

Extracorporeal Shockwave Therapy

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Objectives

Following completion of this lecture the student will be able to:

- Describe the mechanical characteristics of ESW.
- Identify musculoskeletal pathology that may benefit from ESWT.
- Discuss the biological effects of ESW on soft tissue and bone .

Outline

- Essential and History of ESWT
- Characteristics and Principle of Production/generation
- Physical parameters of ESW
- Physiological Effects & Mechanism of Action
- Clinical Applications
- Adverse effects of ESW
- Evidence-Base of ESWT

ESWT: Essential and History

- Therapeutic shockwave was first introduced into medicine in 1970 for distraction of urinary stones (**lithotripsy**)
- In 1980's , ESW is used for **musculoskeletal disorders**.
- By the early 1990s, reports to start to appear in the journals and conference about use of ESW for **soft-tissue problems**.
- 1999 – Radial shock wave (**RSWT**) principle introduced
- 2011: more than 1000 clinical studies widely accepted therapy in rehabilitation & orthopedics for new fields & clinical indications

ESWT: Definition

- **Shock-wave** is an acoustic large-amplitude compression wave, with high pressure peak adjustable in a limited frequency range with two wave sides; positive pressure phase and negative pressure phase.

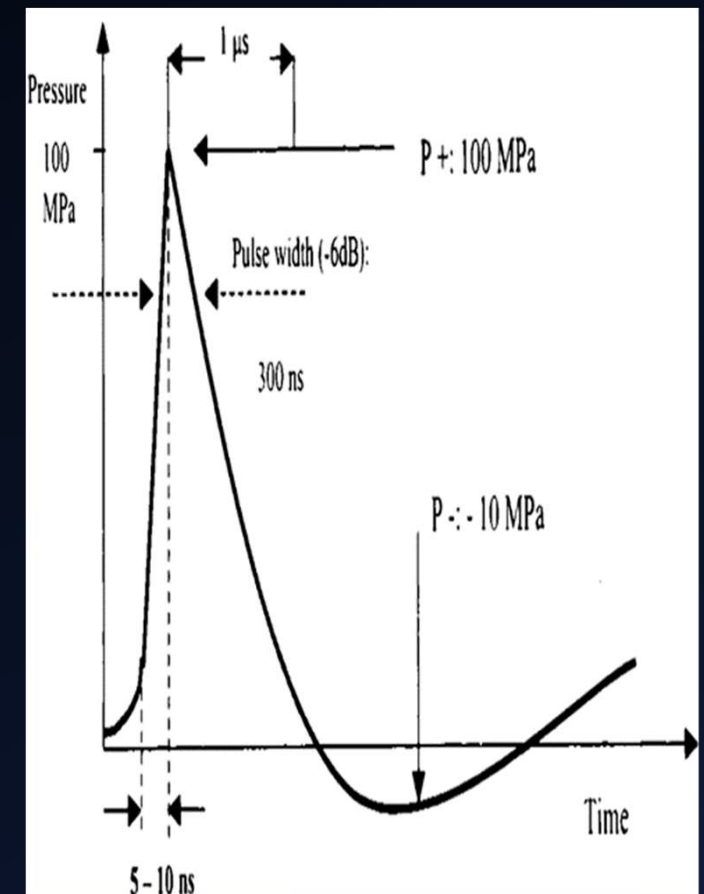
Extracorporeal = outside body

Shockwave = intense, short energy wave travelling faster than speed of sound



ESWT: Characteristics

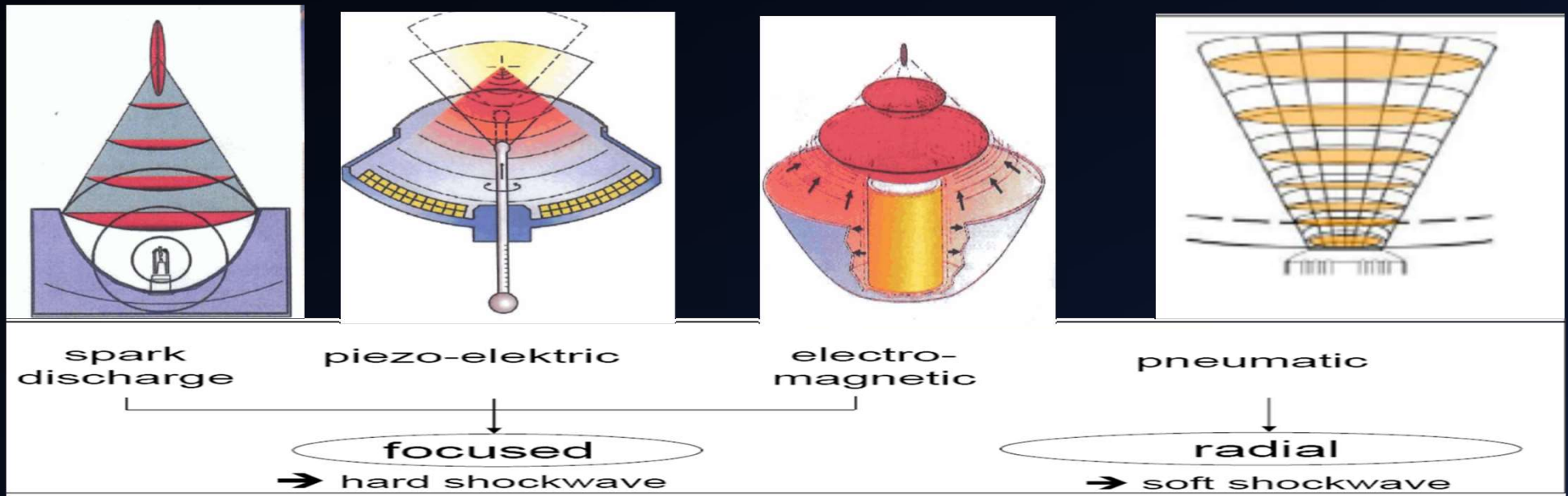
- Non-linear type of pressure wave
- High Peak positive pressure typically 5-100MPa
- Fast pressure rise duration <10 ns
- Short life duration ≤10 μsec
- Narrow effective beam (2-8mm diameter)
- Frequency range 16HZ-20MHz
- Pause of negative pressure -20 MPa



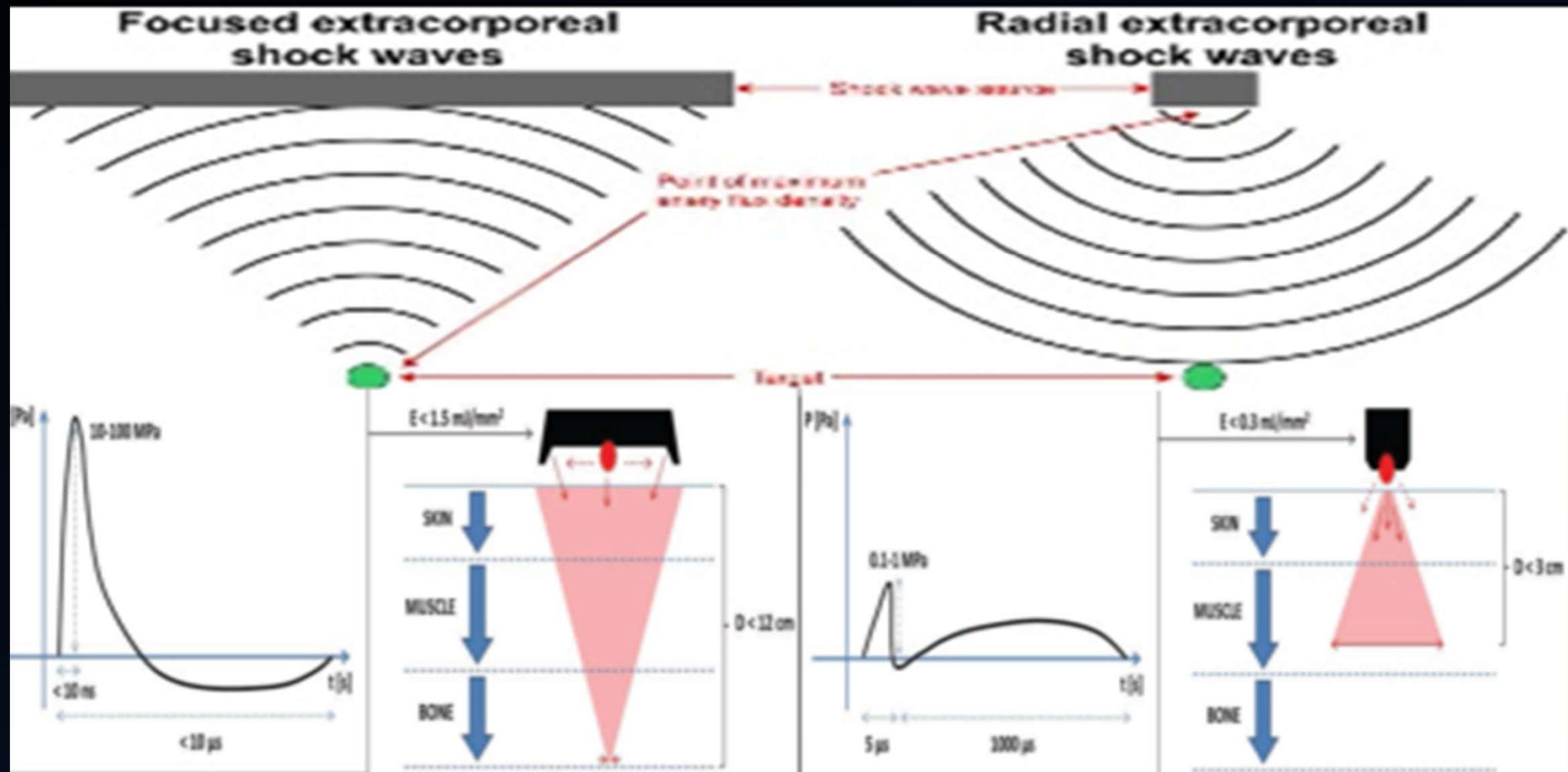
ESWT: **Production/Generation**

Types

- ❖ **Focus:(FWSWT)** **Electrohydraulic, Electromagnetic & Piezoelectric**
- ❖ **Radial: (RESWT)** **Pneumatic**



Radial vs focused principle



Focus		VS	Radial
	Electromagnetic, electrohydraulic,	Generator	Pneumatic
	100-1000Bar	Pressure amplitude	1-10bar
	Higher (1500m/sec)	Speed	Slower (10m/sec)
	≈0.2μsec	Pulse duration	0.2-0.5msec
	Nonlinear spike like	Waveform	Nearly sine
	0.01-1.50mJ/mm ² (medium-high)	Energy flux density	0.01-0.05mJ/mm ² (low)
	Focus/ converge	Pressure field	Radial /diverge
	Deep :>12cm,	Penetration depth	Superficial:≤3cm
	Cell	Effect	Tissue
	1-3	Treatment sessions	3-5
	Higher	Adverse effect	Lower
	Required	Anesthesia	No
	No	Guided	X-ray or US guided
	Low costs of the unit	Cost	high costs per unit

Shock Wave Parameters: Energy

The energy of the shock wave (E) is measured in mill joules (mJ)

Energy Flux Density (EFD)

The energy density is the amount of energy in one square millimeter of the focal point field and is measured in mJ/mm²

The effects of shock waves are dose dependent

Low <
0.28mJ/mm²



Medium
0.28-0.59mJ/mm²



High >
0.60mJ/mm²

ESWT-Mechanism of Action

Mechanical
Phase



physical-
chemical
phase



Chemical
Phase

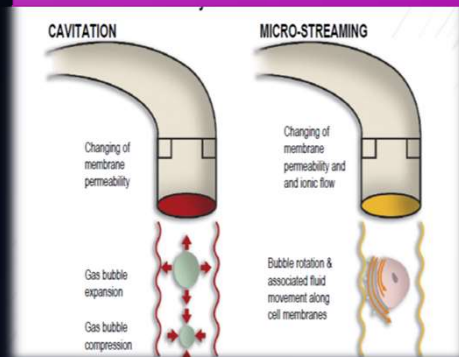


Biological
phase

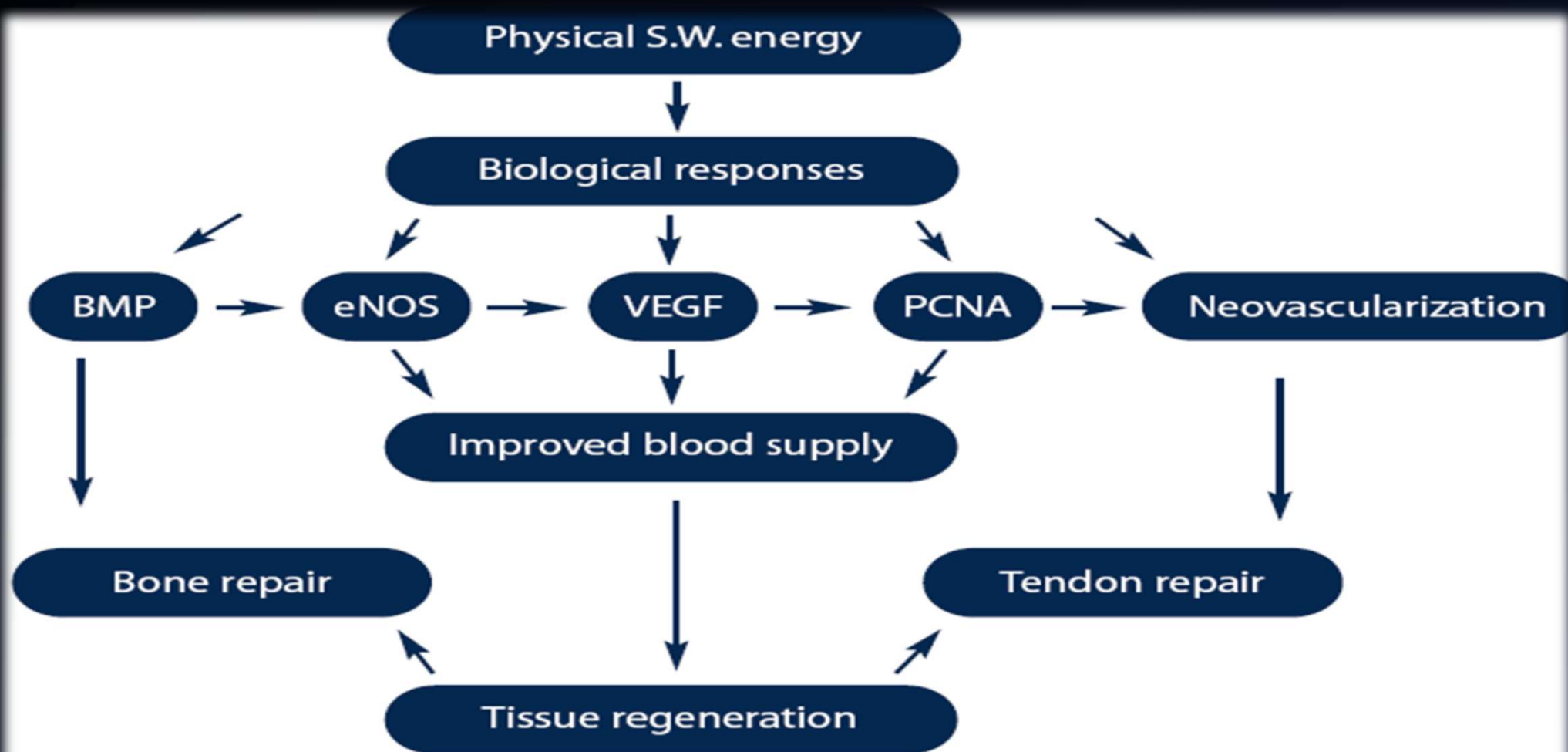
Due to extracellular cavitation, ESWT ionizes the molecules and there is an increase of membrane permeability

Stimulates cells to release biomolecules (e.g. ATP),

Alter the functions of ion channels in the cell membrane and the calcium mobilization in cells



ESWT-Biological effects



ESWT-Physiological Effects

Increased local blood flow and Neovascularization

Reduction of concentration of Substance P (decrease pain/edema)

Transient analgesic effect on afferent nerves

Break down calcific deposits (primarily, but not exclusively in tendon)

Stimulation of activity of osteoblasts – increase healing of bone

Stimulation of production of collagen by fibroblasts- acceleration of healing processes of Ligament and tendon

Increase in cellular activity and release of (BMP, eNO, VEGF)

ESWT- indications

Pain in muscles, insertions tendons

- Groin pain
- Achillodynia
- Plantar fasciitis
- Achilles tendinopathy
- Patellar tendonopathy
- Tennis and Golfers elbow (medial and lateral epicondylalgia)
- Biceps tendinopathy
- Supraspinatus tendinopathy

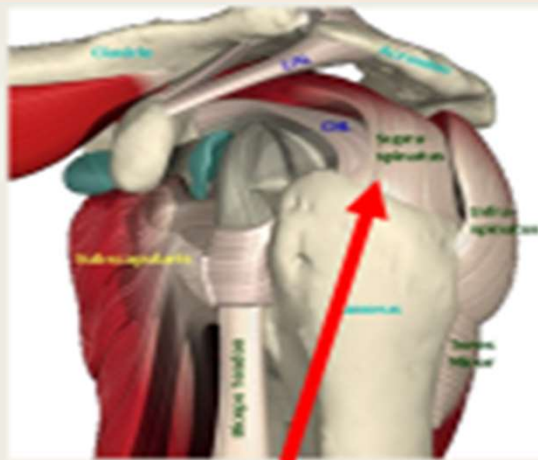
Calcifications

- ❑ Heel spur (calcar calcanei)
- ❑ Tendinosis calcarea
- ❑ Long tendon of biceps calcification

Dermatology,

- ❖ Scars
- ❖ Diabetic ulcers

ESWT- indications



Supraspinatus tendon



Common extensor tendon



Patella tendon



Achilles tendon



Plantar fascia

ESWT-Clinical Application

EFD

LOW (up to 0.28mJ/mm^2)
MEDIUM (up to 0.59mJ/mm^2)
HIGH ($> 0.60\text{mJ/mm}^2$)

Number of shock

Shock number between 1000 - 2000,
Some research has tried as few as 100-500
500 more effective than 100

A single session using local anesthesia –
not physiotherapy.

Number of Tx, sessions

3–5 sessions at low energy levels, for the
majority of patients.

No RCT trials yet to determine the
maximally effective therapy session
number and interval (3days-3weeks).

ESWT-Achilles Tendinopathy

11 studies reviewed

ESWT produces greater short-term and long-term improvements in pain and function compared to other non-operative treatments (e.g. rest, footwear modification, NSAIDs, stretching, or strengthening)

Therapy parameters

Pressure: 2–3 bars

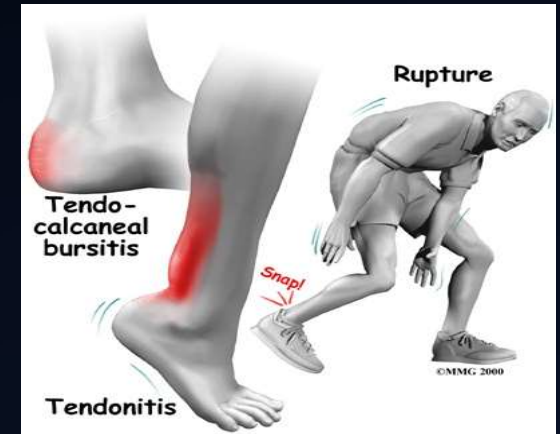
Frequency: 5–10 Hz

pulses (number of shock 2000)

Patient position lying on back supported with

Frequency of treatments 5–10 days

Number of treatments 3–5 sessions



ESWT-Plantar fasciitis

Therapy parameters

Pressure: 2.5 bars

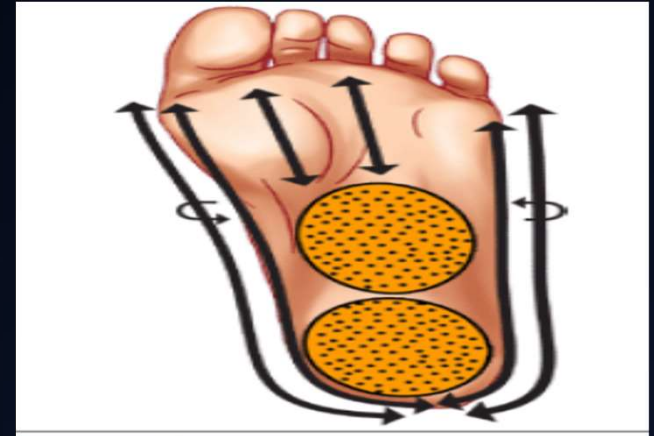
Frequency: 10 Hz

pulses (number of shock 2000)

Patient position lying prone , leg supported under ankle

Frequency of treatments 5–10 days

Number of treatments 3–5 sessions



ESWT- calcification

Focused ESWT:

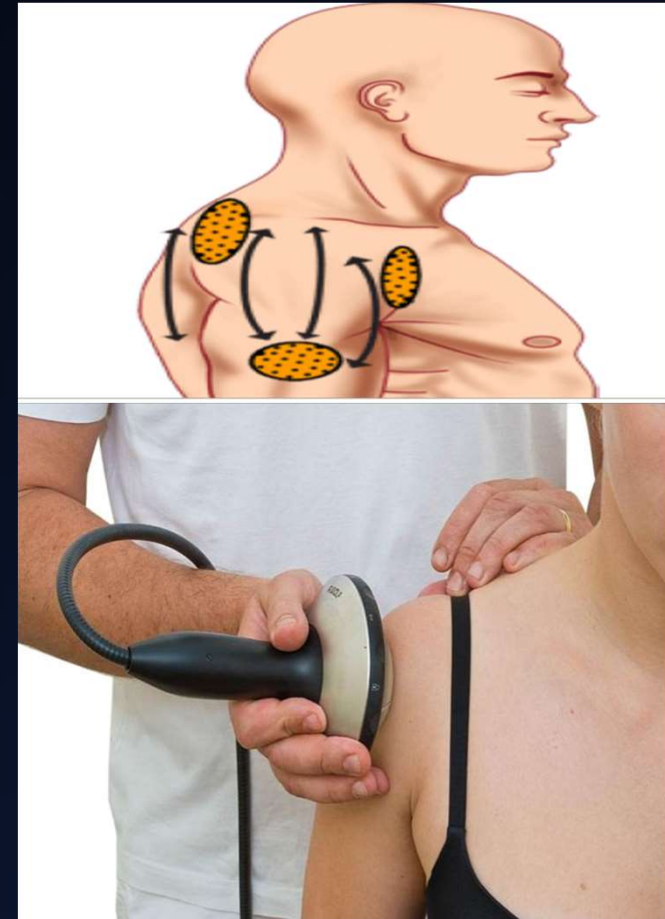
Electrohydraulic/ Electromagnetic:

2.000 shocks;
EFD 0,19 -0.35 mJ/mm²,
1 to 3 sessions

Radial ESWT:

- ❖ 4.000 shocks; 4-5 bar, 3-5 treatments.
- ❖ Application interval: 1-2 weeks.
- ❖ No local anesthesia.

Patient position lying on back or sitting



ESWT- calcification



ESWT- Contraindications

- Application just **above the nerve**
- Application on **certain tissues** (eyes and periorbital area, myocardium, spinal cord, epiphysis, gonads, kidneys, liver)
- Application over malignancy
- Application over Metal implants
- Application in case of **TBC**
- Application of **therapeutic X - rays** within last 6 weeks
- Pharmacotherapy by **corticosteroids within last 6 weeks**
- Sensational deficit in the treated area
- **Disc hernia or protrusion**

ESW- Possible Adverse Events

- ❑ Temporary hyper/hypo- sensitivity
- ❑ Transient pain
- ❑ Hematoma (up to 4%)
- ❑ Erythema and Petechia
- ❑ Local irritation

Adverse events are equivalent to other physical modalities

Local symptoms are much more common in RSWT

Most of the patients never experience any of these side effects, if occur usually resolved within 3 to 5 days

ESW- Therapy sequences



Location of the area to be treated

The area to be treated is located using palpation in order to deliver the therapy precisely



Gel application

Sufficient amount of gel is applied to the area located in step 1.



Therapy initiation

The Shockwave applicator is slightly pushed against the area to be treated and the start button is pressed