

## Abstracts

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Guest Keynote Lecture 1

### Stem Cells In Orthopaedic Surgery – Current Knowledge And Evidence

Lee Eng Hin

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The immense interest in stem cells has arisen as a result of the belief that they have the potential to regenerate new tissues and organs, to cure diseases that hitherto are incurable and to delay or prevent diseases associated with aging. Hematopoietic Stem Cells (HSCs) are currently widely used clinically in bone marrow transplants for hematologic malignancies. Pluripotent stem cells such as Embryonic Stem Cells (ESCs) are associated with both ethical and scientific issues. Induced Pluripotent Stem Cells (iPSCs) have less ethical issues but the scientific issues still remain. Adult stem cells such as Mesenchymal Stem Cells (MSCs) currently have more potential for clinical use as they have less ethical and scientific issues associated with their use in humans, especially if autologous cells are used.

This talk examines the current knowledge in the area of adult stem cells and the evidence for their efficacy in clinical use for orthopaedic indications. Pre-clinical studies done in our centre on the effects of stem cells on cartilage, ligament and meniscus repair will be presented. The path to the clinic involves clinical trials which have to be properly planned and executed. The cells have to be processed under GMP conditions and there must be compliance to ethical and regulatory guidelines. To date there have been few approved trials for hESCs and iPSCs. There are however many clinical trials for adult stem cells from various sources such as bone marrow, fat and peripheral blood, most of which lack appropriate controls and are not randomized. The majority of these studies are with autologous cells and tend to report good results in the short term. Level 1 and 2 studies for orthopaedic indications will be analyzed and presented. There is a need for well-designed randomized controlled studies with a longer term follow up to establish the efficacy of cell therapy.

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Keynote Lecture 1

### Effect Of Shock Waves On Macrophages: A Possible Role In Tissue Regeneration And Remodelling

Naths Grazia Sukubo, Elisabetta Tibalt, Stefano Respizzi, Massimo Locati, M.Cristina d'Agostino

#### Introduction

Extracorporeal Shock Wave Therapy (ESWT) is broadly used as a non-surgical therapy in various diseases for its pro-angiogenic and anti-inflammatory effects. However, the molecular mechanisms translating tissue exposure to shock waves (SW) in a biological response with potential therapeutic activity are largely unknown. As macrophages take part in both the onset and amplification of the inflammatory response, and well in its resolution, we investigated the effect of SW on their biology.

#### Methods

Human monocyte-derived macrophages were polarized to classic (M1) pro-inflammatory macrophages or alternative (M2) anti-inflammatory macrophages and exposed to SW at different intensities. Expression levels of marker genes of macrophage activation were measured by qPCR at different time points.

#### Results

SW did not induce activation of resting macrophages at any energy level used. Conversely, when used at low energy SW caused a significant inhibition of some M1 marker genes (CD80, COX2, CCL5) in M1 macrophages and a significant synergistic effect for some M2 marker genes (ALOX15, MRC1, CCL18) in M2 macrophages. SW also affected cytokine and chemokine production, inducing in particular a significant increase in IL-10 and reduction in IL-1 $\alpha$  production.

#### Conclusions

Macrophage exposure to low energy SW dampens the induction of the pro-inflammatory profile characterizing M1 macrophages and promotes the acquisition of an anti-inflammatory profile synergizing with macrophage alternative activation.

#### Keywords

Macrophages; Shock waves; Inflammation; ALOX15

#### Abbreviations

CCL, CC chemokine ligand; CCR, CC chemokine receptor; CXCL, CXC chemokine ligand; ESWT, extracorporeal shock wave therapy; IL, interleukin; IFN, interferon; LPS, lipopolysaccharide; SW, shock waves

## Abstracts

Abstract 1

**Shockwave Enhances Vessel Dilatation Through Nitric Oxide Production And Augments Angiogenesis Through VEGFR2 Recycling****Sheng-Ying Chung***Division of Cardiology, Dept. of Internal Medicine,  
Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine,  
Kaohsiung, Taiwan***Device and producing company:** Evotron (HMT, Switzerland)**Introduction:** This study aimed at testing whether SW-induced vasodilation and angiogenesis may be through endothelial vascular endothelial growth factor receptor 2 (VEGFR2) signaling.**Material and Method:** Human umbilical vein endothelial cells (HUVECs) treated with SW (0.12 mJ/mm<sup>2</sup>, 200 impulses with frequency 2 Hz) underwent Western blotting and phosphorylation of VEGFR2, Akt, and eNOS. Tube formation and migration assays were also performed with SW treatment in the SU5416 and siRNA-driven silencing of VEGFR2. Rab11a (key protein for slow endocytic recycling) was silenced with siRNA in vitro. Critical limb ischemia was induced before SW treatment on post-operative days 1 and 7. Laser Doppler flowmetry was used to evaluate blood flow recovery on Day 14 in vivo.**Results:** Augmented ligand-independent phosphorylation in VEGFR2-Akt-eNOS axis and endogenous NO production, attenuated rat carotid artery vasoconstriction, increased cellular migration and tube formation, elevated sprouting of carotid artery and blood flow in ischemic limb in ob/ob mice were noted with SW treatment. SU5416 and VEGFR2 silencing both inhibited SW-induced angiogenesis. SW-induced angiogenesis, which was accompanied by increased VEGFR2 protein expression without transcriptional change, was suppressed by chloroquine and Rab11a silencing but enhanced by monensin treatment.**Discussion:** An optimal SW setting was established for the induction of vasodilation and angiogenesis in endothelial cells was noted after SW-induced vasodilatation. The delayed SW-induced angiogenesis was found to be attributable to an increased number of VEGFR2 from endosome-plasma-membrane recycling.**Conclusion:** SW induced vasodilatation through VEGFR2-associated signaling pathway activation and enhanced angiogenesis via recycling of VEGFR2 in endothelial cells.

Abstract 2

**Shockwave Regulates Focal Adhesion Maturation And Cell Proliferation By Activating The mTOR-FAK Mechanotransduction Signaling Axis****Fan-Yan Lee<sup>1,4</sup>, Yen-Yi Zhen<sup>2,4</sup>, Ching-Jen Wang<sup>3,4</sup>, Hon-Kann Yip<sup>2,4</sup>***<sup>1</sup>Divisions of Thoracic and Cardiovascular Surgery; <sup>2</sup>Division of Cardiology; <sup>3</sup>Dept. of Orthopedic Surgery;  
<sup>4</sup>Center of Shockwave Medicine and Tissue Engineering,  
Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Taiwan***Device and producing company:** Evotron (HMT, Switzerland)**Introduction:** Extracorporeal Shock Wave Therapy (ESWT), capable of activating angiogenesis, suppressing inflammation and inducing wound closure, is a clinical therapeutic tool. Its exact molecular mechanisms are still poorly understood and to be explored in this study.**Materials and Methods:**

We applied ESWT to the Adipose-derived mesenchymal stem cells (MSC) at different energy flux density (EFD). Cell lysates were subjected to either western blot analysis or immunofluorescent staining. An optimal EFD was determined, change in MSC morphology with its cytoskeleton observed, cell number counted, and pFAK localized. The upstream regulator was identified by pharmacological blocking of pressure-stimulated mechanotransduction kinases.

**Results:** ESWT at EFD of 0.12 mJ/mm<sup>2</sup> for 100 impulses maximally phosphorylates FAK, and induces FAK maturation and translocation to focal adhesion complex. ESWT, at higher EFD, dramatically reduces pFAK and causes cytoskeletal damage. Microfilaments, but not microtubules, play an important role in FAK activation. The upstream regulator of ESWT triggered FAK phosphorylation is mTORC1, whose phosphorylation is not affected by structural integrity of cytoskeleton. ESWT-based mechanotransduction can activate the mTORC1-FAK axis for promoting cell proliferation without serum.**Discussion:** This study is unique in investigating the clinical therapeutic effects of ESWT at cellular level. We report the mTORC1-FAK signaling axis as a novel signaling pathway of mechanotransduction in MSC. The discrepancy of cellular outcomes at different EFD in various literatures might be attributable to different net forces transmitted to the cells.**Conclusion:** ESWT orchestrates mechanotransduction, and activates the mTOR-FAK signaling axis, a novel mechanotransductive pathway, to govern focal adhesion assembly and mesenchymal stem cell proliferation.

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Abstract 3

**The Exploration Of The Influences Of Extracorporeal Shock Wave On Physiological Function Of Bone Microvascular Endothelial Cells**

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*China-Japan Friendship Hospital, Beijing, China*

**Device and producing company:** Dornier

**Introduction:** Extracorporeal shock wave is one therapy for the early stages of osteonecrosis of the femoral head; however the mechanism of it is still unclear.

**Methods:** We acquired cancellous bone from the femoral head, separated and the cultured bone microvascular endothelial cells in vitro. The bone microvascular endothelial cells were identified by the antibody of markers of vWF and CD31 of endothelial cells, then were randomly assigned according to different energy flow densities and numbers of shots. The tuber formation ability was observed by 3-D culture in vitro, the migration capability was observed by scratch test, and the apoptosis was detected by flow cytometry test.

**Results:** Our experiments show that extracorporeal shock wave can improve the tuber formation ability, the migration capability and apoptotic resistance of bone microvascular endothelial cells.

**Discussion:** Many studies have shown that endothelial cells play a vital role in pathological processes of osteonecrosis of the femoral head. Therefore the exploration of the influences of extracorporeal shock wave on physiological function of bone microvascular endothelial cells is significant.

**Conclusion:** Extracorporeal shock wave can improve the tuber formation ability, the migration capability and apoptotic resistance of BMEC but related to the energy flow density.

Abstract 4

**Shock Wave Promotes Cellular Uptake Of Methotrexate And Enhances Its Cytotoxicity For Osteosarcoma Cells By ATP Release**

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**Device and producing company:** WIKKON Company, China

**Introduction:** Osteosarcoma is the most prevalent primary malignant bone tumor, and treatment is difficult and prognosis remains poor. Minimizing the dose of chemotherapeutic drugs is a current challenge for the management of osteosarcoma patients.

**Methods:** Human osteosarcoma U2OS cells were treated with shockwaves. Using different biological methods, to investigate whether and how shock waves can promotes cellular uptake of methotrexate(MTX) and its cytotoxicity.

**Results:** Shockwaves promoted the cell uptake of fluorophores. Shock waves promote cell uptake of MTX and enhance its cytotoxicity. Shockwave-or-ATP-induced P2X7 receptor stimulation promotes cell permeability, MTX uptake, and cytotoxicity of U2OS cells.

**Discussion:** Shockwave-induced ATP release may activate P2X7 receptors to increase MTX entrance into cells to induce apoptosis because binding of ATP and P2X7 receptor may stimulate the opening of cell membrane channels to promote entrance of MTX into cells.

**Conclusion:** Shock waves promote methotrexate-induced apoptosis by altering cell membrane permeability in a P2X7 receptor-dependent fashion. Shock waves may represent a possible adjuvant therapy for osteosarcoma.

Abstract 5

**Extracorporeal Shockwave Therapy Effectively Prevented Diabetic Neuropathy**

Yi-Ling Chen<sup>1</sup>, Kuan-Hung Chen<sup>2</sup>, Tsung-Cheng Yin<sup>3</sup>, Tien-Hung Huang<sup>1</sup>, **Chun-Man Yuen<sup>4</sup>**, Hon-Kan Yip<sup>1</sup>  
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*Kaohsiung Chang Gung Memorial Hospital and ChangGung University College of Medicine, Kaohsiung, Taiwan*

**Device and producing company:** Evotron (HMT, Switzerland)

**Introduction:** We tested the hypothesis that extracorporeal shock wave (ECSW) therapy can effectively protect sciatic nerve (SN) from diabetes mellitus (DM)-induced neuropathy in leptin-deficient (ob/ob) mice.

**Material and Methods:** Eighteen-week C57BL/6 mice (n=8) served as age-matched controls (group 1) and ob/ob mice (n=16) were categorized into DM (group 2) and DM + ECSW (group 3). The animals were sacrificed two weeks post-ECSW.

**Results:** The protein expressions of oxidative stress (NOX-1, NOX-2, oxidized protein), inflammation (MMP-9, TNF- $\alpha$ , iNOS), apoptosis (Bax, cleaved caspase-3, & PARP), and DNA-damage marker ( $\gamma$ -H2AX) were significantly higher in schwannoma cell line treated by menadione (25 QM) compared with control group and were significantly reversed after ECSW (0.12mJ/mm<sup>2</sup>, 200 impulses) (all p<0.001). mRNA expressions of inflammation (MMP-9, TNF- $\alpha$ , iNOS), oxidative stress (NOX-1, NOX-2) and apoptosis (Bax, caspase-3) in SN were significantly higher in group 2 than in group 1 and were significantly reversed in group 3, whereas the mRNA expressions of anti-oxidants (HO-1, NQO1) progressively increased from group 1 to group 3 (all p<0.001). Cellular expressions of F4/80+, CD14+,  $\gamma$ -H2AX+ cells, and number of vacuolar formation in SN showed a pattern identical to that of inflammation markers among all groups (all p<0.001). Microscopic findings of Schwann cells and myelin-sheath scores, and number of eNOS+ cells in SN showed a reversed pattern compared to that of inflammation among all groups (all p<0.001).

**Discussion:** The oxidative stress and apoptosis were significantly reduced in the group treated by ECSW.

**Conclusion:** ECSW therapy protected SN against DM-induced neuropathy.

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Keynote Lecture 2

### Extracorporeal Shockwave Therapy In Diabetic Foot Ulcers

**Ching-Jen Wang**, Jai-Hong Cheng, Yur-Ren Kuo, Wolfgang Schadene, Rainer Mittermayr  
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Diabetic foot ulcers (DFUs) are among the most common foot disorders with ulceration, infection, and gangrene that may ultimately lead to lower extremity amputation. The goals of treatment include the control of diabetes and proper shoe wear. An effective therapy and appropriate foot care are important in wound healing in DFUs. Recently, extracorporeal shockwave therapy (ESWT) was reported to significantly promote and accelerate the healing of complex soft tissue wounds as compared to the standard methods of treatment in DFUs. ESWT showed positive results in short-term and long-term outcomes in diabetic patients suffering from foot ulcers. In this article, we review the clinical results of ESWT in DFUs.

Keynote Lecture 3

### Acoustic Stimulation And Tropism On Skeletal Muscles: Perspectives On Tissue Resilience In Sports And Ageing

**Kenneth Craig Vincent<sup>1</sup>**, Wolfgang Schaden<sup>2</sup>, Laupepa Aposetolo Karalus<sup>3</sup>  
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*<sup>3</sup>Kinematics Centre, Victoria, Australia*

Skeletal muscles primarily the largest organ of the body contributes approximately 45 - 50% of total body weight and is regulated via voluntary control of the somatic muscle system. The main functions of skeletal muscles include but are not restricted to: breathing, thermo-regulation, energy storage, power generation, posture, locomotion and balance. Skeletal muscles simultaneously secrete factors that have an auto-para-endocrine communication network known to interact even with non-muscle tissue. These communicative mediators termed "myokines" have multifarious characteristics providing a molecular link between muscle function and whole-body physiology. Several factors such as age, mechanical load, nervous stimuli, hormonal changes, nutrient intake and metabolism influence the anabolic and catabolic balance of skeletal muscles, that in-turn influence human function, and overall wellness. Skeletal muscle health and activity influence athletic performance and quality of life across the lifespan, and the ability to intervene and improve skeletal muscle resilience and function could potentially help address overuse muscle fatigue syndromes in the athletic populations, while simultaneously addressing age related sarcopenia in the elderly. This paper discusses some of the activity and age related functional processes associated with skeletal muscles, and postulates the possibilities for effective intervention utilising a specific flash type stimulus improving muscle plasticity and function, as noted in our pioneering pilot study of these population groups.

Abstract 6

### Update On The Efficacy Of Extracorporeal Shockwave Treatment For Myofascial Pain Syndrome And Fibromyalgia

Silvia Ramon<sup>1,2</sup>, **Karin Freitag<sup>3</sup>**, Markus Gleitz<sup>4</sup>, Leonor Hernandez<sup>1</sup>, L. Romero<sup>1</sup>  
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Chronic muscle pain syndrome is one of the main causes of musculoskeletal pathologies requiring treatment. Many terms have been used in the past to describe painful muscular syndromes in the absence of evident local nociception such as myogelosis, muscle hardening, myalgia, muscular rheumatism, fibrositis or myofascial trigger point with or without referred pain. If it persists over six months or more, it often becomes therapy resistant and frequently results in chronic generalized pain, characterized by a high degree of subjective suffering.

Myofascial pain syndrome (MPS) is defined as a series of sensory, motor, and autonomic symptoms caused by a stiffness of the muscle, caused by hyperirritable nodules in musculoskeletal fibers, known as myofascial trigger points (MTP), and fascial constrictions.

Fibromyalgia (FM) is a chronic condition that involves both central and peripheral sensitization and for which no curative treatment is available at the present time. Fibromyalgia shares some of the features of MPS, such as hyperirritability.

Many treatments options have been described for muscle pain syndrome, with differing evidence of efficacy. Extracorporeal Shockwave Treatment (ESWT) offers a new and promising treatment for muscular disorders.

We will review the existing bibliography on the evidence of the efficacy of ESWT for MPS, paying particular attention to MTP (Myofascial Trigger Point) and Fibromyalgia (FM).

## Abstracts

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Abstract 7

### The Effect Of Radial Shock Wave Therapy On The Change Of Sonoelastography In Myofascial Trigger Point

Narin Ngamrungsiri, Areerat Suputtitada

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**Device and producing company:** Swiss Dolarclast Classic, EMS

**Introduction:** This research focused on the study of radial shockwave therapy (RSWT) to the physical properties of the trigger point (TrP) measured by sonoelastography. For better understanding of the biological effects of RSWT on TrP.

**Methods:** Participants, who have TrP in the upper trapezius muscle, received preliminary assessments, including sonoelastography. For a total of 3 weeks, RSWT was applied at trigger point of upper trapezius each time at one week interval.

**Results:** 12 participants were recruited into the study. After the third therapy, The mean difference changes in elasticity index were statistically significant decreased (.687; .533, .841).

**Discussion:** Elasticity index, which was the quantitative measurement of viscoelastic property, found to be statistically significant decreased after the treatment.

**Conclusion:** The present study demonstrated RSWT was effective in causing reduction in shear stress elastogram, which was related to the improvement in mechanical properties of trigger points.

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Abstract 8

### Combination Of ESWT And Dynamic Myofascial Treatment Improves Postural Stability And Spirometry Parameters In Athletes

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*<sup>2</sup>Charles University, 2nd Med. Faculty, Dept. of Neurology, Prague, Czech Republic*

**Device and producing company:** BTL SWT6000, Storz Duolith

**Introduction:** Elite athletes are oftenly suffering from muscle overuse symptoms, causing local overload symptoms and dynamic muscle dysbalance. Moreover, muscle overload combined with inappropriate breathing techniques can result in metabolic sequels, insufficient performance and early fatigue in sportsmen. The authors are presenting their experience with use of dynamic myofascial treatment (DMT) and ESWT in 15 elite athletes, age 15-25.

**Methods:** Control group 1 contained 7 patients treated with DMT and sham shockwave applicators, group 2 contained 8 patients treated with manual therapy and low energy ESWT applied on triggerpoints (0,08 mJ/mm<sup>2</sup>) and dynamic application of radial SWT in carefully selected muscle groups (2,4 bars, 2000 shocks, 8 Hz). We have measured VAS, spirometry parameters and ROMs in spine and selected joints. Only 1 session was performed to observe the short term effect of treatment.

**Results:** Combination of ESWT and DMT (in group 2) was significant in increase of vital capacities and peak expiratory flow compared to control group (manual therapy only). Also, improvement in ROMs and VAS decrease was significant in Group 2 compared to control group.

**Discussion:** We have proved, that combination of low energy SWT with DMT were more effective in improvement of functional spirometry parameters and in ROM correction and VAS decrease in overloaded muscle groups. Our patients reported immediate response in pain relief, relaxation and reported better sports performance.

**Conclusion:** We have found beneficial effect of combination of ESWT and DMT in pretreatment of athletes before race.

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Abstract 9

### rESWT For Postoperative Low Back Pain After Lumbar Spine Surgery

Yajun Liu

*Beijing Jishuitan Hospital, China*

**Device and producing company:** DolorClast, EMS

**Introduction:** The aim of this study is to evaluate the effectiveness of rESWT for postoperative pain after back surgery compared with pharmacotherapy.

**Methods:** 90 patients with low back pain 3 months after single level lumbar spine operation for degenerative disease was randomized divided into 2 groups. The rESWT group and the pharmacotherapy group.

**Results:** A statistically significant difference exists between the 2 groups in post-treatment VAS (t=-4.534, p<0.001) or ODI (t=-3.216, p=0.002) (p<0.05).

No obvious adverse effects were observed.

**Discussion:** Our study shows rESWT for postop. LBP is effective and safe. The effect is better than NSAIDs+Muscle relaxant in 3 months FU. We still need high-lever evidence to support our conclusion. and it would be better if we set a sham group for case control.

**Conclusion:** rESWT for postop. LBP is effective and safe.

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Abstract 10

### Effect Of Focused ESWT Treatment On Neuropathic Pain In Cervical Spine Radiculopathies

Tomas Nedelka<sup>1,2</sup>, Jiri Nedelka<sup>1</sup>

<sup>1</sup>Rehabilitation, Sports Medicine and Pain Treatment Center;

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Prague, Czech Republic

**Device and producing company:** Storz Duolith

**Introduction:** Compression of nerve root in cervical spine causes axial pain and irradiation of neuropathic pain (NP) to arm. NP is usually resistant to standard pharmacotherapy and physical treatment. Neuromodulatory treatment (pregabalin) was proved to be effective, but has a lot of adverse effects. Spinal surgery is the other treatment option, however, often carries risks of peri/postoperative complications. In contrast, shockwave therapy is a safe, non-invasive procedure with reported effect on nociceptive low back pain (Nedelka et al., 2014). Our present study reports the effect of ESWT on radicular pain in patients suffering from nerve compression.

**Methods:** Control group A contained 22 patients with MRI and EMG verified one segment nerve root compression. Patients were treated by sham device. Group B contained 23 patients with unilateral radicular compression. ESWT was performed at EFD 0,20 mJ/mm<sup>2</sup>, 800 shocks, 4 weekly sessions. We have measured values from validated PainDETECT NP questionnaire before treatment and at 1,3 and 6 months follow-up. Follow-up EMG and MRI were done after 6 months.

**Results:** In control group A, significant decrease in VAS at 4 weeks only, with no change in NP. Significant VAS and NP decrease was registered in Group B. Therapy was well tolerated.

**Discussion:** Our study in cervical NP brought similar results as we have previously reported in facet low back pain, with more impact on NP relief.

**Conclusion:** We have observed efficacy of focused ESWT on NP in patients with cervical radiculopathy.

Keynote Lecture 4

### Shockwave Therapy Of The Heart

Johannes Holfeld, Daniela Lobenwein, Can Tepekçoylü, Michael Grimm

Ischemic heart disease represents a collective term for a continuous disease pathophysiology, ranging from acute myocardial infarction to congestive and chronic heart failure. According to the World Health Organization (WHO) and its Global Burden of Disease study 2010 ischemic heart disease represents the most common cause of death and disability-adjusted life years (DALY) worldwide. Due to demographic changes in developed countries with an increase in life expectancy and a changing, more Western lifestyle in threshold countries, the number of patients suffering from ischemic heart disease is expected to rise dramatically in the future, presenting a major challenge for health care systems.

Keynote Lecture 5

### Biological Mechanism Of Shockwave In Bone

Jai-Hong Cheng, Ching-Jen Wang

Shockwave is a rapid, short duration acoustic wave that carries energy and can propagate through tissue medium. This kind of physical force can be a mechanical stimulus that induces biological effects in living tissue. Extracorporeal shockwave therapy (ESWT) acts as a mechanical stimulus which promotes biological healing processes through a mechanotransduction. The biological effects of ESWT are reported such as tissue regeneration, wound healing, angiogenesis, bone remodeling, and anti-inflammation. Until now, however, little is known about the basic mechanism of action of this type of therapy. This article describes the molecular mechanism on the current status of ESWT with pre-clinical and clinical applications for treating disorders in bone.

## Abstracts

Abstract 11

### Medial Tibial Subchondral Bone Is The Key Target For Extracorporeal Shockwave Therapy In OA Rat Knee

Ching-Jen Wang<sup>1,2</sup>, **Jai-Hong Cheng**<sup>1,3</sup>, Chien-Yiu Huang<sup>1,2</sup>, Fan-Yen Lee<sup>1,4</sup>, Hon-Kan Yip<sup>1,5</sup>

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Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Kaohsiung, Taiwan

**Device and producing company:** Richard Wolf; Germany

**Introduction:** The purpose of the current study was to investigate the subchondral bone of medial tibia as the target for ESWT in OA knee treatment and compared with various locations on lateral tibia condyle and femur.

**Material and Method:** Fifty-six Sprague-Dawley rats were divided into seven groups including sham, OA knee, ESWT to proximal medial tibia on OA rats knee, ESWT to distal lateral femur condyle on OA rat knee, ESWT to proximal lateral tibia on OA rat knee, ESWT to proximal lateral tibia and distal lateral femur condyles on OA rat knee as well as ESWT application to medial and lateral femur on OA rat knee. The examinations included gross pathological OA changes, Safranin O stain, cartilage degradation including OARSI score and cartilage area, bone mineral density, micro-CT scan, mechanical strength analysis and immunohistochemical analysis.

**Results:** Application of ESWT to medial tibial subchondral bone showed significant reduction on pathological lesions and cartilage lesion than lateral tibia and femur. ESWT on medial tibial subchondral bone increased BMD, bone volume, yield stress and decreased bone porosity. The TUNEL, PCNA and osteocalcin were significantly influenced the levels of molecular expression in different locations of ESWT application.

**Discussion:** ESWT showed the chondroprotective effects at various locations of the knee joint in OA knee of rats. However, the mechanism of ESWT knee in OA remained unclear and required further study.

**Conclusion:** Our results confirmed that application of ESWT to the medial tibia subchondral bone have more effective therapy for OA knee than lateral locations of joint knee.

Abstract 12

### 3-D Reconstruction Imaging Assessment Of The Therapeutic Effect Of Radial Extracorporeal Shock Wave Therapy On Osteochondral Lesions Of The Talus

**Geng Yan Xing**

Department of Orthopaedic Surgery, the General Hospital of Chinese People's Army Police Force, Beijing, China

**Device and producing company:** Switzerland EMS Dolor Clast

**Introduction:** To explore the effectiveness of radial extracorporeal shock wave therapy (rESWT) in the treatment of osteochondral lesions of the talus (OLT) through three-dimensional (3-D) computer reconstruction measurement of damaged volume.

**Methods:** 24 cases with OLT were analyzed. MRI were performed before and after three courses of rESWT treatment. A 3-D volume measurement module was used to calculate the volume of talus and osteochondral lesions area in combination with VAS and AOFAS.

**Results:** The mean volume were decreased after treatment. All patients' pretherapy VAS scores were significantly reduced after treatment and AOFAS parameters were significantly increased after treatment ( $P < 0.05$ ).

**Discussion:** This 3-D model can more accurately measure the volume of OLT to evaluate the efficacy and clinical significance of the arthroscopic and rESW compound therapy on OLT.

**Conclusion:** The rESWT had a curative effect of patients with OLT, and can delay and reduce lesion development.

## Abstracts

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Abstract 13

### Extracorporeal Shockwave Therapy (ESWT) In The Treatment Of Atrophic Non-Unions Of Femoral Shaft Fractures

Shu-Jui Kuo, I-Chang Su, **Ching-Jen Wang**, Jih-Yang Ko

#### Introduction

As of now, the role of extracorporeal shockwave therapy (ESWT) in the treatment of atrophic non-unions is inconclusive. The purpose of the study was to investigate the effectiveness of ESWT and the role of this technology in the treatment of atrophic non-union of femurs.

#### Methods

We retrospectively analyzed 22 patients treated between July 1999 and September 2007 in our hospital with ESWT for atrophic non-unions of isthmic femoral shaft fractures that were initially treated surgically using closed reamed nailing procedure. Patients with open fractures, skeletal immaturity, on anti-osteoporotic medications, with infections, pathological fractures, smokers, with systemic disease compromising bone healing, and excessive deformity were excluded from this study. Due to incomplete follow-up one (1) patient who moved abroad after ESTW treatment was not included in this study and as part of the 22-patients cohort. Radiographs were obtained before treatment and once a month after treatment for 12 months.

#### Results

Using ESWT we showed that 14 fractures out of 22 (63.6%) achieved bony union with an average union time of 9.2 months (range 6-13 months). The union rate was 100% (8 of 8 cases) when ESWT was performed within 12 months from closed reamed nailing surgery versus 42.9% (6 of 14 cases) when ESWT was performed after 12 months from initial surgery. The eight (8) patients out of the total 22 patients cohort, who did not achieve bony union after ESWT, received subsequent treatment with bone grafting with augmentative plating surgery and all achieved bony union within 5 months after intervention.

#### Conclusion

For patients with atrophic non-unions of femoral shaft fractures, ESWT can be used as an alternative and effective non-invasive method of treatment. ESWT treatment does not negatively influence/compromise previous surgeries and if needed it can be followed by additional surgeries without any complications.

Abstract 14

### Reasons For Success And Failure Of ESWT In Forearm And Lower Leg Shaft Non-Unions

**Frank Bätje**

*Focused On Shockwaves, Hannover, Germany*

**Device and producing company:** MODULITH® SLK and Duolith® SD1 »ultra« - STORZ MEDICAL AG, Switzerland  
MODULARIS Variostar® - SIEMENS Healthcare GmbH, Germany

**Introduction:** Non-unions of long bones are common problems and require interventions. The ESWT is generally successful and offers itself as 1st choice treatment. Here we searched for reasons for treatment failures to provide assistance in choosing surgery or non-surgical procedure.

**Methods:** A total of 378 cases of impaired fracture healing of both forearm and lower leg bones were treated with high-energetic focused shockwaves - only diaphyseal fracture complications were included. Retrospectively, the therapeutic success was measured by questionnaires and / or radiological controls.

**Results:** By a follow-up rate of 63% the relation of complete bony healing to non-healing was 61% to 38% (and 1% drop out). Depending to different bones we determined the following results: radius: 67% : 33% : 0%, ulna 76% : 24% : 0%, tibia 56% : 43% : 1% and fibula 64% : 33% : 3%.

These unhealed cases had significantly increased risk profiles. Those treatment failures to ulna, tibia and fibula were not associated with prolonged existence of bone healing trouble before ESWT - quite the contrary, these intervals were even shorter.

**Discussion:** Our guideline-corresponding ESWT of selected long bone diaphyseal non-unions (378 cases between 2001-2015, devices: STORZ MODULITH® SLK, STORZ Duolith® SD1 »ultra«, SIEMENS MODULARIS Variostar®) provided satisfactory results at radius, ulna and fibula but less convincing success at tibia, probably due to peculiarities of the circulation and classification of fractures.

**Conclusion:** Our ESWT experiences with other long bones are similar, so we always recommend the ESWT as a treatment of 1st choice in post-traumatic bone healing disorders.

## Abstracts

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Abstract 15

### **rESWT For Bone Non-Union Of Paediatric Patients**

**Yajun Liu, Wei Tian**  
*Beijing Jishuitan Hospital, China*

**Device and producing company:** STORZ

**Introduction:** rESWT for two paediatric patients reported on bone non-union of paediatric patients.

**Methods:** One is 2 years old, one is 17 months old. Both are treated with rESWT using very low energy.

**Results:** Within 1 month after the rESWT, both are healed.

**Discussion:** The rESWT is effective for paediatric bone non-union. There is still no guidance for the energy and sessions we should apply for paediatric patient. Very low energy may be enough for very young babies.

**Conclusion:** The rESWT is effective for paediatric bone non-union.

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Abstract 16

### **ESWT For Non-Healing Fractures Of The Clavicle - Still A Valid Contraindication**

**Frank Bätje**  
*Focused On Shockwaves, Hannover, Germany*

**Device and producing company:** MODULITH® SLK and Duolith® SD1 »ultra« - STORZ MEDICAL AG, Switzerland

**Introduction:** The ESWT at the clavicle is considered contraindicated because of lung tissue in the focus. The fear is, according to animal studies, haemorrhage of the lung tissue, heterotopic ossification or even pneumothorax. Before classification as a contraindication, however, studies have been published over hundreds uncomplicated clavicle fracture treatments. We carry out such treatments also and describe the necessary precautions.

**Methods:** A total of 37 cases of impaired fracture healing of middle / lateral clavicle were treated with high-energetic focused shockwaves. To prevent complications, patients with serious lung diseases, acute airway infections, increased cardiovascular risk factors and those who could not understand this context were excluded. Therapeutic success was measured by questionnaires and / or radiological controls. We used auscultation, spirometry and oxygen saturation as control instruments.

**Results:** By a follow-up rate of 70% the relation of complete bony healing to non-healing was 69% to 27% (and 4% drop out). As we stood in contact with all patients we noticed no pneumological complication.

**Discussion:** Classification of the clavicle-ESWT as a contraindication comes from this era when shock wave therapy devices were so oversized that the adjacent lung tissue had to be necessarily compromised. Using more suitable devices with smaller applicators and 30 °-angular position enables preservation of the lung apex.

**Conclusion:** Our long standing ESWT experiences at the clavicle are good in terms of results and patient safety. If all safety measures are observed the risk of treatment appears to be low. One single, a maximum of two ESWT should be sufficient. A minimum of four weeks of immobilization increases the treatment success.

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Abstract 17

### **Extracorporeal Shockwave Therapy For Avascular Necrosis Of Femoral Head**

**Ching-Jen Wang, Jai-Hong Cheng, Chung-Cheng Huang, Han-Kan Yip, Sergio Russo**

The etiology of osteonecrosis of the femoral head (ONFH) is multifactorial. Treatment of ONFH is disease stage dependent. For early stages, femoral head preservation procedures are preferred including core decompression, muscle pedicle grafting and de-rotational osteotomy. Core decompression with bone grafting is considered the gold standard. However, the results are inconsistency and unpredictable. An effective non-invasive method of treatment is imperative. Recently, extracorporeal shockwave therapy (ESWT) has shown beneficial effects in ONFH. ESWT improves pain and function of the hip and regression of the ONFH lesion. ESWT is more effective than core decompression with or without bone grafting, cocktail therapy that combined HBO, ESWT and oral alendronate is shown effective for patients with early osteonecrosis. The purpose of the article is to review, update and summarize the clinical treatment of ONFH using shockwave therapy.

## Abstracts

Keynote Lecture 6

### Extracorporeal Shockwave Therapy (ESWT) - First Choice Treatment Of Fracture Non-Unions?

Wolfgang Schaden<sup>1,2</sup>, Rainer Mittermayr<sup>1,2</sup>, Nicolas Haffner<sup>2</sup>, Daniel Smolen<sup>2</sup>, Ludger Gerdesmeyer<sup>3</sup>, Ching-Jen Wang<sup>4</sup>

<sup>1</sup>AUVA Trauma Center Meidling, Vienna, Austria

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<sup>3</sup>Department of Orthopedic Surgery and Traumatology, University Schleswig Holstein, Germany

<sup>4</sup>Center for Shockwave Medicine and Tissue Engineering, Department of Orthopedic Surgery, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Kaohsiung, Taiwan

Fracture non-unions are still a challenging problem in orthopedics. The treatment of non-unions remains highly individualized, complex, and demanding. In most countries the surgical approach with debridement of the non-union gap, anatomical reduction and appropriate osteosynthesis along with autologous bone grafting is considered as the standard of care. One of the very first non-urologic applications of extracorporeal shockwave treatment (ESWT) concerned non-healing fractures. Since the early 1990s the knowledge of the working mechanism has increased enormously. The purpose of this review article is to demonstrate by peer-reviewed literature in conjunction with our own experiences that ESWT can be an efficient, non-invasive, almost complication-free and cost effective alternative to surgical treatment of non-healing fractures.

Keynote Lecture 7

### Extracorporeal Shockwave Therapy In Nonunion Or Delayed Osseus Union

Edson Antonio Serrano Del Carpio, Jean Carlo Criado Huerto  
Neomedica Shockwave Unit, Lima, Perú

**Device And Producing Company:** ORTHOGOLD 280, DIREX

#### BACKGROUND:

Several studies had shown the the effectiveness and benefits of the high energy extracorporeal shockwaves treatment (HE ESWT) in non nonunion or delayed osseus unión.

#### METHOD:

We design a prospective intervention study, from april 2012 until april 2016, in this time they were evaluated 72 cases of non-unions, of which only 42 cases entered the study, 20 patients did not received treatment by decision of patients and 10 patients did not received the treatment by medical indication. Forty two non unions in forty patients with nonunion or delayed osseus unión were performed HE ESWT and them followed at lest for 8 months.

All patients were sedated with intravenous anesthesia by an anesthesiologist for the procedure, some of them were performed in operated room in this cases the fracture was located with C arm, in most of patients thatreatment were performed in procedure room, in this cases the fracture were located with previus marked Rx. The patients recieved HE ESWT with two diferents devices (Orthogold 280, and Direx,) using same protocol, this includes at lest 4000-6000 pulses in level of energy of 0.4-0.5 mJ/mm<sup>2</sup> (28-34 kV), with a frequency of four pulses per minute.

After HE ESWT all patients were immobilized with cast or was weightbearing restricted between 6 and 12 weeks (use of crutches in femur and tibia fractures) depending of the type, localization of the fracture, loosening of the implants. The fracture healing was assessed with plain radiographs every two months, The range of follow up was 4-48 months.

#### RESULTS:

42 nonunions were followed in 40 patients, The rate of bony union was 42.9% (18) at 4 months, 69% (29) at 6 months, and 76.2% (32) at 8 months follow up. El 23.8% (10) of the patients do not consolidated at 8 months follow-up.

The 67.2% (32) of cases were of males and 23.8% (10) females with an average age of 40.5 years (range, 8-78 years). The average of surgeries was 1.64 (range, 0-3). The average of time of non unión was 9.3 months (range, 1-32 months). The 69.1% (29) of fractures were closed and el 30.9% (13 )were open fractures. The most frequent bones treated were femur 40.5% (17), tibia 28.6% (12) and humerus 9.5% (4). The types of nonunions were 73.2% (31) oligo-atrophic and 26.2% (11) hypertrophic. The most frequent implants were locking plate 28.6% (12), convencional plate 19.1% (8), intramedullary locked nail 16.7% (7), external fixator 9.5% (4) and 21.4% (9) of the patients had no implants at treatment time. The 73.8% (31) of the patients received only one treatment, 23.8% (10) received two tratments and only 2.4% (1) received 3 treatments. The Orthogold 280 device was used in 83.3% (35) of cases and 16.7% (7) of the cases was treated with Direx device. The average of time of inmovilization was 7.3 weeks (range, 6-12). The aligo-atrofic nonunions was 73.9% (31) and 26.1% (11) was hypertrophic nonunions.

#### DISCUSSION:

ESWT is an excellent alternative treatment for non-unions, however it is very important to do good selection of the patients, is very important use high-energy devices to have the highest percentage of success and also make individualized post-treatment with clear indications of inmovilization according to the type of fracture, location, loosening of implants and number of surgeries.

#### CONCLUSIONS:

HE ESWT is a safe and effective alternative method in the treatment of selected nonunions of long bones, with no surgical risks. There were no systemic complications or device-related problems. Local complications included petechiae and hematoma formation that resolved spontaneously.

## Abstracts

Abstract 18

### Which Factors Lead To Failures In The ESWT Of Bone Healing Disorders Of The Proximal Femur?

**Frank Bätje***Focused On Shockwaves, Hannover, Germany***Device and producing company:** MODULITH® SLK-STORZ MEDICAL AG, Switzerland**Introduction:** Non-healing fractures of the femoral neck or the trochanteric region require complex and definitive surgical corrections, mostly implantation of joint prostheses. Here the success of ESWT in own clientele was evaluated and successes and failures were evaluated to patient-related and treatment-related causes with the background to recommend the method as a good alternative to surgery.**Methods:** A total of 81 cases of delayed fracture healing or non-union were treated with high-energetic focused shockwaves. All patients have been transferred by specialists of traumatology or orthopedic surgery. Retrospectively, the therapeutic success was measured by questionnaires and / or radiological controls.**Results:** By a follow-up rate of 77% the relation of complete bony healing to non-healing was 50% to 42% (and 8% drop out). Femoral neck non-unions showed much better results (80% : 20% : 0%) than non-unions of the trochanteric region (40% : 49% : 11%).**Discussion:** Our guideline-corresponding shock wave therapies in bone healing disorders of the proximal femur (81 patients between 2002-2015, device: STORZ MODULITH® SLK, all treatments by the same medical doctor) provided only at the femoral neck but not in the intertrochanteric or subtrochanteric region compelling bone healing.**Conclusion:** In all healed and unhealed cases the periods since surgical therapy, general or bone-specific risk factors, the number of ESWT-sessions and the total number of high-energetic shockwaves ( $> 0.45 \text{ mJ} / \text{mm}^2$ ) were evaluated but showed us no appropriate explanations for success or failure of treatments.

We can therefore apply no therapeutic success stratification.

Abstract 19

### Do Radial Shockwaves Safely Modulate Growth At The Physis? Preliminary Short Term Outcomes In Immature Rabbits

**Sowmya Ramesh<sup>1,2</sup>, Farasat Zaman<sup>2</sup>, Lars Sävendahl<sup>2</sup>, Vrisha Madhuri<sup>1</sup>**<sup>1</sup>*Paediatric Orthopaedics unit, Christian Medical College, Vellore, India*<sup>2</sup>*Department of Women's and Children's Health, Paediatric Endocrinology, Karolinska Institutet and Karolinska University Hospital, Stockholm, Sweden***Device and producing company:** Radialspec, Medispec, USA**Introduction:** Shockwave (SW) therapy is being used in the treatment of chronic musculoskeletal disorders. We explored the effect of low/high dose radial SW on growth plates (GP). A positive or negative effect on growth could be harnessed for therapeutic growth modulation while no change establishes safety.**Material and Method:** New Zealand white rabbits (n=3 each) received low dose of 1500 impulse/5 Hz/90mJ, 4 times/month (group 1) and high dose of 3000 impulse/5Hz/180mJ, 3 times/month (group 2) on the right distal femur (medial & lateral) with left as control. After one month, GPs were assessed by histomorphometry and immunostaining for PCNA (cell proliferation), TUNEL (apoptosis) and COL-X (hypertrophy).**Results:** Growth plate height increased in group 1 (13.7%) and group 2 (15.2%). Normalized to untreated limb, only group 2 had significant (P<0.05) increase in cell proliferation (69%). COL-X positive cells increased in group 1 (25%) and group 2 (36%). The apoptotic cells were insignificant in articular cartilage (AC) and GP. Final bone length also remained unchanged.**Discussion:** The in vivo short term effect of low and high energy radial SW had an increase in GP height. In addition, high energy group showed significant increase in cell proliferation and bone formation. No significant increase in cell death at AC confirms safety for the adjacent joint. Further studies would confirm the effect on bone length at maturity.**Conclusion:** The histological effects indicate that SW could potentially modulate bone growth and is safe for the adjacent articular surfaces.

## Abstracts

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Abstract 20

### Extracorporeal Shock Wave Therapy In Osgood Schlatter Disease

Vikas Basa, **Vrisha Madhuri***Paediatric Orthopaedics unit, Christian Medical College, Vellore, India***Device and producing company:** Radialspec, Medispec, LTD Corporate, USA**Introduction:** Traditionally rest, immobilization and analgesics in Osgood-Schlatter disease (OSD) relieve symptoms in 3 to 6 months. Radial shock wave therapy (RSWT) in OSD may shorten the course of disease.**Methods:** 30 children, mean age 12.9 years diagnosed as OSD over 2 years based on clinical and radiological criteria were selected. Five children played in competitive regional sports. All children had prior treatment elsewhere without resolution of symptoms. Median duration of symptoms was six (range 0.3 to 24) months. Prior treatment included analgesics, activity restriction in all and casting in two for four weeks. Visual Analogue scale VAS for pain, Western Ontario and McMaster Universities WOMAC score for function and knee flexion in hip extension were assessed before treatment. 2000 shocks at 5Hz, 90mJ was administered over the tibial tuberosity supplemented with naproxen for 1 week. One month post therapy VAS, WOMAC and knee ROM were reassessed and compared with pre-treatment scores.**Results:** There was a significant improvement in VAS and WOMAC scores. Wilcoxon signed Rank test assessed the difference in scores. Pre ESWT, mean VAS score $\pm$ 3SD was 6.8731.01 whereas post was 2.0731.23. Pre ESWT, mean WOMAC score was 10.2330.89 whereas post was 0.6730.96.**Discussion:** Improvement in scores was statistically significant ( $p < 0.001$ ). Follow-up at 3-24 months showed recurrence of symptoms in two. One child with no improvement underwent casting. There were no adverse local effects.**Conclusion:** RSWT was safe and effective for OSD treatment.

Abstract 21

### Treatment Of Bone Marrow Edema - A New Approach With ESWT

**Thomas Pontasch***Ordination Dr. Pontasch, Graz, Austria***Device and producing company:** Evotron, Dolorclast**Introduction:** Using Eswt as a valuable tool in treatment of bone marrow edema, as a save method without the risk of severe side effects of drugs**Methods:** Casereports over 10 years - using ether radial and electrohydraulic devices**Results:** Fast pain relieve, improvement in range of motion, fast return to normal activity without sideeffects - alternative treatment, if the use of drugs is not possible**Discussion:** Although controversial discussion - there are only very few data and studies of treatment of bone marrow edema in literature, besides studies of our colleagues in the Ewst society D'Agostino, Russo, Frairia, Wang et al published 2012 in Shockwave.**Conclusion:** Eswt is very helpful in treatment of bone marrow edema especially because there are only very few side effects and easy to handle or if the use of drugs is not possible.

Abstract 22

### Shock Wave Treatment For Painful Bone Marrow Edema In Knee Osteoarthritis- A Single-Center Case Series

**Gao FuQiang***China-Japan Friendship Hospital, Beijing, China***Device and producing company:** Dornier Compact DELTA II**Introduction:** The aim of this retrospective study was to evaluate the results of patients who had undergone extracorporeal shock wave combined with alprostadiol, with painful bone marrow edema in osteoarthritis of the knee.**Methods:** 78 patients with knee pain and showed bone marrow edema in MRIs. The postoperative results were evaluated by the VAS for pain, the Western Ontario and McMaster University Osteoarthritis Index (WOMAC) and MRI scans as well as plain radiographs.**Results:** The postoperative VAS and WOMAC knee scores revealed a significant decrease in pain in the early period after ESWT ( $p < 0.05$ ). MRI scans showed a higher incidence of distinct reduction and complete regression of bone marrow edema at 3 months.**Discussion:** It has the potential to resolve patient suffering quickly. They seemed to act faster and more efficacious with a lower complication rate.**Conclusion:** Extracorporeal shock wave combined with alprostadiol is an effective treatment in patients who have painful bone marrow edema in osteoarthritis of the knee.

## Abstracts

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Abstract 23

### ESWT In The Management Of Spontaneous Osteonecrosis Of The Knee (SONK): A Case Study

**Patrick Oon Leng Goh***Sports Medicine International, Singapore***Device and producing company:** EPOS; Dornier Medtech**Introduction:** SONK is a poorly understood condition resulting in bone necrosis, subchondral collapse and end-stage osteoarthritis. ESWT has been used in Avascular Necrosis of the hip, but its use in SONK is not established.**Methods:** Patient was a 62 year old male with SONK diagnosed on MRI. The osteochondral lesion covered 50% of the medial condyle on AP view, with extensive marrow edema. His conservative treatment included 4 sessions of focussed ESWT (0.27mJ/mm<sup>2</sup>, 3000 shocks).**Results:** VAS Pain scores reduced from 8.5 (pretreatment) to 5(3 months) to 3 (8 months). MRI 3 months post treatment showed remarkable reduction in bone edema, although continued osteochondral collapse had occurred.**Discussion:** SONK lesions extending over 40% of the AP radiographic view have a poor prognosis. This patient, with a 50% lesion made him an unlikely candidate for successful conservative management. ESWT may have contributed to this patient's positive outcome.**Conclusion:** The case study suggests a possible role for ESWT in extending the threshold for conservative management of SONK.

Abstract 24

### Adult Osteochondritis Dissecans And Focussed ESWT: A Successful Treatment Option

S. Thiele, **R. Thiele**, L. Gerdesmeyer

Extracorporeal shockwave therapy (ESWT) has gained acceptance in the medical field and in the treatment of non-unions and delayed bone healing. ESWT has been used effectively for many years as a noninvasive surgical procedure. The idea of treating Osteochondritis dissecans of knee and talus arose in the middle of the 1990's. OCD is known as a pre-arthritis factor in the long-term and still there is no consistent treatment. In the literature there is still only a small number of publications but international societies for shockwave treatment are convinced that ESWT on OCD shows to be an effective and safe method in the treatment of OCD in the early stages. We want to summarize the actual data on the treatment of OCD by ESWT.

Keynote Lecture 8

### Current Concepts Of Shockwave Therapy In Stress Fractures

**Carlos Leal**, Cristina D'Agostino, Santiago Gomez Garcia, Arnold Fernandez

Stress fractures are common painful conditions in athletes, usually associated to biomechanical overloads. Low risk stress fractures usually respond well to conservative treatments, but up to one third of the athletes may not respond, and evolve into high-risk stress fractures. Surgical stabilization may be the final treatment, but it is a highly invasive procedure with known complications. Shockwave treatments (ESWT), based upon the stimulation of bone turnover, osteoblast stimulation and neovascularization by mechanotransduction, have been successfully used to treat delayed unions and avascular necrosis. Since 1999 it has also been proposed in the treatment of stress fractures with excellent results and no complications. We have used focused shockwave treatments in professional athletes and military personnel with a high rate of recovery, return to competition and pain control. We present the current concepts of shockwave treatments for stress fractures, and recommend it as the primary standard of care in low risk patients with poor response to conventional treatments.

Keynote Lecture 9

### Current Knowledge On Evidence-Based Shockwave Treatments For Shoulder Pathology

Daniel Moya, Silvia Ramón, Leonardo Guiloff, **Ludger Gerdesmeyer**

Shoulder pain is one of the most common musculoskeletal pathologies. Treatment by ESWT (extracorporeal shockwave therapy) has emerged as an alternative when conservative treatment fails in rotator cuff calcific tendinopathy, prior to invasive procedures. The clinical efficacy of ESWT in non-calcific tendinopathy remains controversial. The good results in the treatment of rotator cuff calcifications, have led to indications of ESWT being expanded to other shoulder pathologies. We review the current state of indications and evidence based practice.

## Abstracts

Abstract 25

**Pain Reduction, Functionality And Quality Of Life Improvement After Shockwave Therapy Of Tendinitis**Dedes Vasileios<sup>1</sup>, Panoutsopoulos Georgios<sup>2</sup>, Zyga Sofia<sup>2</sup>, Mitseas Athanasios<sup>3</sup><sup>1</sup>Ph.D. Candidate, Department of Nursing, Faculty of Human Movement and Quality of Life, University of Peloponnese, Sparta, Greece<sup>2</sup>Associate Professor, Department of Nursing, Faculty of Human Movement and Quality of Life, University of Peloponnese, Sparta, Greece<sup>3</sup>Orthopaedic Surgeon, Scientific Director of Orthopaedic Clinic, Messinon Therapeutirion, Kalamata, Greece

**Introduction:** The calcified tendinitis of the shoulder, the tennis elbow, the plantar fasciitis and the tendinitis of the Achilles' tendon are the most frequent tendon diseases. People with tendinitis exhibit reduced mobility due to pain and inflammation caused by the movement of the involved tendons. The pain and the limited functionality negatively affect the daily activities of these people, reducing the level of their quality of life. Addressing these incidents mainly includes symptomatic treatment with local or oral anti-inflammatory and opioid drugs, steroids, anticonvulsants, antidepressants and combinations thereof, physical therapy, injection therapy and surgery. Lately, the shockwave therapy, which is non-invasive, simpler, faster and safer, is gaining ground.

**Objective:** To record the intensity of the pain, the functionality and the quality of life before the treatment and investigate if there is a significant improvement in these parameters after the treatment and the use or not of medicines.

**Methodology:** The sample consisted of 161 patients presented to orthopaedic clinic, from February to December 2015 and the physician considered their need for the particular treatment. The researcher created an original questionnaire (the UoP-PFQ), which can be paired with the specialized examination for each type of tendinitis, as a tool for the physician, to record the parameters of pain, functionality and quality of life. The patients evaluated the pain, the functionality and the quality of life on a five-point Likert scale, before and after the treatment. The questionnaire's reliability (Cronbach's Alpha) is 0.884

**Results:** 62 cases were related to tennis elbow (38,5%), 44 cases to plantar fasciitis (27,3%), 28 to Achilles' tendonitis (17,4%) and 27 to calcific shoulder tendonitis (16,8%).

At the first attendance 11 cases (6,8%) reported low intensity pain (with a partial reduction of activity and occasional use of analgesics); 98 cases (60,9%) reported high-intensity pain (with activities' restriction and occasional use of NSAID / opioid analgesics) and 52 cases (32,3%) reported very intense pain (with systematic use of NSAIDs/opioid analgesic).

125 people were subjected to 3 therapy sessions (77,6%), 28 people to 4 sessions (17,4%), 7 people to 5 sessions (4,3%) and 1 people to 10 sessions (0,6%).

There was one treatment per week for 146 patients (90,7%), one every ten days for 13 patients (8,1%) and one every fifteen days for 2 patients (1,2%).

During the sessions cycle, 137 people did not use any medication (85,1%), 15 used local pharmaceutical formulations (9,3%), 6 people used NSAIDs (3,7%), 2 people used opioid analgesics (1,2%) and 1 used injectable cortisone (0,6%). The pain reduction and the improvement of functionality and quality of life after the treatment were greater by at least two points on the five-point Likert scale and they were all statistically significant ( $p < 0,001$ )

**Conclusions:** The Shockwave Therapy appears to reduce significantly the pain that accompanies tendonitis and seems to improve the functionality and the quality of life of the patients, without side effects. It might be a first line therapeutic choice because of its effectiveness and safety, especially in people under treatment for other diseases, where the pain's management with NSAIDs and/or opioid analgesics is under restrictions.

Abstract 26

**Current Evidence Of Extracorporeal Shock Wave Therapy In Chronic Achilles Tendinopathy**

Ludger Gerdemeyer, Rainer Mittermayr, Martin Fuerst, Munjed Al Muderis, Richard Thiele, Amol Saxena, Hans Gollwitzer

Chronic Achilles tendinopathy has been described as the most common overuse injury in sports medicine. Several treatment modalities such as activity modification, heel lifts, arch supports, stretching exercises, nonsteroidal anti-inflammatories, and eccentric loading are known as standard treatment mostly without proven evidence. After failed conservative therapy, invasive treatment may be considered. Extracorporeal shock wave therapy (ESWT) has been successfully used in soft-tissue pathologies like lateral epicondylitis, plantar fasciitis, tendinopathy of the shoulder and also in bone and skin disorders. Conclusive evidence recommending ESWT as a treatment for Achilles tendinopathy is still lacking. In plantar fasciitis as well as in calcific shoulder tendinopathy shock wave therapy is recently the best evaluated treatment option. This article analysis the evidence based literature of ESWT in chronic Achilles tendinopathy. Recently published data have shown the efficacy of focused and radial extracorporeal shock wave therapy.

Abstract 27

**Lateral Epicondylitis: This Is Still A Main Indication For Extracorporeal Shockwave Therapy**

S. Thiele, R. Thiele, L. Gerdemeyer

Extracorporeal shockwave therapy (ESWT) is used in a number of indications in the medical field. A number of tendinopathies show good and excellent results due to evidence based medicine. The treatment of lateral epicondylitis is known to show conflicting results. This overview of the published RCT's on ESWT for lateral epicondylitis tries to show the reasons for this conflicting data-base and point out, why we think that this is still a main indication for extracorporeal shockwave therapy.

## Abstracts

Abstract 28

### Prospective Cohort Study Examining Short Term Changes In Pain After Application Of Extracorporeal Shockwave Therapy In 178 Consecutive Patients

Aston Ngai, Abdulaziz Farooq  
Aspetar Hospital, Doha, Qatar

**Device and producing company:** Orthogold 100

**Introduction:** ESWT has been found to be useful in treating chronic musculoskeletal injuries but there was conflicting evidence regarding its efficacy in some conditions. This prospective outcome study investigates the short term effect of focal ESWT on reported pain in these patients.

**Methods:** Between December 2015 and May 2016, 178 patients (136 non-athletes, 42 athletes) with chronic musculoskeletal injuries were treated with an incremental focal ESWT without anaesthesia. The patients' pre and post-treatment pain score, 5 point Likert scale and adverse events were reported.

**Results:** There were significant reductions in pain in knee (2.9, SD=1.6), foot (2.4, SD=1.7) shoulder (2.4, SD=1.6), elbow (2.2, SD=1.4) and ankle injuries (1.8, SD=1.9) ( $p < 0.001$ ). Depending on the tissue type, pain reductions ranged from 1.9 (SD=1.4,  $p = 0.01$ ) to 2.9 (SD=1.9,  $p < 0.001$ ). 89% of patients required only one or two treatments. Immediately after treatment, 38% reported mild improvement, 49% felt much improvement, and 13% were unchanged or slightly worse. Patient response in different tissues was no different. More males than females (93% compared to 82%,  $p < 0.05$ ) reported being much improved. 4 incidences each of Erythema (1.6%) and short term pain increase (1.6%) were reported.

**Discussion:** The results suggest that most patients obtain short-term pain reduction in most regions and tissue types with one or two treatment with focal ESWT.

**Conclusion:** There is good short term reduction in reported pain after treatment with focal ESWT. Male patients seemed to improve more female patients. Future research should examine the durability of these pain reductions to longer term.

Keynote Lecture 10

### Current Concepts Of Shockwave Therapy In Chronic Patellar Tendinopathy

Carlos Leal, Silvia Ramon, John Furia, Arnold Fernandez, Luis Romero, Leonor Hernandez-Sierra

Patellar tendinopathy (PT), a condition also described as jumper's knee, is a frequent injury associated to sporting activities that involve jumping or running, as well as sudden changes of direction [1]. It is a common cause of complaint and leave in soccer, basketball and volleyball [2,3]. The overall prevalence of PT has been reported as of 14.2% in the general population, being higher in athletes, with as much as 44.6% in elite volleyball players and 31.9% in basketball players [3]. There is an overall prevalence of 8.5%, being higher in volleyball players (14.4%) and lower in soccer players (2.5%) [13].

PT has been defined as an overuse injury caused by repetitive mechanical stress loads on the patellar tendon [4] that cause an initial inflammatory response followed by a stage of degeneration [5,6]. However, the etiology of the PT is uncertain. Slow and hypoxic tendon regeneration after an inflammatory reaction from a mechanical demand seems to be the most accepted histopathological etiology [5,6,23,24]. The macroscopic appearance of the tendon is a brownish tissue described as mucoid. Microscopically it is characterized by an abnormal collagen array, with little cellularity and vascularity. The scar tissue is usually degenerative and dysplasia, and there is an increase in the concentration of glycosaminoglycans [25,26].

The first stage of PT can be described as a reactive tendinopathy and early tendon disrepair phase, that leads in many cases to a second stage of tendon late disrepair and degeneration phase [27].

Histological studies have shown there are an absence of inflammatory cells, normal levels of prostaglandin and a lack of vascularity, so it cannot be defined as a tendinitis but as a chronic avascular tendinopathy, usually on the inferior pole of the patella [55]. Even though PT has been related to high demand physical activity, it has also been described in sedentary individuals. Some intrinsic factors that increase the risk of PT are overweight [14,15] hamstring muscle retractions, quadriceps stiffness [14e16], limb length discrepancy [18], limited motion of the ankle joint [20], or flat feet [14,19]. The most relevant extrinsic factor, and probably the major cause in the development of PT, is inappropriate training and exercise [2,15,17]. Jumping and landing techniques, acceleration and deceleration protocols and sports gesture training are crucial in preventing PT [21,22,46].

Chronic patellar tendinopathy diagnosis is mainly clinical, and can be classified according to the scale of the Victorian Institute of Sport Assessment (VISA) [7] or the Blazina modified scale [1,2,8e10]. Many treatment strategies have been described, from load control to surgical procedures, all focused on a combination of pain control, regeneration of the damaged tissue and progressive re-training of the extensor mechanism [11,12]. Many of the conservative treatments are widely used without a high evidence based consensus, but it is a common finding to have good results in over 70% of the patients [7,8,13e15]. Surgery is usually indicated as a result of a failure of conservative treatments, with good and excellent results in only 45e50% of these group of patients.

The use of mechano-transductional stimulation of chronic tendinopathies has been a growing field of research in the past two decades [54,55,67]. The extracorporeal application of focused shockwaves, or direct mechanical impacts in the form of pressure waves on chronic tendinopathies, has shown good or excellent results similar or better to surgery, with the advantage of being a non invasive procedure with minimal side effects. It is currently a well-accepted and common treatment for tennis elbow, chronic plantar fasciitis and patellar tendinopathies [41,44,54,67]. There are still controversies regarding treatment protocols, as many different approaches have been published with relatively similar results. The use of focused or radial devices, the levels of energy required, the frequency of impacts and the number of sessions required, are just some of the extremely variable parameters in the literature, still with good results and no major complications [41,43,54].

## Abstracts

Keynote Lecture 11

### Osteogenetic Effect Of Extracorporeal Shock Waves In Human

L. Gerdesmeyer, W. Schaden, L. Besch, M. Stukenberg, L. Doerner, H. Muehlhofer, A. Toepfer

The plantar heel pain is known as an insertional tendinopathy of the plantar fascia at the medial aspect of the calcaneus. Many predisposing factors are discussed, such as muscle contractures, obesity, overuse or anatomical malalignment. Most patients complain about a stabbing-like pain in the plantar, medial heel region radiating to the foot and occurring mainly load-dependent after prolonged standing, walking or running. Pain during first steps in the morning or after rest are significant clinical findings with characteristic tenderness at the medial tuberculum calcanei. In chronic cases rest pain and pain during the night can occur. Numerous therapeutic procedures have been reported. Conservative therapeutically options like different manual therapeutic concepts (especially stretching), orthotic fittings with special inserts and night splinting as well as cortisone injections are well described but efficacy according evidence based medicine is still lacking. Promising alternatives include local application of autologous growth factors (PRP) [1], local radiofrequency ablation [2], ultrasound therapy [3] or radiation therapy [4]. Extracorporeal shock wave therapy (ESWT) is recently the best proven therapy and indicated as a first line option with regards to evidence based medicine [5,6]. ESWT was found to improve blood perfusion and thus metabolism of the surrounding soft-tissue which is altered by chronic inflammation. In addition to a proven analgesic effect, research by Wang et al. showed that perfusion in the tendon area is significantly improved by low energy ESWT [7,8]. Furthermore it was recognized in the late 80s that shock waves have effects on bone metabolism. Haupt et al. observed in his kidney stone patients that the iliac crests thickened when they were located in the treatment area of the shockwave [9]. Later on shockwave were firstly used for bone pathologies [10e12]. Depending on the amount of acoustic energy shock wave can damage the bony structures. Even complete fractures were observed if energy level far beyond proven clinical treatment level is applied [13]. If shock wave therapy is used in a proper way consolidation of non-unions can be found even in patients with multiple revision surgeries. For this indication, hypertrophic non-unions have a much better prognosis than atrophic nonunions [14]. Several studies have confirmed this positive osteogenic effect [15,8] which is based on induction of neovascularization by increased angiogenic factors and bone marrow cells as well as bone progenitor cells [16,8]. Until now the osteogenetic effect on unaffected human bone is still unknown. This study analysis the effect of focused extracorporeal shock waves on human calcaneus.

Abstract 29

### Safety, Tolerability And Efficacy Of Extracorporeal Shockwave Therapy As A Novel Treatment For Intermittent Claudication: A Randomised Controlled Trial

Thomas Cayton, Amy Harwood, George Smith, Ian Chetter  
*Academic Vascular Dept., Hull Royal Infirmary, Hull, England*

**Device and producing company:** Piezowave 2 device supplied by Impact medical

**Introduction:** Peripheral arterial disease (PAD) has a population prevalence of 4.6% with Intermittent claudication (IC) presenting as one of the earliest and most common symptoms .PAD has detrimental effects on patients walking ability in terms of maximum walking distance (MWD) and pain free walking distance (PFWD). Research has suggested extracorporeal shockwave therapy (ESWT) may induce angiogenesis in treated tissue therefore our objective was to assess the safety, tolerability and efficacy of ESWT as a novel treatment of intermittent claudication.

**Method:** Thirty patients with unilateral claudication were randomised to receive either ESWT (Piezowave 2 Shockwave system) or sham treatment to the calf muscle bulk three times per week for three weeks. Treatment tolerability, ankle brachial index (ABI), MWD, PFWD and safety were all formally assessed as outcome measures at 4, 8 and 12 weeks follow up.

**Results:** ESWT was well tolerated by all those within the active treatment group with no safety issues or complications reported. All patients within the active treatment group improved in both MWD and PFWD. At all time points weeks there was a statistically significant improvement in the active treatment group when compared to the sham treatment group ( $P > 0.05$ ). No changes in ABI were observed.

**Discussion:** ESWT is safe and well tolerated when applied to the calf muscle bulk and demonstrated a dramatic improvement in walking distances, comparable to more established treatment options.

**Conclusion:** Whilst these results are encouraging, further research is required to help substantiate these findings with longer-term results assessed and a larger study size.

Abstract 30

### Infection In The Orthopaedic Patient, The Role Of Shockwave Treatment

Richard Coombs<sup>1</sup>, Milad Hanna<sup>2</sup>, Moustafa Hafez<sup>1</sup>  
*<sup>1</sup>Imperial College London;*  
*<sup>2</sup>Charing Cross Hospital, London; Great Britain*

**Device and producing company:** Storz SLXF2

**Introduction:** We have treated more than one thousand patients with a variety of orthopaedic problems over a period of twenty years including six patients with infection.

**Methods:** Shockwave treatment has been provided with up to fourteen sessions of treatment over a twelve month period for each of six patients with deep infection.

**Results:** All six patients have experienced resolution of their infection with no recurrence to date.

**Discussion:** Our experimental work and clinical experience have confirmed that shockwave treatment has the potential to kill bacteria.

**Conclusion:** Shockwave treatment is helpful for orthopaedic patients with deep infection for whom alternative treatment has proved ineffective.

## Abstracts

Abstract 31

### Uterine Fibroids And Shockwaves

Cesar Eisner

**Device and producing company:** Storz Medical SD1 Ultra

**Introduction:** Fibroids are benign uterine tumors that occur in almost 30% of women of reproductive age and often have menorrhagia and anemia when their location is intrauterine.

Applying focused shock waves of low intensity, for mechanotransduction, the growth factors produced vascularization and transdifferentiation (transition from differentiated tissue to a less differentiated), transforming their fibroblasts into myofibroblasts, which exhibit high contractility and low proliferation.

Transdifferentiation occurs when TGF $\beta$ 1 joins receptors and activates fibroblast genes that promote phenotypic conversion.

Describe a non-invasive therapeutic methodology for recovering the miomatosa menorrhagia and consequent anemia with shock waves, increasing both the elasticity of myomas as the myometrial trophism, in order to achieve adequate hemostasis during menstrual contractions.

**Methods:** The technique is based on applying shock waves placing the applicator on the umbilicus and performing simultaneous monitoring doppler transvaginal triplex, where the linear deflections of the waves can be seen passing through the window ecodoppler located on the site to be treated.

They should be considered criteria for inclusion and exclusion.

**Dose:** About the uterine body: 50 shockwaves 0.25 mJ / mm<sup>2</sup> per cc of uterine volume, and each fibroid: 100 shockwaves 0.35 mJ / mm<sup>2</sup> per cc of volume of each fibroid, applied in weekly sessions of no more than 5000 waves per session, at a frequency of 3 Hz.

**Results and Conclusion:** We proceeded to treat a woman of 42 years with an intramural fibroids, menorrhagia and anemia. After treatment was observed with doppler ultrasound fibroid central vascularization (nonexistent in untreated), normalization of menorrhea (5 cloths per day to 1) reduction of dysmenorrhea (for better myometrial irrigation) and hematocrit unchanged. Quantitative elastography revealed increased elasticity of myoma 137% (which went from blue to green in color scale) and increased myometrial trophyism 30% (for reperfusion). The histogram revealed that 76% of fibroid tissue was transformed.

(Transdifferentiation 36%, reperfusion 20%, and 20% had no change.) After 6 periods, normal changes remained and ultrasound showed partial disappearance of myoma.

Abstract 32

### Regenerating Peripheral Nerves - Shockwave Treatment As A Supportive Mean

David Hercher, Christina Schuh, Michaela Stainer, Rudolf Hopf, Antal Nogradi, **Rainer Mittermayr**  
*Ludwig Boltzmann Institut for Experimental and Clinical Traumatology, Vienna, Austria*  
*Austrian Cluster for Tissue Regeneration*

**Device and producing company:** Dermagold 100, MTS

**Introduction:** Peripheral nerve injuries are common and a frequent cause of hospitalization displaying a major burden to patients and social health-care systems. ESWT has been shown to be one of very few treatment option which accelerates peripheral nerve regeneration. Despite recent advances in understanding the underlying mechanisms of ESWT, little is known of the effects on Schwann cells (SCs) and peripheral nerve regeneration. In this study we investigated these two aspects.

**Methods: *in vitro*:** Schwann cells have been isolated from motor, sensory and mixed nerves, respectively. Dissected nerves have been treated with ESWT prior to isolation. Cultured SCs were evaluated using FACS analysis and western blot.

***in vivo*:** A femoral nerve defect model was established in the rat. The effects of ESWT on motor fibers regenerating through a sensory environment have been evaluated using automated gait analysis, electrophysiology, histology and qPCR.

**Results: *in vitro*** data indicate a strong influence of ESWT on the activation status of SCs of different phenotype. Motor SCs differ from sensory SCs regarding proliferation and expression of myelination associated proteins. ESWT is able to induce proliferation of motor and sensory SCs.

***In vivo*** data indicate inferior regeneration of motor axons through a sensory nerve graft compared to a phenotypically matched graft. ESWT can ameliorate this effect and accelerate nerve regeneration.

**Discussion:** This study indicates that ESWT is able to accelerate peripheral nerve regeneration in a model which reflects the clinical reality after autologous nerve transplantation. Thereby providing support for the use of ESWT after peripheral nerve injury.

**Setup: *in vitro*:** waterbath, whole nerve

***in vivo*:** 1x transcutaneously after wound closure

## Abstracts

Abstract 33

### ESWT In Experimental Traumatic Spinal Cord (SCI) Injury

Katja Posa, Mohamed Ashmwe, David Hercher, **Rainer Mittermayr**  
*Ludwig Boltzmann Institut for Experimental and Clinical Traumatology, Vienna, Austria*  
*Austrian Cluster for Tissue Regeneration*

**Device and producing company:** Dermagold 100, MTS

**Introduction:** Traumatic spinal cord injury (SCI) affects annually 250,000 to 500,000 people worldwide and significantly changes their daily living. More than 60% of individuals with SCI develop symptoms of spasticity and over 80% suffer from chronic neuropathic pain in the paralyzed body parts below the lesion. Altogether, these SCI induced impairments result in severe decline in the patient's quality of life.

Although enormous progress was achieved in understanding the pathophysiology of SCI in the past treatment options to cure or improve symptoms at least are still very limited.

The aim of the present study was to develop an experimental model of traumatic spinal cord injury and to investigate the influence of low-energy shockwave therapy at clinically relevant time points, i.e. sub-acute and chronic phases after SCI.

**Methods:** A traumatic rodent spinal cord injury model was established by using Sprague Dawley rats which were subjected initially to a laminectomy at the THX1 level. Thereafter, a contusion with a force of 150 kdynes was induced directly to the spinal cord using the Infinite Horizon Impactor (Precision Systems and Instrumentation, LLC, Lexington, KY, USA). Depending on the group allocation animals received 500 shockwaves at an energy flux density of 0.11mj/mm<sup>2</sup> at 5Hz once a week for 3 consecutive weeks whether 2 weeks after the traumatic impact (sub-acute model) or 5 weeks thereafter (chronic model) and were compared to control animals.

Analysis in the initial phase of the study included the open field walking test (BBB).

**Results:** A reliable and clinical relevant experimental model of traumatic spinal cord injury could be established. ESWT proofed to be well tolerated by the animals without clinical relevant impact on lung tissue. In the first analysis control animals were compared with animals in the chronic model receiving shockwaves after 5 weeks. The induced traumatic injury resulted in a low BBB score of approximately 4 in all animals having no ESWT at this time point. Until week 2 after injury a continuous improvement was observed but maintained at a level of approximately 12 with no significant differences between groups. After the first ESW treatment the BBB score in the chronic model improved becoming significantly different at week 17 after impact compared to controls in which the BBB score remained constant.

**Discussion:** This study gives first hints that ESWT is able to positively influence spinal cord recovery after traumatic infliction in this experimental spinal cord injury model as indicated in improved BBB scores in the chronic model.

Guest Keynote Lecture II

### Biologics And The Musculoskeletal System

**Lee Eng Hin**  
*NUS Tissue Engineering Program, National University of Singapore*

In recent years there has been a growing trend towards biological approaches to manage orthopaedic conditions ranging from sports injuries to degenerative and inflammatory joint disease. Biologics are medicinal products that are made by biologic processes instead of being chemically synthesized. Biologics in common use are blood and blood products (e.g. platelet rich plasma - PRP), vaccines, monoclonal antibodies, recombinant therapeutic proteins (e.g. BMP), tissue (e.g. bone graft substitutes), and cells (e.g. bone marrow and stem cells).

This talk will focus primarily on biologics such as Bone Marrow Aspiration Concentrate (BMAC), Platelet Rich Plasma (PRP) and Bone Morphogenetic Protein (BMP) and their use in the treatment of musculoskeletal problems. Point of care devices to concentrate bone marrow (BMAC) have been developed by various companies and marketed as an alternative to bone graft for the treatment of delayed and non-unions. Their effect is unlikely through stem cells as only 0.001% of the aspirate contains stem cells. Platelet-rich plasma (PRP) has been advocated as a rich source of active factors to promote bone and cartilage repair. The composition and quality of these preparations vary and their efficacy is still controversial. There is some evidence that PRP may be useful for cartilage repair in short term studies. BMP 2 and BMP 7 have been approved by FDA for clinical use for some years for lumbar interbody fusion and for bone healing respectively. Recently, BMP2 has come under scrutiny due to serious side effects in its off-label use especially in the cervical spine. The user has to be aware of the potential side effects of off-label use of BMP.

## Abstracts

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ISMST Lecture II

### The Impact Of Shockwave Medicine In The World's Health System. Actual Datas

**Richard Thiele**, Sergej Thiele  
*IZS, Internationales Zentrum für Stoßwellentherapie, Berlin, Germany*

**Device and producing company:** All available

**Introduction:** ESWT is used successfully all over the world. Starting with the mechanical effect of SW in the urology , now the ESWT is a treating method in Orthopaedy, Traumatology, Plastic Surgery , Hearthsurgery and Dermatology.

**Methods:** This survey summarize the status quo of the non urological ESWT on behalf of acceptance by goverments, insurances, physicians. Where has the ESWT an approval for what indication? What kind of reimbursement exists in the different countries ! etc

**Results:** The answers of 19 different national societies or leading users of known national ESWT-centers where brought together from Europe, Asia and America etc.

**Discussion:** What can the international society of ESWT users do , to get a complete acceptance , approval and adaequate reimbursement for this successful treatment method? etc

**Conclusion:** The difference in the world is big , but generally we have reached already a lot and when we can use the knowledge inter-nationally we will get a complete worldwide acceptance of ESWT.