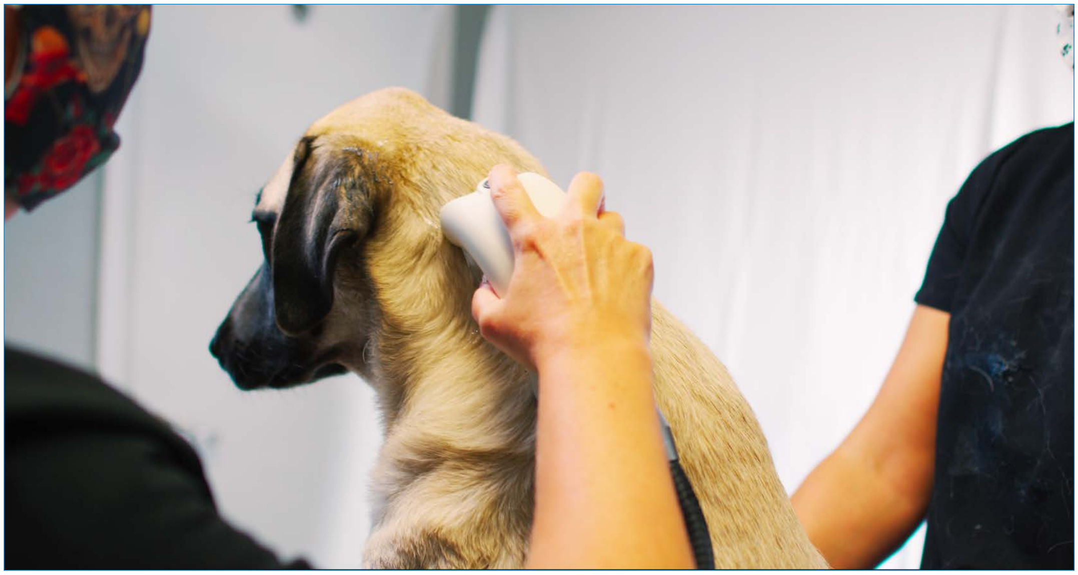
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-15	6-8	3000	0.272-0.362	15-18	8-10	NA

Patient should be sedated for this procedure.

Position the therapy source on the joint line angled to the area of OCD determined by radiographs. Therapy source should be angled for energy to reach the lesion. The tarsus should be fully flexed or partially flexed to allow access to the area of interest. Choose standoff pad slightly larger than lesion to incorporate new periosteum.

Goal of therapy: create new bone formation by stimulating osteoblast production and prevent a cartilage flap from separating

Myofascial trigger points



Myofascial trigger points

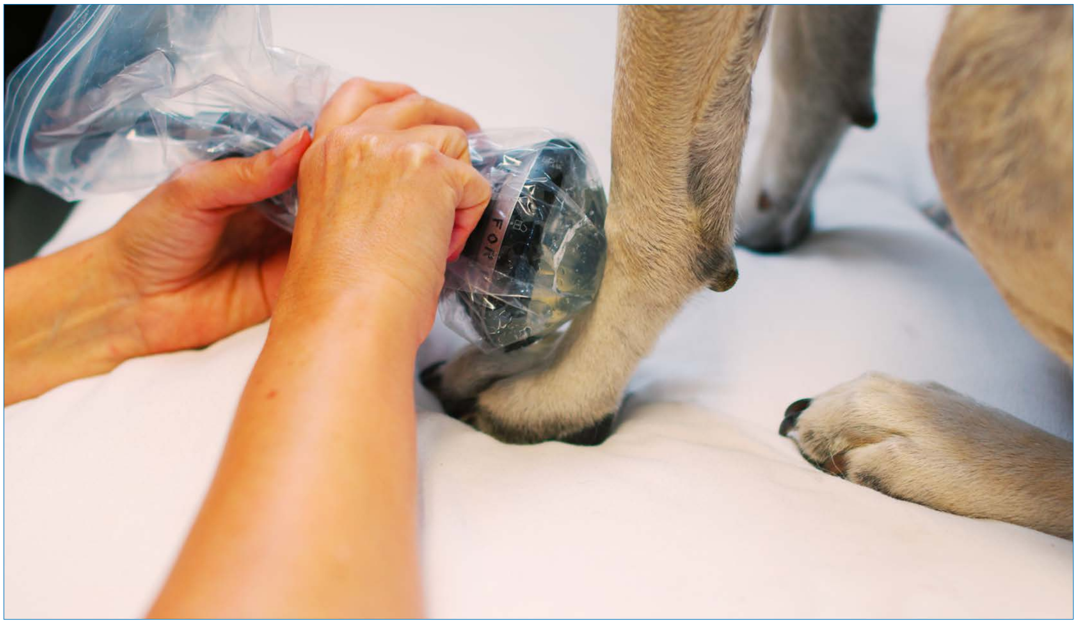
Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm²	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
5-30	6-8	500-1000	0.032-0.134	0.6-8	0.1-3	15-18

The FBL10x5G2 is very useful for trigger point therapy. If it is not available, dynamic movement of any pin-point therapy source can be used to identify single trigger points that are resolved through static positioning of therapy source.

Place the therapy source on the trigger point in the muscle affected, angle until energy reaches the trigger point and hold in position. If trigger point remains, slightly scan in the direction of the muscle fibers during treatment until trigger point releases. If uncertain where in the muscle belly the trigger point is, scan with the therapy source until a flare occurs. Focus on the area of the flare. Movement between flared areas is dynamic, static positioning at a single point will require about 500-1000 static pulses to resolve a specific point.

Goals of therapy: release of trigger point, vasodilation via upregulation of nitrogen monoxide (NO), increase metabolic activity, angiogenesis, decrease inflammation

Wounds



Wounds

Standoff Pad (mm)	Frequency	Number of Pulses	EFD mJ/mm^2	F7G3 Intensity	F10G4 Intensity	FBL10x5G2 Intensity
0	4-6	750-1000	0.054-0.097	1-5	0.5-2	8-14

Sterile gel should be used over wounds and covered with plastic film. Additional gel is added on top of the plastic film between the film and the therapy source. Therapy source should be moved very slowly over entire area starting at the periphery and moving in. This is a dynamic treatment process to allow the entire surface of the wound to receive energy. Number of pulses given is for an area with diameter of around 10 mm and may need to be adjusted according to size of the wound.
Caution- do not use over malignant tissue

Goal of therapy: Stimulate angiogenesis, promote stem cell release, vasodilation via upregulation of nitrogen mon-oxide (NO)

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Notes

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Tablet PC, App and Clax unit trolley not included in the scope of delivery.