

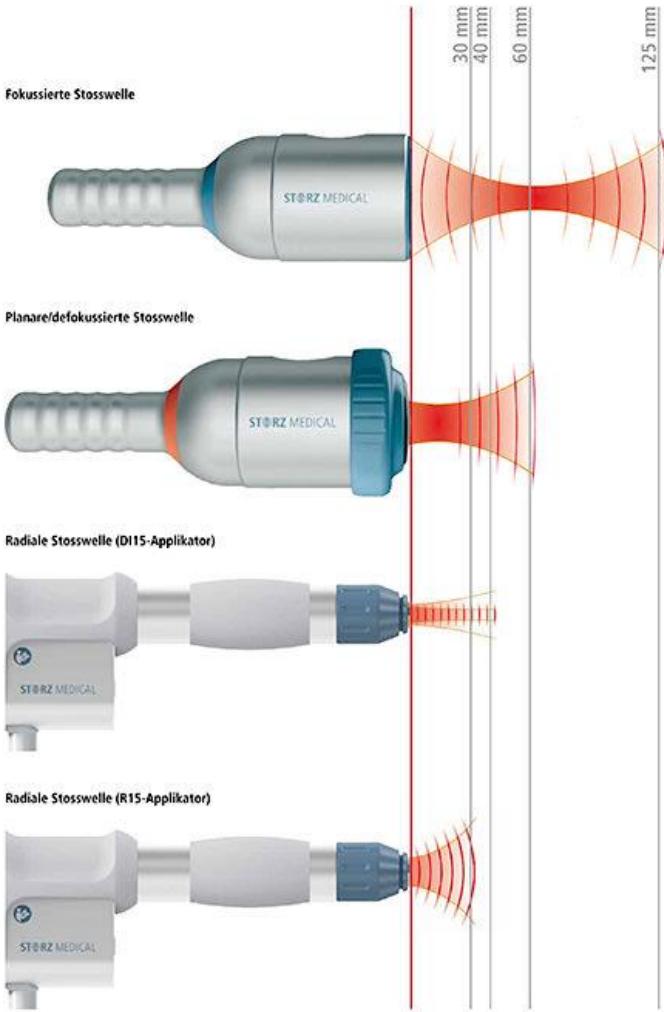
ESWT in lymphology

Prof. Dr. Karsten Knobloch, FACS



Shockwaves





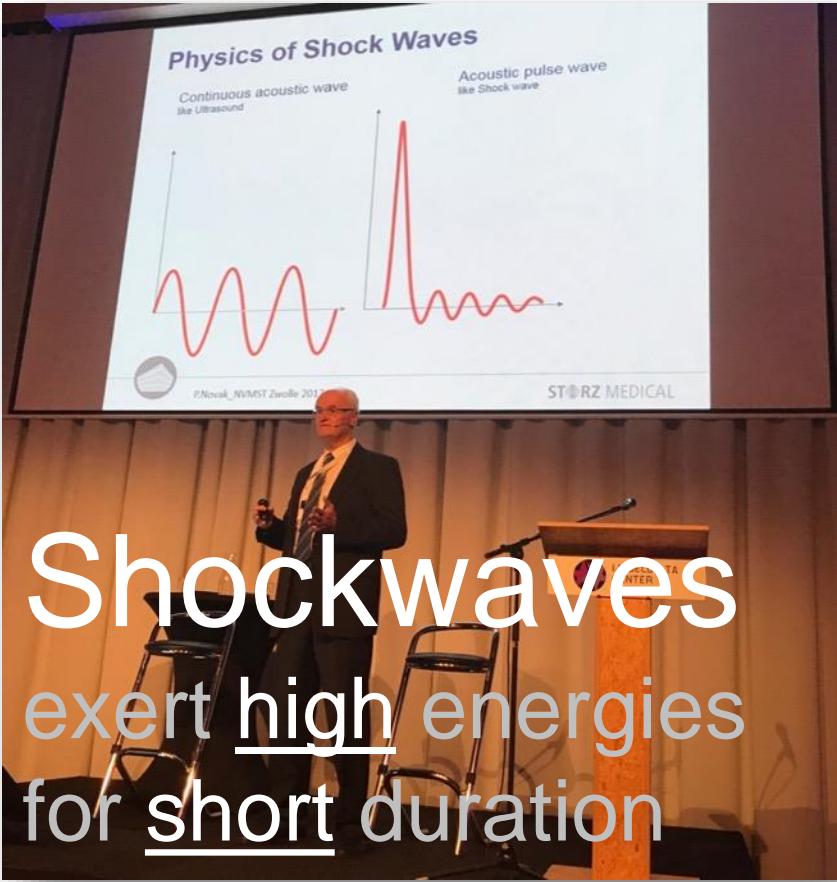
deep
superficial

Acoustic Waves

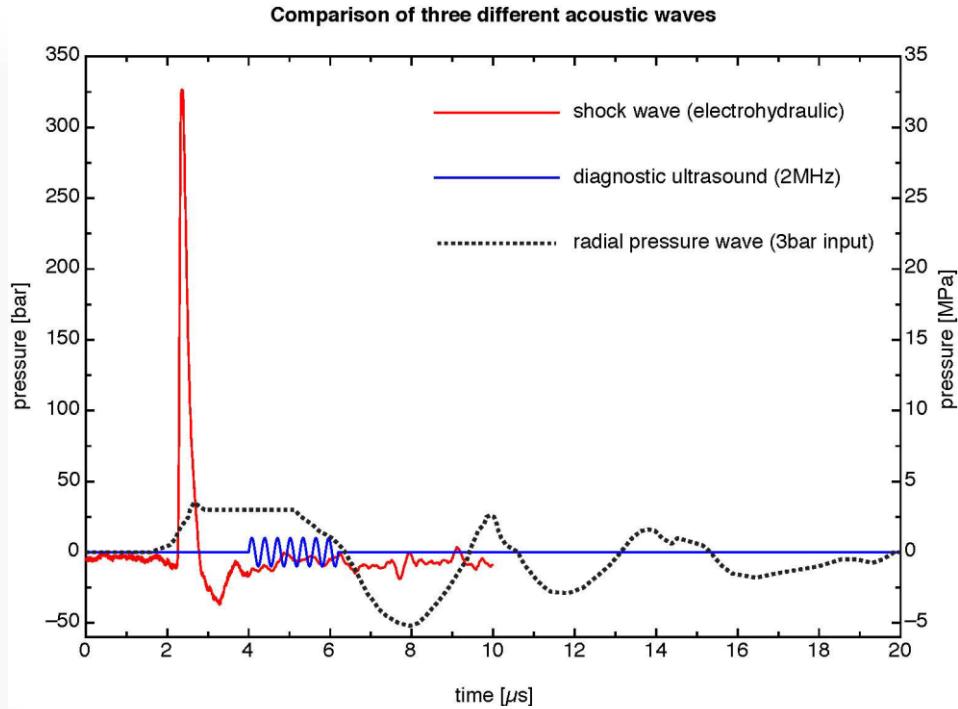
Different depths & effects



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Shockwaves
exert high energies
for short duration



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SpaceX Rocket Launch Created Shock Wave 4 Times Larger Than California

By Mike Wall, Space.com Senior Writer | March 23, 2018 07:30am ET

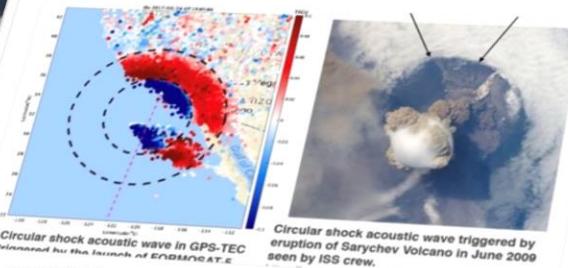


Am Geophysical Union @theAGU

"We've seen many cases of a rocket-produced disturbance, but there's never been something that perfectly circular and with that large area."

Via [#AGUblogsow.ly/sc6830j4Rjm](#)

9:05 AM - Mar 22, 2018



August 2017 SpaceX rocket launch created large circular sho...
The unusual trajectory the SpaceX Falcon 9 rocket took when delivering a Taiwanese satellite into orbit last August created an

[blogs.agu.org](#)

9 See Am Geophysical Union's other Tweets



1980



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g google.de

Wittlinger Therapiezentrum nach Großhadern (Klinik) - Google Maps

The map shows a route from Wittlinger Therapiezentrum in the south to Großhadern (Klinik) in the north. The primary route is highlighted in blue and consists of two segments: one segment from the start point to a junction near Starnberg, and another segment from that junction to Großhadern (Klinik). A second route, shown in grey, follows a similar path but continues further west through the Alpine region before turning north towards Großhadern. The map also displays several lakes (Ammersee, Starnberger See, Chiemsee, Tegernsee, Rottach-Egern, Schliersee, Walchensee, and Achensee) and numerous towns and cities along the route. Major roads like the Autobahn A8 and A95 are clearly marked.

Wittlinger Therapiezentrum, Alleestraße 8
Großhadern (Klinik), Marchioninistraße 1

Reiseziel hinzufügen

Jetzt starten OPTIONEN

Wegbeschreibung auf mein Smartphone senden

über A8 1 Std. 12 Min.
Schnellste Route; übliche Verkehrslage
⚠ Diese Route führt über eine Landesgrenze.

DETAILS

über A8 und A95 1 Std. 44 Min.
127 km

Satellit

Kartendaten © 2018 GeoBasis-DE/BKG (©2009)Google Deutschland Bedingungen Feedback geben 10 km

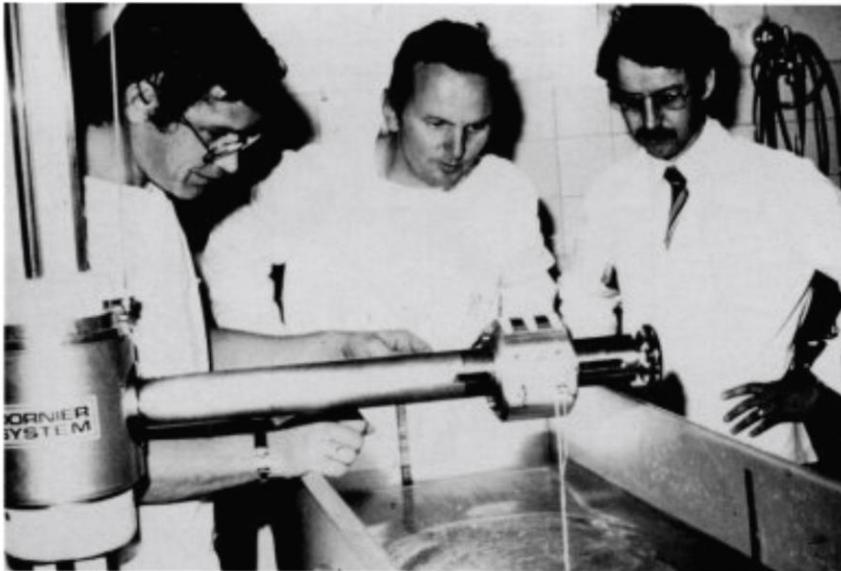
Klinikum Großhadern, Germany





1st ESWT machine

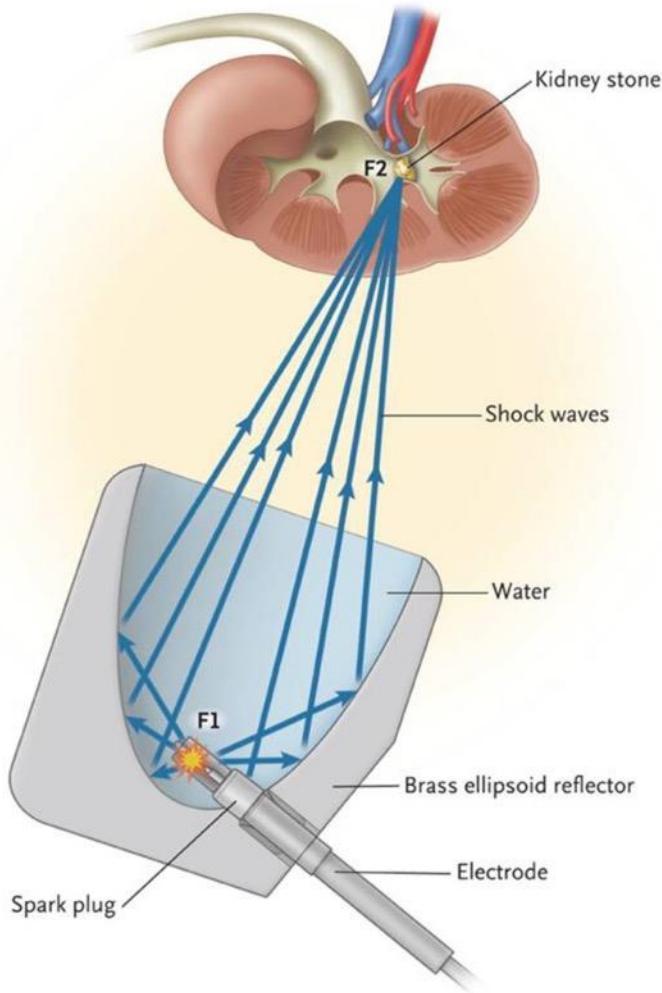
Munich Feb 7, 1980



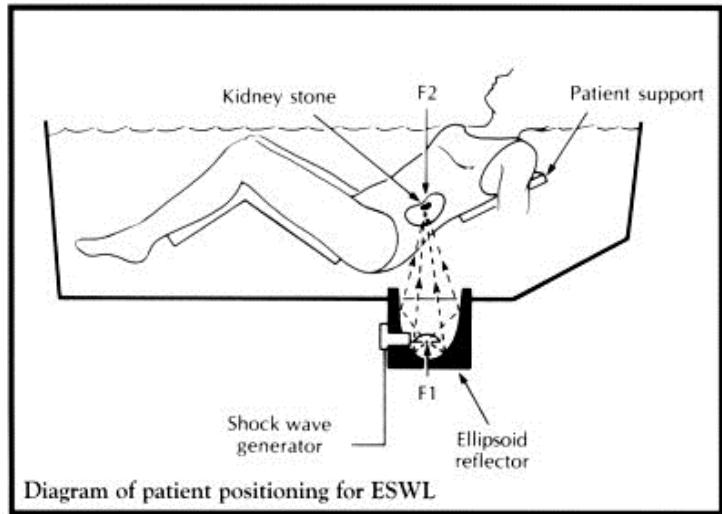
Chaussy, Eisenberger & Forssman reviewing prototype of
Extracorporeal Shockwave Equipment



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Feb 7, 1980



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1980



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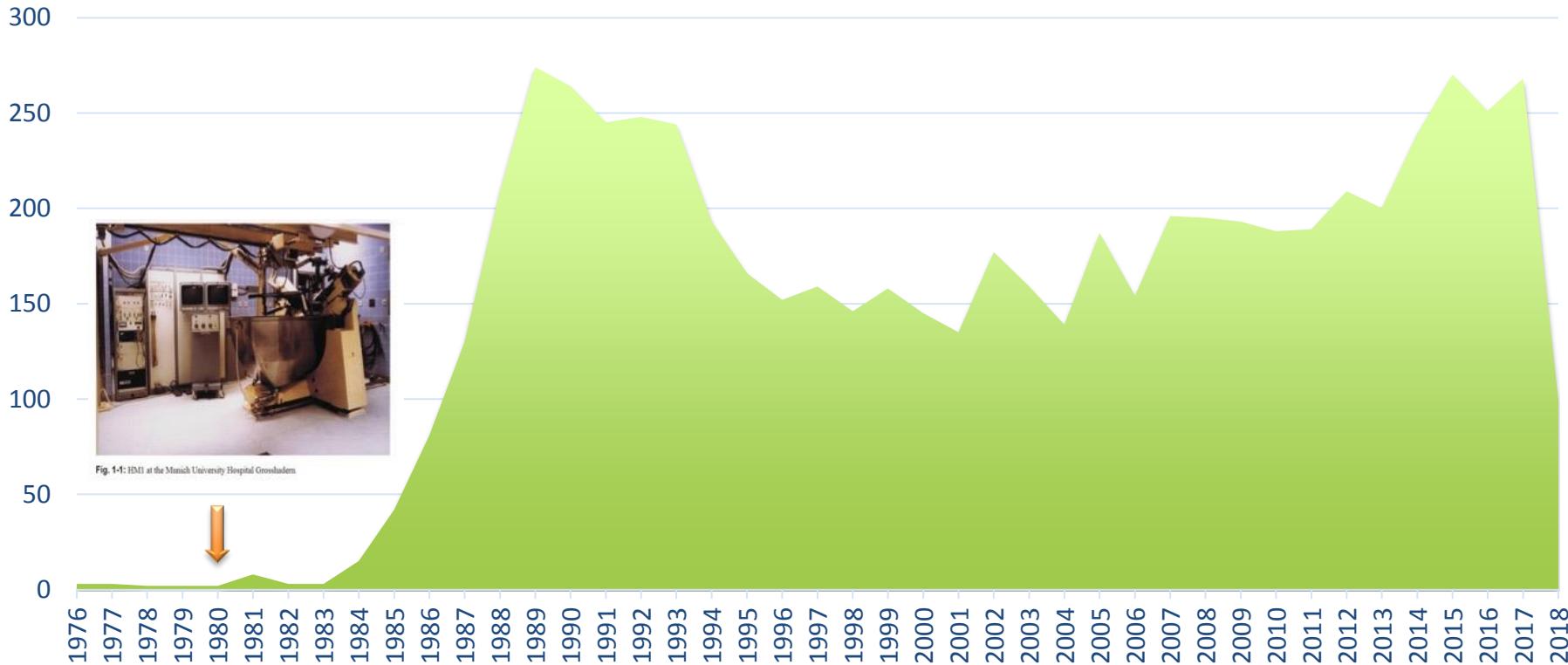
1980



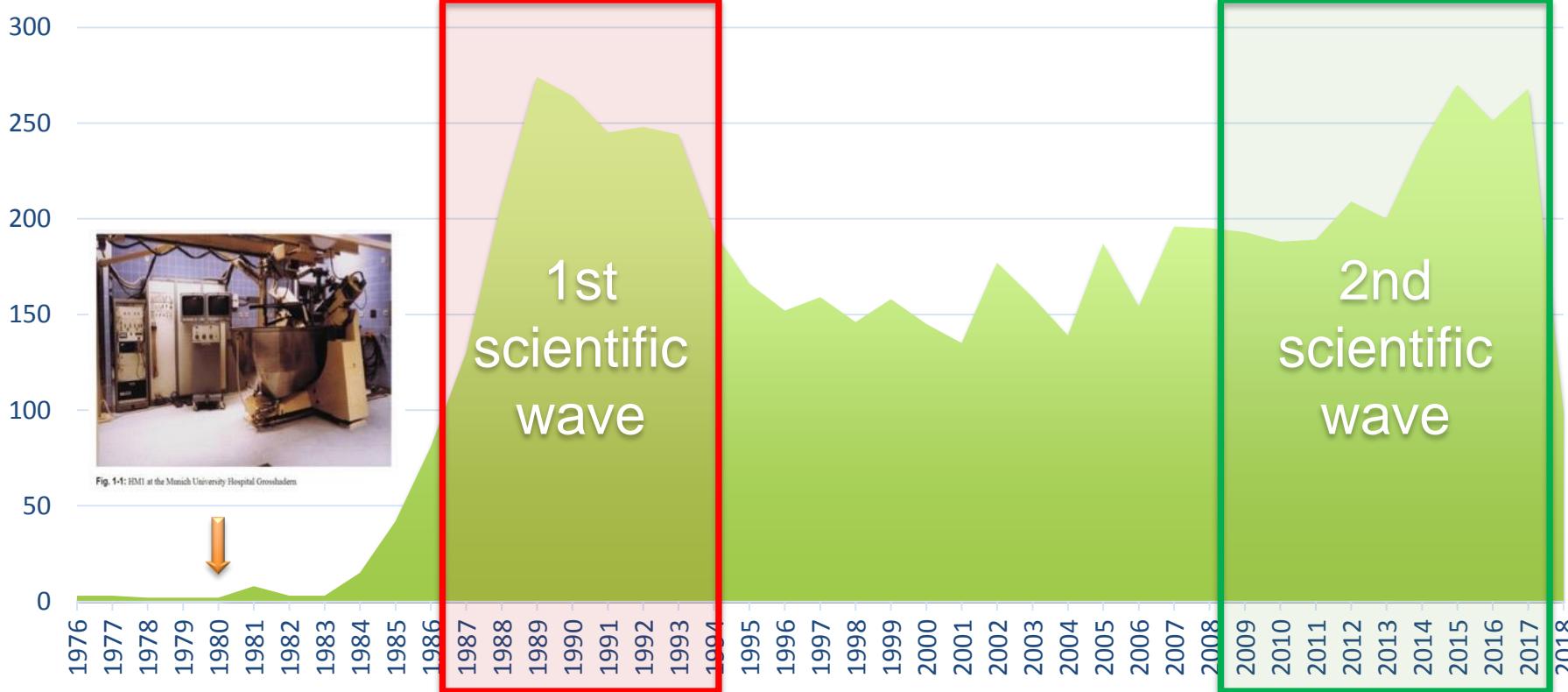
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ESWT in lymphology

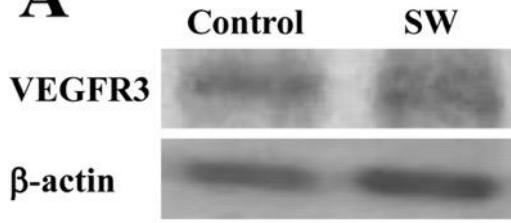


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Extracorporeal shock wave therapy ameliorates secondary lymphedema by promoting lymphangiogenesis

Kubo et al. Journal of Vascular Surgery Volume 52, Issue 2, Pages 429-434 (Aug 2010)

A

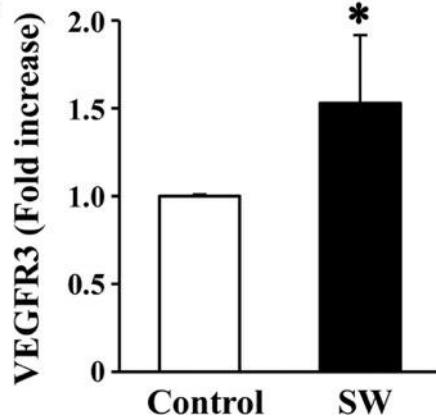


Control SW

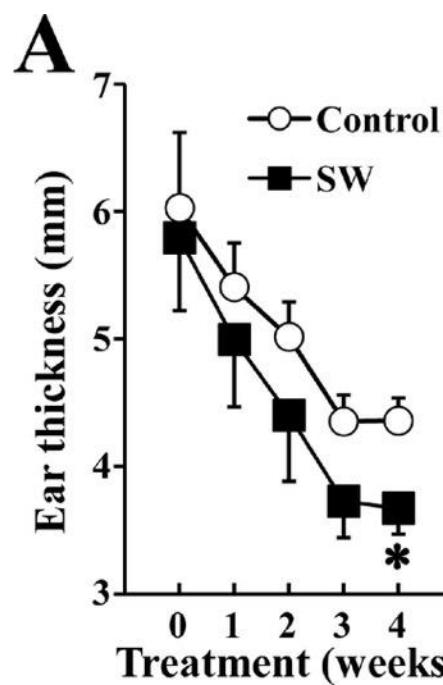
VEGFR3

β-actin

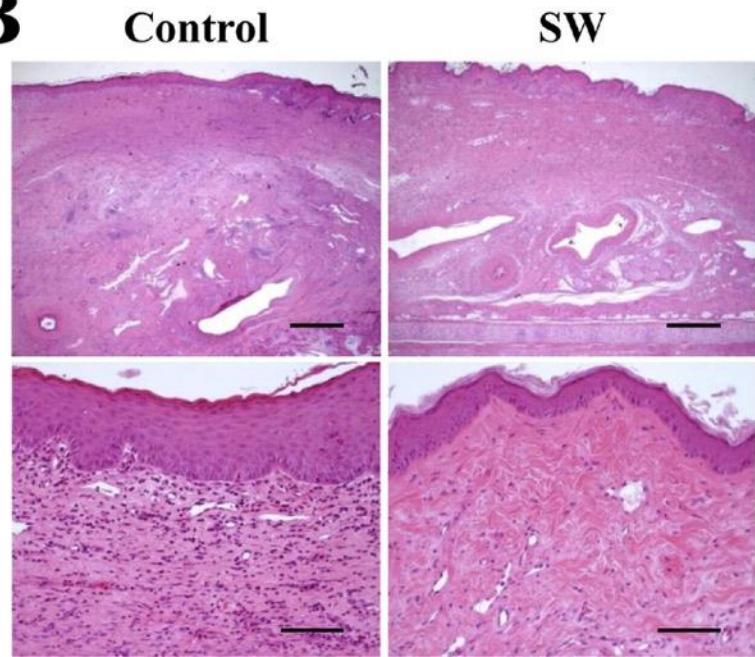
B



A



B



Control

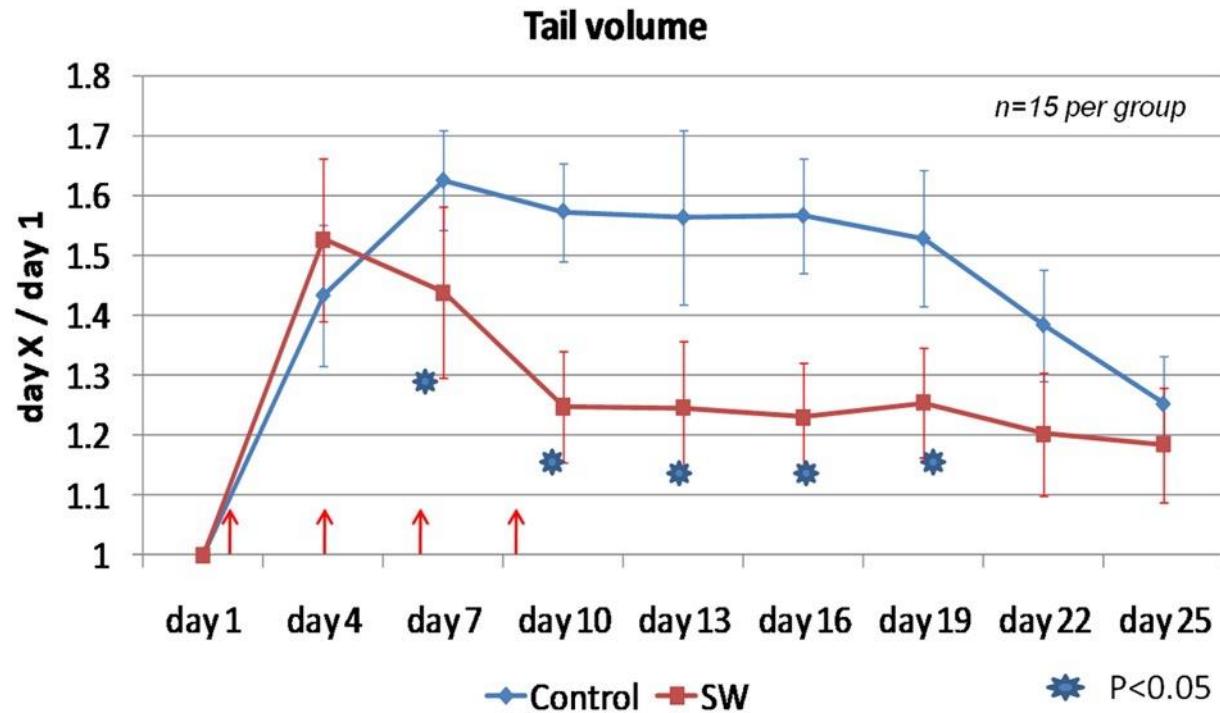
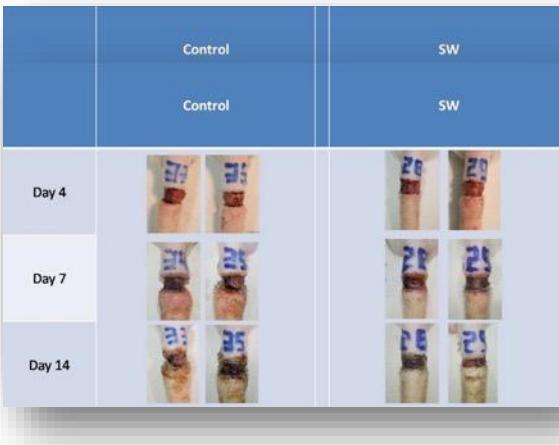
SW

Extracorporeal Shock Wave Therapy Induces Therapeutic Lymphangiogenesis in a Rat Model of Secondary Lymphoedema by Serizawa et al.

European Journal of Vascular and Endovascular Surgery Volume 42 (2), 254-260 (August 2011)

Extracorporeal SW therapy

One SW treatment consisted of 0.25 mJ mm^{-2} (total energy flux density), 500 impulses, using a SW generator (DUOLITH® SD1; Storz Medical, Switzerland) based on our previous studies, in which maximal up-regulation of VEGF expression was achieved at $\sim 0.1 \text{ mJ mm}^{-2}$ (positive energy flux density).⁴⁻⁸ According to the manufacturer, 0.1 mJ mm^{-2} (positive energy flux density) is equivalent to 0.25 mJ mm^{-2} (total energy flux density). Animals in the SW group received low-energy SW therapy to the surgical site four times (post-operative days 3, 5, 7 and 9), whereas those in the control group received the same procedures but without the SW treatment.



ESWT bei sekundärem Lymphödem

Original Article

Ann Rehabil Med 2013;37(2):229-234
pISSN: 2234-0645 • eISSN: 2234-0653
<http://dx.doi.org/10.5535/arm.2013.37.2.229>



Clinical Outcomes of Extracorporeal Shock Wave Therapy in Patients With Secondary Lymphedema: A Pilot Study

Hasuk Bae, MD, Ho Jeong Kim, MD

Department of Rehabilitation Medicine, Ewha Womans University School of Medicine, Seoul, Korea



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Table 1. General characteristics of the subjects (n=7)

| Characteristic | Value |
|--|-----------|
| Age (yr), mean±SD | 52±9.9 |
| Female | 7 |
| Duration of lymphedema (mo), mean±SD | 25.3±12.7 |
| Lymphedema stage 3 | 7 |
| Chemotherapy | 7 |
| Radiotherapy | 7 |
| Combination physical therapy ^{a)} | 4 |

SD, standard deviation.

^{a)}Physical therapy, manual massage and pneumatic compression by a physical therapist.



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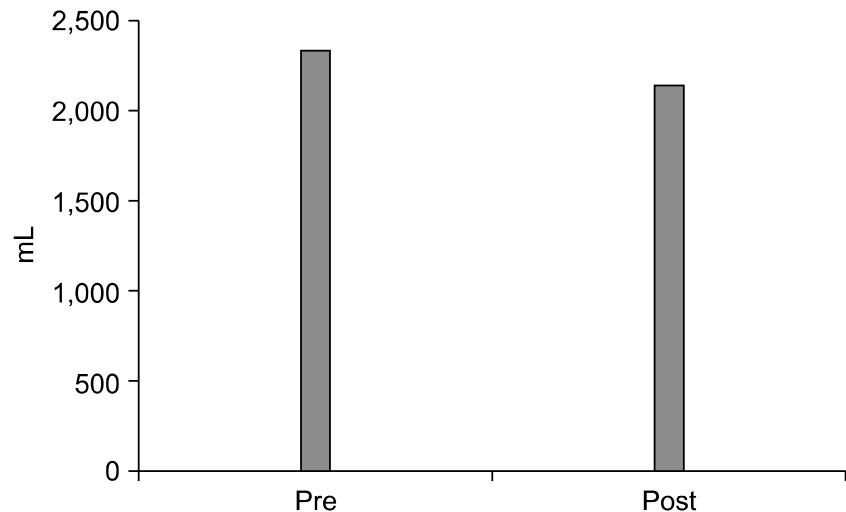


Fig. 1. The volume of the affected upper extremity after four consecutive extracorporeal shock wave therapy (ESWT) was reduced significantly ($p<0.05$). After ESWT, the mean of volume drop was 37.23%.

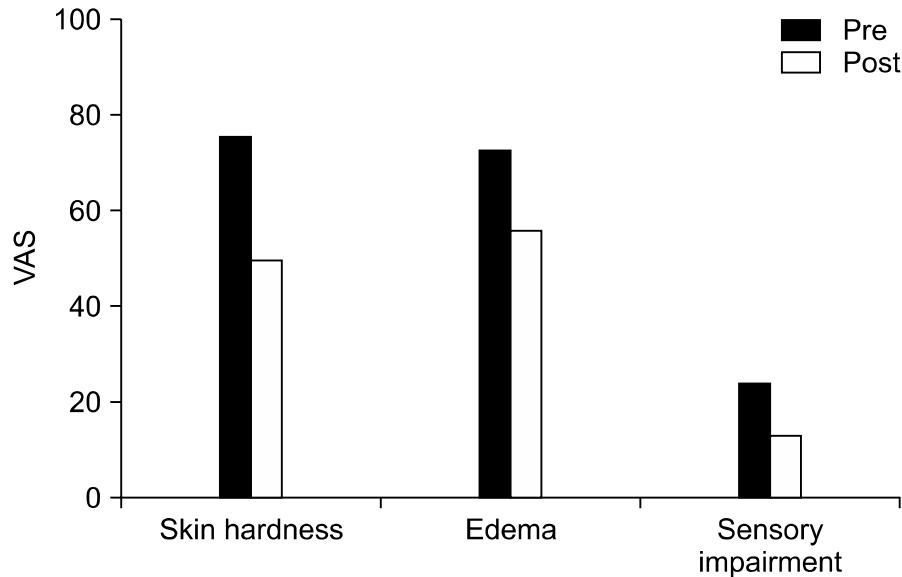


Fig. 3. Visual analogue scales (VASs) of skin hardness, edema, and sensory loss were significantly improved after the fourth extracorporeal shock wave therapy ($p<0.05$).



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NIVEA



NIVEA

*Good-bye
Cellulite*

2005



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Anti-fibrosclerotic effects of shock wave therapy in lipedema and cellulite

Werner Siems^{a,□}, Tilman Grune^b, Peter Voss^b and Rainer Brenke^c
^aLoges-School of Physiotherapy, Research Institute of Physiotherapy & Gerontology, D-38667 Bad Harzburg, Germany
^bResearch Institute of Environmental Medicine at Heinrich-Heine University, D-40021 Duesseldorf, Germany
^cHufeland Hospital, Center for Pneumology, Allergology, Natural Medicine & Orthopedics, D-56130 Bad Ems, Germany



- 26 females with cellulite with lymphdrainage with or without ESWT
- ESWT reduces oxidative stress and improves cellulite

Anti-fibrosclerotic effects of shock wave therapy in lipedema and cellulite

Verner Siems^{a,b}, Tilman Grune^b, Peter Voss^b and Rainer Brenke^c
 Loges-School of Physiotherapy, Research Institute of Physiotherapy & Gerontology, D-38667 Bad
 Harzburg, Germany
 Research Institute of Environmental Medicine at Heinrich-Heine University, D-40021 Duesseldorf,
 Germany
 Hufeland Hospital, Center for Pneumology, Allergology, Natural Medicine & Orthopedics, D-56130
 and Ems Detmold, Germany

Skin improvement with every ESWT session

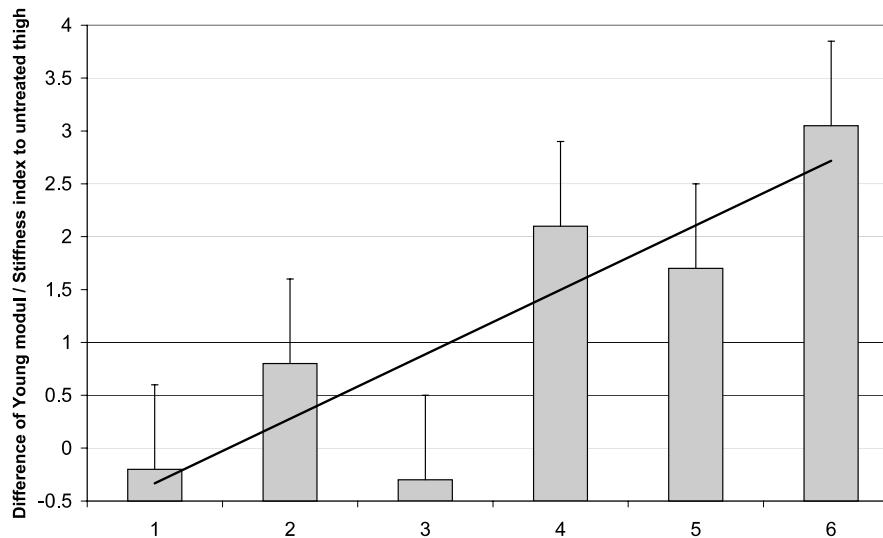
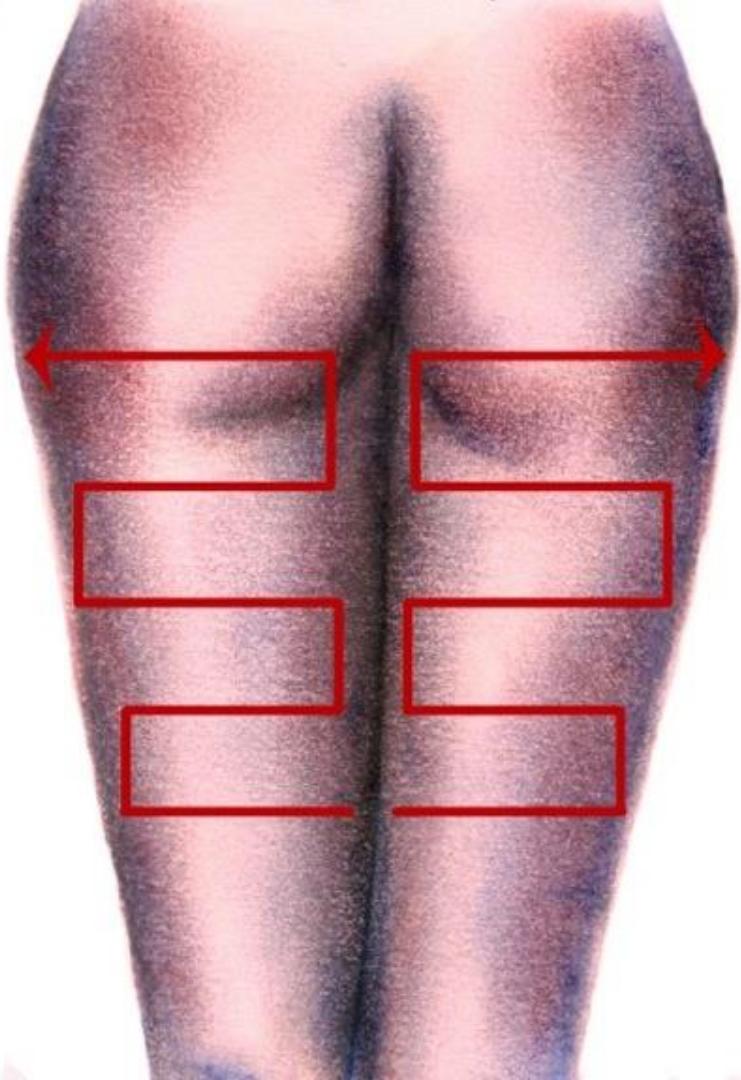


Fig. 3. Improvement of biomechanic skin properties during a 2 weeks-period with 6 sessions of shock wave application each for 8 minutes (1.000 impulses) in 5 patients with cellulite. In this part of the study the patients were treated only with SWT, but without parallel CPDT. Therefore, the increases of smoothening and elasticity (Young modul or stiffness index) which are given as difference between Young modul/stiffness index of the treated and untreated extremity are completely due to SWT. Values as Young modul/stiffness index without dimension; trend was calculated as linear trend.

6 ESWT Sessions

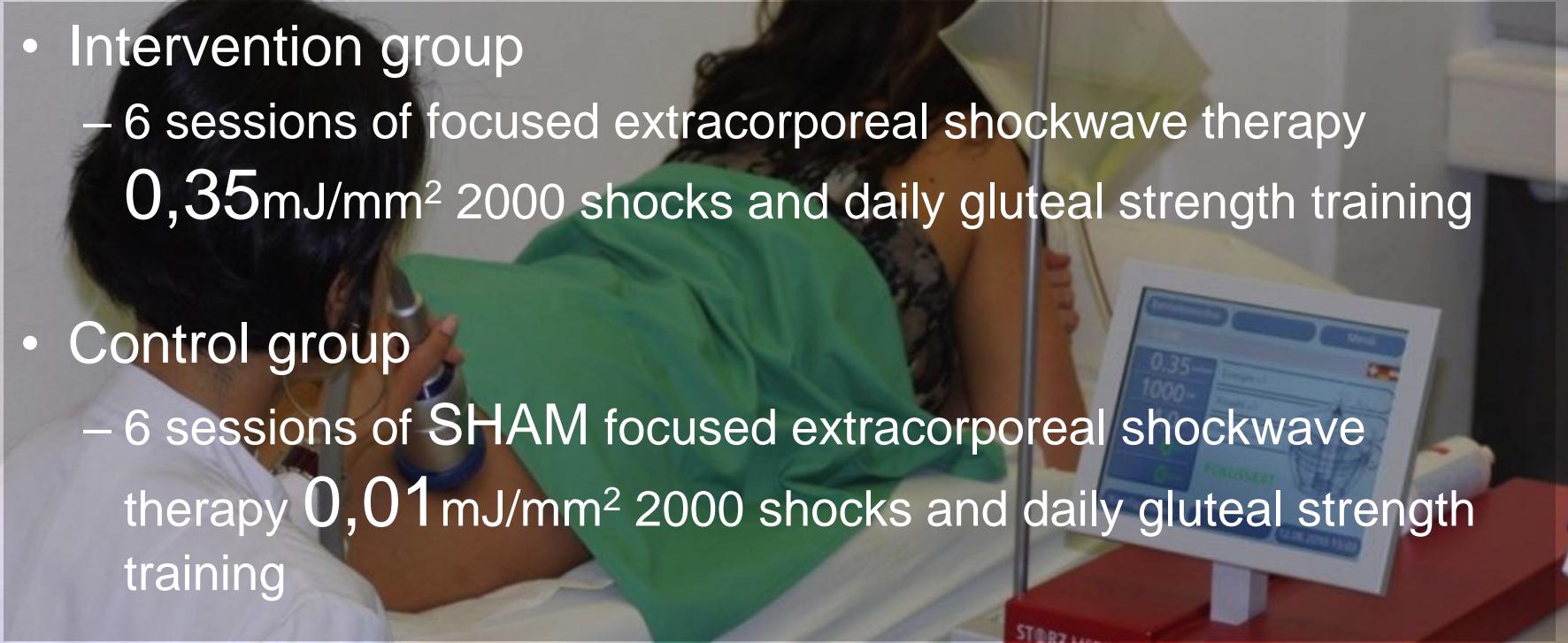


RCT ESWT in cellulite

Knobloch et al. 2013

CelluShock RCT Knobloch K

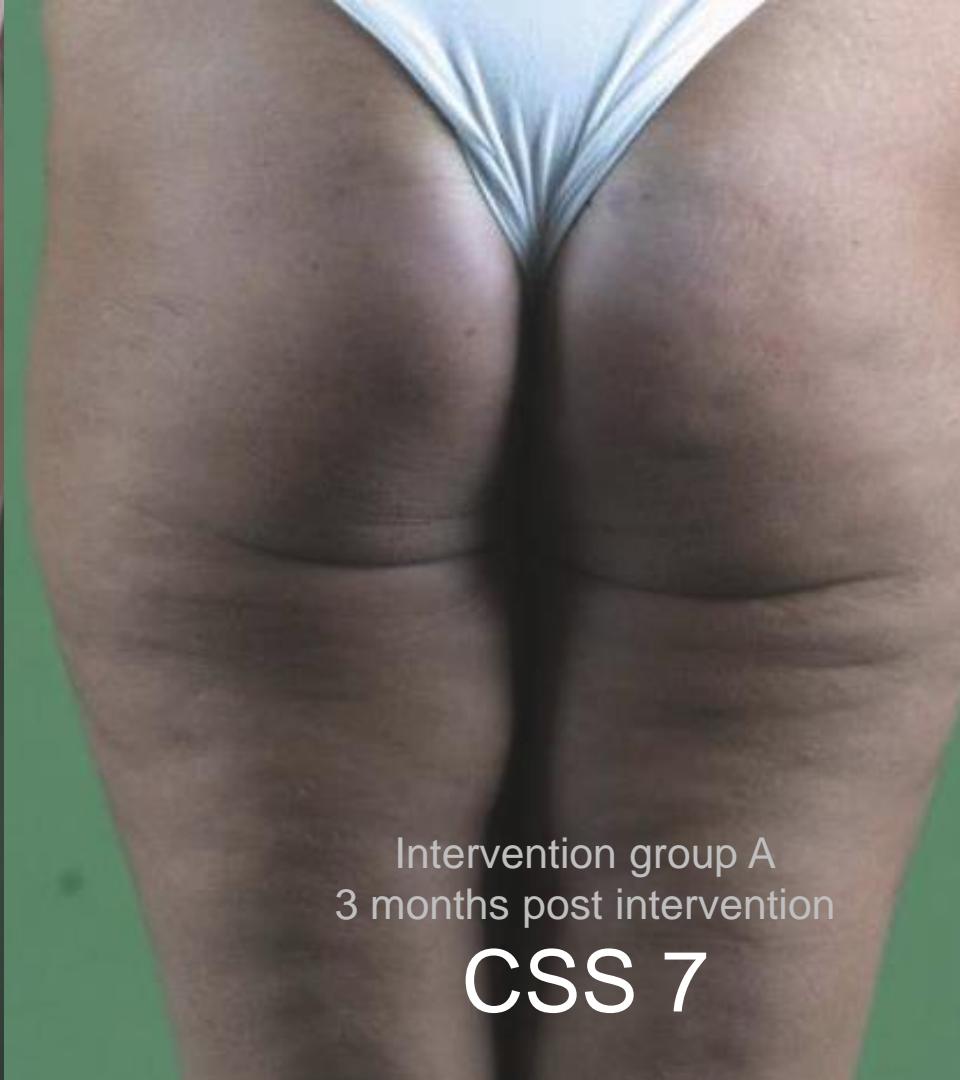
- Intervention group
 - 6 sessions of focused extracorporeal shockwave therapy
 $0,35\text{mJ/mm}^2$ 2000 shocks and daily gluteal strength training
- Control group
 - 6 sessions of SHAM focused extracorporeal shockwave therapy $0,01\text{mJ/mm}^2$ 2000 shocks and daily gluteal strength training





Intervention group A
before

CSS 15



Intervention group A
3 months post intervention

CSS 7



Intervention group A
Baseline

CSS 12

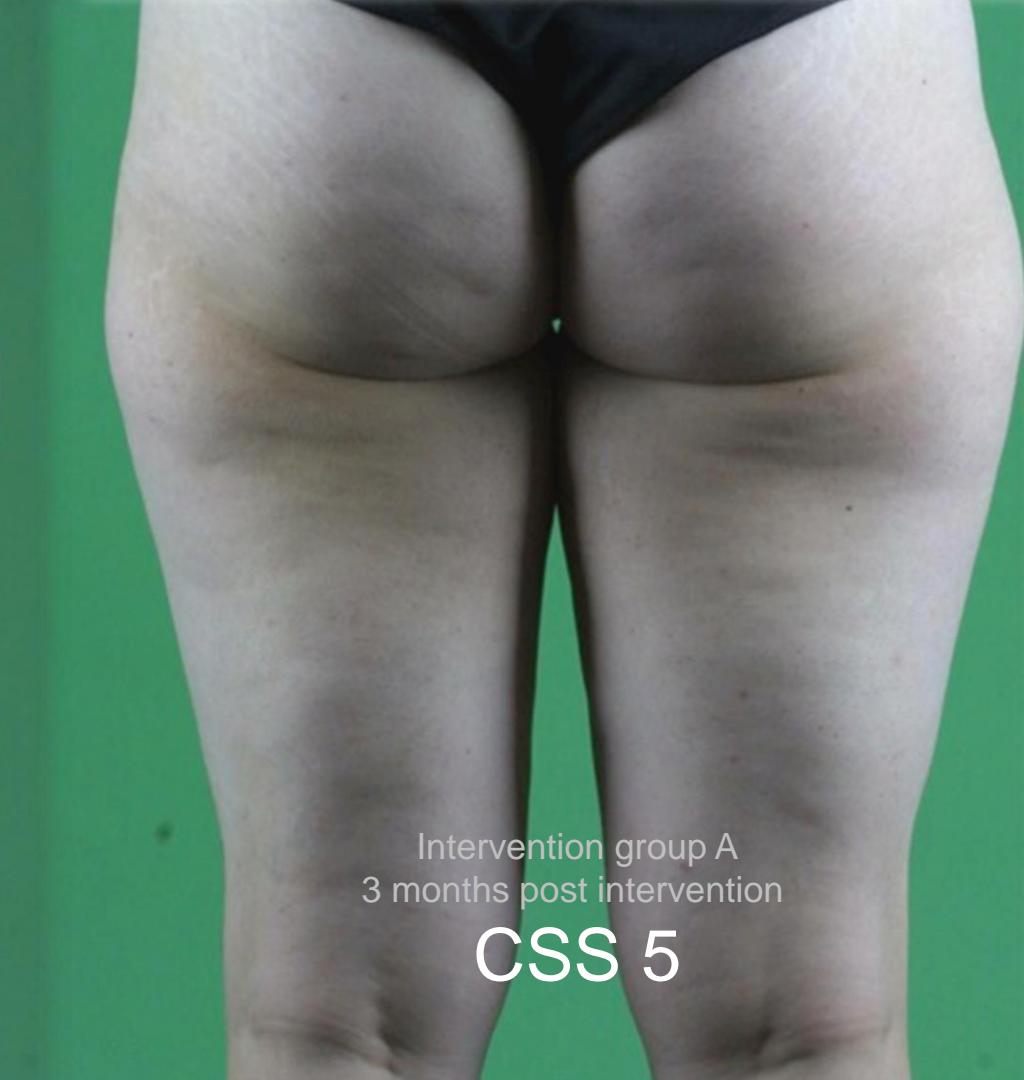
Intervention group A
3 months post intervention

CSS 2



Intervention group A
Baseline

CSS 11



Intervention group A
3 months post intervention

CSS 5

Cellulite Severity Scale

ESWT in cellulite Knobloch et al.

Dermatol Ther (Heidelberg) 2013; 3:143–155
DOI 10.1007/s13555-013-0036-5

ORIGINAL RESEARCH

Cellulite and Focused Extracorporeal Shockwave Therapy for Non-Invasive Body Contouring:
a Randomized Trial

Karsten Knobloch · Beatrix Joest · Robert Krammer · Peter M. Vogt

To cite as: Knobloch K, Joest B, Krammer R, Vogt PM. Cellulite and Focused Extracorporeal Shockwave Therapy for Non-Invasive Body Contouring: a Randomized Trial. Dermatol Ther (Heidelberg). 2013; 3:143–155. doi:10.1007/s13555-013-0036-5. © The Author(s) 2013. This article is published with open access at Springerlink.com

ABSTRACT

Introduction: Focused extracorporeal shockwave therapy (ESWT) has been demonstrated to improve wound healing and skin regeneration such as in burn wounds and scars. We hypothesized that the combination of focused ESWT and a daily gluteal muscle strength program is superior to SHAM-ESWT and gluteal muscle strength training in moderate to severe cellulite.

Clinical trial identifier: NCT00947414.

Methods: This was a single-center, double-blinded, randomized-controlled trial. For allocation of participants, a 1:1 ratio randomization was performed using opaque envelopes for the concealment of allocation. Eligible patients were females aged 18–65 years with cellulite. The primary outcome parameter was the photo-nutritive Cellulite Severity Scale (CSS) determined by two blinded, independent assessors. The intervention group (group A) received six sessions of focused ESWT (2,000 impulses, 0.35 mJ/mm², every 1–2 weeks) at both gluteal and thigh regions plus specific gluteal strength exercise training. The control group (group B) received six sessions of SHAM-ESWT plus specific gluteal strength exercise training.

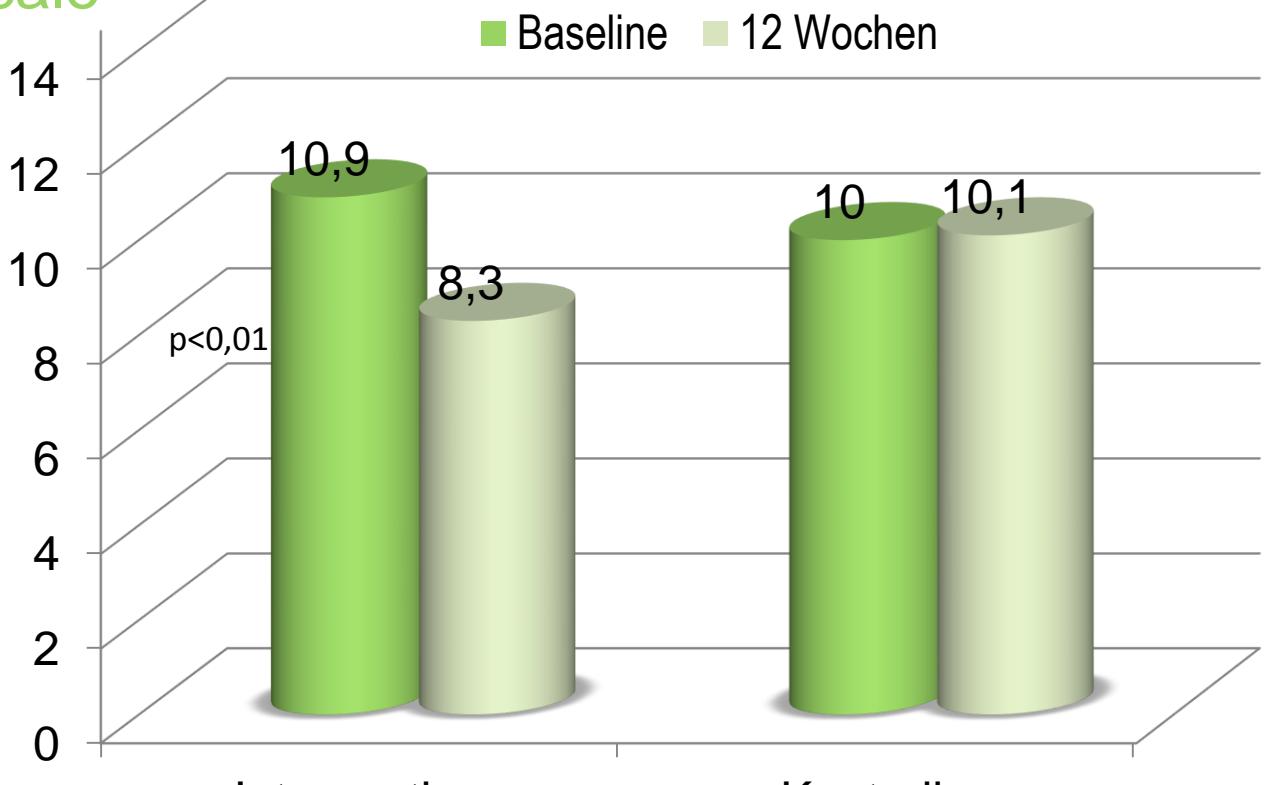
Results: The CSS in group A was 10.9 ± 3.8 (mean ± SD) before intervention and 8.3 ± 4.1 after 12 weeks ($P = 0.001$, 2.53 improvement, 95% confidence interval (CI) 1.43–3.62). The CSS in group B was 10.0 ± 3.8 before intervention and 10.1 ± 3.8 after 12 weeks ($P = 0.876$, 95% CI 1.1–0.97). The change of the CSS in group A versus group B was significantly different ($P = 0.001$, -24.3 effect size, 95% CI -36.5 to -12.1).

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External contact for this article is available on the journal website:
www.springeropen.com



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International Journal of Surgery

journal homepage: www.journal-surgery.net



Review

Extracorporeal shock wave therapy (ESWT) for the treatment of cellulite – A current metaanalysis



CrossMark

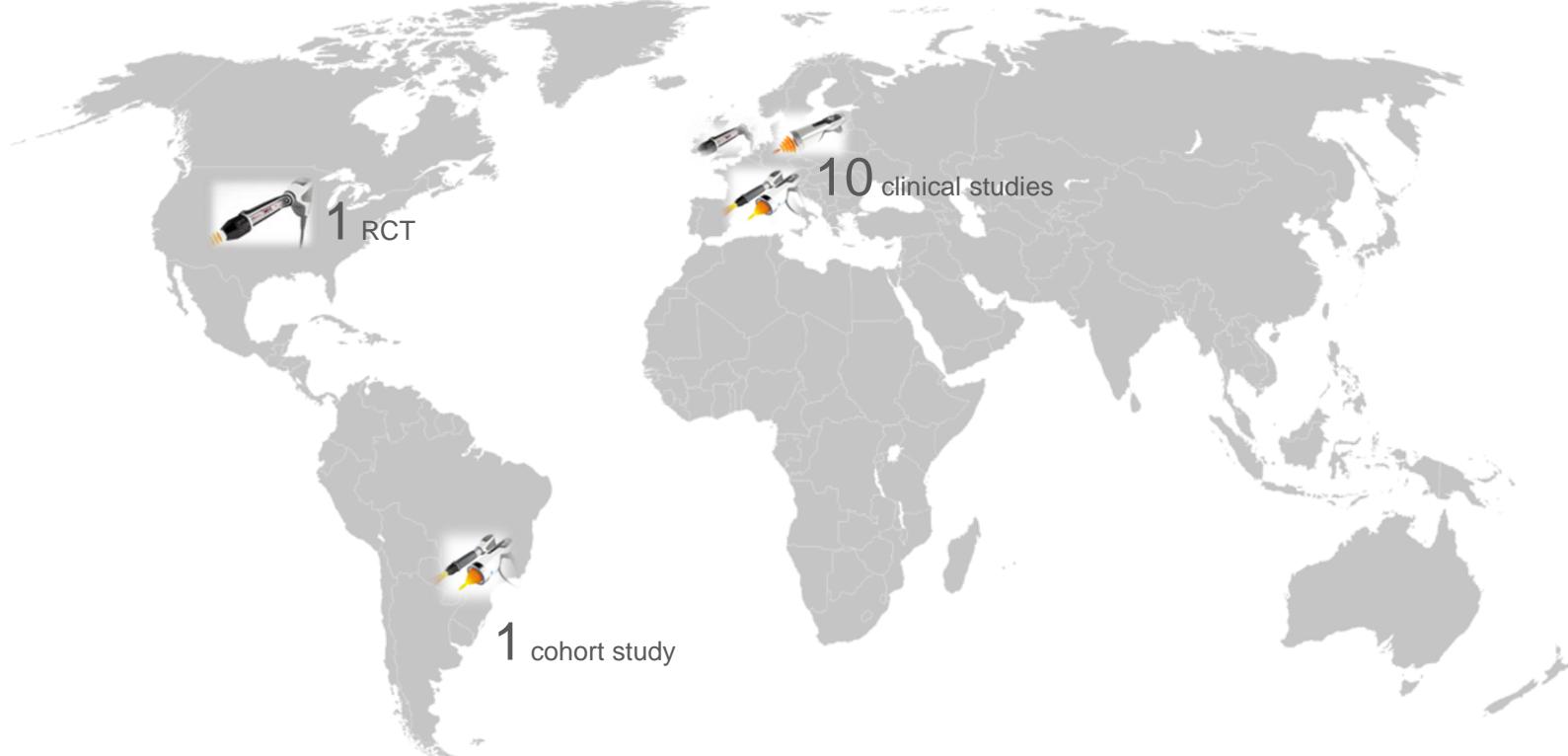
Karsten Knobloch ^{a,*}, Robert Kraemer ^b

^a SportPraxis Prof. Dr. Karsten Knobloch, Hannover, Germany

^b Plastic, Hand and Burn Surgery, University of Schlewig Holstein, Lubeck, Germany

HIGHLIGHTS

- Both, focused & radial ESWT devices are effective in treating cellulite.
- Typically, one or two weekly sessions and 6–8 sessions overall were studied.
- Outcome parameters mainly focused on photographs, circumference measurements and ultrasound.
- Reporting quality showed substantial heterogeneity from 22 to 82 points with a mean of 57 points.

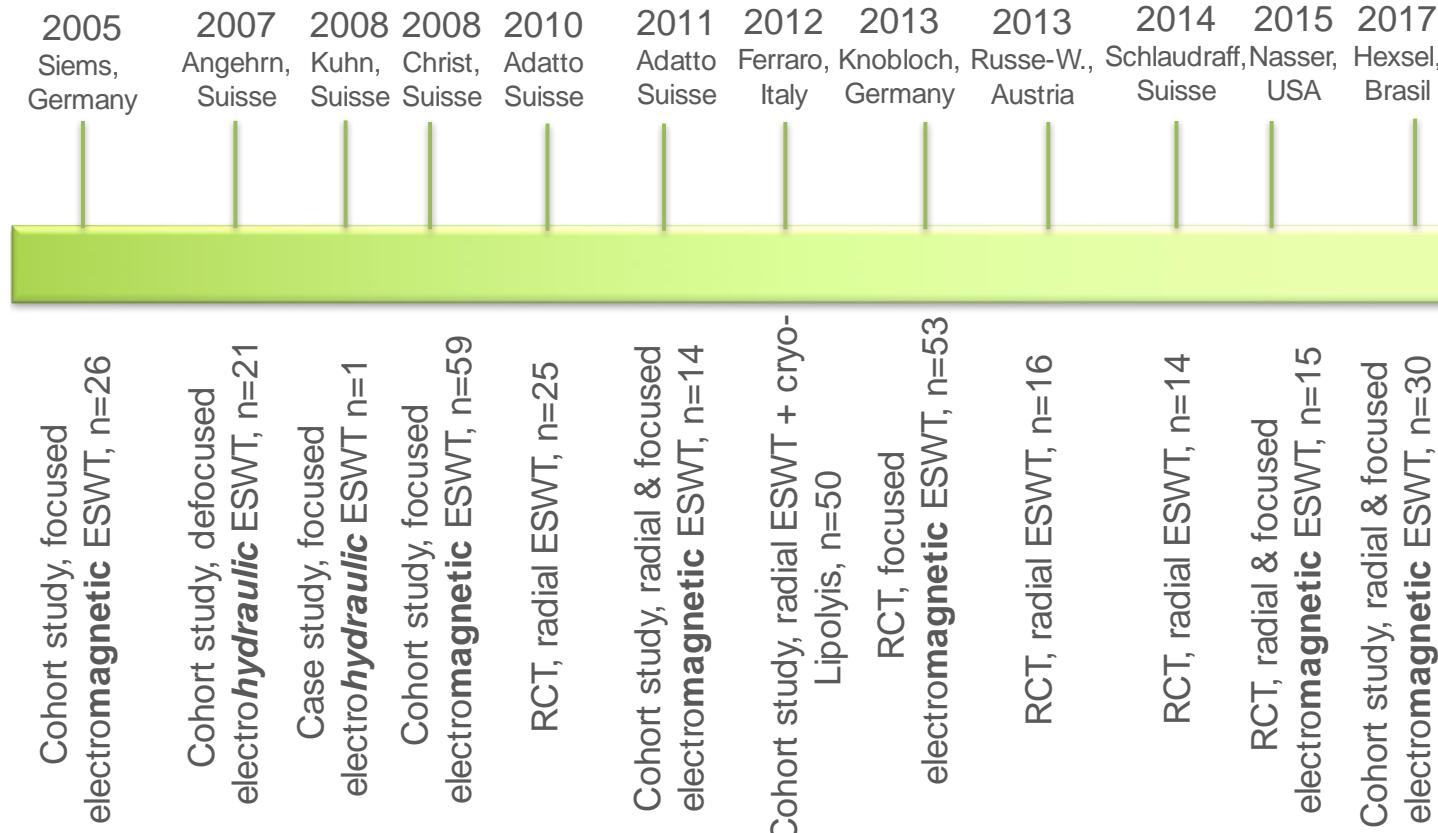


ESWT in cellulite – a worldwide perspective



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Timeline of ESWT in cellulite





Review

Extracorporeal shock wave therapy (ESWT) for the treatment of cellulite – A current metaanalysis



Karsten Knobloch ^{a,*}, Robert Kraemer ^b

^a SportPraxis Prof. Dr. Karsten Knobloch, Hannover, Germany

^b Plastic, Hand and Burn Surgery, University of Schleswig Holstein, Lubeck, Germany

HIGHLIGHTS

- Both, focused & radial ESWT devices are effective in treating cellulite.
- Typically, one or two weekly sessions and 6–8 sessions overall were studied.
- Outcome parameters mainly focused on photographs, circumference measurements and ultrasound.
- Reporting quality showed substantial heterogeneity from 22 to 82 points with a mean of 57 points.

- Currently 12 clinical trials „**ESWT & Cellulite**“
 - 5 RCTs
 - 322 females included in studies yet
 - 123 females in RCT

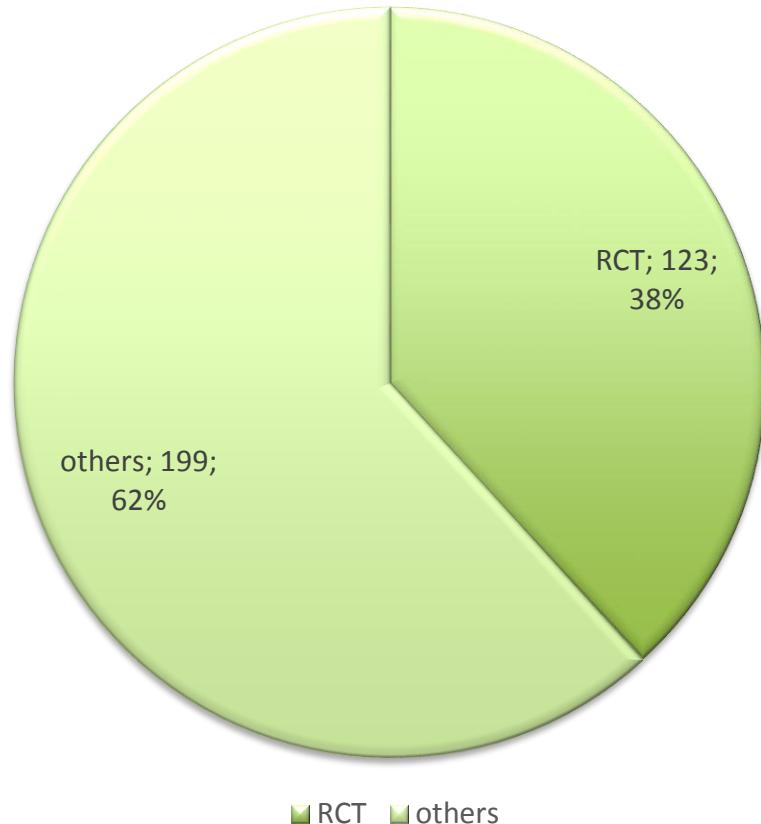


Table 1

All included clinical studies on the effects of extracorporeal shock wave therapy (ESWT) on cellulite with details on study design, number of participants, type, device and treatment parameters, number of treatments, follow-up and main results of the trials.

| Author | Year | Study design | Level of evidence | Number of patients | Type of ESWT | Device type | Energy flux densities | Pressure | Number of sessions | Follow-up | Outcome measures |
|---------------------|------|---|-------------------|---|--|---|---|---|--|--------------|---|
| Siems et al. | 2005 | Cohort study | 3 | 26 (intra-individual control, one treated leg) | Focused ESWT | DermaSelect, Storz Medical | 0.16 mJ/mm ² , 1000 impulses | — | 3–6 sessions | 2 weeks | • Mitigation of oxidative stress • Improvement of high resolution ultrasound with collagen remodelling |
| Angehrn | 2007 | Cohort study | 3 | 21 | Low-energy defocused ESWT | ActiVitor-Derma | 0.018 mJ/mm ² , 40.000 shots | — | 12 (twice a week) | 8 weeks | • Epidermal improvement, neocollagenogenesis |
| Kuhn | 2008 | Case study | 4 | 1 (intra-individual control, one treated leg) | Focused ESWT | ActiVitor-Derma electrohydraulic device, SwiftTechMedical | 0.115 mJ/mm ² , 4 Hz, 800 impulses on 2 × 2 cm ² sample | — | 4 | unclear | • Skin elasticity improvement 105% at 6 months f/u |
| Christ | 2008 | Cohort study | 3 | 59 | Planar ESWT | Storz CellActor SC1 | 0.25 mJ/mm ² , 3200 impulses per session | — | 6 (n = 15) or 8 (n = 44) sessions (twice a week) | 3 & 6 months | • Improvement on skin roughness, number of depressions and elevations |
| Adatto | 2010 | RCT, 1:1 allocation | 1b | 25 (intra-individual control, one treated leg) | Radial ESWT | Storz D-Actor 200 | — | 2.6–3.6 bar, 15 Hz, 3000 impulses on 10 × 15 cm rectangle | 6 twice a week | 12 weeks | • Reduction of subcutaneous fat layer |
| Adatto | 2011 | Cohort study | 3 | 14 | Radial and focused ESWT | Storz CellActor SC1 | 0.45–1.24 mJ/mm ² , 1500 impulses | 3–4 bar, 3000 impulses | 8 (twice a week) | 12 weeks | • Mean fat thickness reduction by 3 cm |
| Ferraro | 2012 | Cohort study | 3 | 50 | Radial ESWT + cryo-lipolysis (Promoltalia) | Proshockice | — | 50–500 bar, 1–6 Hz combined with a freezing probe for cryolipolysis | 4 sessions every 15 days | 12 months | • Circumference reduction by 4.5 cm |
| Knobloch | 2013 | RCT, 1:1 allocation, gluteal strength training ± focused ESWT | 1b | 53 | Focused ESWT | Storz Duolith | 0.35 mJ/mm ² , 2000 impulses | — | 6 (once a week) | 12 weeks | • Improvement of Cellulite Severity scale CSS from 10.9 to 8.3 by 24% (double-blinded standardized photographic evaluation) |
| Russe-Willingsseder | 2013 | RCT, 2:1 allocation | 1b | 16 (11 verum, 5 placebo) | Radial ESWT | Storz D-Actor 200 | — | 2–3 bar, 3.500 impulses | 8 (once a week) | 12 weeks | • Subjective patient improvement • Photoscore improvement |
| Schlaudraff | 2014 | RCT, 1:1 allocation | 1b | 14 (intra-individual control, one treated leg) | Radial ESWT | EMS Swiss DolorClast | — | 3.5–4 bar, 15.000 impulses, 15 Hz | 8 (twice a week) | 4 weeks | • Improvement of cellulite grade by 0.93 grades |
| Nassar | 2015 | RCT, 1:1 allocation | 1b | 15 (crossleg study, 1 leg being treated, one served as intraindividual control) | Focused and radial ESWT | Storz SC1 | 0.56–1.24 mJ/mm ² , 1500 impulses, per leg | 2.6–5 bar, 16 Hz, 3.000 impulses | 8 (twice a week) | 12 weeks | • Crossleg study • Reduction of subcutaneous fat layer from 1.4 ± 0.4 cm to 1.0 ± 0.3 cm at 3 months follow-up • 1.7 cm circumference reduction |



Metaanalysis ESWT in Cellulite

Knobloch & Krämer

- Both, focused as well as radial ESWT devices have been found effective in treating cellulite so far
- Typically, one or two sessions per week and 6–8 sessions overall were studied in the published clinical trials
- Follow-up typically ranged between three and six months
- Overall, outcome parameters mainly focused on digital standardized photographs, circumference measurements and specific ultrasound examinations
- Only one RCT to date used a non-validated patients' questionnaire to assess the patients' evaluation of the treatment



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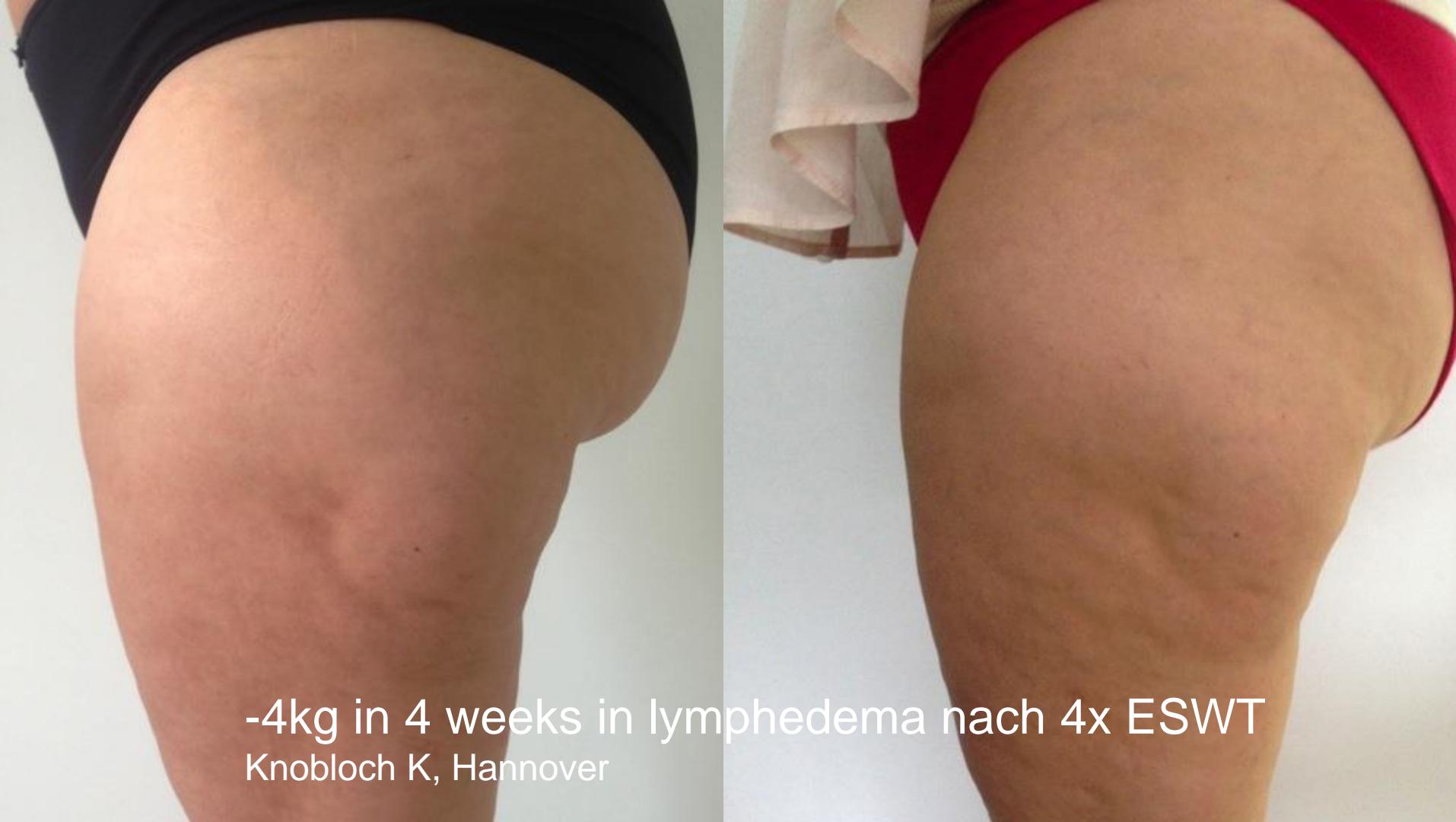
Secondary lymphedema 9wks after thigh lift



Before treatment

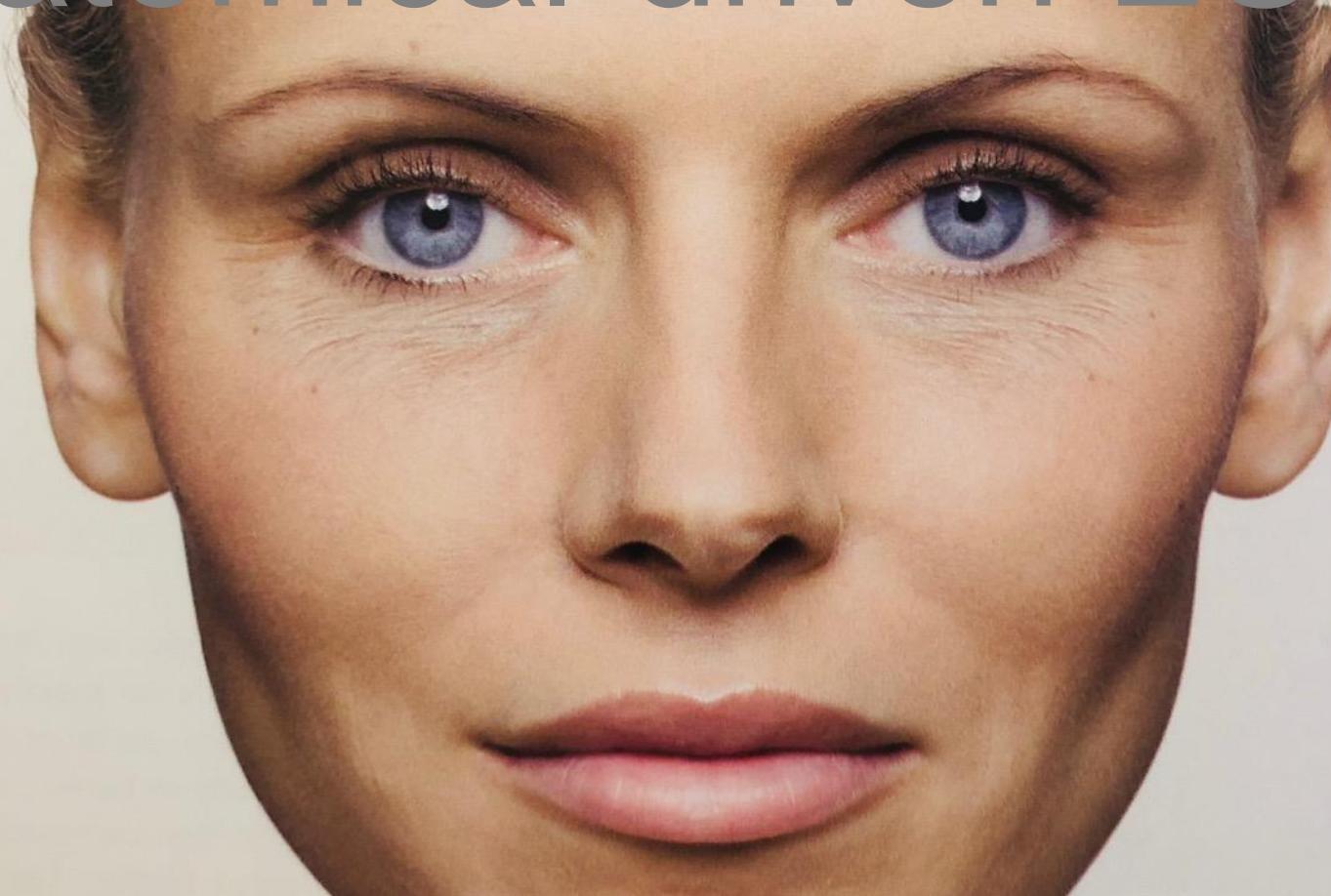
After single treatment

Secondary lymphedema 9wks after thigh lift



-4kg in 4 weeks in lymphedema nach 4x ESWT
Knobloch K, Hannover

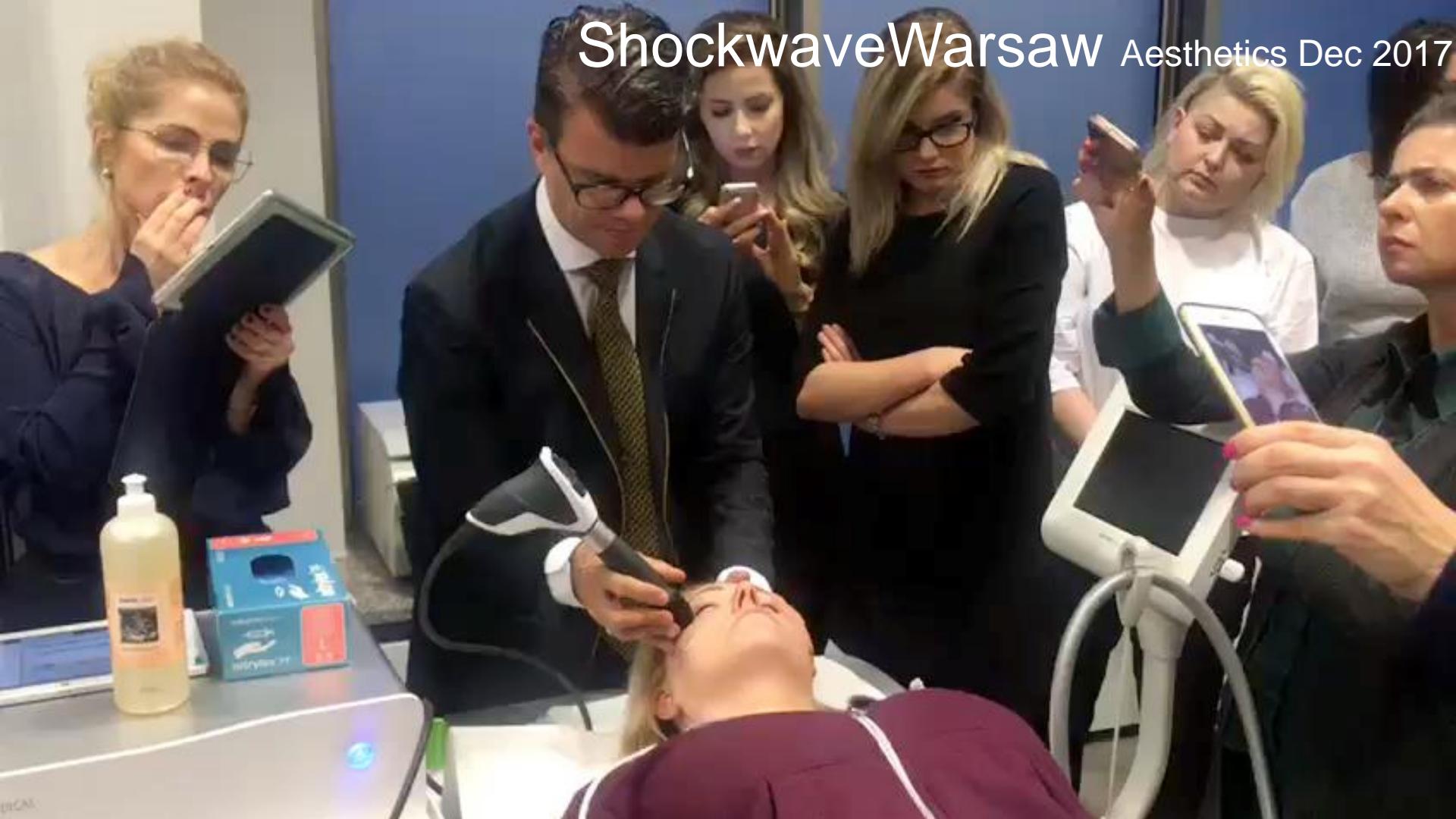
Anatomical-driven ESWT



Anatomical-driven ESWT

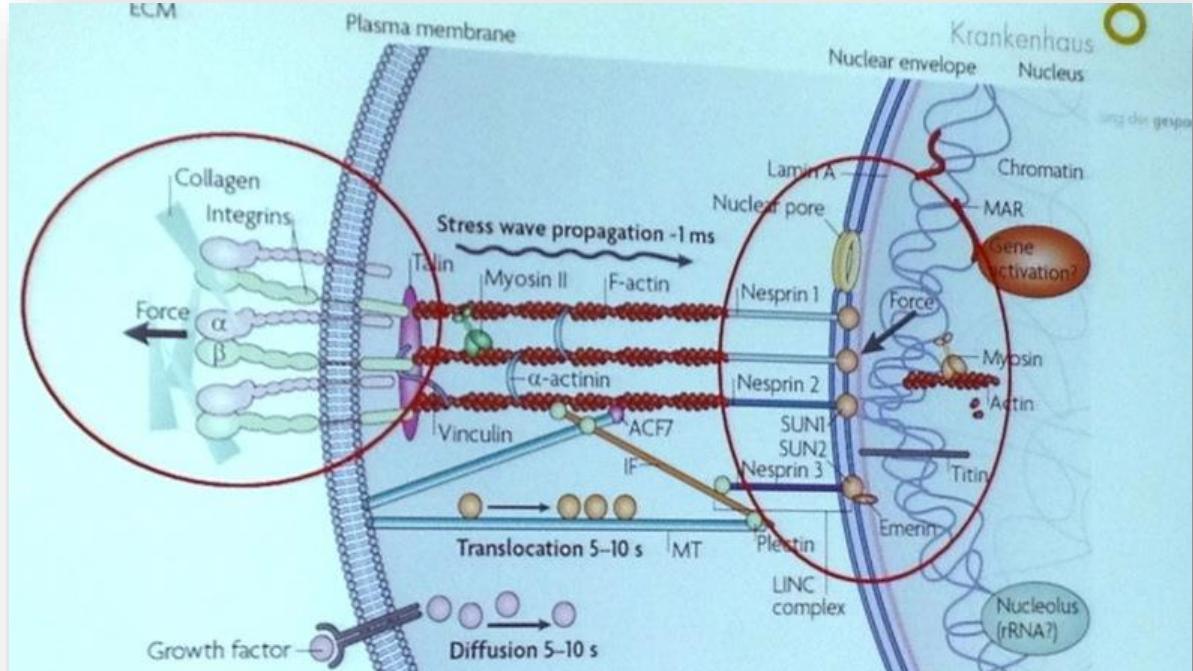


ShockwaveWarsaw Aesthetics Dec 2017



Mechanism





Mechanotransduction

Wang, Tytell, Ingber Nature Rev 2009



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Toll-like receptor 3 signalling mediates angiogenic response upon shock wave treatment of ischaemic muscle

Johannes Holfeld¹, Can Tepeköylü¹, Christin Reissig², Daniela Lobenwein¹, Bertram Scheller², Elke Kirchmair¹, Radoslaw Kozaryn¹, Karin Albrecht-Schgoer³, Christoph Krapf¹, Karin Zins⁴, Anja Urbschat⁵, Kai Zacharowski², Michael Grimm¹, Rudolf Kirchmair³, and Patrick Paulus^{6*}

¹Department of Cardiac Surgery, Innsbruck Medical University, Innsbruck, Austria; ²Department of Anesthesiology, Intensive Care Medicine and Pain Therapy, University Hospital Frankfurt, Frankfurt am Main, Germany; ³Department of Internal Medicine III, Innsbruck Medical University, Innsbruck, Austria; ⁴Department of Anatomy and Cell Biology, Vienna Medical University, Vienna, Austria; ⁵Faculty of Medicine, Philipps University Marburg, Marburg, Germany; and ⁶Department of Anesthesiology and Operative Intensive Care Medicine, Kepler University Hospital, Linz, Austria

Received 16 February 2015; revised 6 November 2015; accepted 18 November 2015; online publish-ahead-of-print 16 December 2015

Time for primary review: 31 days

DIGEST Award winners 2017



Focused ESWT activates stem cells



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AntifibroticESWT

Ledderhose disease

13 patients, 56 ± 8 yrs

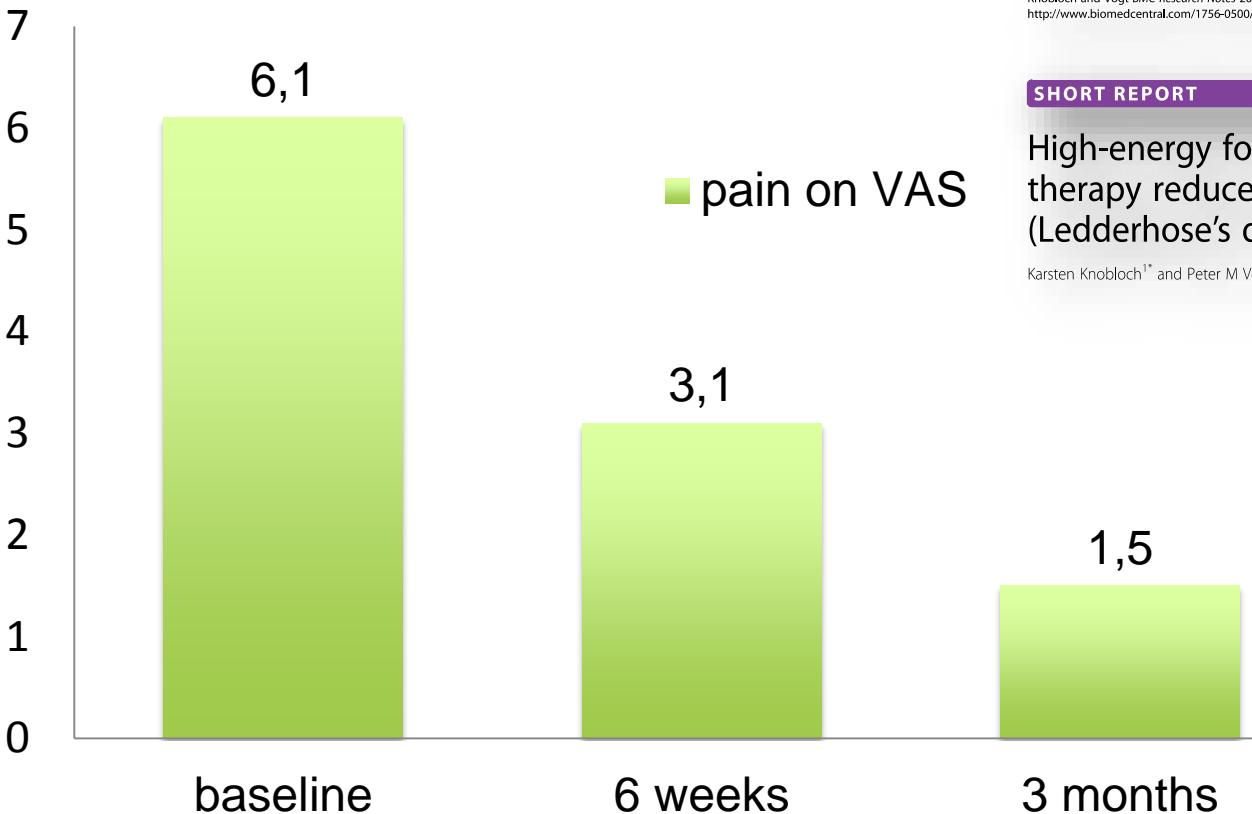


SHORT REPORT

Open Access

High-energy focussed extracorporeal shockwave therapy reduces pain in plantar fibromatosis (Ledderhose's disease)

Karsten Knobloch^{1*} and Peter M Vogt²



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International Journal of
Molecular Sciences

Article

Extracorporeal Shock Wave Therapy Alters the Expression of Fibrosis-Related Molecules in Fibroblast Derived from Human Hypertrophic Scar

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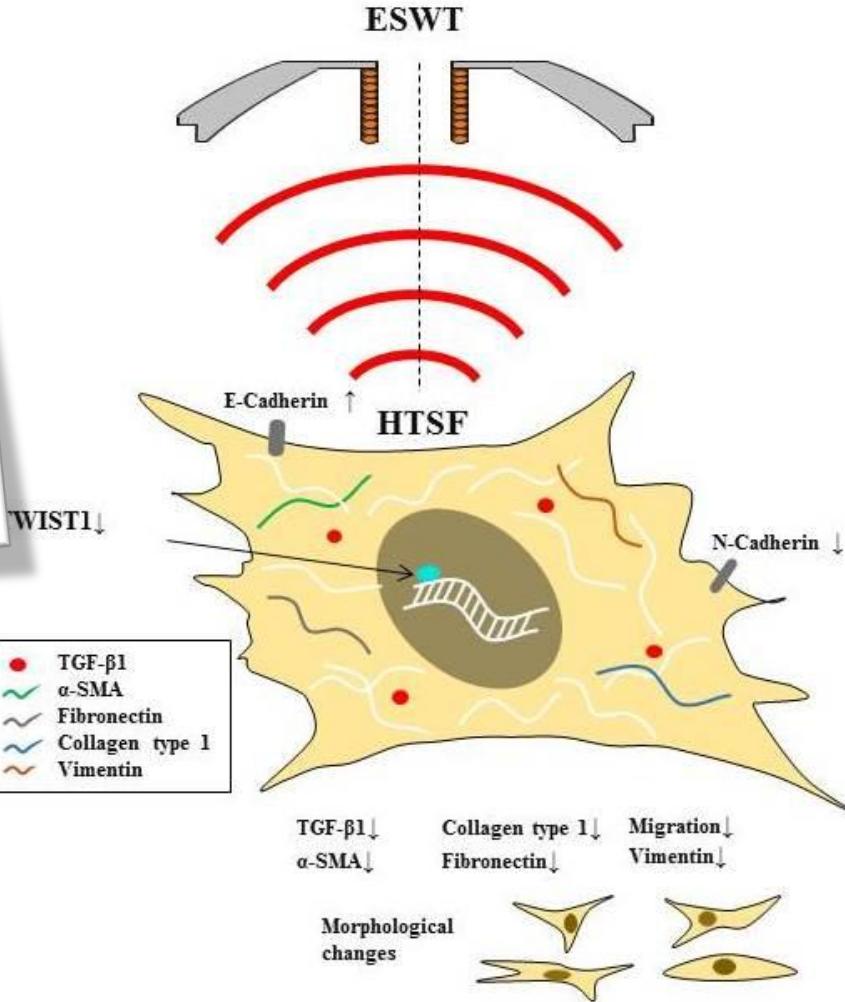
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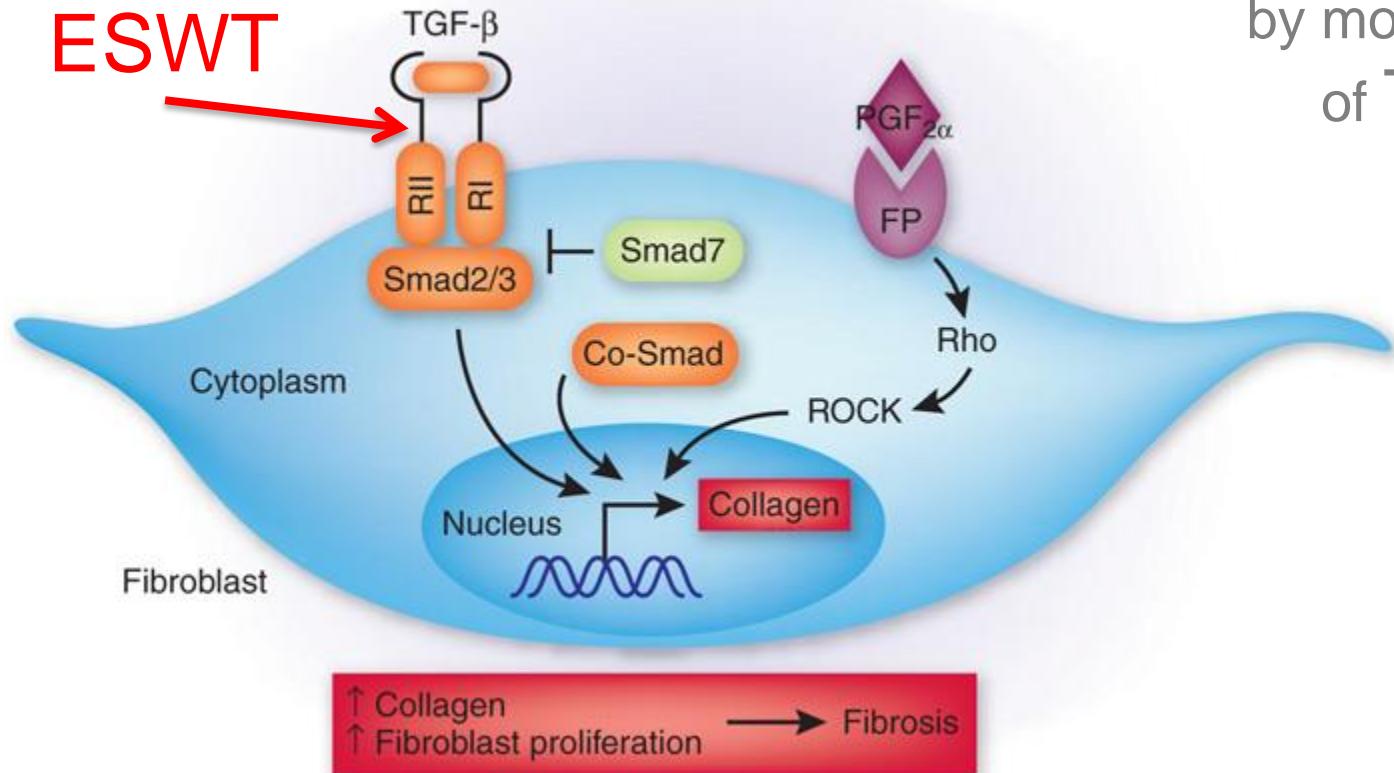
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ESWT can be antifibrotic by modulation of TGF- β



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ESWT biological effects



Stimulation of
Microcirculation
(Blood, Lymph)



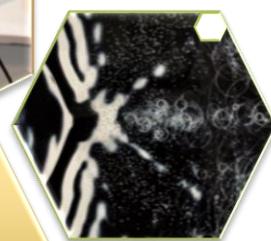
Increase of cell
wall permeability



Release of Nitric
oxide



Stimulation of
Stem cells



Stimulation of
Growth factors
(VEGF, BMP,
TGF- β 1, TGF- β 3)



Antibacterial
effect



Antifibrotic effect



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Thank you

