

# Extracorporeal Shockwave Therapy

MOHAMMED TA, OMAR PHD, PT, CLT  
COLLEGE OF APPLIED MEDICAL SCIENCES  
REHABILITATION HEALTH SCIENCES DEPARTMENT



# 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 over 30 years ago for distraction of urinary stones (**lithotripsy**)
- Recently, ESW is used for musculoskeletal disorders in the early 1980's.
- 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 surgery Emerging 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 one the wave side, the positive **pressure increases in a short time follows by negative pressure.**

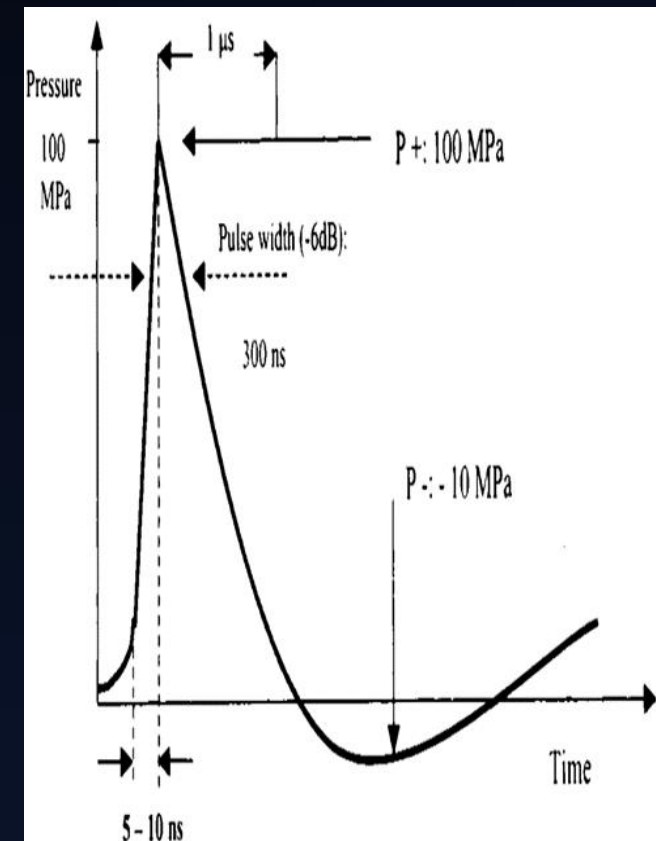
**Extracorporeal** = outside body

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



# ESWT: Characteristics

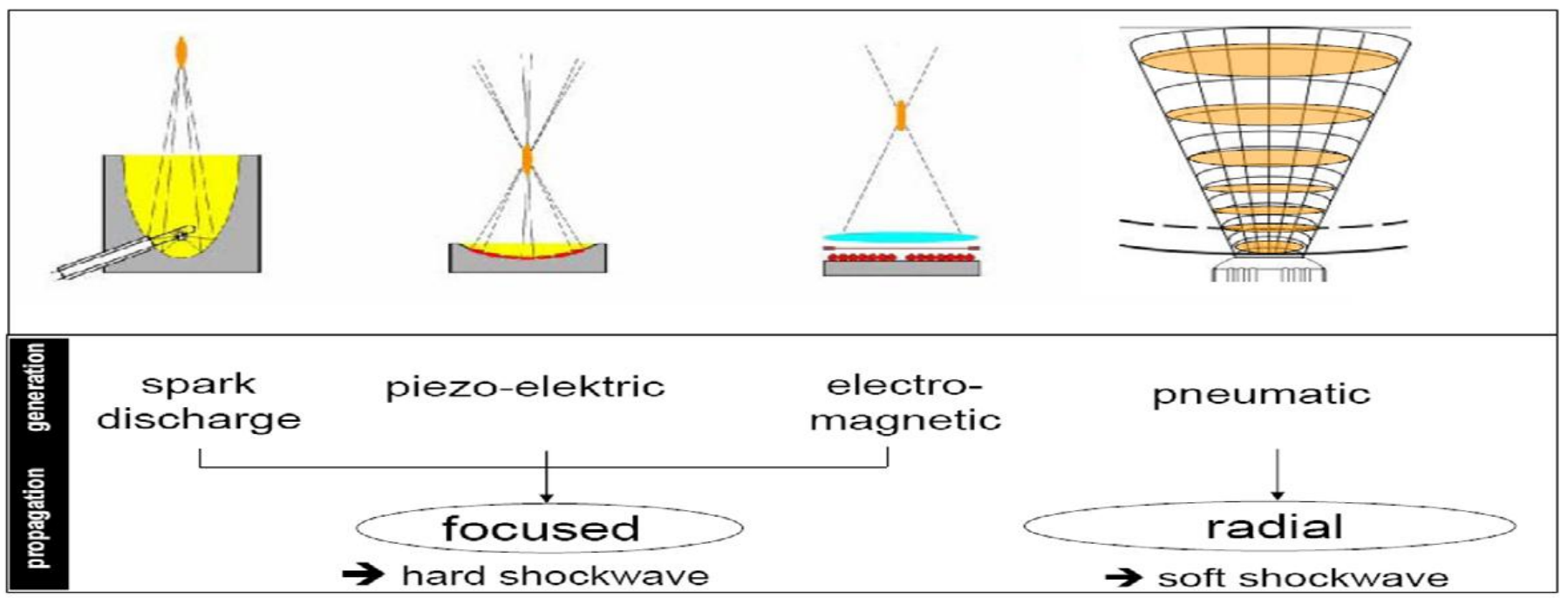
- High Peak pressure typically  $\approx 100\text{MPa}$ 
  - 50-80MPa
  - 35 - 120MPa
- Fast pressure rise duration  $< 10\text{ ns}$
- Short life duration  $\leq 10\text{ }\mu\text{sec}$
- Narrow effective beam (2-8mm diameter)
- Frequency range 16HZ-20MHz
- Pause of negative pressure



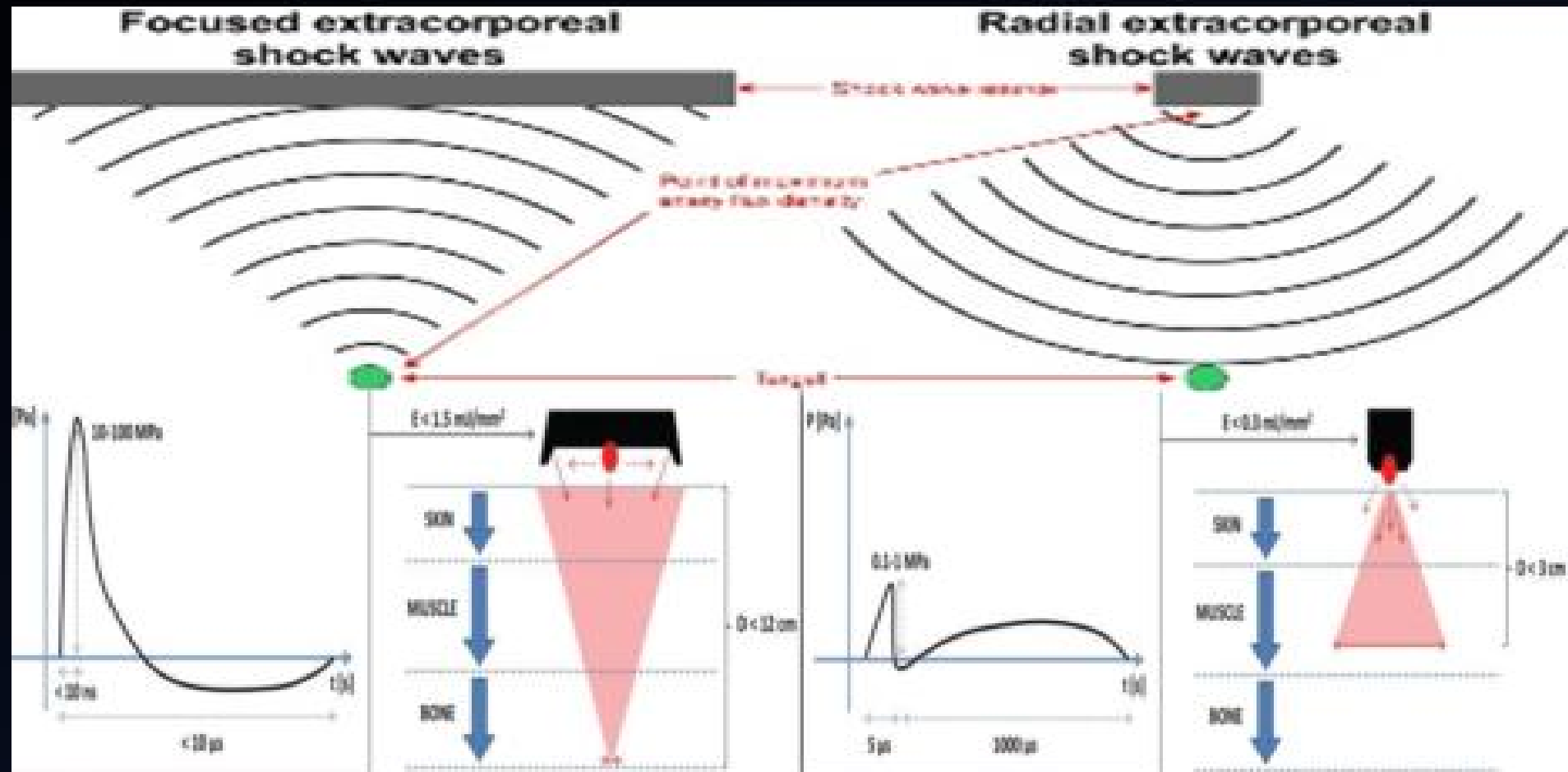
# ESWT: Production/Generation

## Types

- ❖ Electrohydraulic, Electromagnetic and Piezoelectric
- ❖ Radial or Electro-pneumatic



## Radial vs focused principle





Focus	vs	Radial
Electromagnetic, electrohydraulic,	Generator	Pneumatic
100-1000Bar	Pressure	1-10bar
≈0.2μsec	Pulse duration	0.2-0.5msec
0.01-1.50mJ/mm2 (high)	Energy flux density	0.01-0.05mJ/mm2 (low)
Focus	Pressure field	Radial
Large>12cm, Deep	Penetration depth	Small <3cm, Superficial
Cell	Effect	Tissue
1-3	Treatment sessions	3-5
Higher	Adverse effect	Lower

# Radial vs focused SWT

---

## Radial:

- ❖ Designed for superficial treatment
- ❖ Clinically focused
- ❖ No anesthesia, no analgesics
- ❖ Higher comfort of the therapy
- ❖ Low costs of the unit

## Focused:

- Developed to reach internal organs
- X-ray or ultrasound guided
- Anesthesia necessary
- Costs per unit, treatment

# Shock Wave : Parameters

---

## Energy Flux Density (mJ/mm<sup>2</sup>)

Amount or concentration of energy  
in the focus area

Measure EF is mJ/square area (mm<sup>2</sup>)

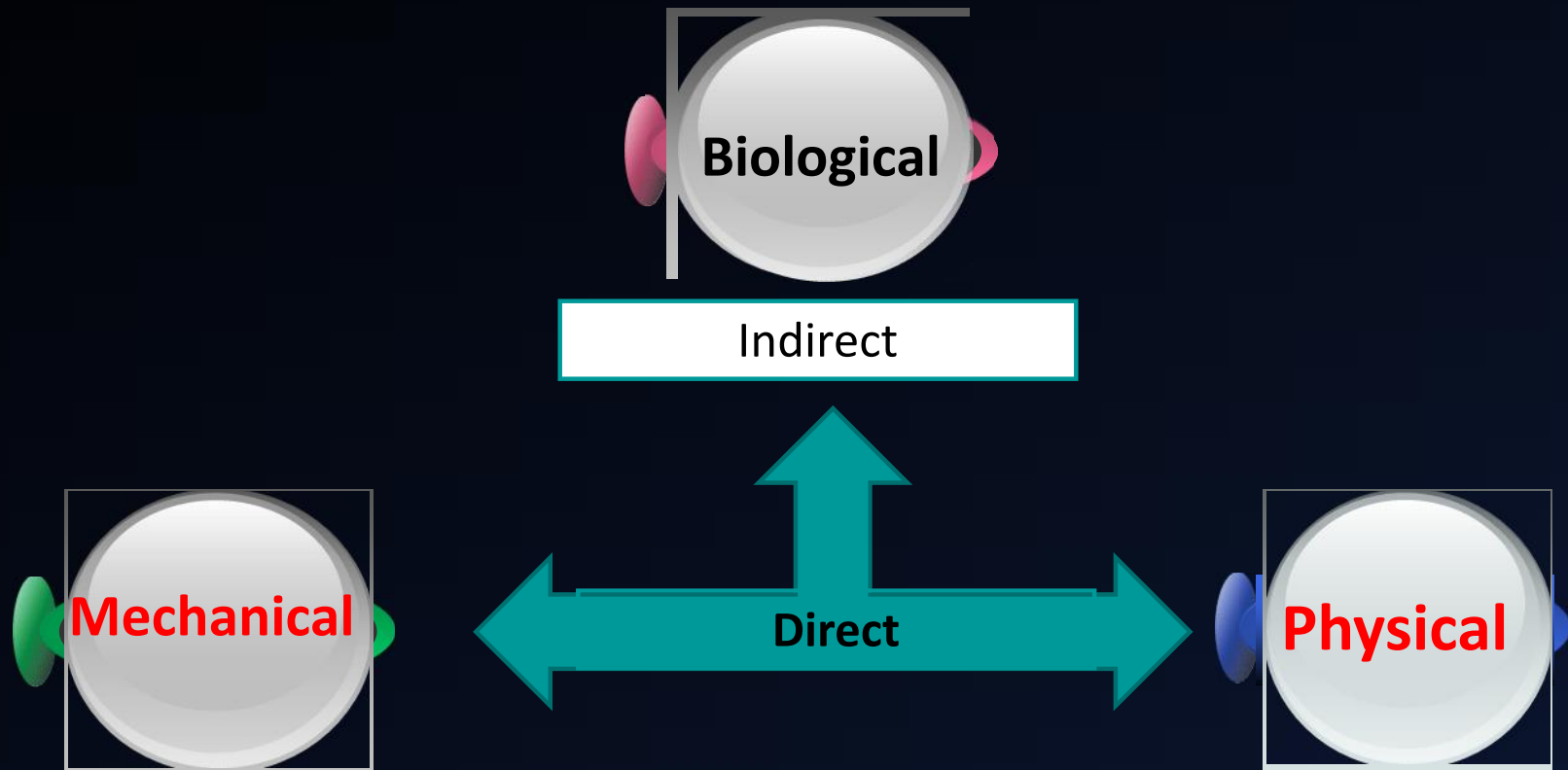
Low < 0.28mJ/mm<sup>2</sup>

Medium 0.28-0.59mJ/mm<sup>2</sup>

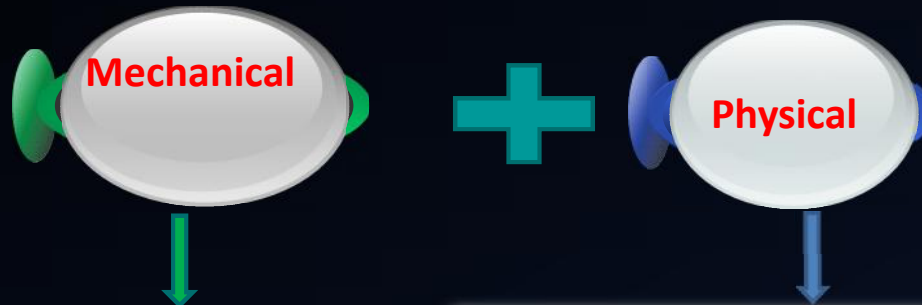
High > 0.60mJ/mm<sup>2</sup>

# ESWT-Mechanism of Action

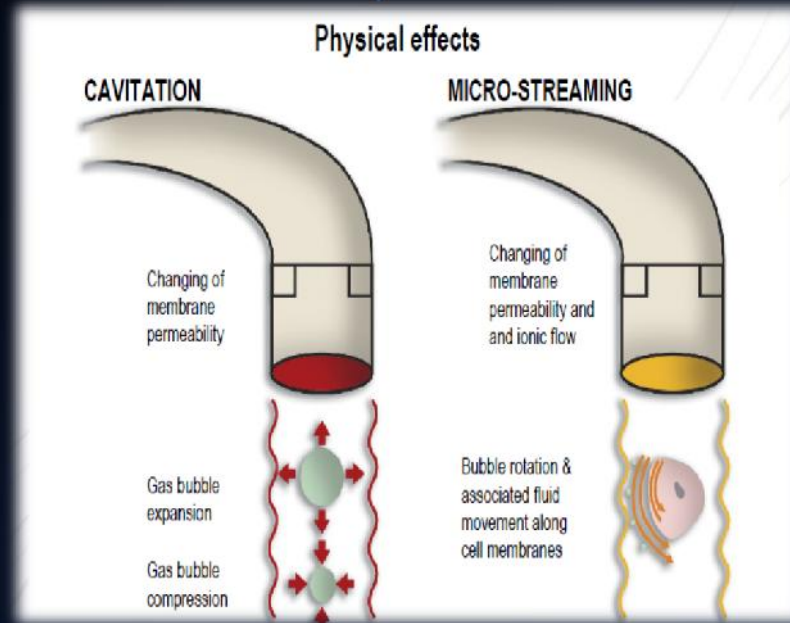
---



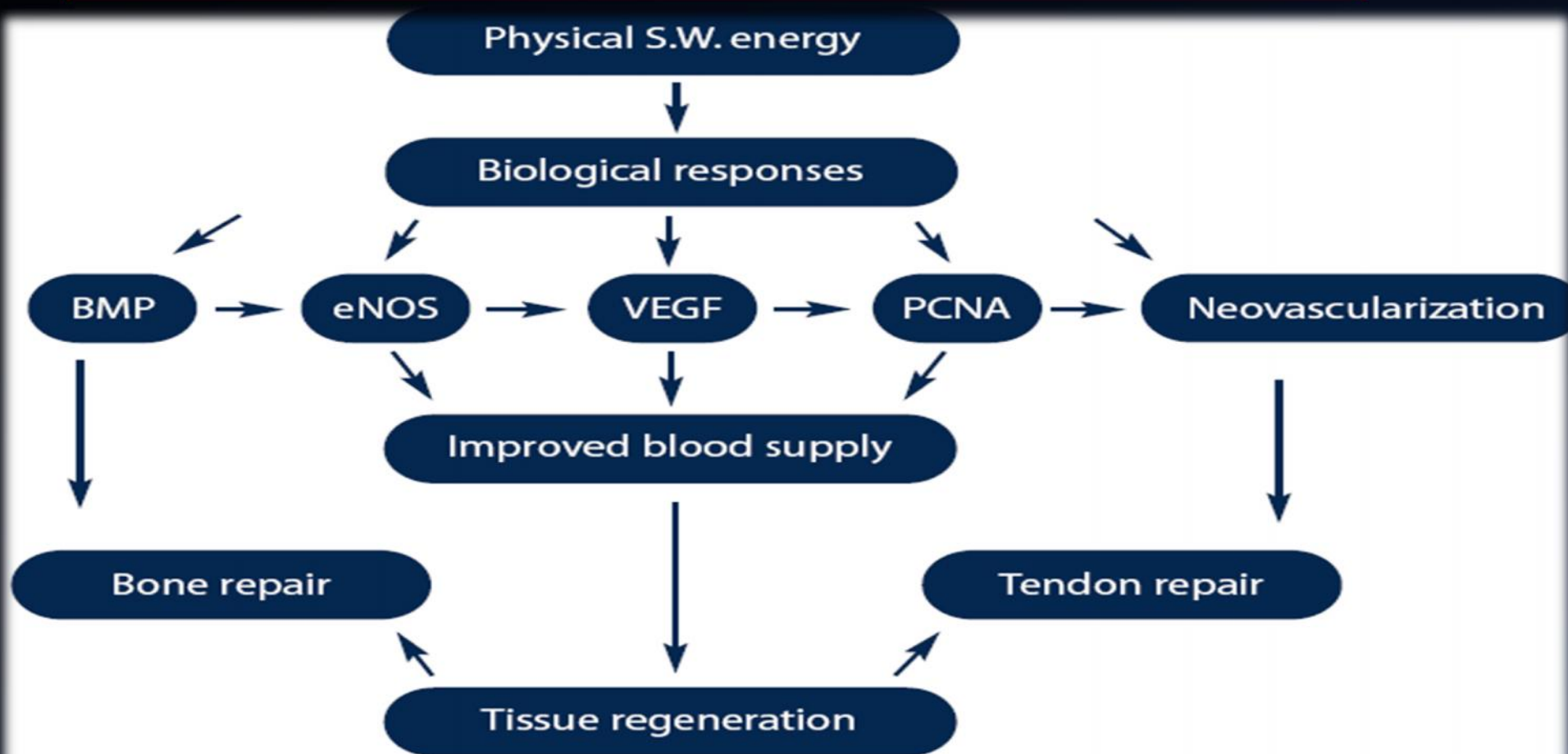
# ESWT-Physical & mechanical of Action



Molecular ionization  
Increase cell membrane  
permeability.



# 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, & inflammatory cytokines)

# 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

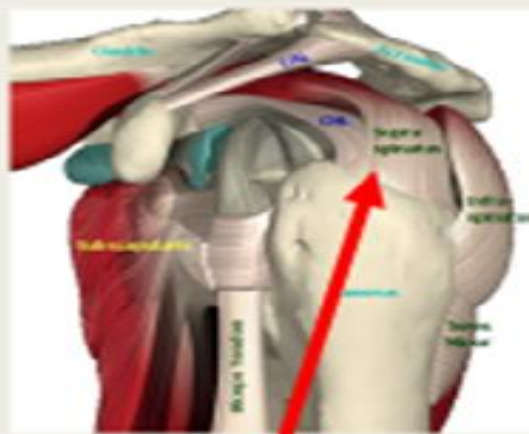
- ❑ Heel spur (calcar calcanei)
- ❑ Tendinosis calcarea
- ❑ Long tendon of biceps calcification

## Dermatology,

- ❖ Scars
- ❖ Diabetic ulcers



# ESWT- indications



Supraspinatus tendon



Common extensor tendon



Patella tendon

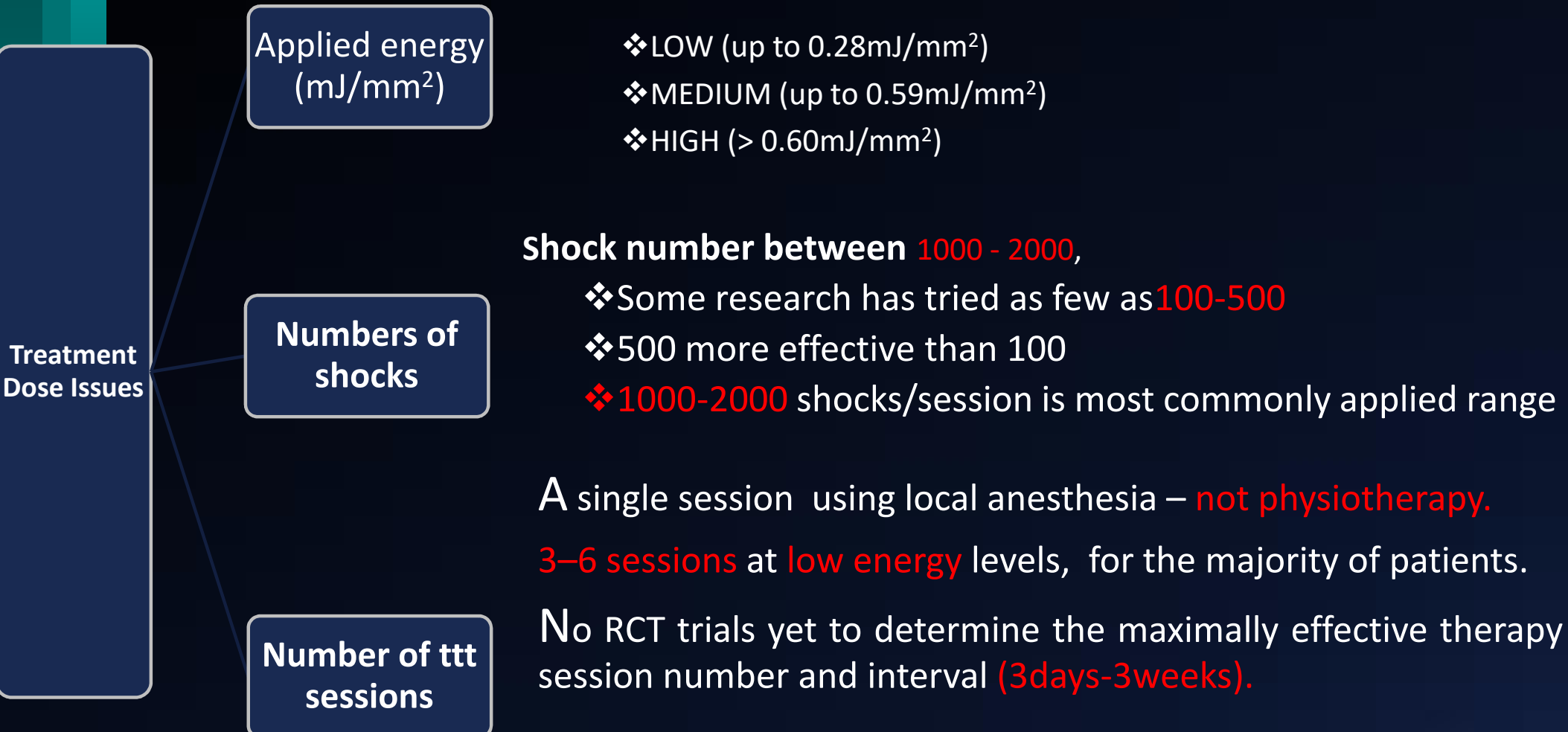


Achilles tendon



Plantar fascia

# ESWT-Clinical Application



# ESWT-Achilles Tendinopathy

- Insertional: within 2 cm of its insertion.
- Mid-substance: 2-6 cm proximal to its insertion

**S/S:** Pain, swelling, and impaired performance

## 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

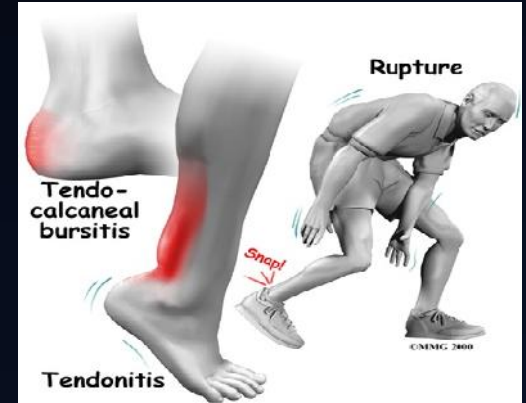
Frequency: 5–10 Hz

pulses (number of shock 2000)

**Patient position** lying on back supported with knee

**Frequency of treatments** 5–10 days

**Number of treatments** 3–5 sessions



# 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