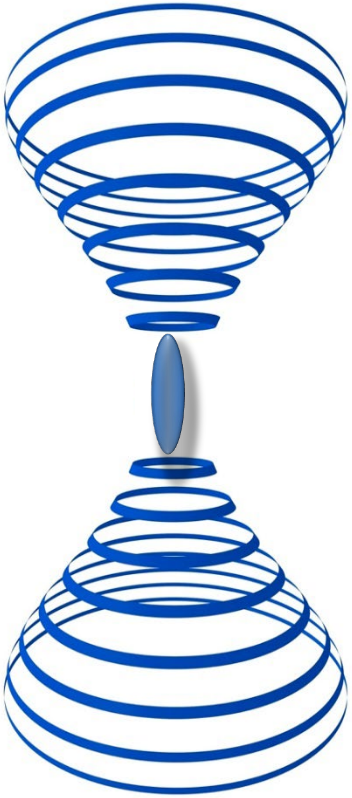
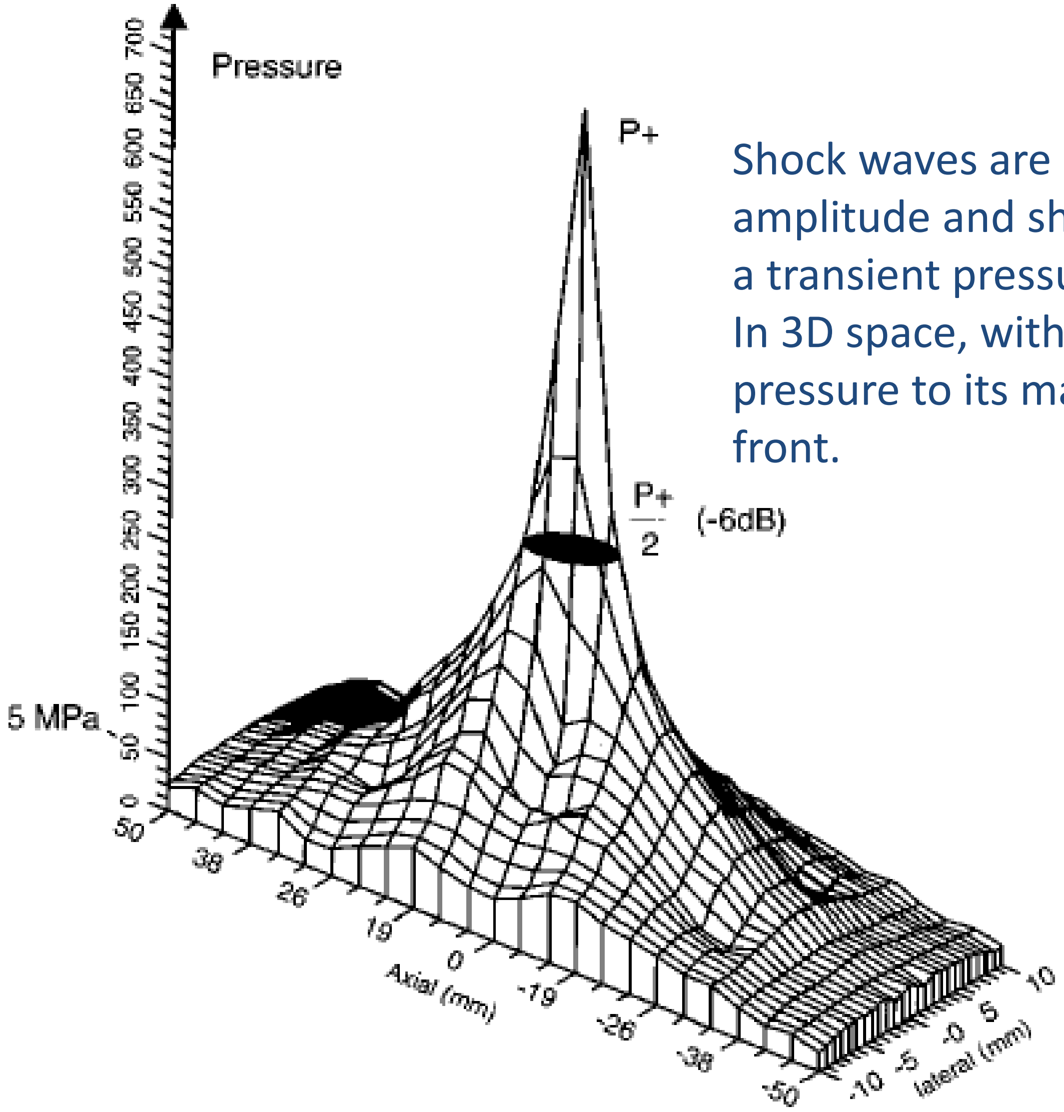
# We can go where your hands can't.

# Acoustic Compression Technology - Basics



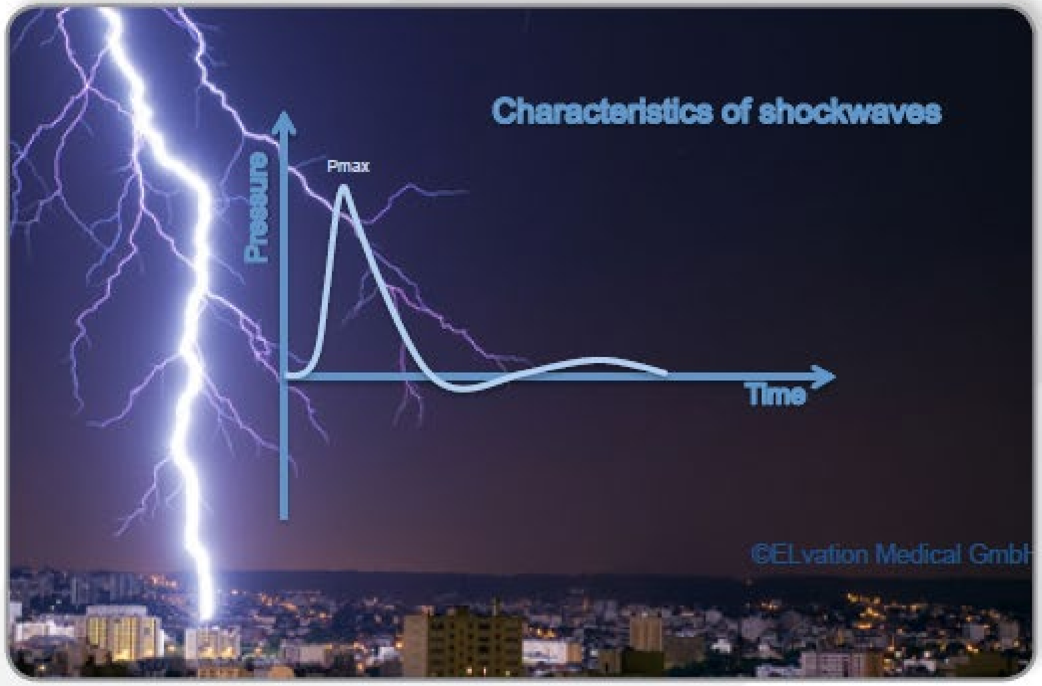
# Acoustic Pulse (shockwave)




Shock waves are single-impulse with high-amplitude and short-length sound waves from a transient pressure disturbance that propagate In 3D space, with a sudden rise from ambient pressure to its maximum pressure at the wave front.

# Physical principles of Myofascial Acoustic Compression pulses

MyACT produces a very strong energy pulse (1-50 Mpa) for four nanoseconds or what is an extremely short period of time



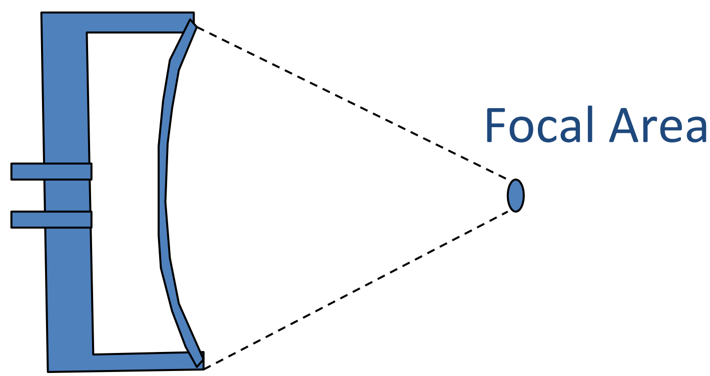
# The Pressure Field, MPa

- The pressure generated by the shock wave
- High peak pressure ranges from 5 – 130 Mpa

Pressure Field

Energy Flux Density

Total Applied Energy




- LE ESWT Pressure range varies 7 – 49 Mpa (Megapascals) 1 Mpa = 145.038 psi

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# Acoustic Pulse Characteristics


**SHORT-CUTS**

| | | | |
|---|---|---|---|
| 6 | | Press 2 seconds | Activation of the intensity substages 0.0 to 0.9 |
| 2 | | Press 5 seconds | Deactivation of the intensity substages |
| 5 | 4 | Press both | Display of software version |
| 2 | 5 | Press both | Presetting of the total number of pessure-waves |
| 2 | | Press | Deactivation of the presetting of the total number |
| 1 | 4 | Press both | Reset pulse rate to zero (For single pulse select 0) |
| 3 | 6 | Press both | Reset intensity to zero |
| 5 | | Press | Average value per treatment |
| 5 | 3 | Press both | Total pulses of the connected therapy source |
| 5 | 6 | Press both | Total amount of pulses emitted by the device |

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## Speed – Left side +/-

- A nanosecond is one billionth of a second
- One nanosecond is to one second as one second is to 31.7 years.

## Pressure – Right side +/-

- 1 MPa (mega Pascal) equals 145 PSI
- 50 megapascals is the equivalent 7,200 lbs psi

# Shockwave History - Lithotripsy

# High Energy Devices FDA Class II

Ossatron and Dornier Epos Ultra

- Approved in US for treatment of chronic proximal plantar fasciitis

Siemens Sonocur Basic

- Approved in US for treatment of chronic lateral epicondylitis

-Single treatment under anesthesia

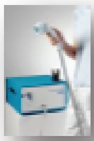
- Last resort before surgery

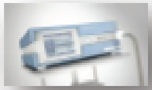
- Unfortunately, the treatment is needed in multiple places

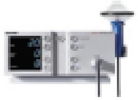
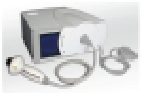
- No substitute devices

# Comparison - Focused Shockwave





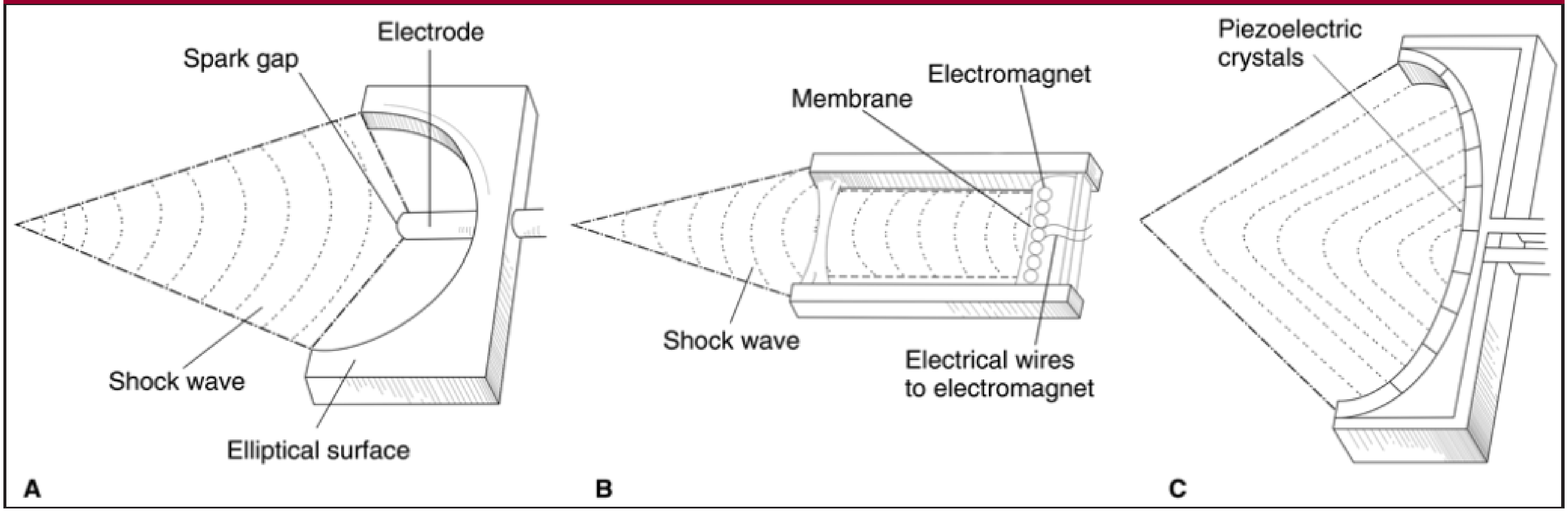


| | Richard Wolf PiezoWave | Richard Wolf Piezoson 100+ | Dornier AR2 | Dornier Aries | Storz Duolith | MTS Orthogold | EMS PiezoClast | Sanuwave Orthopace |
|---|---|---|---|---|---|---|---|---|
| Technology | Piezo | Piezo | Electrohydr. | Electrohydr. | Electromag. | Electrohydr. | Piezo | Electrohydr. |
| Penetration depth | 0-40mm | 0-50mm | | | 0-65 mm (0-35mm ) | 0-40mm | 0-40mm | 40-100mm |
| Focus dimension | 2,5 x 10mm | 2,1 x 6,4mm | | | Ca. 5 x 25mm | 3,4 x 38mm | 2,5 x 10mm | 7,2 X 28mm |
| Pressure | 11 – 82 MPa | 21 –140 MPa | | | Max 62 MPa | | 11 – 82 MPa | 39,6-47,7 MPa |
| Mi/mm$^2$ | 0,03 - 0,4 | 0,05 – 1,48 | | | 0,01 – 0,55 | | 0,03 - 0,4 | 0,01 - 0,12 |
| Mi/mm$^2$ total | | 0,1 – 1,95 | | | | | | 0,11 – 0,15 |
| Energy level | 20 | 20 | | | | | 20 | 6 |
| Life time activations | 5.000.000 | 5.000.000 | | | 2.000.000 | Ca 2.000.000 | 5.000.000 | 50.000 refurbish |
| Frequency Hz | 8 | 4 | | | 8 | | 8 | 4 |

# How are acoustic pulses produced?

Figure 1

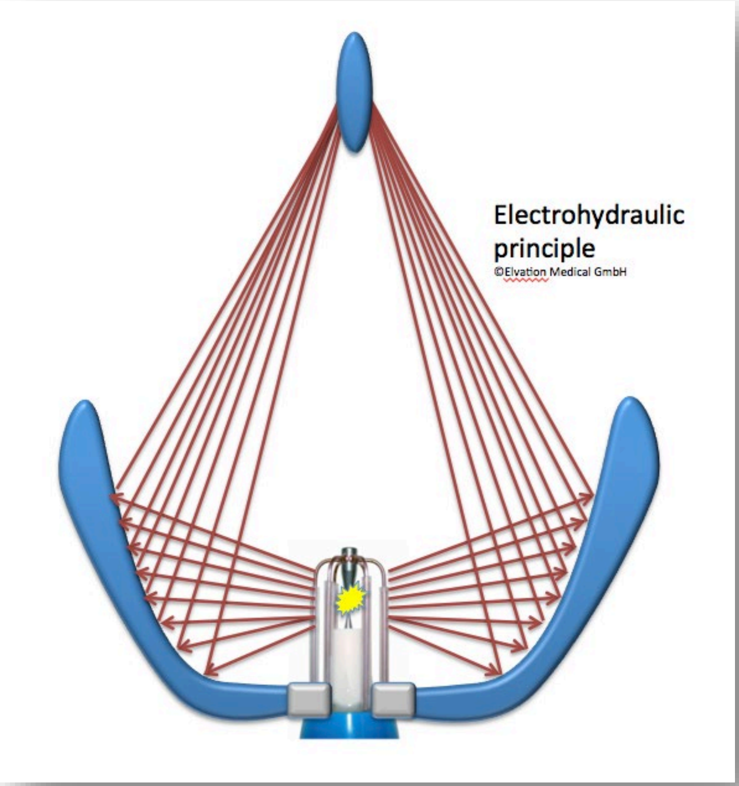



Methods of shock wave production. **A,** Electrohydraulic. **B,** Electromagnetic. **C,** Piezoelectric.

# Electrohydraulic Principle

## Orthogold 100 technology is dated

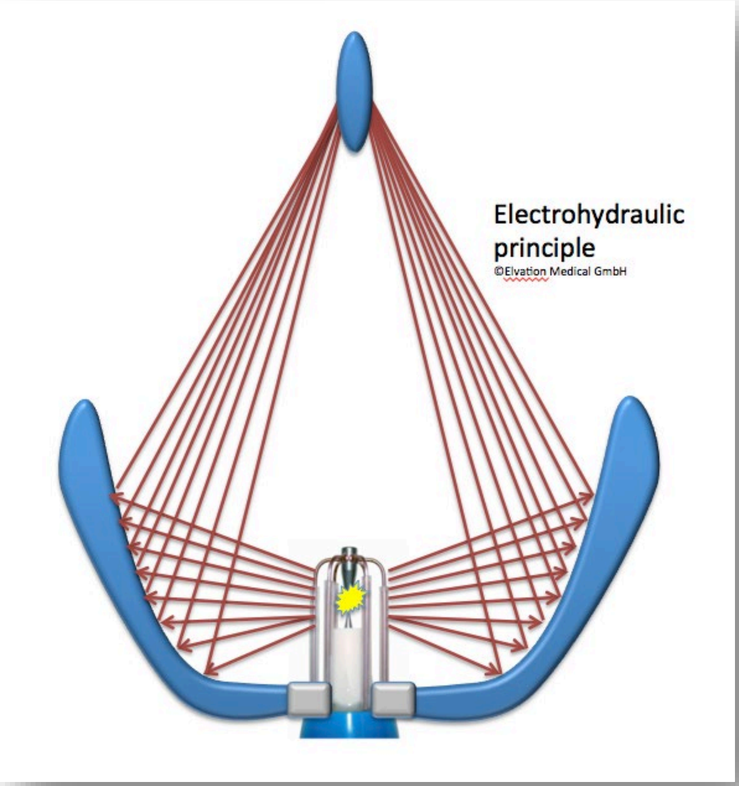
- First generation of transducer design to produce acoustic wave sound compression (shockwave)
- Uses a similar design to the sparkplug of a car
- Relies on a high voltage, rapid discharge across the spark gap
- The resultant spark heats and vaporizes the surrounding water, thereby generating a gas bubble filled with water vapor and plasma.
- The expansion of this bubble produces a sonic pulse
- The subsequent implosion creates a reverse pulse, manifesting itself as a shock wave



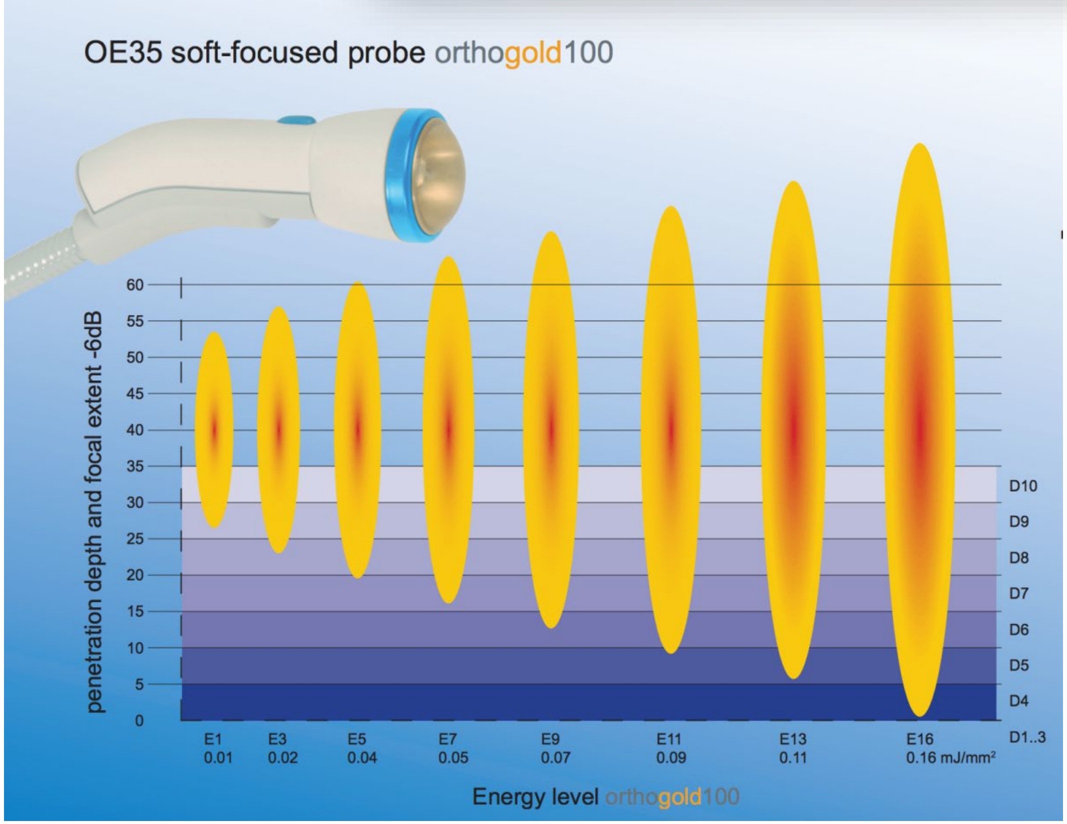
# Electrohydraulic Principle

- The concentrically expanding shock wave is reflected by the surface of the ellipsoid and is then refocused into the focal point

- Electrohydraulic shock wave  devices are usually characterized by fairly large axial diameters of the focal volume



# Sparkwave (Orthogold 100)




- Depth of compression is adjusted by turning up intensity which widens overall compression area
- This unnecessarily involves healthy tissue in the “treatment zone”.
- Increasing intensity to achieve penetration depth is not aligned with actual clinical needs/requirements
- Increased patient discomfort is unwanted result of increased penetration depth

# The Piezoelectric Principle

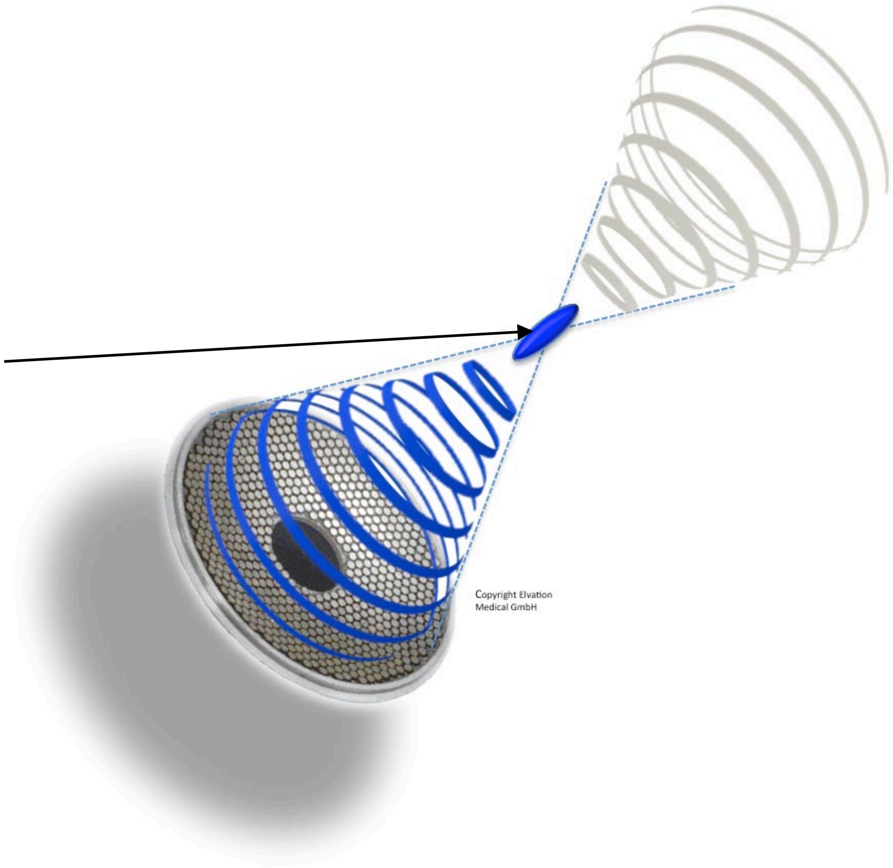
## The Piezoelectric Principle


- The most advanced method for producing shockwaves
- A large number of piezo crystals are mounted on the inside of a dish (dish = concave moulded form)
- Energy is not re-directed but is direct and controllable
- Energy is focused into a well defined treatment zone that is reproducible from one treatment to the next

# The Piezoelectric Principle

- The geometric arrangement of the crystals along the inside of the dish creates a  self-focusing wave

- This leads to extremely precise focusing and a high energy density within a well-confined focal volume

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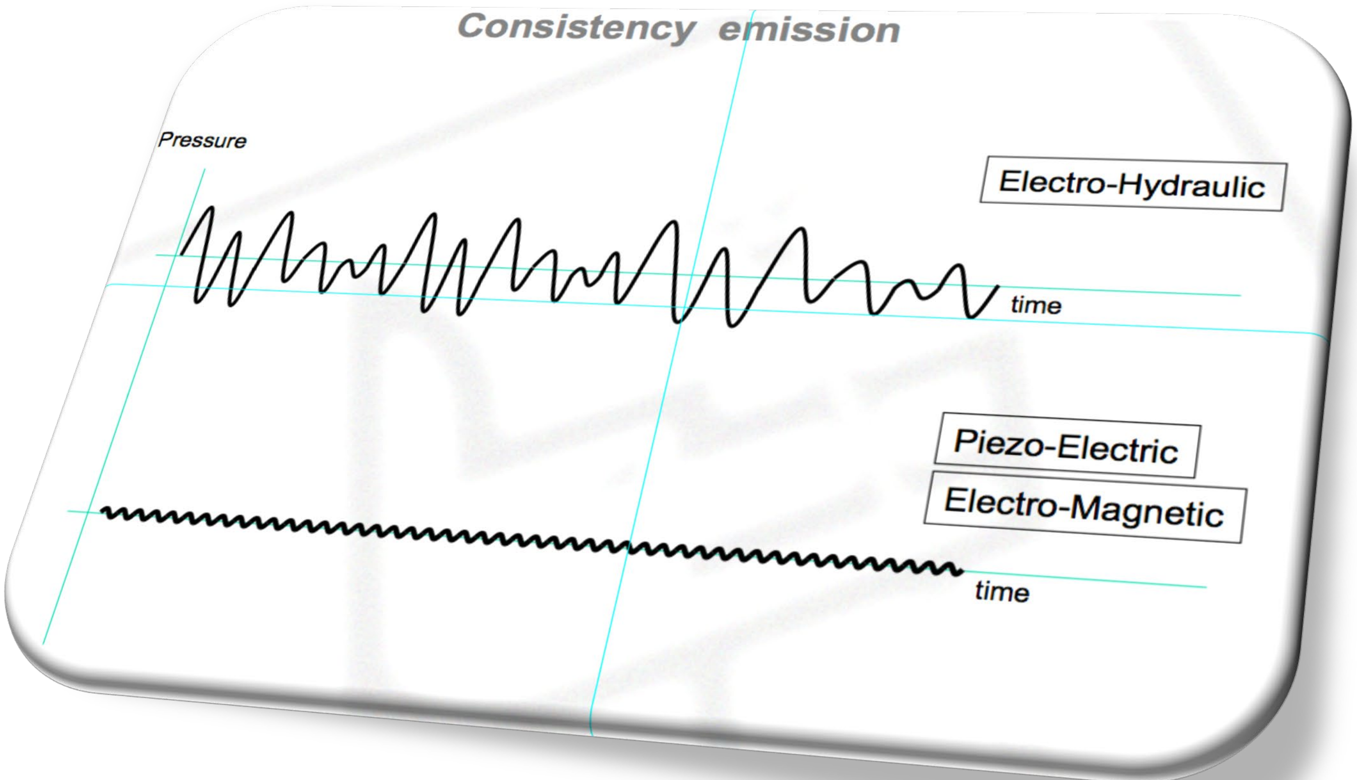
# The Piezoelectric Principle

- Piezoelectric energy output is very consistent compared to electrohydraulic
- No surprises to the patient from on pulse to the next due to power surges



# Introducing

## PiezoWave² Myofascial Acoustic Compression Therapy (MyACT)

### MyACT delivers mechanical energy – not light, electrical or thermal energy

- Tenocytes in tendons, fibroblasts in ligaments and skin, osteocytes in bone, chondrocytes in articular cartilage and endothelial cells in blood vessels are mechano-sensitive and respond to mechanical forces
- MyACT targets tissue at varying depths to compress and manipulate tissue
- PiezoWave2 delivers the most energy at a depth that you define without being compromised by tissue absorption

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think in value

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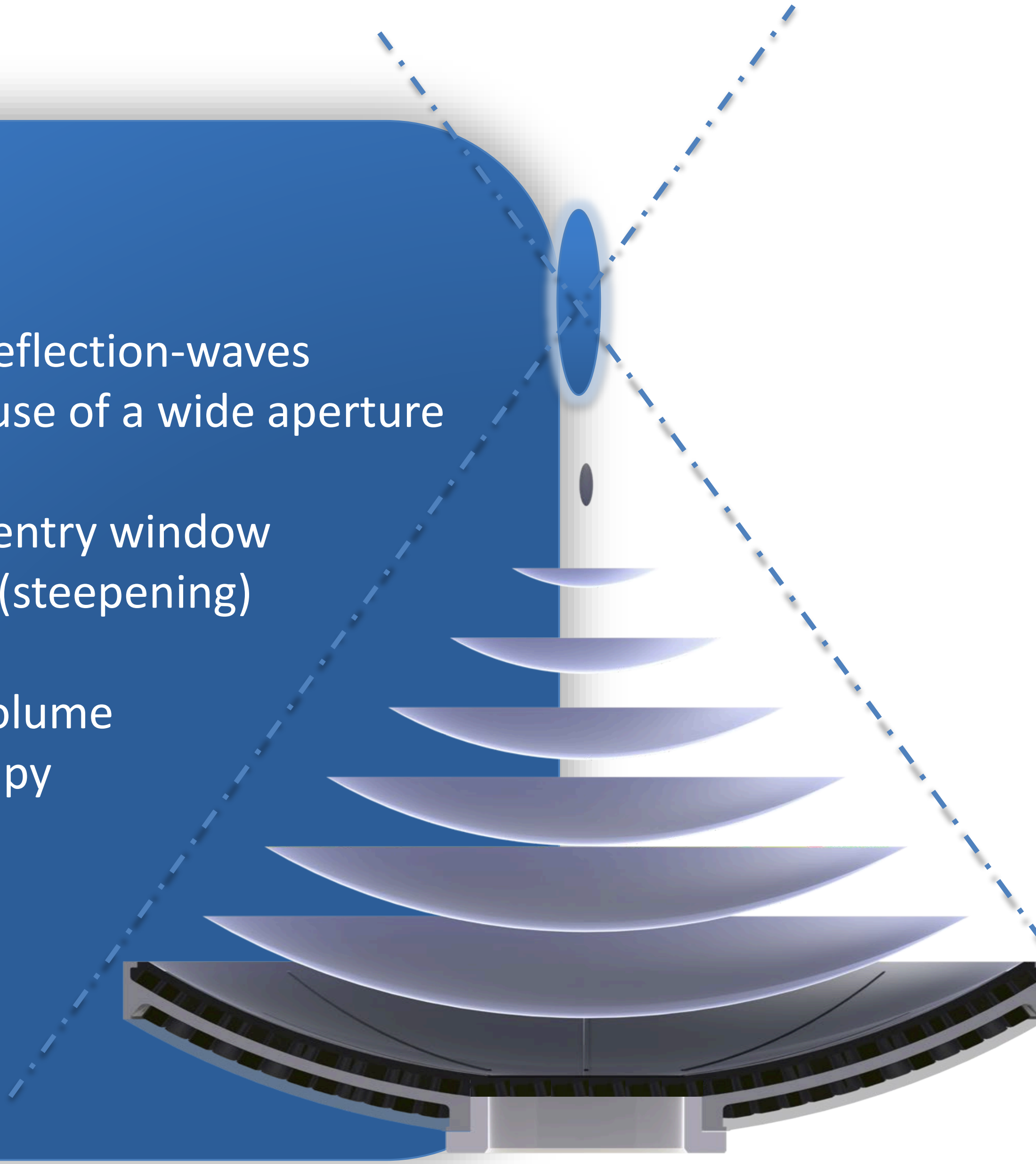
# Not all modalities are created equal

## Unparalleled treatment control

- Quick and easy control over energy delivery, treatment depth and treatment location
- MyACT is focused deep in tissue to deliver the greatest amount of energy at the desired focal point
- MyACT's focal point is adjustable to different depth levels in 5mm steps
- MyACT flares the patient's familiar pain to confirm the area that requires treatment
- Targeting MyACT at varying depths to compress and manipulate tissue results in a focused an precise deep tissue massage
- Myofascial Acoustic Compression Therapy's influence as a pin-pointed delivery of mechanical stimulus can result in biochemical events that lead to increased circulation and pain relief – key components in the healing process

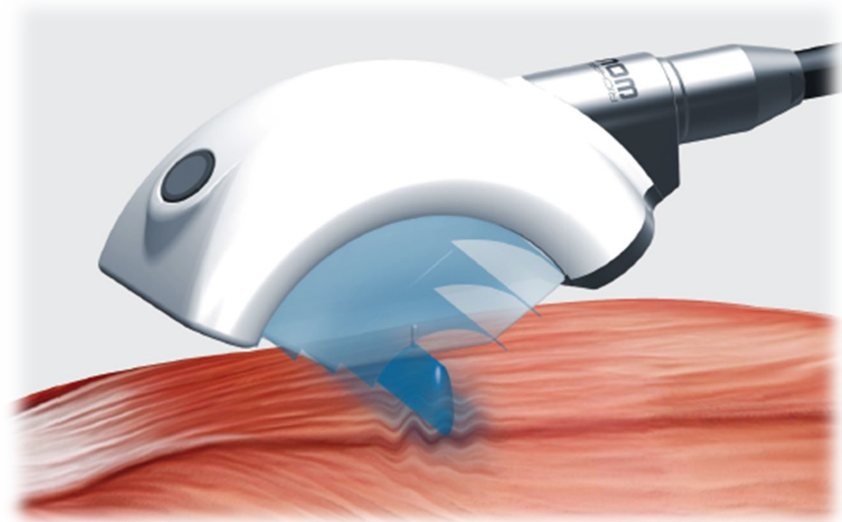
# Direct Focusing (DFL)

- No pain due to uncontrolled reflection-waves
- No pain at the skin level because of a wide aperture angle
- No pain at the acoustic pulse entry window because of sound attenuation (steepening) occurs just at the focal point
- Well defined powerful focal volume perfect for diagnosis and therapy
- extremely durable
- Low noise level compared to Electrohydraulic devices



# Focused shockwave

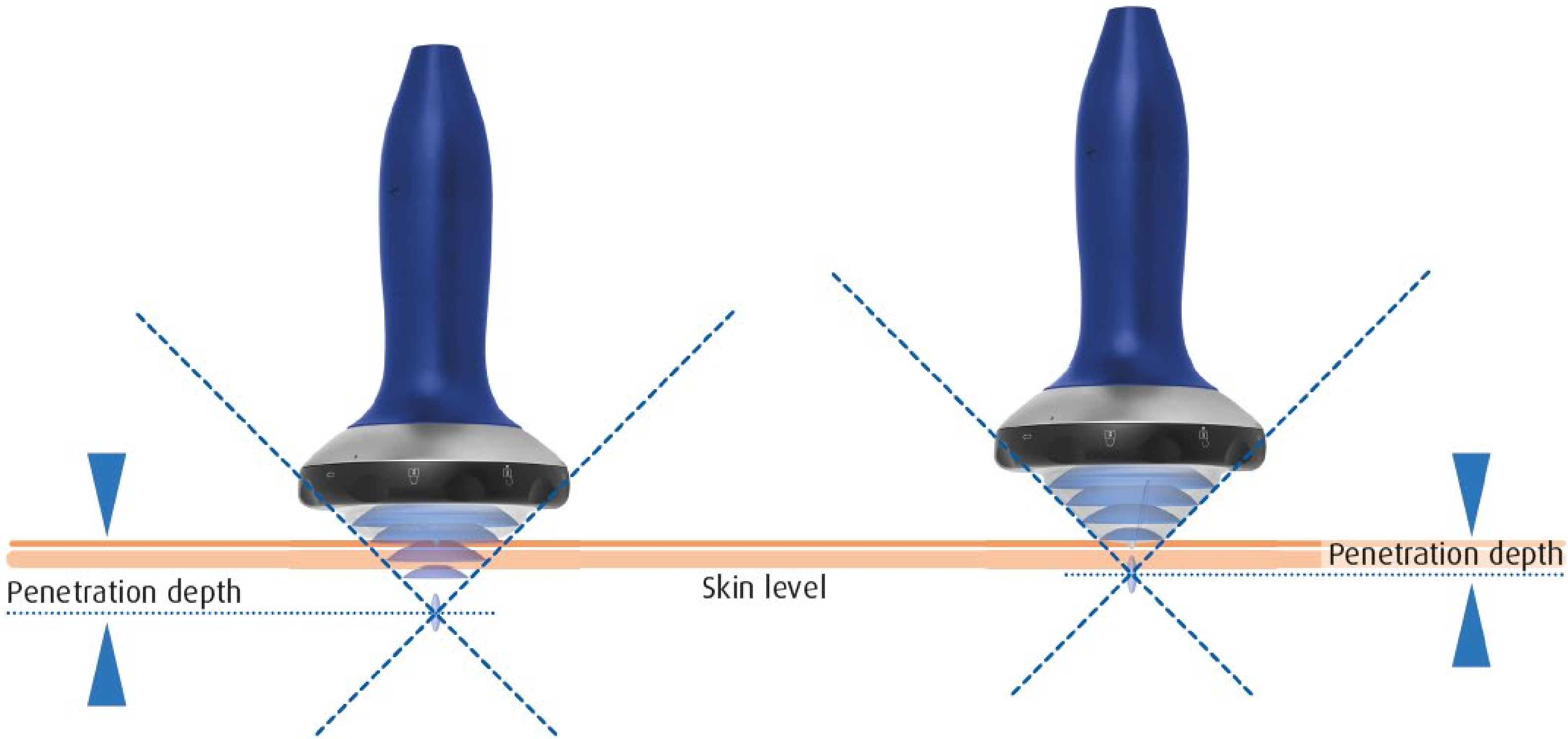
Pin point Focus



Linear Focus

# Controlling Depth Penetration

- Interchangeable gel pad spacers adjust the focused area's depth of penetration providing accurate delivery of compression exactly where it is needed and eliminating unnecessary normal tissue involvement
- Seven gel pads with 5mm increments from 0 and 30mm



# PiezoWave2 Therapy Sources

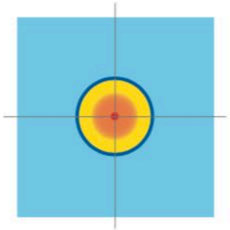
- The clinician is in control adjusting depth of penetration and energy output separately
- Unique Linear Therapy Source (FBL 10x5G2) treats a large area and is ideal for large muscle work
- Delivering therapeutic compression energy exactly where it is needed

**FBL10x5G2**
The horizontal line with the largest volume and highest pulse energy

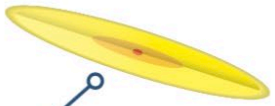
**Penetration depth**
30 mm 29 mm 20 mm

Maximum energy flux density 0,16 mJ/mm²

**F7G3**
Convenient therapy source with small focal point



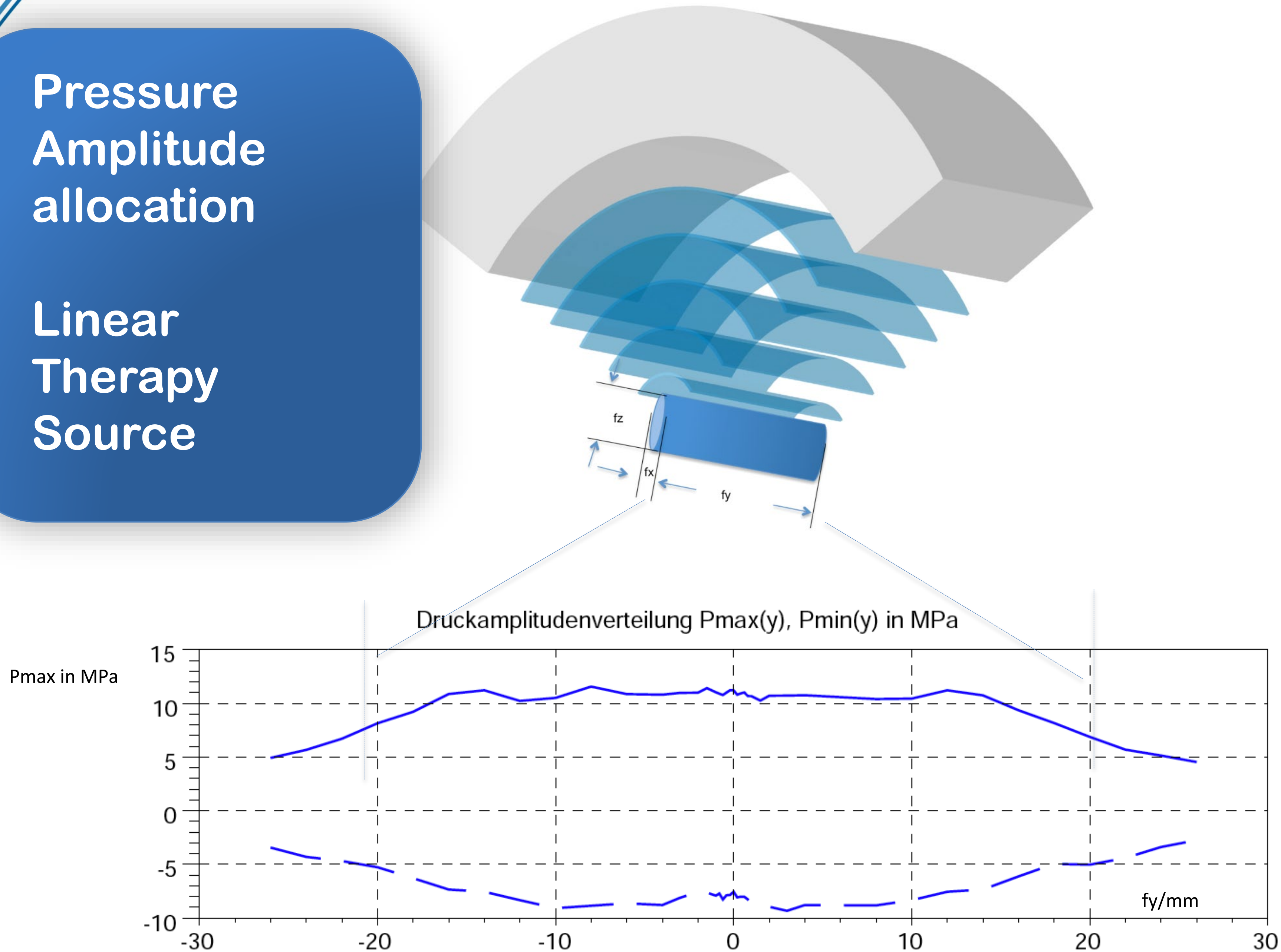
**Penetration depth**
40 mm
33 mm
30 mm



Maximum energy flux density 0,4 mJ/mm²

# Pressure Amplitude allocation

# Linear Therapy Source

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# Indications

- Areas where fibrosis, scarring, and resultant decreased blood supply are inhibiting healing
- No sedation required for low-med energy
- In-office procedures done by doctor therapist, trainer, or staff
- Pain levels cause impairments/disability
- Surgical or injection options being contemplated

# Three primary target sites

- Desmopathies – tendon disease – commonly at bone attachments
- Enthesopathies – ligament/fascia to bone
- Bone – non-union fractures, avascular necrosis, etc.

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# MyACT treats pain resulting from

- Myofascial dysfunction
- Tendinopathy
- Trigger Points
- Repetitive stress injuries
- Enthesopathy
- Soft Tissue Strains

# Indications

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- Pain levels cause impairments/disability
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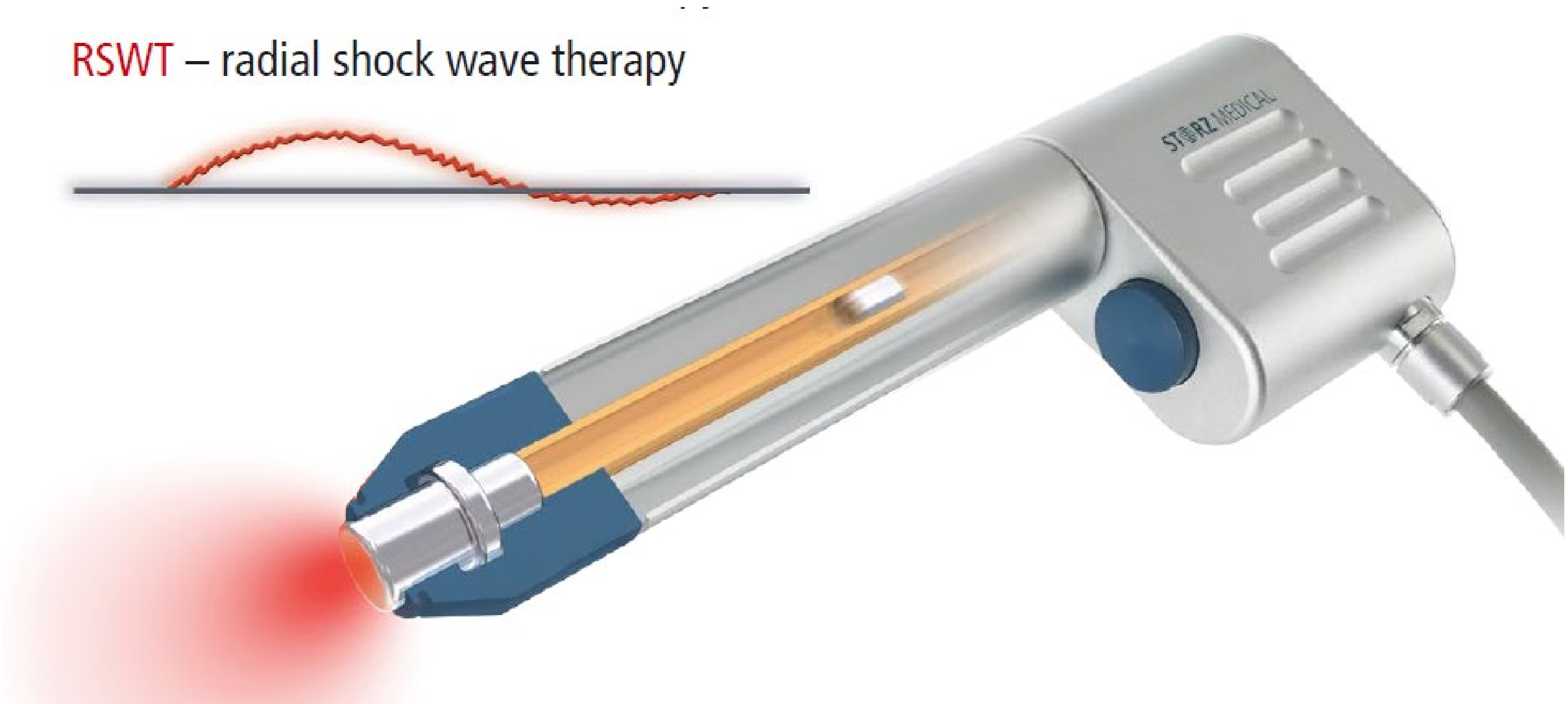
# Complications

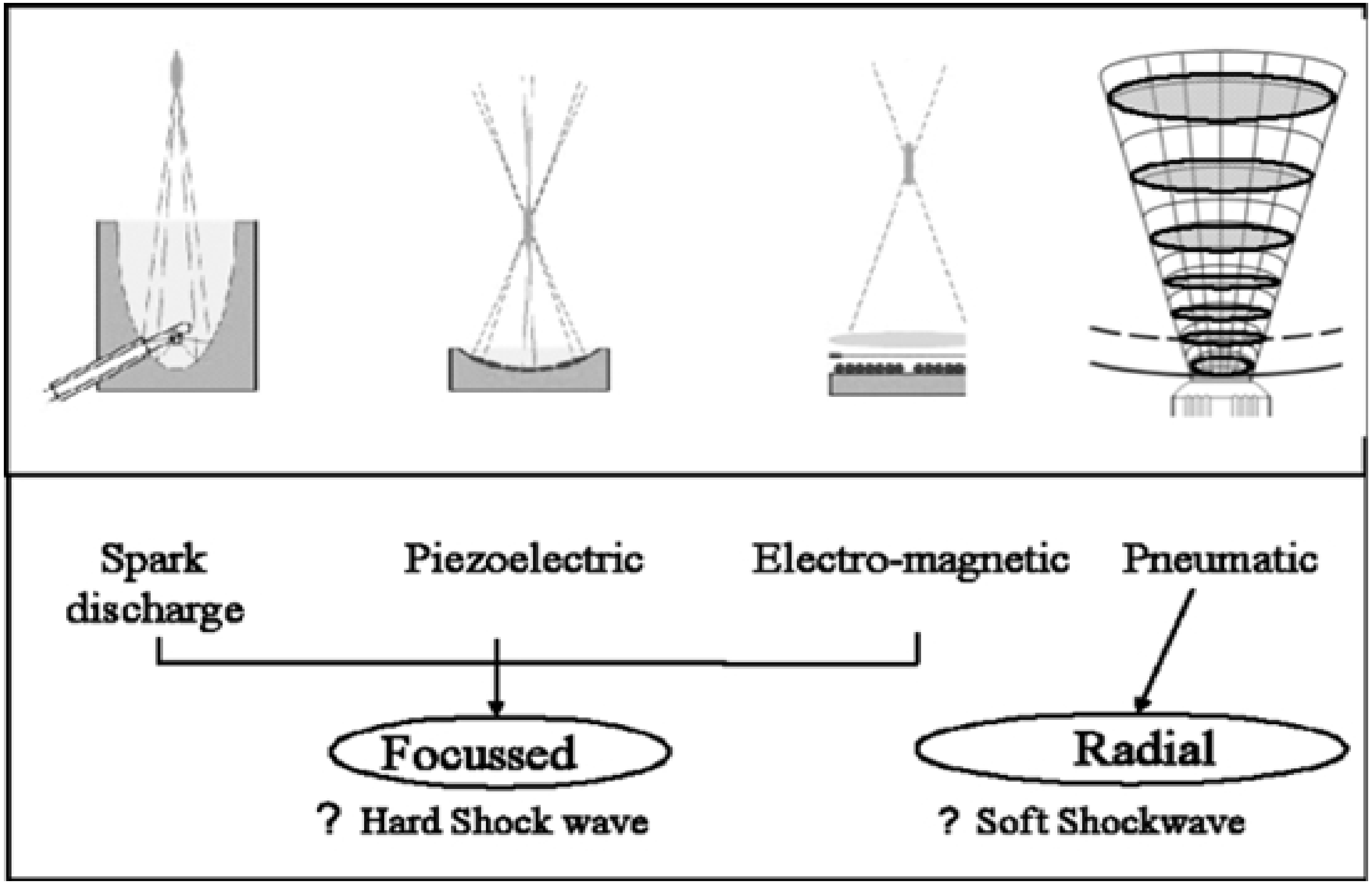
- Post treatment soreness (resolves in 24 hours)
- Hematomas (rare)
- Edema (rare)
- No serious complications are reported in literature – excellent safety profile reported

# Radial Pressure Wave Devices

# US Competition - Karl Storz D-Actor

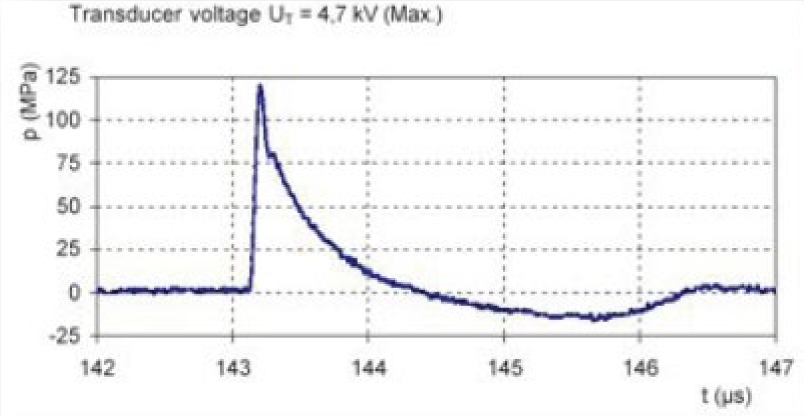


# Types of Shock Wave Therapy



# Radial Pressure Wave

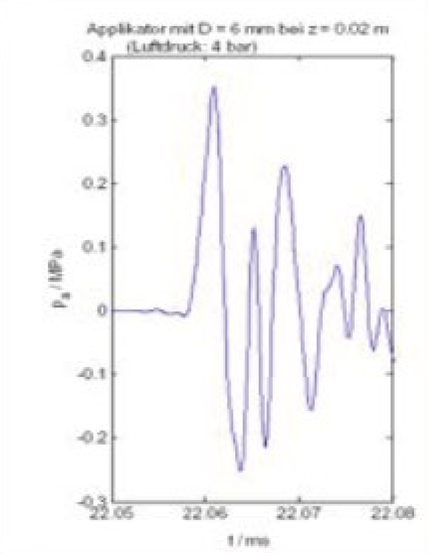
## Shockwave




Acoustic wave with:

- High pressure peak (over 50 MPa)
- Very short rise time < 1 µs
- Low tensile wave component

## Pressure wave




Acoustic wave with:

- Low pressure peak
- Long rise time
- Pressure pulsation

# Pressure Wave is not a shockwave!

- Confusion in the market because research refers to all these as ESWT
- LIPUS (low intensity pulsed ultrasound) ands to the confusion

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# What does that mean for the application?

| Attributes | Focused | Radial |
|---|---|---|
| Pointed/Targeted (pain) diagnostic | ✔ | ✗ |
| Depth control | ✔ | ✗ |
| Penetration depth up to 4 cm | ✔ | ✗ |
| Precise target tissue effect | ✔ | ✗ |
| Painless application (skin) due to wide aperture angle | ✔ | ✗ |
| Quiet (piezo technology) and no vibrations | ✔ | ✗ |
| Covers the complete range of ESWT / TPST indications | ✔ | ✗ |
| High therapeutic success rate for all ESWT / TPST indicat. | ✔ | ✗ |

| | **Effective Pain Relief** | **Safe** Non-Invasive | **Simple** Easy-to-use | **Therapy Frequency** Weekly – Patient Friendly | **Clinical Focusing** Patient guidance | **Depth of Penetration** Deep tissue treatment | **Focused therapy** Precise dose delivery | **Patient Referral** New Technology |
|---|---|---|---|---|---|---|---|---|
| **MyACT** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Laser (LLLT)** | ✓ | ✓ | ✓ | ✓ | | | | ✓ |
| **Ultrasound (LIPUS)** | ✓ | ✓ | ✓ | | | | | |
| **Electrotherapy** | ✓ | ✓ | ✓ | | ✓ | | | |

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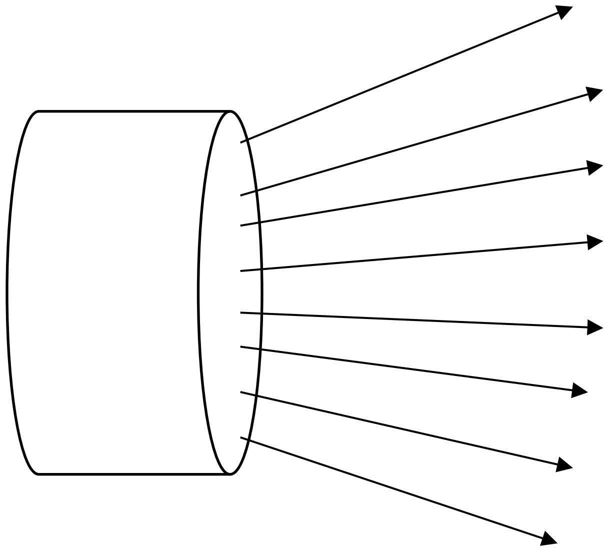
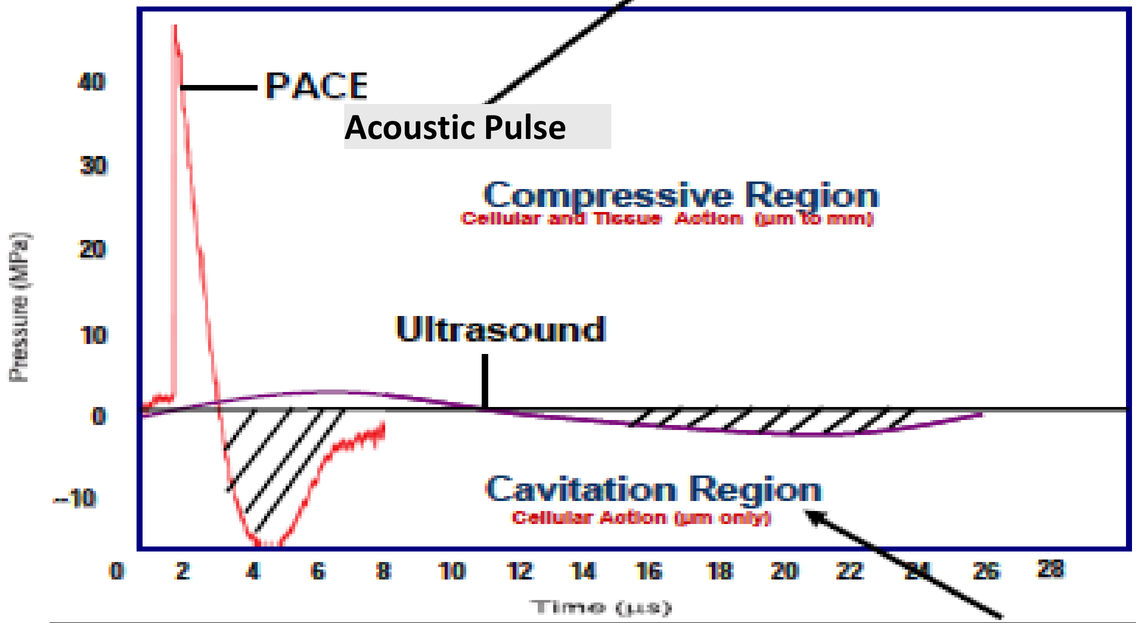
# Ultrasound Specs

- The energy distribution within the radiated field is 2.4 w/cm2 maximum
- and it takes a generally conic shape, having decreasing intensity at
- progressively increasing distance from the face of the transducer.



# Myofascial Acoustic Compression – Unlike Other Acoustic Energy Alternatives

**Focused Shockwaves Produce Compressive Forces 40 - 80 Times Higher Than Ultrasound**




**Shockwaves produce larger cavitation bubbles (more potent), as compared to minimal cavitation with ultrasound, causing powerful tensile waves at the cellular level**

# Shooting at the source of pain – the key to efficacy

Three methods used to localize treatment

- Anatomic Focusing (based on anatomical understanding or palpation)
- Image Guided Focusing (use of ultrasound, fluoroscopy or CT)
- Clinical Focusing (use patient feedback, i.e. pain flaring based to guide treatment locale)

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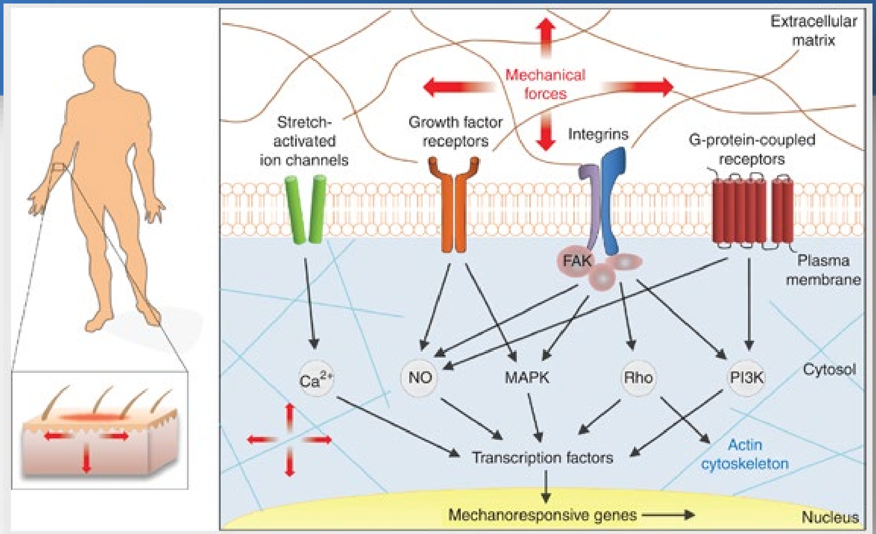
# Clinical Focusing – The diagnostic value of MyACT

- Diagnosis of referred pain and the recognition of originating trigger points can be ascertained with focused Myofascial Acoustic Compression Therapy.
- Likewise abnormal musculoskeletal tissue can be “flared” with MyACT thus defining the spot(s) for treatment
- Following this, highly accurate, focused MyACT can be delivered without guess work or the use of expensive imaging equipment
- Patients participate in a process of the location of the origin of pain and experience a treatment

# Clinical Support
# Identifying Mechanisms of Action

# …and the Science says,

**Mechanotransduction** refers to the many mechanism by which cells convert mechanical stimulus into chemical activity



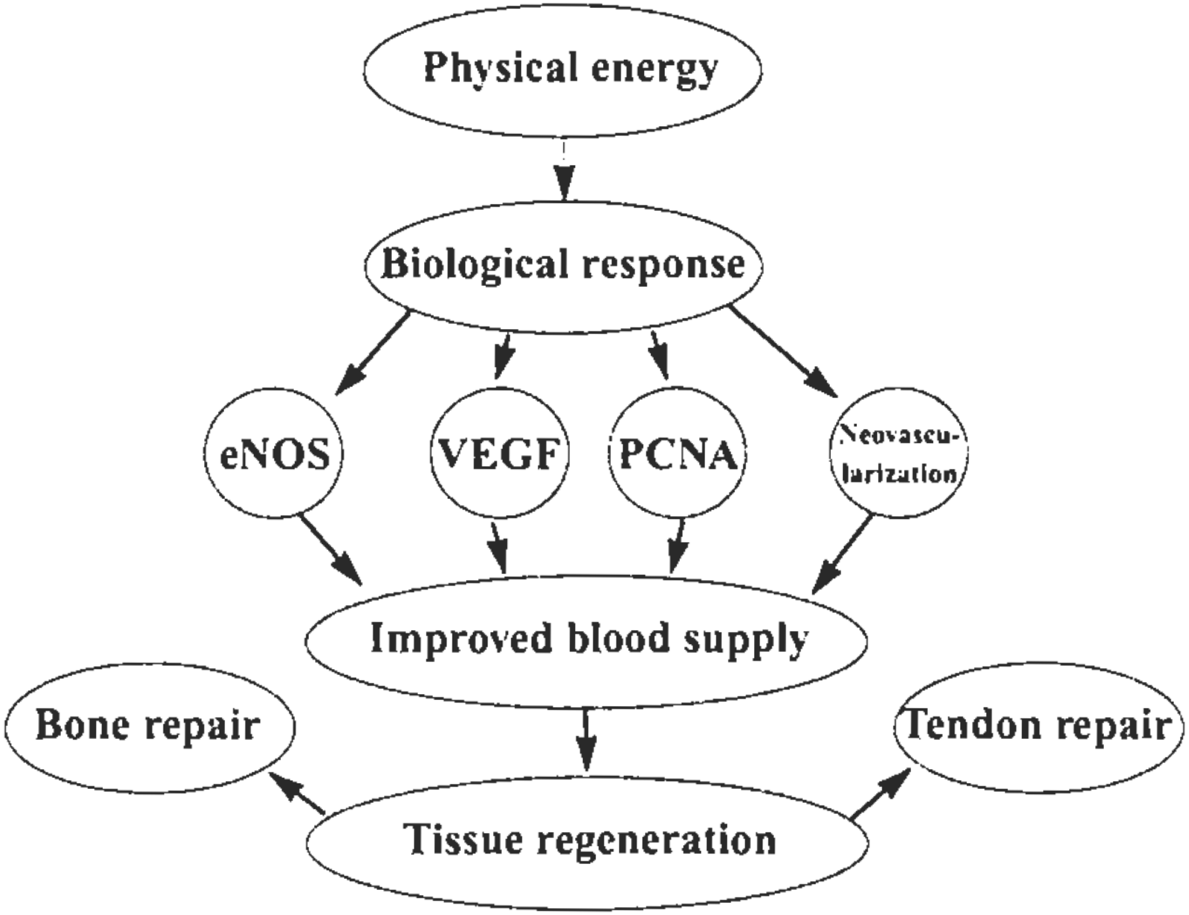
# Mechanisms of Action

- MyACT employs the natural mechanisms, by which cells "convert" mechanical forces into cellular biochemical events

- Compression  exerts a mechanical stress on cells resulting in heightened expression of proangiogenic genes such as eNOS (endothelial nitric oxide synthase), VEGF (Vascular Endothelial Growth Factor), CXCL5, CCL2, CCR2 (Chemokines and receptors), and proangiogenic proteins of VEGF and vWF

- Promotes increased circulation and pain relief

# Known responses to applications of focused sound



# Mechanotransduction

Wang and Li *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology* 2010, **2**:16
http://www.smarttjournal.com/content/2/1/16

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SPORTS MEDICINE ARTHROSCOPY REHABILITATION THERAPY TECHNOLOGY

REVIEW — Open Access

## Mechanics rules cell biology

James HC Wang*[1] and Bin Li[2,3]

**Abstract**
Cells in the musculoskeletal system are subjected to various mechanical forces *in vivo*. Years of research have shown that these mechanical forces, including tension and compression, greatly influence various cellular functions such as gene expression, cell proliferation and differentiation, and secretion of matrix proteins. Cells also use mechanotransduction mechanisms to convert mechanical signals into a cascade of cellular and molecular events. This mini-review provides an overview of cell mechanobiology to highlight the notion that mechanics, mainly in the form of mechanical forces, dictates cell behaviors in terms of both cellular mechanobiological responses and mechanotransduction.

### 1. Introduction

Mechanical forces act on humans at different levels, from the body as a whole to individual organs, tissues, and cells. It is well known that appropriate mechanical loads are beneficial to bone and muscle by enhancing their mass and strength. On the other hand, excessive mechanical forces can also be detrimental; for example, excessive mechanical loading of tendons plays a major role in the development of tendinopathy [1,2]. Thus, mechanical forces have a profound effect on tissue homeostasis and pathophysiology. The central players in the human body's response to mechanical forces are various types of mechano-sensitive cells. Examples of such cells include tenocytes in tendons, fibroblasts in ligaments and skin, osteocytes in bone, chondrocytes in articular cartilage, and endothelial cells in blood vessels. Mechanical forces induce a wide range of cellular events, including proliferation, differentiation, and gene and protein expression by both adult differentiated and stem cells [3]. This mini-review provides a concise overview of cellular mechanobiological responses, with a focus on cells from musculoskeletal tissues. In addition, mechanotransduction mechanisms, by which cells "convert" mechanical forces into cellular biochemical events, are also briefly reviewed to emphasize the notion that mechanics, mainly in the form of external and internal mechanical forces, plays a vital role in cell biology. Note that readers who are interested in a more broad and in-depth understanding of the role of mechanics in cell biology should consult relevant papers, which are abundant in the literature.

### 2. External Mechanical Forces

External mechanical forces are defined as forces, such as tensile, compressive, or shear stresses, that are applied to cells from their environment. Depending on the cell type, the forces can come in one form or a combination of them. For example, fibroblasts in tendons and ligaments are mainly under tensile stress *in vivo*, while chondrocytes and osteocytes are subjected to compression and shear stress due to fluid flow in addition to tensile forces. In blood vessels, endothelial cells lining the vessel surface are subjected to a combination of tensile stress due to vessel expansion, hydrostatic pressure, and fluid shear stress.

Because of the ability to control experimental conditions, *in vitro* model systems have been developed to investigate cellular mechanobiological responses. In many of these systems, tensile forces are applied to the substrate and hence cause substrate deformation, which in turn loads cells that adhere to the underlying substrate. There are two ways to apply tensile mechanical forces to cells: the substrate may be stretched uniaxially or biaxially. Uniaxial stretching is appropriate for application of mechanical forces to cells originating from tendons (e.g., patellar and Achilles tendons) and ligaments (e.g., anterior cruciate ligament and medial collateral ligament), as these cells are aligned with their long axis parallel to the tendon or ligament and are therefore subjected primarily to uniaxial stretching *in vivo* [4-6]. On the other hand,

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Full list of author information is available at the end of the article



"….mechanical forces have a profound effect on tissue homeostasis and pathophysiology. The central players in the human body's response to mechanical forces are various types of mechano-sensitive cells. Examples of such cells include tenocytes in tendons, fibroblasts in ligaments and skin, osteocytes in bone, chondrocytes in articular cartilage, and endothelial cells in blood vessels. Mechanical forces induce a wide range of cellular events,including proliferation, differentiation, and gene and protein expression by both adult differentiated and stem cells"

## Why is this important?

Technology that can deliver mechanical stimulus in a defined, therapeutic dose directly to specific areas of the body can positively influence common musculoskeletal conditions.

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# Mechanotransduction

Wang and Li *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology* 2010, **2**:16
http://www.smarttjournal.com/content/2/1/16

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Mechanical forces act on humans at different levels, from the body as a whole to individual organs, tissues, and cells. It is well known that appropriate mechanical loads are beneficial to bone and muscle by enhancing their mass and strength. On the other hand, excessive mechanical forces can also be detrimental; for example, excessive mechanical loading of tendons plays a major role in the development of tendinopathy [1,2]. Thus, mechanical forces have a profound effect on tissue homeostasis and pathophysiology. The central players in the human body's response to mechanical forces are various types of mechano-sensitive cells. Examples of such cells include tenocytes in tendons, fibroblasts in ligaments and skin, osteocytes in bone, chondrocytes in articular cartilage, and endothelial cells in blood vessels. Mechanical forces induce a wide range of cellular events, including proliferation, differentiation, and gene and protein expression by both adult differentiated and stem cells [3]. This mini-review provides a concise overview of cellular mechanobiological responses, with a focus on cells from musculoskeletal tissues. In addition, mechanotransduction mechanisms, by which cells "convert" mechanical forces into cellular biochemical events, are also briefly reviewed to emphasize the notion that mechanics, mainly in the form of external and internal mechanical forces, plays a vital role in cell biology. Note that readers who are interested in a more broad and in-depth understanding of the role of mechanics in cell biology should consult relevant papers, which are abundant in the literature.

**2. External Mechanical Forces**
External mechanical forces are defined as forces, such as tensile, compressive, or shear stresses, that are applied to cells from their environment. Depending on the cell type, the forces can come in one form or a combination of them. For example, fibroblasts in tendons and ligaments are mainly under tensile stress *in vivo*, while chondrocytes and osteocytes are subjected to compression and shear stress due to fluid flow in addition to tensile forces. In blood vessels, endothelial cells lining the vessel surface are subjected to a combination of tensile stress due to vessel expansion, hydrostatic pressure, and fluid shear stress.

Because of the ability to control experimental conditions, *in vitro* model systems have been developed to investigate cellular mechanobiological responses. In many of these systems, tensile forces are applied to the substrate and hence cause substrate deformation, which in turn loads cells that adhere to the underlying substrate. There are two ways to apply tensile mechanical forces to cells: the substrate may be stretched uniaxially or biaxially. Uniaxial stretching is appropriate for application of mechanical forces to cells originating from tendons (e.g., patellar and Achilles tendons) and ligaments (e.g., anterior cruciate ligament and medial collateral ligament), as these cells are aligned with their long axis parallel to the tendon or ligament and are therefore subjected primarily to uniaxial stretching *in vivo* [4-6]. On the other hand,

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"The fact that mechanics plays a dominant role in cell biology provides a solid foundation and rationale for use of mechanics to improve human health by designing appropriate equipment/instruments, exercise protocols, and rehabilitation regimens…. combined use of "bio-interventions" and "mechanics" will further improve the outcome of clinical treatments of musculoskeletal injuries."

## Why is this important?

PiezoWave2 MyACT represents the most sophisticated "mechanical" or physical medicine modality to-date because it can deliver the most specific and controllable mechanical energy to areas of the musculoskeletal system.

# Clinical Focusing

Perspectives on Modern Orthopaedics

## Extracorporeal Shock Wave Therapy in the Treatment of Chronic Tendinopathies

Andrew Sems, MD
Robert Dimeff, MD
Joseph P. Iannotti, MD, PhD

**Abstract**

Many clinical trials have evaluated the use of extracorporeal shock wave therapy for treating patients with chronic tendinosis of the supraspinatus, lateral epicondylitis, and plantar fasciitis. Although extracorporeal shock wave therapy has been reported to be effective in some trials, in others it was no more effective than placebo. The multiple variables associated with this therapy, such as the amount of energy delivered, the method of focusing the shock waves, frequency and timing of delivery, and whether or not anesthetics are used, makes comparing clinical trials difficult. Calcific tendinosis of the supraspinatus and plantar fasciitis have been successfully managed with extracorporeal shock wave therapy when nonsurgical management has failed. Results have been mixed in the management of lateral epicondylitis, however, and this therapy has not been effective in managing noncalcific tendinosis of the supraspinatus. Extracorporeal shock wave therapy has consistently been more effective with patient feedback, which enables directing the shock waves to the most painful area (clinical focusing), rather than with anatomic or image-guided focusing, which are used to direct the shock wave to an anatomic landmark or structure.

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None of the following authors or the departments with which they are affiliated has received anything of value from or owns stock in a commercial company or institution related directly or indirectly to the subject of this article: Dr. Sems, Dr. Dimeff, and Dr. Iannotti.

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*J Am Acad Orthop Surg* 2006;14:195-204



In the past decade, interest has increased in using extracorporeal shock wave therapy (ESWT) to manage chronic tendinopathies that are refractory to other forms of nonsurgical management. Despite the burden of disease that tendon pathology represents and the amount of work that has been performed in the past two decades, much remains to be learned about the etiology, pathophysiology, and management of these tendinopathies. Current nonsurgical protocols are often more an art than a science.

Numerous studies have evaluated the efficacy of ESWT as a method of managing tendinopathies. Strict comparison of these studies is difficult, however, because of the many variables that define the application parameters of ESWT. These variables include the amount of energy delivered, the method of delivery and focusing, frequency of delivery, and use of anesthesia. In addition, treatment response varies depending on anatomic site, etiology, and severity and chronicity of the condition being treated, as well as in rehabilitation protocols used in conjunction with ESWT. The indica-



"Extracorporeal shock wave therapy has consistently been more effective with patient feedback, which enables directing the shock waves to the most painful area (clinical focusing), rather than with anatomic or image-guided focusing, which are used to direct the shock wave to an anatomic landmark or structure."

## Why is this important?

The legacy of the use of focused sound (shock wave) in the USA is "high energy" which required anesthesia and no patient guidance. Patient guidance is defined as the eliciting a deep, dull ache (flaring) that is accomplished with "low energy" devices like the PiezoWave2.  Simply put, the patient tells us where to treat. This dramatically improves the delivery of the energy and resulting mechanotransduction.

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# Mechanotransduction

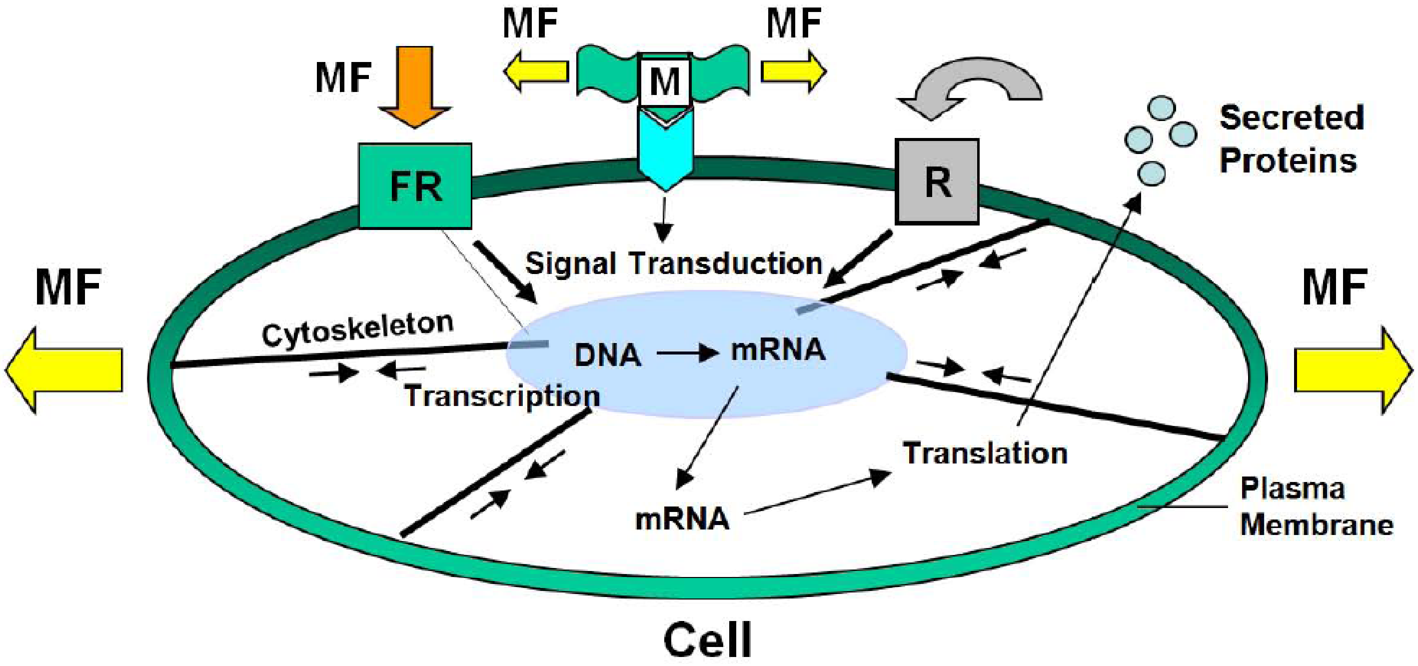


**Figure 1 Schematic illustration of the "mechanical nature" of cellular mechanotransduction mechanisms**. Mechanical forces (**MF**) can induce mechanotransduction by directly altering conformation of an extracellular matrix (**ECM**) protein and integrin configuration and transmitting forces to the cytoskeleton and nucleus, thus eventually affecting transcription and translation. Also, mechanical forces can unfold a domain of the extracellular protein (**M**) and expose a cryptic site that may serve as an activating ligand for a cell surface receptor, resulting in a series of signaling events. Also, when mechanical forces are applied to "force receptors" (**FR**), such as integrins and G proteins, they initiate signal transduction, resulting in transcription followed by translation. As a result, soluble factors are secreted into the ECM, which act on the receptor (**R**) and then initiate a cascade of signaling events. Note that double arrows indicate intracellular tensions in the actin filaments. (Modified with permission from Wang and Thampatty, **Fig. four** in *Encyclopedia of Biomaterials and Biomedical Engineering*, 2008, p.1783-1793, Taylor & Francis).

# Clinical Focusing – The diagnostic value of MyACT

- Diagnosis of referred pain and the recognition of originating trigger points can be ascertained with focused Myofascial Acoustic Compression Therapy.
- Likewise abnormal musculoskeletal tissue can be "flared" with MyACT thus defining the spot(s) for treatment
- Following this, highly accurate, focused MyACT can be delivered without guess work or the use of expensive imaging equipment
- Patients participate in a process of the location of the origin of pain and experience a treatment

# Upregulation of Lubricin

Cell Tissue Res (2011) 346:255–262
DOI 10.1007/s00441-011-1258-7

REGULAR ARTICLE

## Extracorporeal shockwave-induced expression of lubricin in tendons and septa

Dafang Zhang · Cathal J. Kearney · Thomas Cheriyan · Thomas M. Schmid · Myron Spector

Received: 2 July 2011 / Accepted: 20 September 2011 / Published online: 19 October 2011


**Abstract** Lubricin, a lubricating glycoprotein that facilitates tendon gliding, is upregulated by mechanical as well as biochemical stimuli, prompting this study of its induction by extracorporeal shockwave therapy (ESWT). The objective of this study was to characterize and quantify the effect of ESWT on lubricin expression in tendons and septa in a rat model. Hindlimbs of six rats were treated with low-dose ESWT and those of another six with high-dose ESWT, using contralateral limbs as controls. After 4 days, resected samples were processed for immunolocalization of lubricin using a purified monoclonal antibody. ESWT was found to increase lubricin expression in both low-dose and high-dose ESWT-treated tendons and also in septa. Lubricin expression generally increased with increasing dose of ESWT. Increased lubricin expression may contribute to the beneficial effects of ESWT in providing pain and symptom relief in musculoskeletal disorders by decreasing erosive wear.

**Keywords** ESWT · Lubricin · Tendon · Septum · Rat

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### Introduction

Lubricin, a lubricating molecule in diarthrodial joints, has been shown to enhance tendon-gliding in vitro (Zhao et al. 2010) and in vivo (Kohrs et al. 2011). Lubricin is a mucinous glycoprotein initially found to be produced by synovial cells (Rhee et al. 2005) and isolated from synovial fluid (Swann et al. 1985). Superficial zone protein (SZP), produced by superficial zone chondrocytes (Schumacher et al. 1994), is homologous to lubricin (Jay et al. 2001) and megakaryocyte-stimulating factor (MSF) (Flannery et al. 1999), all of which are products of the megakaryocyte-stimulating factor gene (*msf*) (Jay et al. 2001). Collectively, these homologous glycoproteins have been referred to as proteoglycan 4 and are encoded by 12 exons of the gene *msf*, also known as *Prg4* (Englert et al. 2005). Lubricin, which has been found to demonstrate anti-adhesion (Englert et al. 2005) as well as lubricating properties, has been reported in bovine ligaments (Lee et al. 2008a) and in canine tendons (Sun et al. 2006). Its presence within fascicles and fascicular sheaths in caprine (Funakoshi et al. 2008) and human (Funakoshi and Spector 2010) tendons suggested a role in interfascicular tribology.

Certain mechanical (Sun et al. 2006) and biochemical stimuli (Jones and Flannery 2007; Lee et al. 2008b) have been shown to regulate lubricin expression in vivo, prompting this investigation of the effects of extracorporeal shockwave therapy (ESWT) on lubricin expression in tendons. ESWs are pressure waves of short duration in

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"ESWT was found to stimulate endogenous lubricin production in tendons and septa…increased lubricin deposition in tendons and septa following ESWT contributes to the beneficial effects of ESWT by facilitating movement macroscopically among gross structures, as well as microscopically among collagen fascicles."

## Why is this important?

ESWT by facilitates movement macroscopically among gross structures, as well as microscopically among collagen fascicles. Lubricin may decrease wear and tear in tissues treated with ESWT and thus provides relief from symptoms and pain.

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# Vascular endothelial growth factor (VEGF)

- A signal protein produced by cells that stimulates vasculogenesis and angiogenesis
- It is part of the bodies system that restores the oxygen supply to tissues when blood circulation is inadequate
- Serum concentration of VEGF is high in Bronchial Asthma and low in Diabetes Mellitus
- VEGF's normal function is to create new blood vessels during embryonic development, new blood vessels after injury, muscle following exercise, and new vessels (collateral circulation) to bypass blocked vessels.

# CPT Codes – Based Feedback

- 0019T EXTRACORPOREAL SHOCK WAVE INVOLVING MUSCULOSKELETAL SYSTEM, NOT OTHERWISE SPECIFIED, LOW ENERGY
- 97140 – Manual Therapy
- 97035 – Ultrasound / Phonophoresis
- 97124 – Massage for Myofascial Release
- 90901 – Biofeedback Services
- 97016 – Vasopneumatic Devices
-

Having said that….

# Insurance Billing

***CPT 97140, manual therapy techniques (mobilization/manipulation, manual lymphatic drainage, manual traction,*** (*Graston Technique, Active Release Technique (ART), Myofascial Release and Muscle Energy Techniques),**one or more regions, each 15 minutes) cannot be reported or billed if the chiropractor also reports or bills for a chiropractic manipulative treatment (CMT) on the same anatomical region4 as the therapeutic procedure. If a chiropractor reports both a CPT 98940-series service and CPT 97140 on the same date of service, the chiropractor's medical records must document the differences between the two procedures and that each was conducted on a different anatomical site. To document this, you may use Modifier 59 (Distinct procedural service) when billing for these procedures (i.e., CPT 97140-59).***

***It is not appropriate to bill CPT 97124, massage, for myofascial release. For myofascial release, CPT 97140 should be reported.***

*(It is our policy that Billing and coding for 97140 performed on a second visit on the same day inappropriate and not allowed when CMT has been administered in the same region as 97140.*

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