Extracorporeal Shockwave Therapy and Treating Musculoskeletal Conditions

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- 1989 graduate Kearney State College
- 1991 graduate Mayo Clinic Physical Therapy School
- 2013 Doctorate graduate Regis University Denver Co
- Taught 14 years Wichita State Physical Therapy program
- Studied in Russia, Czechoslovakia, Hungary and Australia
- Instructor for KU Med Rural Health Education

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The aims of modern Extracorporeal Shockwave Therapy

- No/less medication
- No/less injections (e.g. Cortison!)
- No/less operations
- Non-invasive, Low risk-level
- High effectiveness!
- Happy Patient → Successful Practice!

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WHAT ARE THE EFFECT OF EXTRACORPOREAL SHOCK WAVES?

- 1. Pain relief/elimination
- 2. Increase of blood circulation in the entire surrounding tissue
- 3. Inhibition of inflammation
- 4. Activation of reparative processes in the tissue including scleraxis production
- 5. Muscle relaxing effect

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WHAT ARE THE EFFECT OF EXTRACORPOREAL SHOCK WAVES?

- 6. Activation of mesenchymal stem cells
- 7. Blockade of neurogenic inflammation via depletion of Substance-P (playing an important role in the pathogenesis of tendinopathies such as tennis elbow, plantar fasciopathy, etc.)
- 8. Breaks up soft tissue calcifications
- 9. Improved blood circulation in the treated tissue. Actual angiogenesis
- 10. Reduction in sensation of pain (mediated by non-myelinated C nerve fibers)

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Contraindications for Extracorporeal Shockwave

- Treatment over air-filled tissue (lungs, intestines)
- Treatment of torn tendons (if > 50% injured!)
- Treatment of pregnant women
- Treatment of persons under 22 years of age (exception: treatment of Osgood-Schlatter disease)
- Treatment of patients with blood coagulation disorders (including local thromboses)
- Treatment of patients treated with oral anticoagulants
- Treatment of tissues with local tumours or local bacterial or viral infections
- Treatment of patients who have been treated locally with cortisone (minimum interval between shock wave treatment and the last local cortisone injection: six weeks)

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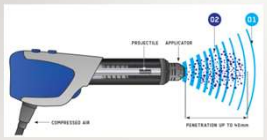
FUNDAMENTALS: RADIAL SHOCK WAVES - RSWT®



- **Radial shockwaves are generated by compressed air that accelerates a projectile, which strikes a fixed applicator at a high speed (up to 90km/h).**
- **The kinetic energy is converted into an acoustic pressure wave delivered to the target tissue through the skin.**

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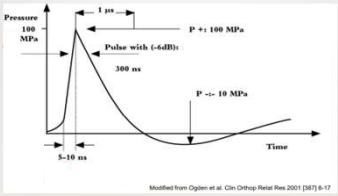
PROPERTIES OF A SHOCK WAVE

- "A shock wave is a sonic pulse that has certain physical characteristics."*



*Ogden JA, Tóth-Kischkat A, Schultheiss R Principles of shock wave therapy. Clin Orthop Relat Res 2001;(387):8-17

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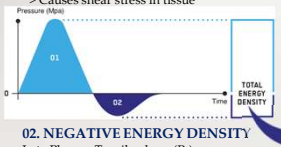
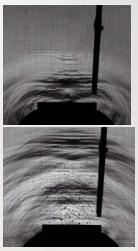
RADIAL SHOCKWAVE CHARACTERISTICS

01. POSITIVE ENERGY DENSITY
Early Phase = Compression phase (P+)
> Causes shear stress in tissue



02. NEGATIVE ENERGY DENSITY
Late Phase = Tensile phase (P-)
> Causes cavitation bubbles



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CLINICALLY PROVEN EFFECTS

- PAIN RELIEF
- REDUCTION OF INFLAMMATION
- STIMULATION OF NATURAL HEALIING

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Pain relief and reduction of neurogenic inflammation

- **Primary mechanism of action**
- **Inhibition of the release of Substance P**
- **Why is this important?**

Wuerfel T, Schmitz C, Jokinen LLJ. **The Effects of the Exposure of Musculoskeletal Tissue to Extracorporeal Shock Waves**. Biomedicines. 2022 May 6;10(5):1084. doi: 10.3390/biomedicines10051084. PMID: 35625821; PMCID: PMC9138291.

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Inflammation

Syndrome with multiple causes

- **Pain**
- **Swelling**
- **Thermal increase**
- **Stiffness**
- **Functional Disability**

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NEUROGENIC INFLAMMATION

Nociceptive stimuli trigger a protective response releasing Substance P by the c-fiber nerves

Shock waves inhibit the release of substance P blocking neurogenic inflammation

Substance P increases the sensitivity of c-fiber nerves leading to an increase of nociceptive signaling

Substance P stimulates the activation of mast cells leading to release of histamine and vasodilatation

- Neurogenic inflammation is a self stimulating mechanism that block healing processes and the expression of scleraxis
- Scleraxis is a transcription factor required for proper embryonic development of tendons.
- Scleraxis is the earliest detectable marker for differentiated tendon cells and activates downstream tendon differentiation genes.

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SHOCKWAVE & SUBSTANCE P

1. Red chili peppers contain **Capsaicin**. At first this substance overwhelms the so-called C nerve fibers responsible for transmitting pain but then disables them for an extended period of time. Everybody knows the feeling – first, the mouth is on fire, then it feels completely numb.

First it burns, then it goes numb!

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SHOCKWAVE & SUBSTANCE P

- Research has indicated that **pressure wave therapy** works the same way.[a,b] When activated, the C nerve fibers release a specific substance (substance P) in the tissue as well as in the spinal cord. This substance is responsible for causing slight discomfort during and after shock wave treatment. However, with prolonged activation, C nerve fibers become incapable for some time of releasing substance P and causing pain.[c]
- **Pain first, then recovery!**

a. Maier et. al., Clin Orthop Relat Res 2003; (406):237-245
b. Klonschinski et al., Pain Med 2011;12:1532-1537
c. In addition, shock waves activate the so-called Aδ nerve fibers (sensory afferences from the periphery) via receptors in the tissue. According to the gate control theory of Melzack and Wall (Science 1965; 150:971–979) these activated Aδ fibers then suppress the conduction of pain in the second-order neuron of the sensory pathway in the dorsal horn of the spinal cord.

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PRESSURE WAVE & SUBSTANCE P

3. Less substance P = less pain
   Less substance P = less neurogenic inflammation [d]

4. Neurogenic inflammation is decreased
   + Release of growth factors
   + Activation of stem cells into the treated tissue[e]
   + Increase of Scleraxis gene expression

HEALING

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SHOCKWAVE AND SUBSTANCE P

- ***Especially on the nerval system the effect*** *of pressure waves seems to be mediated by* ***cavitation***[f]

d. Shock waves lead in the treated tissue to a stronger expression of growth factors such as BMP (bone morphogenetic protein), eNOS (endothelial nitric oxide synthase), VEGF (vascular endothelial growth factor) and PCNA (proliferating cell nuclear antigen) as well as to an activation of stem cells (Wang CJ, ISMST Newsletter 2006 Vol 1 Issue 1; Hofmann et al., J Trauma 2008; 65:1402–1410).

e. Schelling et al., Biophys J 1994;66:133-140

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HOW DO SHOCKWAVE ACT ON THE MUSCULOSKELETAL SYSTEM

- Via a multitude of molecular and cellular mechanisms, resulting in the following main therapeutic effects:
  - Reduction in sensation of pain (mediated by non-myelinated C nerve fibers)
  - Blockade of neurogenic inflammation via depletion of Substance-P (playing an important role in the pathogenesis of tendinopathies such as tennis elbow, plantar fasciopathy, etc.)
  - Activation of mesenchymal stem cells
  - Release of growth factors
  - Improved blood circulation in the treated tissue

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Diagnosis treated with ESWT

- Tennis elbow
- Patellar Tendonitis
- Calcific Tendonitis
- Muscle strain/tear
- Scar after surgery
- Golfers elbow

Neck pain
Rotator cuff tear
Knee arthritis
Meniscal injuries
Adhesive capsulitis
Headaches

Low back pain
P. Fasciitis
Bursitis
ACL post-op
Trigger finger
Trigger points

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Tennis Elbow

Treatment Protocol:
- ✓ Maximal energy tolerated by the patient
- ✓ 2000 shocks
- ✓ Frequency 10 Hz
- ✓ 1 session per week

Significant differences were observed between groups. The radial shock wave group outcome demonstrated:

- greater reduction of VAS score
- greater reduction of DASH score
- greater Maximal grip strength than the control group

Yang TH, Huang YC, Lau YC, Wang LY. **Efficacy of Radial Extracorporeal Shock Wave Therapy on Lateral Epicondylosis, and Changes in the Common Extensor Tendon Stiffness with Pretherapy and Posttherapy in Real-Time Sonoelastography**: A Randomized Controlled Study. Am J Phys Med Rehabil. 2017 Feb;96(2):93-100. doi: 10.1097/PHM.0000000000000547. PMID: 27323324

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Adhesive Capsulitis

Treatment Protocol:
- ✓ 4 sessions one week apart
- ✓ 3.5 bars, (EFD) 0.16 mJ/mm²
- ✓ frequency 8 Hz
- ✓ 15mm applicator

- **In comparaison to the control group, the radial shock wave group presented a reduction of the DASH score of 54 after 4 weeks but also of 54 after 24 weeks**

Ahmed Zaky Hussein & Robert A. Donatelli (2016) **The efficacy of radial extracorporeal shockwave therapy in shoulder adhesive capsulitis: a prospective, randomised, double-blind, placebo-controlled, clinical study**, European Journal of

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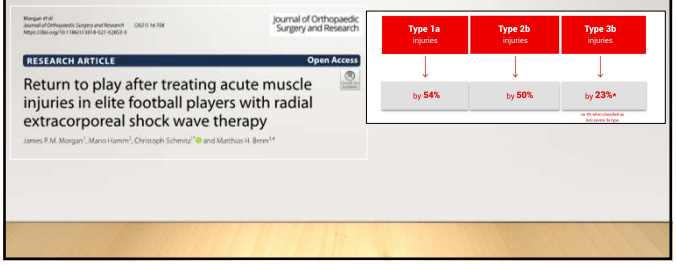
Muscle Injuries



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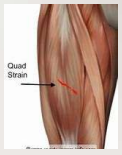
Muscle Injuries

Individually adapted sessions to patient feedback and sensitivity.

- **20 Hertz**
- **1.0 to 3.4 bar**
- **6000 to 12000 shocks per session**
- **3 treatments a week**



Morgan JPM, Hamm M, Schmitz C, Brem MH. **Return to play after treating acute muscle injuries in elite football players with radial extracorporeal shock wave therapy.** J Orthop Surg Res. 2021 Dec 7;16(1):708. doi: 10.1186/s13018-021-02853-0. PMID: 34876172; PMCID:

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Related Basic Science Study

- **"This is the first study demonstrating that radial extracorporeal shock wave therapy has the potential to modulate the biological function of human skeletal muscle cells. Based on our experimental findings, we hypothesize that radial extracorporeal shock wave therapy could be a promising therapeutic modality to improve the healing process of sports-related structural muscle injuries."**
- Mattyasovszky SG, Langendorf EK, Ritz U, Schmitz C, Schmidtmann I, Nowak TE, Wagner D, Hofmann A, Rommens PM, Drees P. Exposure to radial extracorporeal shock waves modulates viability and gene expression of human skeletal muscle cells: a controlled in vitro study. J Orthop Surg Res. 2018 Apr 6;13(1):75. doi: 10.1186/s13018-018-0779-0. PMID: 29625618; PMCID: PMC5889540.

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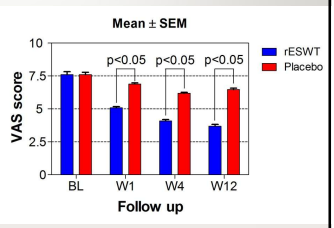
Knee Osteoarthritis

- **4 sessions of rESWT with a DolorClast device operated at 0,25mj/mm² have demonstrated beneficial effects on VAS and WOMAC score up to 3 months after the last treatment session.**



Zhao Z, Jing R, Shi Z, Zhao B, Ai Q, Xing G. **Efficacy of extracorporeal shockwave therapy for knee osteoarthritis: a randomized controlled trial**. J Surg Res. 2013 Dec;185(2):661-6. doi: 10.1016/j.jss.2013.07.004. Epub 2013 Jul 30. PMID: 23953895.

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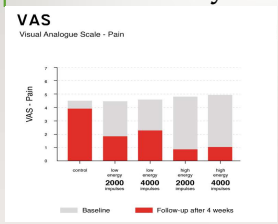
Clinical Study Knee Osteoarthritis



- Reduction of VAS score is directly linked to the energy delivered per shock and not to the total number of shocks.

Ya-Fei ZHANG, MD, Yang LIU, MD, Shao-Wen CHOU, MD and Hao WENG, PhD. **Dose-related effects of radial extracorporeal shock wave therapy for knee osteoarthritis: a randomized controlled trial** J Rehabil Med 2021; 53: jrm00144

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Chronic RC Calcific Tendonitis

«high energy» treatments		«low energy» treatments
1500 impulses at 0.32mJ/mm²	V S	6000 impulses at 0.08mJ/mm²
Total energy dose 480J/mm²		Total energy dose 480J/mm²

«**High energy ESWT appears to be more effective than low energy ESWT**, but threshold energy has yet to be defined.»

Gerdesmeyer L, Wagenpfeil S, Haake M, Maier M, Loew M, Wörtler K, Lampe R, Seil R, Handle G, Gassel S, Rompe JD. **Extracorporeal shock wave therapy for the treatment of chronic calcifying tendonitis of the rotator cuff: a randomized**

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Case study in 29 yo male with acute onset left shoulder calcific tendonitis

- Jan 7, 2025 insidious onset left shldr pain. MEC xrays calcific tendonitis. Advil/ice take the edge off
- Jan 14 PT eval L shldr flex 11 deg/pain, Ext 38 deg, Abd 17 deg/pain, ER 6 deg/pn
- MSK US 2 calcifications in SS tendon.
- Rx STM L shldr. ESWT 25mm head 2500 pulses 2 bar 20 hz. 10 mm focused head 2500 pulses 2 bar 20 hz pain 6-7/10. HEP codmans exs, scap squeezes
- Jan 17 PT "80% better". ROM Flex 141 deg no pn, Ext 59 deg, Abd 160 deg no pn, ER 56 deg/feels it a bit.
- Rx STM L shldr. ESWT as above on Jan 14. Pain still at 6/10. HEP Grn Tband 10 reps of Ext, ER and IR 2 times a day

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Case study in 29 yo male with acute onset left shoulder calcific tendonitis

- Jan 22, 2025 PT "99-100% better". Sleeping in bed.
- AROM L shldr all with no pain. Flex 156 deg, Ext 68 deg, Abd 174 deg, ER 70 deg
- MMT Flex R is 56.4 lb L is 42.3 lb = 75%. Abd R is 45.3 lb L is 41.3 lb = 91%
- ER R is 34 lb L is 21.7 lb = 63%. IR R is 41.3 lb L is 41.3 lb = 95%.
- ESWT 25 mm head 2.5 bar 2500 pulses at 20 hz. 10 mm focused 2.5 bar 2500 pulses at 20 hz pn scale 6/10.
- HEP pec, doorway, post capsule stretches. IYT's 2 sets 10 2 times/day 1 lb wt.
- Graduated to HEP and call if need anything.

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Low Back Pain

Medicine (Baltimore) 2023 Dec 29;102(52):e36596. doi: 10.1097/MD.0000000000036596

Extracorporeal shock wave therapy for low back pain: A systematic review and meta-analysis

Zhuorao Wu a, Tianqi Zhou a, Shuangchun Ai a,b,*

ESWT for LBP has efficacy and safety in improving pain, dysfunction,

and psychological conditions compared to other therapies.

ESWT has shown advantages in terms of long-term efficacy.

Randomized controlled trials with larger sample sizes and more objective outcomes are re

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Plantar Fasciitis

- **Both ESWT with focused shock waves and second generation RSWT are safe, effective, and easy treatments for chronic PF not responding to conservative therapy.**
- **Efficacy and safety of both ESWT and RSWT for chronic PF have been demonstrated in several RCTs in the international peer-reviewed literature.**
- **Treatment of chronic plantar fasciopathy with extracorporeal shock waves (review)**
  Christoph Schmitz, Nikolaus BM Császár, Jan-Dirk Rompe, Humberto Chaves & John P Furia
- *Journal of Orthopaedic Surgery and Research* **volume 8**, Article number: 31 (2013)

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65%-91% Success rate in MSK injuries

- **Extracorporeal shockwave therapy in musculoskeletal disorders**
- Ching-Jen Wang
- *Journal of Orthopaedic Surgery and Research* **volume 7**, Article number: 11 (2012)
- treatment of sports related over-use tendinopathies such as proximal plantar fasciitis, lateral epicondylitis, calcific or non-calcific tendonitis of the shoulder and patellar tendinopathy……
- Also in non-union of long bone fracture, avascular necrosis of femoral head, chronic diabetic and non-diabetic ulcers and ischemic heart disease…..

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Demonstration

- Any volunteers?

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Questions?

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Thank you!!!!!

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