Learning Curves in Extracorporeal Shockwave Therapy (ESWT) – A German Perspective

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Device and producing company: Storz Ultra

Introduction: A well-designed learning curve (LC) is essential to measure the acquisition and improvement of medical abilities.

Material and Method: To evaluate the current educational options for the German ESWT society DIGEST who started in May 2, 2014 with a 60 hours post graduate ESWT course for physicians only. It consists of 6 modules (each 10 hours) dealing with multiple choice assessments after each module & quality control implemented:

• Introduction to ESWT
• ESWT for upper extremity tendinopathies
• ESWT for lower extremity tendinopathies
• ESWT for bones & cartilage
• ESWT for wounds & aesthetic indications
• ESWT in myofascial pain

Results: As of Dec 2018 27 full-day ESWT courses in 4,5 yrs have been run in Germany and Austria with a total number of 1104 participants as physicians. The course evaluation revealed good to very good (average score 1.4 (1.3-2.0, 1=best, 6=worst) results in terms of deepening of the ESWT knowledge.

Discussion: National-wise, a number of different educational programs have been developed, implemented and are working focusing on either physicians as e.g. in Germany & Austria or to non-physicians internationally like on the ISMST certification courses (ICC). A holistic shockwave expert so to say is not an expert due to only performing a high number of radial and/or focused shockwave sessions on a distinct indication, but is also scientifically active, engaged in the national/international ESWT societies as well as involved in and actively performing ESWT teaching programs.

Conclusion: Extracorporeal shockwave therapy (ESWT) has a substantial learning curve, where structured education is key to improve clinical results.
Variable Sound-Fields of Electro-Hydraulic Extracorporeal Shockwave Applicators
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Device and producing company: n.a.

Introduction: Electro-Hydraulic Extracorporeal Shockwave generation results in shot-varying non-linear sound-fields which are not yet properly characterized.

Material and Method: We have utilized a non-linear wave-propagation simulation in conjunction with experimental spark-gap measurements to predict statistical variations of generated sound-fields. These results are in turn validated with experimental point-wise field measurements in reference water baths as well as in-situ applications.

Results: Experimental verification of simulation results for reproducible fields (i.e. electro-magnetic and piezo) show good agreement and a significant advantage of non-linear simulation techniques over linear approximations for higher pressure waves. Electro-Hydraulic based generation is shown to result in a probabilistic field distribution based on experimental spark-location distributions.

Discussion: We present clear evidence of the non-stationary nature of Electro-Hydraulic generated sound-fields based on computational models alongside supporting experimental measurements. The indeterminate location of the collapsing, spark-gap induced plasma bubble, creates in an inter-shot variable sound field. This results in varying energies and peak pressures being applied throughout the treatment area. In combination with anatomic models the resulting in-silico treatment options can be numerically modeled and differences in applicator technologies estimated.

Conclusion: We introduce a novel approach to fully model the sound-fields of Electro-Hydraulic applicators. This approach can be applied in estimating and comparing of treatment modalities.
In an era of evidence-based medicine (EBM), ESWT has achieved high-level scientific evidence (meta-analysis of randomised placebo controlled blinded trials) for just a handful of musculoskeletal indications, including plantar fasciitis, lateral epicondylitis and calcific shoulder tendinosis, even finding its way into various standardised treatment guidelines for such conditions. For many other musculoskeletal conditions which are less studied, the application of ESWT currently ranges from being labelled “promising” to “experimental” or “unproven”.

Yet, for decades, ESWT has been embraced and applied in sports medicine as a solution or part-solution for a range of musculoskeletal conditions in athletes which could fall into the “unproven” or experimental” category by EBM’s rules.

This dichotomy is partly reflective of the limitations of clinical evidence in the “real” world of clinical practice and clinical decision making. The case against an over-reliance on clinical evidence when contemplating ESWT applications in athlete populations, may be argued along the following lines:

1. EBM purports to use clinical research to drive clinical guidelines, which are meant to drive clinical practice. However, even in certain extensively researched areas of medicine, data from high quality RCT’s may be absent, incomplete, or contradictory. Results, whether positive or negative to the null hypothesis, may not be generalizable beyond the descriptors of a study’s inclusion criteria. A meta-analysis selects studies based on common criteria, but may exclude peripheral data while strengthening an average result for an average clinical scenario. For an elite athlete whose circumstance is anything but “average”, such a result may have little or no relevance.

2. EBM’s model for clinical evidence is based on a pharmaceutical paradigm. However, ESWT interventions are by nature far more complex than comparing a drug against a placebo. ESWT treatments involve numerous variables, some easily measurable, some not. Where clinical research demands standardisation or population and protocol to produce a valid research outcome, there can be treatment nuances specific to an athlete and his circumstance, which, based on the treating clinician’s judgement, experience and expertise, can deeply impact a final result. It would be far too complex to design studies, much less RCT’s for ESWT that can take into account each variance and nuance.

3. Inherent in EBM’s paradigm is the need for statistical power, i.e. sufficiently large numbers to drive a result. However, athlete pools, and in particular, elite athlete pools, are typically small. Most published sports medicine studies involving high level athletes typically involve small numbers, many without a control group.

Clinical practice is problem-orientated and patient centric. It involves clinical decision making, for which it is widely recognised that information from clinical research alone is often insufficient.

“Clinical reasoning”, as described by various authors, integrates mechanistic reasoning, clinical experience, patient and professional values, and available evidence (from high to low level evidence). Mechanistic reasoning in ESWT requires an understanding of the patho-physiology of the injury, and the basic science behind ESWT. Clinical experience is gained only with first-hand treatment of patients and first-hand observation of outcomes, which can inform, and provide nuance to the management of the next similar patient. Values and priorities of an athlete may differ largely from those of non-athletes, and influence a decision to favour ESWT over cortisone or surgery.

Clinical reasoning centres around the individual and his particular clinical scenario, while EBM (with its research driven engine) values average data, devaluing the individuality of the patient, which may be considered anathema in the treatment of elite athletes.
Radial Extracorporeal Shock Wave Therapy (Reswt) with the MP1 in Insertional Tendinopathy of Rotator Cuff Arthropathy – A Prospective Randomized Controlled Trial

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Device and producing company: MP1 (Storz medical, Tägerwilen, Swiss)

Material and Method: A total of 32 patients randomly received assigned treatment. All patients were suffering from insertional tendinopathy of rotator cuff arthropathy. Mean clinical relevant pain duration was 3.4 month. The MP1 (Storz medical, Tägerwilen, Swiss) was used in all cases to apply rESWT. The active group received 3 shock wave treatments performed with 2000 impulses each. Working pressure 2.5 bar. Treatment area was identified as the most painful insertion area of the RC. All patients received additional standard physiotherapy. The control group received sham rESWT plus physiotherapy in the same manner.

Primary Criteria: Constant and Murley Score (CMS) 12 weeks after last intervention. Second criteria was defined as overall pain score (VAS) at daily activities. Success rate was defined as at least 60% pain reduction compared to baseline.

Results: Primary outcome measure: Compared to control group there was a significant better improvement of shoulder function on the CMS in the active group (mean change [SD], 12.9 pts [11.0], p<0.01). Secondary criteria showed significantly better outcome after rESWT + Physiotherapy compared to physiotherapy alone (P < 0.025 one-sided, MW = 0.36) compared to control. Non difference was found regarding biometric data set.

Only minor side effects as small petechial bleeding and skin reddening directly after intervention. They disappeared without relevant effects, moderate discomfort was found during treatment.

Conclusion: rESWT is a very effective and safe in treatment in insertional tendinopathy of the rotator cuff arthropathy. The effect size reaches clinical relevance. No significant side effects were found. The effect of physiotherapy can be improved by radial ESWT.
Frequence Matters In Facial Radial ESWT – Refinements for Aesthetic Anti-Aging Shockwave Therapy

Karsten Knobloch

Institution: SportPraxis Prof. Dr. Karsten Knobloch, Hanover; Germany
Device and producing company: Storz Ultra, radial shockwave applicators C15 and Di15

Introduction: To assess whether frequency (5-21Hz) of radial extracorporeal shockwave therapy (ESWT) plays a role in facial anti-aging shockwave therapy.

Material and Method: 12 females were assessed regarding the pain during radial ESWT on the procerus muscle, which is in TCM Yintang Ex2 acupuncture point. Radial ESWT was used with different pressures (0,3/0,5/0,7/0,9/1,1/1,3/1,5bar) starting with 5Hz with assessment of pain during radial ESWT on the Yingtang Ex2 location on a visual analogue scale from 0=no pain to 10=maximum pain. Frequence was increased from 5Hz to 7/9/11/13/15/17/19/21Hz.

Results: Using a F15 applicator, pain mean pain levels at 5Hz (0,3-1,5bar) where 3 out of 10 on VAS, with a reduction by 19% at 7Hz, by 29% at 9Hz&11Hz, by 24% at 13Hz&15Hz, by 19% at 17Hz and 3 out of 10 at 19 an 21Hz.

Using a Di15 applicator, pain mean pain levels at 5Hz (0,3-1,5bar) where 5 out of 10 on VAS, with a reduction by 17% at 7Hz, by 26% at 9Hz&11Hz, by 37% at 13Hz, by 29% at 15Hz, by 12% at 17Hz and increment of 20% at 19Hz and 48% at 21Hz.

Discussion: Frequence of radial ESWT in facial antiaging therapy matters. Comparing a frequence spectrum from 5Hz to 21Hz, I found that depending on the applicator used, the least pain during radial ESWT on the Ex2 acupuncture point on the procerus muscle of the face was achieved at 9-11Hz with a F15 and at 13Hz with a Di15 applicator. Higher frequencies than 17Hz increased the pain as well as lower frequencies like 5Hz.

Conclusion: Frequence matters in radial ESWT for antiaging medicine. Least pain can be achieved depending on the applicator used with 9-13Hz, while both lower than 7Hz & higher than 17Hz significantly increased treatment pain.
Synergistic Effects of Extracorporeal Shockwave Therapy (ESWT) and Autologous Adipose-Derived Mesenchymal Stem Cells are better than Human Umbilical Cord Wharton’s Jelly-Derived Mesenchymal Stem Cells in Osteoarthritis Knee
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Device and producing company: the DUOLITH® SD1 »ultra« (Storz Medical, Switzerland)

Introduction: Extracorporeal shockwave therapy (ESWT) and mesenchymal stem cells show chondroprotective effect in osteoarthritic (OA) knee.

Material and Method: The pleiotropic characteristics of stem cells are not clear. This study compared adipose-derived stem cells (ADMSCs) and umbilical cord Wharton’s jelly-derived stem cells (hWJMSCs) on ESWT efficacy in OA knee. The design for ESWT application and stem cell injection are shown in Figure 1. Evaluation included ORSI score, histomorphology, micro-CT and immunohistochemical analysis.

Results: Significant improvements were noticed after treatment with single devices. In a combined therapies significantly improved the cartilage repair. The ADMSCs and ESWT+ADMSCs significantly increased the trabecular thickness and bone volume more than ESWT, WJMSCs and ESWT+WJMSCs individually. The TUNEL activity and caspase-3 significantly reduced in ADMSCs and ESWT+ADMSCs groups more than WJMSCs, and ESWT+WJMSCs groups.

Discussion: Mesenchymal stem cells contain cells with pleiotropic potentials that may differentiate into organ systems. Mesenchymal stem cells further promote tissue regeneration. Many biological mechanisms leading to biological repair are under investigation. ESWT was recently noticed to induce the ingrowth of neovascularization leading to tissue repair in clinical implication. Studies had shown that combination of ESWT and stem cells may have synergistic effect. The innovative strategy with combination use of ESWT and ADMSC mesenchymal stem cells may pose a clinical strategy for the treatment of early osteoarthritis of the knee.

Conclusion: ESWT and mesenchymal stem cells are effective for osteoarthritic knee in rats. Combined ESWT and ADMSCs show synergistic effect more than ESWT+WJMSCs in OA knees.
Low Back Pain and ESWT - is There Enough Evidence for This Novel Indication?

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Device and producing company: Storz Duolith

Introduction: Lower back structures are common sources of chronic pain with high prevalence exceeding 60 percent in adult population. Aetiology of non-specific low back pain is multifactorial and lot of structures may play their role in pain generation - overloaded muscles and ligaments, intervertebral discs, joint structures such as facet or sacroiliac joints. Chronic lower back pain is also a frequent cause of disability in adult population, offten leading to drug overuse (NSAIDs, opioids etc.), associated with increased morbidity and mortality outoming from AE and interactions. Therapeutic options are very wide and include exercise and physical therapy, pain interventions and surgery. There is a growing number of studies and RCTs in ESWT and low back pain to be discussed in the presentation.

Material and Method: Authors present the results of recent clinical trials in human and animal model and demonstrate their long term experience in treatment of lower back pain.

Results: ESWT was found to be a safe and effective treatment alternative and its efficacy was confirmed by different studies in myofascial pain, facet and sacroiliac joints and coccydynia.

Discussion: Different treatment protocols were presented in literature, showing superior efficacy of focused therapy over the radial treatment.

Conclusion: ESWT, compared to other treatment options, has shown significant efficacy, negligible risk of damage to spine structures and almost no adverse effects.
ISMST Abstract History Revisited – An Analysis from 2006 To 2018

Karsten Knobloch

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Device and producing company: Storz Ultra, Tägerwilen, Switzerland

Introduction: The annual scientific ISMST meetings provide a stage for new shockwave ideas as well as for the latest experimental and clinical evidence often times well before full paper publication.

Material and Method: Purpose: To evaluate the past 12yrs of ISMST meeting history regarding participation continent-wise, oral & poster presentations (where available) and the topic of the ESWT application provided.

All 208 abstracts from the 2006 Rio de Janiero ISMST meeting (n=43), the 2011 Kiel meeting (n=57), the 2013 Vienna meeting (n=51) and the recent 2018 Auckland meeting (n=57) were studied in detail regarding the authors, the tissues treated by ESWT and the presentation mode (oral or poster).

Results: While especially in 2006 tendons and bone ESWT presentations were dominant (71% of all presentations) at the following ISMST conferences additional indications like ESWT on muscles & fascia, skin and in neurology indications get traction (from 7% in 2006 to 27% in 2018).

• In Rio 2006 43 active presentations were from: Europe 44%, LatinAmerica 42%, North America 5%, Asia 9%
• In Kiel 2011 57 active presentations were from: Europe 72%, LatinAmerica 9%, North America 7%, Asia 12%
• In Vienna 2013 51 active presentations were from: Europe 57%, LatinAmerica 22%, North America 2%, Asia 21%
• In Auckland 2018 47 active presentations were from: Europe 57%, LatinAmerica 22%, North America 2%, Asia 21%

Discussion: The past 12 years of ISMST conferences highlight a shift from tendon & bone ESWT indications to myofascial, skin and neurological ESWT indications. Stem cell action of ESWT has been highlighted already in 2006 in a number of presentations well before full paper publications.

Active participation of Asia is essentially strengthened in the recent years @ISMST annual conferences (from 9% to 64%).

Conclusion: Therefore the ISMST annual conference abstracts provide an early and immediate image of current shockwave science world-wide with cutting-edge developments in shockwave medicine today.
Effects of Low Intensity Extracorporeal Shockwave Therapy (LESWT) on Inflammatory Mediators and Central Sensitization on Capsaicin Induced Nonbacterial Prostatitis Model in Rats
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Introduction: Central sensitization might lead to persist pain. We hypothesize that LESWT might attenuate the NGF and related inflammasone expression in both prostate and spinal cord level.

Material and Method: Adult male S.D. rats were injected with vehicle or capsaicin (10 mM, 0.1 cc) into the prostate. Right after injection, various shock wave (0, 100, 200 or 300 shocks; 0.12 mJ/mm²) were applied into prostate. Three days after LESWT, the L6, S1 spinal cord and dorsal root ganglion at L6 spinal were removed for histology and NGF, BDNF, TRPV1 and COX-2 expression expression by using IHC staining and western blot.

Results: Capsaicin injection into prostate induced significant increase of Cox-2, NGF and BDNF-positive cells in the L6 DRG compared with vehicle injection. This was dose dependently ameliorated by LESWT especially in 200 shock wave group. In western blot analysis, LESWT could also downregulate expression of NGF, BDNF, TRPV1 and COX-2 expression. LESW decreased the signal intensity in Thalamus and periaquaduct in functional MRI.

Discussion: Intraprostatic capsaicin injection activates COX2, NGF and related inflammasone expression in the L6 level dorsal root ganglion. LESWT at prostate could also inhibit the capsaicin induced COX-2 and modulate neurotrophin expression at central nervous systems in a dose dependent fashion.

Conclusion: This finding suggests a potential clinical benefit of LESWT at the optimal dose for ameliorate chronic pain and its associated central sensitization.
Treatment of Carpal Scaphoid Non-Union Using Shock Wave Therapy: A Thirty-Year Experience
Carla Di Luise, Sergio Russo, Valeria Servodidio, Mariantonia Albano

Institution: University of Naples Federico II, Naples; Italy
Device and producing company: Duolith from Storz A.G.).

Introduction: The authors show their thirty-year experiences in the treatment of carpal scaphoid non-union. Since 1992, over 700 patients were treated using different devices and protocols. In this report, the new protocols developed following the evolution of sw equipment are shown and discussed. Delayed consolidation or even non-union are frequent. Surgical treatment has exact indications; Conservative treatment using immobilization evolves to pseudo arthrosis in 10% of cases.

Material and Method: 111 patients were treated with an electromagnetic generator equipped with an ultrasound imaging system (Duolith from Storz A.G.). Protocol was: 4 sessions at 72 h intervals. A variable number of shots and energy, depending on the patient’s degree of pain tolerance, with a maximum of 2000 impulses and a minimum of 0.05 mJ, were delivered for each session. These being two inversely proportional values in reaching the therapeutically effective threshold value. The arm immobilized until the first radiographic and clinical control, after 2 months.

Results: The first statistical data show a better result in patients treated with total energy media around 40J. Lower energies require a second treatment more frequently because often at X-ray at 2 months have absent or partial consolidation. Instead, treatments carried out at higher energies, often give a delayed consolidation.

Discussion: This study leads us to conclude that total energy is an important parameter for therapeutic and prognostic purposes. Furthermore, in patients who do not support adequate energy, It is necessary a local anaesthesia or increase the number of pulses delivered until reaching an average of 40J of total energy for each session.

Conclusion: In conclusion, Shock Wave Therapy can represent a valid tool for the treatment of delayed consolidation or even non-union and the results depend on the total energy and not on the number of treatment sessions.
Extracorporeal Shock Wave Therapy in the Treatment of Primary Bone Marrow Edema Syndrome of the Knee: A Prospective Randomised Controlled Study

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Introduction: The aim of this prospective study was to evaluate the effectiveness of extracorporeal shock wave therapy (ESWT) in normalizing the symptoms and imaging features of primary bone marrow edema syndrome (BMES) of the knee.

Material and Method: This study compared the outcomes of ESWT (Group A) (n = 20) and intravenously applied prostacyclin and bisphosphonate (Group B) (n = 20) in the treatment of BMES of the knee in our department between 2011 and 2013. The Visual Analog Scale for pain (VAS, 100 mm), the Western Ontario and McMaster University Osteoarthritis Index (WOMAC), the SF-36 scores and MRI scans as well as plain radiographs were obtained before and after therapy between two groups.

Results: Compared with Group B, we found greater improvement in VAS, the WOMAC Osteoarthritis Index and SF-36 score at 1, 3 and 6 months post-treatment in Group A (P < 0.05). Furthermore, MRI scans showed a higher incidence of distinct reduction and complete regression of bone marrow edema at 6 months in Group A (95 vs. 65 %; P = 0.018). The MRI at 1 year follow-up showed complete regression in all patients in Group A. However, two cases in Group B continued to normalize over the subsequent follow-up period.

Conclusion: ESWT can produce rapid pain relief and functional improvement. It may be an effective, reliable, and non-invasive technique for rapid treatment of BMES of the knee.
Efficacy and Safety of Extracorporeal Shock Wave Therapy for Orthopedic Conditions: A Systematic Review on Studies Listed In the Pedro Database

Christoph Schmitz, Isabelle Schur

Institution: Institute of Anatomy, Faculty of Medicine, LMU Munich; Germany
Device and producing company: n.a. (literature survey)

Introduction: We present an update of our systematic review on studies listed in the PEDro database focusing on efficacy and safety of ESWT for orthopedic conditions published in 2015.

Material and Method: An evidence-based systematic review of literature was performed according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to examine efficacy and safety of ESWT for orthopedic conditions. To this end, the PEDro database (www.pedro.org.au) was searched from its date of inception to September 30, 2018 to find potentially relevant publications.

Results: ESWT is effective and safe. An optimum treatment protocol for ESWT appears to be three treatment sessions at 1-week intervals, with 2000 impulses per session and the highest energy flux density the patient can tolerate. For major indications (including plantar fasciopathy and Achilles tendinopathy) there is no scientific evidence in favour of either radial ESWT or focused ESWT with respect to treatment outcome.

Discussion: The distinction between radial ESWT as ‘low-energy radial pressure waves’ and focused ESWT as ‘high-energy focused shock waves’ is not correct and should be abandoned. Future randomized controlled trials should primarily address systematic tests of the aforementioned optimum treatment protocol and direct comparisons between radial and focused ESWT.

Conclusion: ESWT has been proven as effective and safe noninvasive treatment option for tendon and other pathologies of the musculoskeletal system in a multitude of high-quality RCTs. For plantar fasciopathy, noncalcific tendinopathy of the supraspinatus tendon and calcifying tendonitis of the shoulder RCTs on ESWT are the predominant type of RCT in PEDro and obtained the highest PEDro scores among all investigated treatment modalities for these conditions. ESWT should be considered by doctors, therapists, patients and payers when discussing treatment options for certain musculoskeletal pathologies.
Deep Calcification of the Hip, As Large As 1/3 of the Hip Head, Reabsorbed With Radial Shock Waves
Massimo Filippo Trimarchi

**Institution:** Tricenter, Messina; Italy  
**Device and producing company:** Swiss DolorClast Master EMS  

**Introduction:** In the scientific literature (pubmed) cases treated with shock waves are not documented. This case describes a large calcification with a volume equal to almost 1/3 of that of the head of the femur.  

**Material and Method:** 5 sessions of Diathermy were carried out to decontract all the muscles of the Rachide, Basin and lower limb, on a daily basis in the first 4. The Shock Waves were about 1 per week, with the Evo Blue handpiece (4 sessions) and the Power (5 sessions) with 3000 applicator pulses of 15mm on calcification and 2000 applicator pulses 36mm in the neighboring area, with a short break every 500 pulses, then recovery of muscle tone with hydrokinesis.  

**Results:** RX 20 September 2016, MRI 11 November 2016, starts rehabilitation 8 November 2016 with VAS 9 (Visual Analogue Scale), marked functional impotence of the limb, significant reduction of the articular ROM, walking was allowed only with crutches. After rehabilitation treatment, VAS 0, crutches removed, complete recovery of the articular ROM. RX control on March 30, 2017 which shows after 4 and a half months from the start of rehabilitation the complete reabsorption of calcification.  

**Discussion:** It is customary to recommend and use as the only method the Focal Shockwave for deep targets. This case, documented with MRI and RX, shows how a large calcification of the hip on a 56-year-old woman, located in the retro-over-trochanteric site (between the upper apex of the trochanter and the head of the femur), can be completely reabsorbed, using a Radial Shockwave Swiss Dolorclast method with Evo Blue handpiece and the Power. Their maximum energy density for each pulse at a maximum pressure of 4 bar is 0.18mJ/mm2 and 0.40 mJ/mm2. The frequency of use was between 10 and 15 Hz while the power was 2.5 bar in the first sessions to then reach 4 bar.  

**Conclusion:** This case shows how a valid approach is also the Shockwave for deep calcifications of the hip and that one should not exclude a priori the Radial one.
Treatment of High-Energy Extracorporeal Shock Wave to Improve Functional Outcome of Rotator Cuff with Shoulder Stiffness

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Device and producing company: Orthospec

Introduction: Rotator cuff lesions with shoulder stiffness in a challenging issue. We aimed to investigate the effectiveness and safety of a single treatment of high-energy extracorporeal shock wave therapy (ESWT) in the treatment of rotator cuff lesions with shoulder stiffness.

Material and Method: Forty-one patients were enrolled for the study. The criterion for shoulder stiffness was ≥50% loss of passive range of motion (ROM). Patients were randomly divided to receive either shockwave or sham treatment (control group) based on statistical randomization. In the shockwave group, we used OrthospecTM Extracorporeal Shock Wave Therapy 3000 impulse 24kV (0.32mJ/mm²) focused at two points. The sham treatment entailed use of the device in which the generator was disconnected. The treated areas were inspected for local swelling, ecchymosis, or hematoma. VAS and Constant score were used for measurement.

Results: These were no difference in the demographic data between the two groups. Three patients underwent surgery 1 week, 4 weeks and 3 months after study respectively, due to severe symptoms. The ESWT group had significantly better VAS, ROM, muscle power, and Constant score when compared with control group, at 6 months and 12 months after treatment.

Discussion: There is no generalized consensus about the management of rotator cuff lesions with shoulder stiffness. Our data showed that a single treatment of high-energy ESWT might improve the long-term functional outcome of rotator cuff lesions with shoulder stiffness. Although ROM and symptoms improved in both groups, the ESWT group had better improvement than the control group 6 months and 12 months after treatment. This phenomenon may be attributable to the mechano transduction effects of ESWT and the slow resolving nature of shoulder stiffness.

Conclusion: ESWT may be a good adjuvant for rotator cuff lesions with shoulder stiffness.
Corrosion Resistance of Zn-Al-Mg Alloys with Hypoeutectic Microstructure

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Institution: Shougang Group Co., Ltd, Research Institute of Technology; China

Material and Method: Four model Zn-Al-Mg alloys were selected in this study included Zn-1%Al-1%Mg, Zn-1%Al-2%Mg, Zn-2%Al-1%Mg and Zn-2%Al-2%Mg. Model alloys were made by a high frequency induction melting furnace (Lifumat 3.3 VAC) in a graphite crucible under argon atmosphere. Purity of Zn and Al was 99.995% and 99.9%, respectively. A master Zn-Mg alloy with about 11.3% by mass Mg was utilized. After been introduced into the crucible, raw materials were slowly heated up to molten state and kept at the temperature for 60 min to dissolve and homogenize. Then, the melt was poured into a water-cooled copper mould. The water-cooled cylindrical mould was 40 mm in inner diameter and 5 mm in inner height. After cooled to room temperature, cast was taken away and cut to samples with 1 mm thickness.

Chemical composition of sample was determined by X-ray fluorescence, as shown in Table 2. Microstructure of the alloys was studied by an scanning electron microscopy (SEM) equipped with an energy dispersive spectrometer (EDS). The accelerated voltage is 15 kV. X-ray diffraction patterns of samples were analyzed using a Bruker D8 diffractometer. Co Kα radiation was used as X-ray source. A step length of 0.03° was used to scan the whole 2-theta range from 20° to 105°.

A PARSTAT 2273 electrochemical test equipment was utilized to measure electrochemical properties of the alloys immersed in 3.5% NaCl aqueous solution at room temperature. A platinum foil with dimension of 30 mm x 30 mm served as counter electrode. The alloys sample was used as working electrode with exposed area of about 1 cm². A Ag/AgCl electrode saturated with KCl aqueous solution served as the referenced electrode. Before potentiodynamic polarization test, open circuit potential(OCP) test were measured in the standard electrochemical cell at room temperature for about 600 s to reach stable potential. The electrochemical potentiodynamic polarization experiments were performed in the range from -1.3 to -0.8 V vs Ag/AgCl, with a scanning rate of 1mV/s.

Conclusion: In this study, corrosion resistance Zn-Al-Mg alloys with hypoeutectic structure were analyzed through electrochemical test. It could be found that microstructure of the Zn-Al-Mg alloys contains bulk Zn-rich primary solidification structure and some lamellar eutectic structures. For the four Zn-Al-Mg alloys, no Mg2Zn11 but only MgZn2 intermetallic compounds could be found. It could be found that more Mg-Zn compounds are contained in the alloys with about 2% Mg than other two alloys, which is due to more Mg contents in the two Zn-Al-Mg alloys. Polarization analysis reveals that along with increasing alloying elements content, the polarization resistances (Rp) increase and the corrosion current density (Icorr) declines. Moreover, it could be found that increasing alloying elements content could raise charge transfer resistance of the Zn-Al-Mg alloys during. Furthermore, it is proposed that finer microstructure could also improved the corrosion resistance as well as adding alloying elements.
Comparison of Bone Tunnel and Cortical Surface Tendon-to-Bone Healing in a Rabbit Biceps Tenodesis Model: Biomechanical and Histological Analysis

Hongbo Tan, Amir H. Lebaschi, Dean Wang, Ian D. Hutchinson, Ying Liang, Xiang-Hua Deng, Scott A. Rodeo, Russell F. Warren

Institution:
Device and producing company:

Introduction: Attachment of a single tendon to bone constitutes the main element of many orthopaedic surgeries, including proximal biceps tenodesis and distal biceps repair. Little is known about whether tendon-to-bone healing is better facilitated by fixation of a tendon within a bone tunnel or onto the cortical surface.

Purpose: To compare tendon-to-bone healing within a bone tunnel (BT) to that after cortical surface attachment (SA) in a rabbit biceps tenodesis model.

Study Design: Controlled laboratory study

Material and Method: Thirty-two rabbits (17 per group) underwent unilateral suprapectoral proximal biceps tenodesis by tendon fixation within a bone tunnel or onto the cortical surface. Postoperatively, rabbits were allowed free-cage activity without immobilization. All rabbits were euthanized eight weeks after surgery. Tendon-bone healing was assessed by bone densitometry, biomechanical testing, and histology.

Results: At eight weeks, no failures were found at the tenodesis site. Bone mineral density was slightly lower in the SA group than the BT group (p = 0.049), and bone volume fraction was not significantly different between groups. There were no significant differences in mean ultimate failure strength (54.76 ±28.11 N for BT; 58.40 ± 16.20 N for SA) and stiffness (16.05 ± 7.49 N/mm for BT; 18.07 ± 4.36 N/mm for SA) between groups. During load-to-failure testing, pullout at the tendon-bone attachment site occurred in eight BT specimens (72.7%) compared to two SA specimens (18.2%) (p = 0.032). In both groups, surrounding fibrovascular scar tissue with areas of direct tendon-bone inter-digitation and early fibrocartilaginous bridging was observed at the interface with no significant qualitative histological differences between groups. However, select areas of hypertrophic chondrocytes between calcified callus and tendon were observed in several SA specimens.

Conclusion: Tendon-to-bone healing within a bone tunnel and on a cortical surface results in similar biomechanical and histologic characteristics.

Clinical Relevance: Fixation of a tendon within a bone tunnel does not enhance tendon-to-bone healing compared to that on a cortical surface. This avoids the need to create a large bone tunnel, which can serve as a stress riser and increase the risk of fracture.

Key Terms: biceps; tenodesis; tendon; healing
One Session of Extracorporeal Shockwave Therapy-Induced Modulation on Tendon Shear Modulus is Associated With Reduction in Pain

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Device and producing company: Storz Minilith SL1 lithotrypter machine (Storz Medical, Switzerland)

Introduction: The aim of the study was to examine the immediate effect of 1 session of extracorporeal shockwave therapy (ESWT) on patellar tendon stiffness and to explore the relationship between the change in tendon stiffness and the pain intensity.

Material and Method: Thirty-four male athletes aged 22.2±3.8 with patellar tendinopathy were recruited. The participants were randomized into ESWT and sham groups. The ESWT group received 1500 impulses of ESWT at 4 Hz with maximal tolerable pain intensity and the other group received sham (<0.08mJ/mm²) intensities. Supersonic Shearwave Imaging (SSI) was used to measure tendon shear modulus (an index of tissue stiffness), and a visual analogue scale was used to quantify the pain intensity during compression with 10 lb pressure directed on the most tender part and then during a single-leg decline squat test. The most painful site (the same as the pain-pressure measurement site) on the patellar tendon was palpated and marked. Focused ESWT was delivered by a Storz Minilith SL1 lithotrypter machine (Storz Medical, Switzerland) at the marked site at each participant's maximal tolerable pain intensity. In the treatment group, 1500 impulses at maximum tolerable pain were delivered at 4 Hz.

Results: A significant reduction in tendon shear modulus (from 57.4±25.5 kPa to 40.6±17.6kPa, $p=0.001$) was detected in the ESWT receiving ESWT with an intensity from 0.13 - 0.33mJ/mm² but not the sham group (from 47.7±17.1 kPa to 41.0± 12.7 kPa; $p=0.06$). In the ESWT group, the change in tendon shear modulus was associated with the change in the intensity of squatting pain ($p=0.55; p=0.023$) but not pressure pain ($p>0.05$).

Conclusion: These findings suggest that one session of ESWT induces reduction of tendon stiffness in volleyball and basketball players with patellar tendinopathy. The reduction in tendon stiffness is associated with reduction in pain during single-declined squat test.

Keywords: tendon shear modulus, extracorporeal shockwave therapy, patellar tendinopathy, single-leg decline squat test
Long-term Functional Change of Cryoinjury Induced Detrusor Underactivity and Effects of Extracorporeal Shock Wave Therapy in a Rat Model

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Device and producing company: shock wave probe (Storz, Germany)

Introduction: To investigate the long term functional change of cryoinjury induced detrusor underactivity (DU) and the therapeutic potential of repeated low energy shock wave therapy (LESW).

Material and Method: Fifty six female Sprague-Dawley rats were assigned into sham and cryoinjury of bladder with or without LESH (0.05 or 0.12 mJ/mm²; 200 pulses; twice a week for 2 weeks after cryoinjury). Under halothane anesthesia, an incision was made in lower abdomen, and cryoinjury was provoked by bilateral placement of a chilled aluminum rod on the bladder filled with 1 ml saline. Measurement of contractile responses to KCl and carbachol in vitro, conscious voiding, and histological and protein changes were performed on week 1, 2, and 4 after cryoinjury.

Results: Cryoinjury of bladder induced a significant decrease in the detrusor contraction amplitude at week 1 (55.0%) and week 2 (57.2%), but the decrease in the contractile response to KCl and carbachol was only noted at week 1. At week 1, significantly increased COX-2 and TGF-β1 expression accompanied a decrease of VEGF and CGRP expression. At week 4, there was a partial recovery of voiding function and a significant increase in the Ki-67 staining. LESH treatment at higher energy level further amplified the Ki-67 staining and improved the recovery of contraction amplitude and the expression of TGF-β1 and VEGF.

Discussion: The findings of the study suggested that LESH at higher energy level improve the pace of recovery from cryoinjury in DU/IAB model. We expect to examine the contractile response to electrical field stimulation to complete a comprehensive analysis of the cryoinjury-induced DU/IAB model, and show the significant improvement of muscle contractility after LESH treatment in bladder strip contraction studies at 1 and 2 weeks after cryoinjury to further confirm the effects of LESH treatment for myogenic DU in the future.

Conclusion: Cryoinjury of detrusor induces DU/IAB with functional impairment lasting for up to 4 weeks, but the associated molecular changes are restored by 2 weeks. LESH improved bladder wall composition, and hastened functional recovery from cryoinjury.
Exposure of Zebra Mussels to Extracorporeal Shock Waves Demonstrates Formation of New Mineralized Tissue Inside and Outside the Focus Zone

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Device and producing company: PiezoClast (Electro Medical Systems S.A., Nyon, Switzerland) and piezoelectric ESW applicator (F10G4) (Richard Wolf, Knittlingen, Germany)

Introduction: The success rate of ESWT for fracture nonunions is approximately 75%. Detailed knowledge regarding the underlying mechanisms that induce bio-calcification after ESWT is limited.

Material and Method: We analyzed the biological response within mineralized tissue of a new invertebrate model organism, the zebra mussel Dreissena polymorpha, after exposure with extracorporeal shock waves (ESWs). Mussels were exposed to ESWs with positive energy density of 0.4 mJ/mm2 (A) or were sham exposed (B). Detection of newly calcified tissue was performed by exposing the mussels to fluorescent markers.

Results: Two weeks later, the A mussels showed a higher mean fluorescence signal intensity within the shell zone than the B-mussels (P<0.05). Acoustic measurements revealed that the increased mean fluorescence signal intensity within the shell of the A-mussels was independent of the size and position of the focal point of the ESWs.

Discussion: These data demonstrate that induction of bio-calcification after ESWT may not be restricted to the region of direct energy transfer of ESWs into calcified tissue. Our results are of relevance for better understanding of the molecular and cellular mechanisms that induce formation of new mineralized tissue after ESWT.

Conclusion: For the provider, ESWs produce an effect on bone more akin to a ‘shot gun’ rather than a ‘rifle’.
Effect of Shockwave on Rabbit Compound Muscle Action Potential and Neuromuscular Junction
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Institution: The second Affiliated Hospital of Kunming Medical University, Kunming; China
Device and producing company: BLT, BLT-6000

Introduction: To evaluate the bilateral change of AChE, nAChR and the morphological changes of muscle tissue when only one leg are accept the Extracorporeal Shock Wave (radial Extracorporeal Shock Wave Treatment, rESWT) processing.

Material and Method: 63 male New Zealand rabbits weighing 2 + / - 0.2kg. The strength of rESWT was determined in 3 rabbits by pre-experiment, and then the remaining 60 rabbits were subjected to a shock of 1.5bar and frequency of 10Hz for 2000 times with the largest position of the left calf triceps muscle abdomen slightly laterally. Divided into six groups, Japanese photoelectric meb-9100k EMG was used to record the lateral head compound muscle action potential of bilateral gastrocnemius muscle under anesthesia on the day of the treatment of the rESWT and at week 1, 2, 4, 6 and 8 after the treatment. Comparing the amplitude and latency of the two sides, One sample was taken from each group and repeated electrical stimulation was performed on the lateral head of bilateral gastrocnemius muscle. The attenuation of amplitude after different frequency stimulation was recorded. Immediately remove the lateral cephalic tissue of bilateral gastrocnemius muscle after EMG examination. Morphological changes of muscle tissue were observed by HE staining after frozen section. The mean optical density was measured after AchE staining, and nAChR was counted after immunohistochemical staining.

Results: The action potential amplitude of the experimental side of the first three groups of rabbits (on the day of treatment and the first and second weeks after treatment) decreased significantly compared with that of the control side (P < 0.05). The amplitude of action potential on the experimental side was not significantly different from that on the control side. There was no significant difference in the latent period of bilateral action potential between all experimental rabbits, and no obvious morphological abnormality of muscle tissue was found in HE staining. The mean optical density of AchE on the experimental side of the first five groups of rabbits was significantly higher than that on the control side (P < 0.05). The mean optical density of AchE on the experimental side decreased slowly after the first week of treatment, and there was no statistically significant difference between the mean optical density of AchE on the experimental side and the control side at 8 weeks after treatment (P > 0.05); Compared with the first 5 groups, the AchR count on the experimental side was significantly decreased (P < 0.05), but gradually increased from the day of shock wave treatment to 8 weeks after treatment, and there was no statistically significant difference in AchR count between the experimental side and the control side at 8 weeks after treatment (P > 0.05).

Conclusion: The effect of rESWT on the maximal hypertrophy of the triceps crus muscle abdomen at a strength of 1.5bar and a frequency of 10Hz for 2000 shocks can reduce the amplitude of its complex muscle action potential, but the effect duration is short and has no significant impact on the muscle tissue morphology. AchE significantly increased and AchR significantly decreased in a short period of time, suggesting that the treatment of this intensity rESWT reduced the number and degree of stimulation received by muscle cells in a short period of time, thereby reducing the generation of action potential.
The Effect Extracorporeal Shockwave Therapy on Fungal Biofilms

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Device and producing company: Orthowave 100; MTS

Introduction: Extracorporeal shockwave therapy (ESWT) has gained popularity within the last decade. Since the effects of ESWT on fungal biofilms have not been examined, this research tests the response of fungi to shockwaves.

Material and Method: Biofilm growth of Rhizopus oryzae performed first in polystyrene 24-well plates. Biofilms were treated with electrohydraulic (0.19 mJ/mm², 3 Hz, 300 pulses) and electromagnetic (0.55 mJ/mm², 3 Hz, 300 pulses) shockwaves alone, antifungal amphotericin B alone, and combination of medication with shockwaves. To create a more clinical setting, biofilms were grown on fibrin glue and treated under similar conditions. Cell viability was read through XTT/menadione absorbance.

Results: Fungal biofilms were dislodged and showed an 86.74% decrease in cellular respiration when treated with electromagnetic shockwaves on 24-well plates. When biofilms were treated with electrohydraulic shockwaves in combination with amphotericin B, an increase in cellular respiration was observed when compared to biofilms treated with amphotericin B alone. Further tests with electrohydraulic shockwaves on fibrin glue suggested the same protective effect previously found.

Discussion: As originally hypothesized, the high energy contained in the electromagnetic shockwaves dislodged the biofilms and significantly decreased cell viability. The unanticipated observations occurred when the lower energy electrohydraulic shockwaves increased cell viability when treated with amphotericin B. Because of the nature of shockwaves, a water bath was constructed. Fibrin glue was used to mimic tissues and grow stronger biofilms. When the high energy electromagnetic shockwaves were used in a more clinically applicable model, the trend repeated. A stimulation in growth was observed when compared to antifungal control, even with amphotericin B present.

Conclusion: An unexpected protective effect was observed when treating fungal biofilm with ESWT in 24-well plates and a clinically applicable model. It is unknown why this occurred without further investigation.
Effect of Waist Sports Injury Patients on the Ability to Restore Life by Shock wave–Ice-Kinesio (SIK) Combined Therapy

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Device and producing company:

Material and Method: 30 waist sports injury patients were randomly divided into two sets. One set with 15 patients which is called SIKT group applied with SIK combined rehabilitation treatment and the other set with 15 patients which is called ET group introduced conventional exercise therapy. After average 2 months’ rehabilitative training, we contrast motor function, sensory function and activity of daily living in the two sets. Applying the marking standard of ADL, Modified Barthel index, and make statistic analysis with evaluated consequence.

Results: The patients’ score of ADL index in SIKT set is obviously higher than that of motor index in movement group (P<0.05). The Modified Barthel index in SIKT set is obviously higher than that of movement group (P<0.01).

Conclusion: SIK combined therapy is an effective rehabilitation method can significantly improve the waist sports injury patient's motor function and daily living.

Objective: Extracorporeal shock wave therapy (ESWT) is a non-invasive, safe, effective and inexpensive method of treatment. Ice therapy have good effects vasoconstriction, pain and edema relief effect. Kinesio can improve circulation, support and relax soft tissue. We introduce Shock wave–Ice-Kinesio (SIK) combined therapy in the field of sports injury rehabilitation. SIK therapy makes full use of the advantages of the three methods to make up for the shortcomings. This study majors in description of SIK combined therapy and its effect on waist sports injury rehabilitative treatment. We summarized a method of applying modern Integrated rehabilitation technology and carried out the refinement into the convalescent care of waist sports injury patients.

Keywords: Extracorporeal shock wave therapy; Ice therapy; Kinesio therapy; Waist sports injury; Rehabilitation
Focused type Extracorporeal Shock Wave Therapy for Epiphysitis in Young Gymnasts - A report of 4 cases

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Institution: Funabashi Ortopedic Hospital, Chiba; Japan
Device and producing company: Duolith SD1, Storz

Introduction: In gymnastics, it is necessary to have high intensity practice from childhood. Therefore, epiphysitis is a common disease among gymnasts. We report 4 cases of epiphysitis in young gymnasts treated using ESWT.

Material and Method: Four patients were treated by repetitive low-energy focused SWT for epiphysitis of medial malleolar, distal end of patella, ischial tuberosity and ala of ilium (11-15 years, 2 male 2 female), respectively. In all cases, insufficient ossification of epiphysis was identified on the X-ray, and bone marrow edema was demonstrated on the MRI before ESWT. Three thousand shots with 0.15-0.20 mJ/mm² were applied per session, in 2-4 week intervals (total 2 or 3 sessions).

Results: In all cases, pain improved gradually after the 1st application. The subjects restarted the practice depending on the pain and returned to the full activity 1-2 months after ESWT. Thereafter, the recurrence of pain has not observed. In all 4 cases, osteogenesis of epiphysis was observed gradually on X-rays. On the final follow-up, ossification was completed as almost equivalent to the healthy side, in each case.

Discussion: We should pay attention to the effect of ESW to epiphysis. Some animal studies demonstrated that high-energy shock wave caused epiphyseal dysplasia and overgrowth of the long bone. On the other hand, low-energy shock wave was safer for epiphysis histologically. In our clinical experience, the application of low-energy ESWT to epiphysitis was safe and effective for young gymnasts to return to activity. ESWT may promote pain relief and stimulate ossification of epiphysis. However, the effect of ESWT to epiphysis is still unknown; therefore we should continue to follow-up carefully.

Conclusion: In our 4 cases of epiphysitis in young gymnasts, low-energy ESWT was a safe and effective option, which may promote pain relief and osteogenesis in epiphysis, and lead to promptly return to activity.
**Extracorporeal Shock Wave Therapy for Chronic Achilles Tendinopathy in Runners**

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**Institution:** Funabashi Orthopaedic Hospital, Chiba; Japan  
**Device and producing company:** Epos Ultra by Dornier MedTech and Duolith II by Storz

**Introduction:** Chronic Achilles tendinopathy is common in high level runners. The purpose of this study is to report clinical results of 21 high level runners that were treated with ESWT.

**Material and Method:** 21 runners (31 feet) who were treated with ESWT were included in the study. The mean follow up period was 14 months. Each subject received ESWT in biweekly intervals to a mean total of 6.8 sessions. Maximum energy flux density (EFD) ranged from 0.08 to 0.36mJ/mm2. Our primary assessment was to analyze clinical results. Our secondary assessment was to measure the thickness of the Achilles tendon in anterior to posterior (AP) direction in MRI before and after ESWT, and analyze the difference.

**Results:** 19 out of 21 runners returned to competition. Those who returned to competition did so at 3.7 months on average and none of them had recurrence of symptoms. The mean period until the improvement of VAS to less than a half was 5 weeks. The mean VAS at the last follow up visit was 2.4. The mean AP thickness of the Achilles tendon after ESWT was 6.7mm (5.0-8.3); it was significantly lower than the mean thickness before ESWT, which was 7.5 mm (6.2-9.2). (p<0.01).

**Discussion:** In the present study, we initiated ESWT a mean of 21 months after presentation of symptoms; late enough to consider some of the cases to be in the late tendon disrepair/degenerative tendinopathy stage. Even so, VAS improved to less than one-half in 5 weeks and 90% of the runners successfully returned to competition at a mean of 3.7 months. In our method - repeated use of high-energy, focused type shock wave on a biweekly basis - the ESWT was effective even in the later stage of Achilles tendinopathy.

**Conclusion:** This study indicates ESWT is a safe and viable option for chronic Achilles tendinopathy in runners. Thickness of the Achilles tendon was significantly decreased after several sessions of ESWT by MRI.
Radial Extracorporeal Shock Wave Therapy (Reswt) and Focussed Extracorporeal Shock Wave Feswt in mid Portion Achilles Tendinopathy – A Prospective Randomized Controlled Trial

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Device and producing company: MP1 (Storz medical, Tägerwil, Swiss), Duolith (Storz medical, Tägerwil, Swiss)

Material and Method: A total of 24 patients randomly received assigned treatment as allocated to either radial extracorporeal shock wave therapy (rESWT) or focussed extracorporeal shock wave therapy (fESWT). All patients were suffering from clinically relevant mid portion tendinopathy to the Achilles tendon. Mean pain duration was 3,8 month. The MP1 (Storz medical, Tägerwil, Swiss) was used to perform rESWT, the Duolith (Storz medical, Tägerwil, Swiss) was used in all cases for fESWT. The radial shock wave group received 3 shock wave treatments performed with 2000 impulses each. Working pressure 2,5 bar. Treatment target was defined as the most painful part of the midportion Achilles. The focussed shock wave group received 2000 impulses with 0,32 mJ within the same treatment area. No local anesthetics were used in any case. No concomitant therapy was applied within the 12 weeks follow up.

Primary Criteria was defined as overall pain score (VAS) at daily activities. Secondary criteria was defined as pain during first steps in the morning. Success rate was defined as at least a 60% pain reduction compared to baseline.

Results: Baseline values showed homogeneity regarding all criteria and biometric data set. Both groups were found to show clinical relevant and significant improvement compared to baseline for primary and secondary criteria 3 month after ESWT (P < 0.01), success rate was 62% in the fESWT group vs. 64% in the rESWT group without statistically significant nor clinical relevant differences. Secondary criteria showed same outcome with no significant difference in between both groups. (P > 0.05).

Only minor side effects such as small petechial bleeding and skin reddening directly after intervention were found in the radial group as the focused treatment group was complete without any relevant side effects. All adverse events disappeared without relevant effects. Moderate discomfort was reported in few cases within both groups during treatment.

Conclusion: rESWT and fESWT were found to have clinically relevant and statistically significant effects in mid portion Achilles tendinopathy compared to baseline. Non difference was found in between both groups as the radial ESWT has some more minor side effects without clinical relevance compared to focused ESWT. rESWT as well as fESWT are effective and save and effective in Achilles tendinopathy.
Outcome Predictors of ESWT for Insertional Plantar Fasciitis
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Institution: Kumamoto Foot and Ankle Center Hotakubo Orthopedic Hospital; Japan
Device and producing company: Duolith SD1, Storz

Introduction: Plantar fasciitis (PF) is one of the most common causes of heel pain. For refractory cases, ESWT has been proposed as useful therapeutic option. We assessed the factors that influenced the outcome of ESWT.

Material and Method: Patients who had PF for more than 6 months and failure to response to conservative treatments were included in this study. A retrospective review of 64 patients (71 feet) who underwent ESWT was performed. 2500 shock waves for 3 consecutive sessions were applied at weekly intervals. Patients were evaluated prospectively with VAS at regular intervals. Follow-up was 6 months post procedure. Multivariable analysis was performed to assess the factors leading to successful outcomes.

Results: The study group consisted of 22 males and 42 females (mean age 55±16.6 years). VAS was significantly improved from 7±2.0 at baseline to 3±1.7 at 6 months in this population. As predicted factors, gastrocnemius tightness, presence of laterality and calcaneus spur did not influence the outcome. Older age, the presence of 1st morning step pain and fascial thickness were found to influence ESWT outcome.

Discussion: This study clarified predicted factors leading to successful outcome. Some reports showed that age affected the outcome of ESWT as with our study, whereas it was reported that fascial thickness was not correlated with functional score. The reason for this difference is not clear, but it might be caused the difference of the evaluated scale or our population that the range of fascial thickness was so wide (2-7.7mm, average 4±1.7mm). Anyway, these predicted factors may have the possibility to increase the success rate of ESWT.

Conclusion: ESWT is a reasonable treatment for refractory PF. This study also provided patient related factors that adversely affected successful treatment.
Extracorporeal Shock Wave Therapy is Effective in Treating Chronic Plantar Fasciitis: A Meta-Analysis of RCTs
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Device and producing company:

Introduction: Plantar fasciitis (PF) is the most common reason for heel pain. The efficacy of extracorporeal shock wave therapy (ESWT) as an ideal alternative to conservative treatments and surgery is controversial, and almost all previous articles compared general ESWT with placebo without indicating the kind of shock wave. We undertook a meta-analysis to compare the efficacy of general ESWT, focused shock wave (FSW), and radial shock wave (RSW) with placebo, to assess their effectiveness in chronic PF.

Material and Method: The PubMed, Medline, EmBase, Web of Science, and Cochrane library databases were searched for studies comparing FSW or RSW therapy with placebo in chronic PF. Clinical outcomes included the odds ratios (ORs) of pain relief, pain reduction, and complications. Relevant data were analyzed using RevMan v5.3.

Results: Nine studies involving 935 patients were included. ESWT had higher improvement rates than the placebo group (OR 2.58, 95% confidence interval [CI] 1.97-3.39, P<.00001). ESWT had markedly lower standardized mean difference than placebo, with heterogeneity observed (standardized mean difference 1.01, 95% CI -0.01 to 2.03, P=.05, I=96%, P<.00001). FSW and RSW therapies had greater therapeutic success in pain relief than the placebo group (OR 2.17, 95% CI 1.49-3.16, P<.0001; OR 4.63, 95% CI 1.30-16.46, P=.02), but significant heterogeneity was observed in RSW therapy versus placebo (I=81%, P=.005).

Conclusion: This meta-analysis suggested that FSW therapy can relieve pain in chronic PF as an ideal alternative option; meanwhile, no firm conclusions of general ESWT and RSW effectiveness can be drawn. Due to variations in the included studies, additional trials are needed to validate these conclusions.
Clinical Study on the Effect of Extracorporeal Shock Wave on Pain and Functional Score of Calcaneal Pain
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Device and producing company: EMS, Dolorclast; XIANGYU, XY-K-shockmaster-500B; XYS.GU-1D

Introduction: To investigate the clinical efficacy of extracorporeal shock wave in the treatment of calcaneal pain.

Material and Method: 98 patients with hepatic pain who were admitted from January 2014 to October 2018 were randomly divided into two groups according to random number method, extracorporeal shock wave treatment (treatment group) and infrared physical therapy (control group), with 49 cases in each group. Treatment for 4 weeks was a course of treatment, and after the treatment, visual analog scale (VAS) was used for evaluation.

Results: At the end of treatment, the VAS foot pain and functional scores were (39.6 ± 6.2) and (25.13 ± 4.64) points in the treatment group and (32.3 ± 6.5) and (17.4 ± 7.2) points in the control group, respectively. (16.5±4.6) and (14.4±8.6) points, (16.1±4.7) and (14.6±8.4) points, the pain of the two groups was significantly reduced and the function was improved (P<0.05). After 4 weeks, the effective rate of the treatment group was 65% (32/49), and the improvement rate was 31% (15/49) better than the control group [27% (13/49) and 63% (31/49)] (both P < 0.05). )

Conclusion: Extracorporeal shock wave treatment is effective in the treatment of calcaneal pain, and its curative effect is better than physical therapy, which is suitable for clinical application.

Keywords: Extracorporeal shock wave; Calcaneal pain
Kartogenin Enhances Fibrocartilage Tissue Formation and Biomechanical Strength in a Rotator Cuff Repair Mouse Model

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Device and producing company:

Introduction: Tendon-to-bone healing after rotator cuff repair remains one of the biggest challenges in orthopaedics. Kartogenin, a small heterocyclic biocompound, has been reported to induce chondrogenic differentiation of endogenous stem cells and enhance healing at the tendon-bone junction by promoting the formation of cartilage-like tissues. The purpose of this study was to investigate the ability of kartogenin to augment rotator cuff repair healing in a mouse model.

Material and Method: Seventy-two C57BL/6 wild-type mice underwent unilateral detachment and transosseous repair of the supraspinatus tendon augmented with either fibrin glue (control group, n = 36) or 10μl of fibrin glue containing 100 μM of kartogenin (experimental group, n = 36) applied at the repair site. Mice were sacrificed at 2 and 4 weeks postoperatively. Repair site integrity was evaluated by fibrocartilage formation with safranin-O staining, collagen fiber organization with picrosirius red staining, and biomechanical analyses with load-to-failure testing of the supraspinatus tendon-bone construct.

Results: After preparation, 64% of the total kartogenin was released from the fibrin gel at 24 hours, and 95% was released by 5 days. The repaired supraspinatus tendon was in continuity with the bone in all animals. The kartogenin group had lower mean cell density at the repair site compared to the control group at 2 weeks and 4 weeks. Larger areas of fibrocartilage were observed in the kartogenin group compared to the control group at 2 weeks and 4 weeks. No difference in mean collagen birefringence was observed between groups at 2 weeks. However, at 4 weeks, the kartogenin group had more organized collagen at the tendon-bone interface compared to that in the control group. No difference in mean load-to-failure was observed between groups at 2 weeks. However, at 4 weeks, the kartogenin group had a higher mean load-to-failure than the control group.

Conclusion: Rotator cuff repair augmentation with kartogenin improved the histologic appearance and biomechanical strength at 4 weeks in a mouse model. Specifically, kartogenin treatment led to larger areas of fibrocartilage formation, improved collagen fiber organization, and improved ultimate strength of the repair construct compared to controls.
Intraosseus Migration of Rotator Cuff Calcifications
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Device and producing company: Direx Orthima

Introduction: The aim of this study is to describe intraosseous migration of rotator cuff calcifications. To our knowledge this phenomenon has not been previously described in the field of shockwave treatment.

Material and Method: We included 6 patients (5 females, 1 male) with symptomatic intraosseous migration of rotator cuff calcifications taken from the databases of three centers dedicated to shock wave treatment. All patients were evaluated clinically, radiographically and with MRI.

Results: Average age was 48.6 years old. Predominance of female sex was high (83%). All cases presented with sharp pain. In one patient the calcium material migrated intramedullary. The intraosseous deposits were poorly visualized at radiography. MRI showed a pronounced edema in the neighboring soft tissue and in bone marrow in the acute phase. CT was an optimum modality to depict the continuity between the subcortical and tendinous calcifications. In 3 cases, biopsy was initially indicated.

Discussion: Rotator cuff calcium hydroxyapatite crystal deposition is a common disorder. Rarely however, the calcification can extend into the epiphyseal region causing subcortical calcium migration and even extensive intramedullary calcium propagation. Most of the reports include isolated cases or small series. Some authors consider this finding as a distinctive form of the disease in terms of clinic presentation, imaging findings and outcome. These erosive lesions showing soft tissue and bone marrow edema, frequently associated with severe pain, can be easily mistaken for osteitis or aggressive neoplastic lesions.

Conclusion: Intraosseous loculation is a rare phenomenon. Recognition of these atypical presentations may prevent an unnecessary biopsy and overtreatment as it can mimic infection or tumor lesions.
Efficacy of Extracorporeal Shockwave Therapy on Calcified and Non-Calcified Shoulder Tendinosis: A Propensity Score Matched Analysis
Kuan Ting Wu, Ching-Jen Wang

Institution: Kaohsiung Chang Gung Memorial Hospital; Taiwan
Device and producing company: Ossastron (Sanuwave, Alpharetta, Georgia) or Orthospec equipment (Medispec Ltd., Yehud, Israel)

Introduction: Extracorporeal shock wave therapy (ESWT) had been proved to be beneficial in calcific tendinosis, however, the treatment efficacy in non-calcific tendinosis of rotator cuff still remains controversial. The present study was to compare the outcomes ESWT among the non-calcific rotator cuff tendinosis and different types of calcific tendinosis on the basis of similar shoulder functional status.

Material and Method: This is a retrospective study with 20 patients per group were enrolled through propensity score matching in a 1:1:1 ratio out of a total 291 patients who had received ESWT for painful shoulder tendinosis. The patients were divided into three groups which include non-calcified tendinosis (NCTS), type I dense calcified tendinosis of shoulder (DCTS) and type II, type III translucent calcified tendinosis of shoulder (TCTS) according to Gartner and Heyer classification. The clinical evaluation included the subjective pain score with visual analog scale (VAS), and functional outcome with Constant and Murley score (CMS).

Results: The VAS of TCTS decrease from 5.4±1.04 to 1.5±2.48 which had statistically greater reduction than NCTS (from 5.5±0.76 to 2.9±2.86) and DCTS (from 5.4±0.94 to 3.8±2.46). For the functional outcome, the overall CMS was superior in TCTS than the NCTS and DCTS (86.9±19.7 vs 78.7±18.3 and 71.1±17.8, p=.014). Besides, significant better improvement in subscales of pain score, strength and range of motion in TCTS than NCTS and DCTS. 70% of patients were complaint-free in TCTS group, which was higher than the NCTS group(15%) and DCTS group(25%) (p<0.05).

Discussion: In the present study, we conducted a match-controlled group comparison of the effect of high-energy ESWT in NCTS, DCTS and TCTS cases. The improvement was significant in every group after ESWT with regards to shoulder pain and function. These findings were in accordance with current literature regarding treatment for calcified tendinosis of the shoulder. Gerdesmeyer et al. reported beneficial effects with respect to pain, shoulder function and calcium resorption of both low- and high-energy ESWT. In a meta-analysis conducted by Verstraelen et al., high-energy ESWT was found to result in greater improvement of the Constant score and higher radiographic resorption in comparison with low-energy ESWT.

Comparing the Constant score and pain score among the groups, the TCTS group demonstrated significant pain reduction and Constant score improvement 12 months after ESWT as compared with the other two groups. In terms of calcific shoulder tendinitis, Rompe et al. reported better resorption of calcium deposits in patients with type II calcification, and inferior outcomes were significant in patients with homogenous deposits in comparison with surgical extirpation. Regarding the energy level of ESWT, Peters et al. demonstrated a greater effect of high-energy treatment, with a higher resorption rate of calcium deposits; they also reported pain recurrence in 87% of patients in the low-energy group with residual calcium deposits, whereas no residual deposits or recurrent pain were observed in the high-energy group. In our study, the calcification was more homogenous and dense in the DCTS group, whereas in the TCTS group, it was inhomogeneous, and of a translucent and cloudy appearance; and superior outcomes were observed in the DCTS group, which was in line with existing literature.

Conclusion: The present match-controlled analysis demonstrated a positive efficacy of ESWT for chronic shoulder tendinosis, with superior outcomes in patients with type II and type III calcification as compared with type I calcification and non-calcified tendinosis at the 1-year follow-up point. The results indicated that an alternative procedure to ESWT should be considered for patients with type I calcification and non-calcified tendinitis owing to the lower satisfaction rate following treatment in these patients.
Institution: Coffs Coast Sports Physiotherapy, Coffs Harbour City; Australia
Device and producing company: Swiss Dolorclast Smart 20 with Evo Blue Handpiece, Swiss Dolorclast

Introduction: Case Studies following 4 patients with supraspinatus calcific tendinosis.

Material and Method: Use of Dolorclast Smart 20 radial shockwave machine over a period of time (10-12 treatments) and tracking resolution and reabsorption of the calcific deposits by either x-ray, ultrasound or a combination of both. Weekly treatments when possible with RSWT in combination with interferrential therapy, cold therapy and progressive rotator cuff strengthening.

Results: A significant amount reabsorption or resolution of calcific deposits in the supraspinatus tendon and a significant reduction of pain, catching sensations and improvement of shoulder function with use of radial shockwave treatments.

Discussion: How many treatments do we feel is an optimal amount to significantly produce reabsorption of calcium deposits in either a newly formed or chronically existing supraspinatus calcific tendinosis. Is there an optimal bar pressure, hertz and number of shocks to aim for to achieve the most effective treatment of this condition and how quickly should we progress these factors in the treatment phase.

Conclusion: I feel that considering the results that the Dolorclast Radial Shockwave machine is an effective treatment modality for the resolution of supraspinatus calcific tendinosis.
Clinical Effect Analysis of Extracorporeal Shock Wave in the Treatment of Acromial Bursitis with High Quality Nursing
Yilin Wang

Institution: The First Hospital of Harbin Orthopedic Ward 8, Harbin; China

Material and Method: A total of 68 patients with acromial bursitis who were admitted to the 8th department of osteopathic surgery of Harbin first hospital from November 2016 to December 2017 were selected and treated with extracorporeal shock wave. The patients were divided into two groups according to the random number table method: observation group (n₁ = 35) and control group (n₂ = 33). Pain scores and range of motion were observed and analyzed at 1-3 weeks and 1 month after treatment in both groups.

Results: Pain score and range of motion of the observation group were better than the control group at 1-3 weeks and 1 month after treatment, and the difference was statistically significant (P<0.05)

Conclusion: The effect of quality nursing intervention in extracorporeal shock wave therapy for patients with acromial bursitis is significant.

Objective: to explore the clinical effect of quality nursing intervention in treatment of acromial bursitis with extracorporeal shock wave.

Keywords: Extracorporeal shock wave; Acromial bursitis; High quality nursing
Comparison of Clinical Control Study on Ultrasound-guided Extracorporeal Shock Wave Therapy for Myotenositis of Long Head of Biceps Brachii

Baolin Li, Wei Li

Institution: The First Hospital of Harbin Institute of Technology, 8th unit of Orthopedic, Harbin; China

Device and producing company: EMS, Dolorclast XIANGYU, XY-K-shockmaster-500B; XYS.GU-1D

Introduction: Clinical observation and comparison on the therapeutic effects of ultrasound-guided extracorporeal shock wave therapy on myotenositis of long head of biceps brachii with non ultrasound-guided extracorporeal shock wave therapy.

Material and Method: 60 patients with myotenositis of long head of biceps brachii who had visited Harbin the First Hospital were enrolled and randomly allocated into two groups using random number table: treatment group and control group. Each group was composed of 30 patients. In treatment group, all patients received ultrasound-guided extracorporeal shock wave therapy (hereinafter referred to U group, n=30); while in control group, they received non ultrasound-guided extracorporeal shock wave therapy instead (hereinafter referred to N group, n=30). The severity of pain for all patients at different time points during the therapy were assessed with visual analog scale (VAS): before therapy; 30minutes, 1 week, 2 weeks, 4 weeks and 8 weeks after therapy. The outcomes of different therapies at 4 and 8 weeks were assessed through NEER system and the incidences of adverse reactions were calculated.

Results: Both therapies generated therapeutic effects to patients. Besides, the therapeutic effects at all time points after therapy for U group were significantly better than that of N group(P<0.05). However, based on assessment of outcomes, the difference between two groups was not statistically significant.

Conclusion: Based on comparison, the therapeutic effect of ultrasound-guided extracorporeal shock wave therapy on myotenositis of long head of biceps brachii was much better than that of non ultrasound-guided extracorporeal shock wave therapy. The ultrasound-guided therapy has been broadly applied in clinical practice due to its advantages including: noninvasive, nonradiative, low cost and timesaving properties.

Keywords: Ultrasound-guided; Extracorporeal shock wave; Myotenositis of long head of biceps brachii.
The Effect of Extracorporeal Shock Wave Therapy On Pain and Range Of Motion in Myofascial Pain Syndrome of Shoulder. Quick and Easy Check LD Test

Jae Man Lee, Hyeon Jun Yu, Han Byeol Park, Ji Hye Kang, Hye Jin Won, Jae Myong Kim

Institution Yeonsei Bone Orthopedic Clinic and Physiofit Center, Gangnam-gu, Seoul; Republic of Korea

Device and producing company: Two different type shock wave devices used in this study were the Swiss PiezoClast® focus shockwave device (EMS Electro Medical Systems, Nyon, Switzerland) and the Swiss DolorClast® radial shockwave device (EMS Electro Medical Systems, Nyon, Switzerland).

Introduction: The objectives of this study, by retrospective review, were to investigate the effects of Radial and Focus ESWT on pain and Long Distance Test(LD Test), ROM Test in MFS of shoulder.

Material and Method: Between January 2018 and February 2019, 66 patients diagnosed with MFS of shoulder underwent Focus and Radial type ESWT at the Yonsei Bone Orthopedic Clinic. There were 42 patients in the F-ESWT (Female 26/ Male 16, Mean Age 50.1 min 36~max 61) group and 24 patients in the R-ESWT (Female 11/ Male 13, Mean Age 48.6 min 29~max 69) group. Pain scores, visual analogue scale (VAS), and distance of LD test, shoulder functional ROM test were assessed prior to treatment and after the sixth treatment sessions.

Results: When we compared the VAS before and after the therapy, pre-VAS was 3.44±1.64 and post-VAS was 2.58±1.28 for F-ESWT group, a significant difference (p<0.05). And pre-VAS was 3.81±1.62 and post-VAS was 2.56±1.09 for R-ESWT group, no significant difference (p=0.158).

We found only 6/42 patients (F-ESWT), 4/24 patients (R-ESWT) did not drop of VAS. The distance of Rt/Lt LD test before and after the therapy, pre-Rt/Lt LD test was 23.50±12.56/21.13 ±13.30cm and post-Rt/Lt LD test was 21.80±11.25/21.43±12.50cm for F-ESWT group, significant different (p<0.05). And pre-Rt/Lt LD test was 23.04±12.07/20.80 ±13.00cm and post-Rt/Lt LD test was 21.22±9.41/18.37 ±10.07cm for R-ESWT group, significant different (p<0.05).

Discussion: We compared the VAS score and distance of LD test before and after 6 therapies, found a significant difference between before and after therapy in ESWT treated group. After six treatment, VAS showed a statistically significant improvement F-ESWT groups, and there was no statistically significant difference in VAS of R-ESWT group, but we could check the improvement of pain after R-ESWT treatment in the most of the patient. LD test presents distance between both hand on patient’s back. The method of this test is to measure distance between the middle of distal phalanx of both thumb by sending the reference hand back and the opposite hand up. This study shows decreased distance of Rt/Lt test significantly after both F-ESWT and R-ESWT.

Conclusion: ESWT was effective in reducing pain and increasing ROM of myofascial pain syndrome of shoulder after 6 times therapy during six weeks. We found both Focus and Radial shock wave can be a good treatment tool. And we thought the LD test is useful method for assess the shoulder ROM functionally.
Extracorporeal Shock Wave Therapy in the Treatment of the Chronic Wound At Dorsal of Foot: 4 Case Reports
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Institution: (1) Murakami Surgical Hospital; Japan, (2) Kurume University Medical Center; Japan, (3) St. Mary's Hospital; Japan, (4) Kurume University Orthopedic department; Japan

Device and producing company: DUOLITH SD1 shock wave system (from Storz Medical AG, Switzerland)

Introduction: The chronic wound at dorsal of foot is incurable, because of less soft tissue and low blood flow. In addition to, if patients have smoking and diabetes, it's more difficult to cure the wound. We reports that we performed extracorporeal shock wave therapy (ESWT) in the treatment of the chronic wound at dorsal of foot.

Material and Method: Representative case: 66-year-old man. He has a past medical history of diabetes. He hit his right foot and went to local hospital. He was diagnosed compartment syndrome and performed fasciotomy. The next day of fasciotomy, He came to our hospital. Post trauma 2 weeks, wound was not healed, so we started ESWT.
We covered wound by urethane film and used K2 Gel Pod which fullled by ultrasound gel, in order to concentrate the shock wave energy to the wound. Treatment was performed with the DUOLITH SD1 shock wave system (from Storz Medical AG, Switzerland). We applied 2500 shocks at an energy flux density of 0.01-0.10 mJ/mm² depending on bio-feedback. Shock wave treatment was performed at weekly intervals.
We asses about wound and pain with Numerical Rating Scale (NRS) and Hand and Foot Wound Assessment Tool (HFWAT).

Results: In all cases, wounds were healed, and decrease pain. Thus NRS and HFWAT were improved. There was no limited range of motion.

Discussion: There are some reports, about the effect of ESWT. That is pain relieving by degeneration of free nerve endings, and, recovery of tissue by releasing growth factor like TGF-β and IGF-1. Thus, ESWT is referred to improving wound healing by releasing VEGF. Furthermore ESWT can suppress covering material to the minimum, we can perform early joint motion range training. We succeed not to leave limited range of motion. We suggest that ESWT improve to heal the chronic wound of limb.

Conclusion: ESWT can be effective treatment to the chronic wound at dorsal of foot.
Clinical Randomized Controlled Study of Ultrasound-guided Extracorporeal Shock Wave Therapy and Blocking Therapy for Carpal Tunnel Syndrome

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Institution: (1). First Hospital of Harbin City, Harbin Medical University, Harbin; China (2) Heilongjiang Provincial Hospital, Harbin; China, (3) Medical Science Institute of Harbin, Harbin Medical University, Harbin; China (4) Hebei Institute of rehabilitation research, Hebei; China

Device and producing company:

Material and Method: From January to October 2018, 60 patients with carpal tunnel syndrome were treated in the outpatient department of Harbin First Hospital. The patients in each group were divided into two groups by random number table: 30 cases in each group were treated with ultrasound-guided extracorporeal shock wave therapy and blocking therapy, and the scores of each group before, after and after the last treatment were evaluated by visual analogue scale (VAS) and the changes of nerve function were compared and analyzed.

Results: The VAS scores of the last treatment in both groups were lower than those before treatment (P < 0.001). After 3 months of treatment, the VAS scores of the patients treated with extracorporeal shock wave (ESWT) decreased significantly, while the VAS scores of the patients treated with blocking therapy increased compared with that of the last treatment. The recovery of nerve function after ESWT guided by ultrasound was significantly higher than that after blocking therapy.

Conclusion: Ultrasound-guided extracorporeal shock wave therapy is effective in treating carpal tunnel syndrome compared with blocking therapy, but by comparing VAS score and nerve function recovery, it can be concluded that ultrasound-guided extracorporeal shock wave therapy has better effect and extensibility, and is suitable for clinical vigorously because of its virtually zero side effects.

Objective: A randomized controlled clinical study of ultrasound-guided extracorporeal shock wave therapy and blocking therapy for carpal tunnel syndrome.

Keywords: Ultrasound-guided; Carpal tunnel syndrome; Extracorporeal shock wave therapy, blocking therapy, nerve function.
Clinical Analysis of Ultrasound Guided Extracorporeal Shock Wave Combined With Acupotomy for Treatment of Dorsal Carpal Ganglion Cyst

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Institution: (1) Department of orthopedic 8th ward, Harbin Institute of Technology Affiliated Harbin 1st Hospital; China, (2) Shockwave Research Laboratory, Harbin Medical Science Research Institute; China

Device and producing company:

Material and Method: 30 cases of dorsal carpal ganglion cyst have been diagnosed in outpatient department, after ultrasound guided aseptic operation, the acupotomy was used to puncture the wall and drain the fluid, the use of divergent extracorporeal shock wave compression shock treatment, the short-term effect, symptom improvement and long-term recurrence were observed.

Results: After minimally invasive treatment with ultrasound guided extracorporeal shock wave, the cyst disappeared or became smaller and softer than before treatment. The clinical symptoms improved obviously, the total effective rate was 93.3%, and the recurrence rate was 6.7% in one year.

Conclusion: Ultrasound guided shock wave minimally invasive treatment of dorsal carpal ganglion cyst, with accurate positioning, visual, safe operation, easy to accept, significant curative effect, low recurrence rate, is worthy of clinical application.

Objective: To observe the clinical analysis of ultrasound guided extracorporeal shock wave combined with acupotomy for treatment of dorsal carpal ganglion cysts.

Keywords: Ultrasonic guidance, Extracorporeal shock wave, Ganglion cyst, Acupotomy
Extracorporeal Shock Wave Therapy Combined With Floating Needle in the Treatment of Lateral Epicondylitis of Humerus, a Clinical Randomized Controlled Trial

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Institution: The First Hospital of Harbin Institute of Technology, 8th Unit of Orthopedic, Harbin; China

Device and producing company:

Material and method: 75 patients with lateral epicondylitis of humerus from June 2017 to June 2018 in the first hospital of herbin were randomly divided into three groups: floating needle group, extracorporeal shock wave group and the combined group (each group were 25 patients). Comparing the therapeutic effect, adl score and vas score before treatment, the first week and the second week by three times a week.

Results: The reduction trend of vas score in the first week and the second week before treatment was basically consistent in the three groups. The overall effective rate of the combined group was significantly higher than both of the floating needle group and the extracorporeal shock wave group and the difference was statistically significant (p<0.05).

Conclusion: Floating needle therapy and extracorporeal shock wave therapy can alleviate the symptoms of patients with lateral epicondylitis of humerus. Floating needle therapy combined with extracorporeal shock wave therapy can be used as a reliable treatment for lateral epicondylitis of humerus.

Objective: To evaluate the clinical efficacy of floating needle combined with extracorporeal shock wave therapy in the treatment of lateral epicondylitis of humerus and search a safety reliable treatment method for lateral epicondylitis of humerus.

Keywords: Floating needle, extracorporeal shock wave therapy, lateral epicondylitis of humerus.
Clinical Randomized Control Study of Shock Wave Therapy Combined With Wax Therapy in the Treatment of External Humeral Epicondylitis

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Device and producing company: EMS, Dolorclast, XIANGYU, XY-K-shockmaster-500B; XYS.GU-1D

Introduction: To observe the clinical efficacy of shockwave therapy combined with wax therapy in the treatment of external humeral epicondylitis, and to explore the mechanism of shockwave therapy combined with wax therapy in the treatment of external humeral epicondylitis.

Material and Method: 96 patients with external humeral epicondylitis from June 2017 to June 2018 in the 8th department of orthopedics, Harbin first hospital were selected and divided into 3 groups: shock wave group, wax therapy group and combined group, with 32 patients in each group. The shockwave group was treated with shockwave therapy, the waxwork group was treated with waxwork, and the combination group was treated with shockwave therapy + wax work. The VAS score, MEPS score, therapeutic effect and recurrence rate of the three groups were compared.

Results: The VAS score, MEPS score, and effective rate of the combined group was significantly higher than that of the shock wave group and the wax therapy group, and the difference was statistically significant (P<0.05).

Conclusion: Shockwave therapy combined with wax therapy is better than shock wave and closed therapy in the clinical treatment of external humeral epicondylitis, and can be used as an effective method in the treatment of external humeral epicondylitis.

Keywords: Shockwave therapy  wax therapy  external humeral epicondylitis.
Extracorporeal Shockwave Therapy Improves Cartilage and Bone Repair on Osteochondral Defect in Rat Model

Jai Hong Cheng, Ching-Jen Wang, Jih-Yang Ko

Institution: Center for Shockwave Medicine and Tissue Engineering, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine; Taiwan

Device and producing company: DUOLITH SD1 ultra, STORZ MEDICAL

Introduction: Osteochondral defect (OCD) is a focal injury in the articular cartilage of joint. It is causing pain, swelling, and catching of the joint. Here, we aim to detail display the pathological changes of the damage cartilage and bone after shockwave treatment.

Material and Method: Damage was created by a drill with 0.5 millimeters for depth and with 2 millimeters for width on the left articular cartilage of femur in OCD rat model. The rats were divided into three groups (ten rats for each group) including Sham, OCD and Shockwave (0.25 mJ/mm², 800 impulses). The animals were sacrificed and the left knees were collected at 2, 4, 8 and 12 weeks post-treatment in the OCD and shockwave groups except Sham at 12 weeks, and all specimens were for pathological, micro-CT and Immunohistochemical analysis.

Results: In the macroscopic analysis, the shockwave statistically improved the cartilage repair at 8 weeks and 12 weeks by International Cartilage Repair Society (ICS) macroscopic scoring system. The epiphyseal compartment bone volume of femur was significant recovered at 12 weeks after shockwave treatment comparing with OCD by micro-CT analysis. Further in histological studies, the histological score and cartilage repair scale were significant reduced after shockwave by HE staining and safranine-O staining to improve cartilage regeneration comparing with OCD. Finally, the Immunohistochemical evidence displayed that shockwave reduced type I collagen, the marker of fibrous tissues, and increased the expression of type II collagen to promote the formation of new hyaline cartilage than OCD.

Discussion: Here, we observed shockwave improved the cartilage and bone regeneration in the OCD of rat knee. However, the experiments were small animal study by shockwave for OCD treatment; it may not be the same results for human clinical trial and need for further demonstration.

Conclusion: The study detail displayed the histological changes in the regeneration of the articular cartilage and bone at 2, 4, 8 and 12 weeks after shockwave treatment on OCD in rat knee.
Shockwave Targeting on Subchondral Bone is More Suitable than Articular Cartilage for Knee Osteoarthritis

Wen-Yi Chou (1+2), Jai-Hong Cheng (2+3), Ching-Jen Wang (1+2), Jih-Yang Ko (1+2)

Institution: (1) Section of Sports Medicine Department of Orthopedic Surgery, (2) Center for Shockwave Medicine and Tissue Engineering, (3) Medical Research, Kaohsiung Chang Gung Memorial Hospital and Chang Gung University College of Medicine, Kaohsiung; Taiwan

Device and producing company:

Introduction: Our study compared the effects of extracorporeal shockwave therapy (ESWT) on the subchondral bone and the articular cartilage for the early osteoarthritis (OA) of rat knee.

Material and Method: The rats were divided into Sham group, Meniscus group (ESWT applied on medial meniscus), OA group, T(M) group (ACL resection OA model followed by ESWT on medial tibial subchondral bone) and Articular cartilage group (ESWT on medial articular cartilage in OA model). Evaluations included the pathological changes of the synovium, articular cartilage and subchondral bone.

Results: The ESWT (0.25mJ/mm² and 800 impulses) did not cause any damages on the cartilage of the meniscus. T(M) group showed significant in pathological examination, micro-CT analysis, cartilage grading score and grading of synovium changes ($P < 0.05$) in the treatment of early OA knee. T(M) group also significantly increased the expression of TGF-$\beta$1 but reduced DMP-1, MMP-13 and ADAMTS-5 ($P < 0.05$).

Discussion: The principal findings of the present study showed that the articular cartilage of early OA knee failed to respond to ESWT. We found that there were no any significant differences in OA lesion score, BMD and medial tibia lesion that indicated the dosage of ESWT we use did not cause any damages in cartilage and subchondral bone. We presumed that the optimal target area for ESWT is not the attenuated articular cartilage but the medial tibia subchondral bone in early osteoarthritis of the knee. With the effect of subchondral protection by ESWT, the progression of OA knee was retarded.

Conclusion: Our results showed that subchondral bone was an excellent target than articular cartilage for ESWT on early knee osteoarthritis.
Extracorporeal Shock Wave Treatment Can Normalize Painful Bone Marrow Edema in Knee Osteoarthritis: A Comparative Historical Cohort Study
Gao Fuqiang, Sun Wei, Li Zirong

Institution: Department of Orthopedics, China-Japan Friendship Hospital, Beijing; China

Device and producing company:

Introduction: Bone marrow edema (BME) represents a reversible but highly painful finding in magnetic resonance imaging (MRI) of patients with knee osteoarthritis.

Material and Method: This study focuses on people who had early-to-mid stage osteoarthritis with knee pain and MRI findings of BME. Patients who underwent ESWT treatment or prescribed alendronate treatment in our department were analyzed. Knee pain and function were measured using the visual analog scale (VAS) for pain and the Western Ontario and McMaster University Osteoarthritis Index (WOMAC), respectively. The degree of BME was measured with MRI scans.

Results: A total of 126 patients who received ESWT treatment (Group A, n=82) or alendronate treatment (Group B, n=44) were included. All patients were followed up clinically and radiographically for a minimum of 12 months. The mean follow-up was 23.5 months (range, 12-38 months). The VAS and WOMAC score decreased more significantly after treatment in Group A than that in Group B (P<0.01) within 3 months. In 6-month MRI follow-ups, there was higher incidence of distinct reduction and complete regression of BME of the affected knee in Group A than that in Group B (P<0.01).

Conclusion: ESWT is an effective, reliable, and noninvasive treatment in patients with painful BME in osteoarthritis of the knee followed by a rapid normalization of the MRI appearance. It has the potential to shorten the natural course.

Objective: The aim of this retrospective study was to evaluate the efficacy of extracorporeal shock wave treatment (ESWT) on painful BME in osteoarthritis of the knee.
Introduction: To observe the clinical effect of extracorporeal shock wave combined with ozone injection in the treatment of knee osteoarthritis, and to explore the mechanism of extracorporeal shock wave combined with ozone injection in the treatment of knee osteoarthritis.

Material and Method: Sixty patients with knee osteoarthritis from June 2017 to June 2018 in eight departments of orthopaedics of Harbin First Hospital were selected. They were randomly divided into three groups: ozone group, extracorporeal shock wave treatment group and extracorporeal shock wave combined with ozone injection group. In each group, 20 cases were treated with ozone injection alone, in the extracorporeal shock wave treatment group, in the extracorporeal shock wave treatment group, and in the extracorporeal shock wave combined with ozone injection group, in the extracorporeal shock wave treatment group. The therapeutic effects and VAS scores of the three groups were compared before treatment and 1, 3 and 6 weeks after treatment.

Results: The effective rate of improving symptoms in the treatment group of extracorporeal shock wave combined with ozone injection was significantly higher than that in the ozone group and extracorporeal shock wave group (P < 0.05).

Conclusion: In the clinical treatment of knee osteoarthritis, extracorporeal shock wave combined with ozone injection is superior to ozone injection alone in the efficiency and recurrence rate, and extracorporeal shock wave alone can be used as an effective method for the treatment of knee osteoarthritis.

Keywords: knee osteoarthritis, ozone, extracorporeal shock wave
The Study of the Effect and Mechanism of Extracorporeal Shock Wave on Knee Osteoarthritis—From Basic Research to Clinical Application

Zhe Zhao, Gengyan Xing

Institution: Department of Orthopaedic Surgery, The Third Medical Center of Chinese Peoples Liberation Army General Hospital, Beijing 100039; China

Device and producing company: EMS

Introduction: Osteoarthritis (OA) is a common disease which causes joint pain and dysfunction in the elderly. How to improve symptoms and delay OA degeneration have been the focus in this field. Since OA non-surgical treatment cannot achieve satisfactory results, it is urgent to make exploration of new non-surgical treatment methods. As an effective biomechanical stimulation, extracorporeal shock wave (ESW) has been performed with satisfactory treatment results on bone nonunion, delayed osseous union, early ischemic necrosis of femoral head, etc. ESW is a noninvasive method which is easily acceptable to patients. In recent years, the findings show that ESW can relieve pain, improve the local microenvironment and delay OA degeneration and so on.

Material and Method: It uses limb function, iconography, histomorphology and proteomics to make comprehensive evaluation. And by conducting random control clinical studies on ESW functions to OA in early or middle stage, its effectiveness and safety have been evaluated from the perspective of pain and functional recovery in order to provide theoretical basis and clinical application reference for ESW treatment.

Results: The basic search results show that ESW can improve rats' knee limb function and delay the OA degeneration. Through controlling the rebuilding of rat knee joint cartilage, the mechanism of articular cartilage degeneration has been relieved. According to the clinical research results, ESW can effectively relieve the pain of OA patients and improve limb functions.

Conclusion: On the basis of deep research on ESW functions and mechanism to OA, the article shows that ESW intervention method is safe and effective and it provides a new option to make non-surgical treatment for OA patients.

Objective: In the previous study, we found that ESW could promote osteogenesis and inhibited of cartilage degeneration, which presented potential application values on OA treatment. Based on this, the research of ESW effect on knee OA and its mechanism is made.

Keywords: Osteoarthritis, Cartilage degeneration, Subchondral bone, Extracorporeal shock wave
Osteoarthritis (OA) of the knee is becoming a major concern for those too young or unable to have knee replacement surgery. Limited non-surgical options leave patients unable to continue their normal life choices and medical professionals feeling a lack of progress in this area of medicine.

Shockwave therapy has been growing in popularity and scientific evidence linking its use to OA knee is growing.

There have been studies performed on rats and in the equine world, which on some level supports the work of Zhao, Z et al (2013) and Chen TW et al (2014). These studies showed a significant reduction in pain (VAS scores down from 7.7 to 3.8 in 12 weeks), improvements to range of movement (ROM), muscle power and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Paul Hobrough, specialist Physiotherapist from the U.K. has spent the last 4 years using RSWT and FSWT on his own knee (diagnosed with advanced OA, two stress fractures, 3 cysts and significant reduction of menisci) following a traumatic rupture of his ACL in 2004 and subsequent reconstruction (same year).

The incredible results he has experience have taken away bi monthly flare ups depriving him of sleep, a limp and he is now able to benefit from a symptom free knee. This experience has led him to use his protocol of six weekly sessions every 6 months, to great effect on a vast range of willing patients with similarly incredible results.

Bringing anecdotal evidence and the recent scientific review, this lecture will enlighten, intrigue and no doubt motivate many SWT clinicians to trial this protocol and seek to replicate the results with their own consenting patients.
Radial Extracorporeal Shock Wave Therapy (Reswt) with the MP1 in Chronic Low Back Pain – A Prospective Randomized Controlled Trial

Ludger Gerdesmeyer (1), Tim Klüter (1), Hans Gollwitzer (1), Peter Diehl (1), Johannes Vester (2)

Institution: (1) Department of Orthopedic Surgery and Sportstraumatology, Medical University Kiel; Germany, (2) IVD Gauting, statistics-clinical trials- clinical monitoring, Data analysis and study planning, Gauting; Germany

Device and producing company: MP1 (Storz medical, Tägerwilen, Swiss)

Material and Method: A total of 46 patients randomly received assigned treatment. All patients were suffering from chronic low back pain for at least 3 month. The MP1 (Storz medical, Tägerwilen, Swiss) was used in all cases. The active group received 3 shock wave treatments performed with 4000 impulses each. Working pressure 2.5 bar. Treatment target was defined as insertional part of erector trunci and Mm interspinalia at the proc spinosos and muscle insertion area of the iliac crest, the insertion of the fascia thorcalumbalis and at the activated trigger points. rESWT was combined with standard physiotherapy. The control group received sham rESWT plus physiotherapy.

Primary Criteria: Oswestry Disability Score 12 weeks after last intervention. Second criteria was defined as overall pain score (VAS) at daily activities. Success rate was defined as at least a 60% pain reduction compared to baseline

Results: Baseline showed homogeneity regarding all criteria and biometric data set. Primary criteria showed statistically significant results 3 month after rESWT (P = 0.0059, one-sided, rESWT success rate 56.20% vs. placebo success rate 38.98%). Secondary criteria all showed significantly better outcome after rESWT plus physiotherapy (P < 0.025 one-sided, MW = 0.5753, LB-CI = 0.5023) compared to control.

Only minor side effects such as small petechial bleeding and skin reddening occurred directly after intervention. They disappeared without relevant effects. Moderate discomfort and radiated pain was found during treatment.

Conclusion: rESWT is a very effective and safe in treatment of chronic low back pain. The effect size reaches clinical relevance. No significant side effects were found. The effect of physiotherapy can be improved by radial ESWT.
Traditional Joint Adhesion Mobilization、Muscle Energy Technique Combined with Shock Wave Therapy for Stiff Ankle

Liu Hui, Liu Bo, Zhang Xin, Zhao Weixia, Zhang Xiaofang, Jing Zhuzi, Wu Sa

Institution: Department of Rehabilitation, Sichuan Provincial Orthopedic Hospital, Chengdu; China 610041

Device and producing company: STORZ、MP100

Material and Method: Wax、traditional joint adhesion mobilization、muscle energy technique、shock wave therapy（STORZ、MP100）and cryotherapy were performed in 26 stiff ankle patients with unilateral ankle and/or foot fracture、calf muscle or tendon injury or those after operation for 4 weeks. It was assessed by dorsiflexion、plantarflexion、total range of motion（ROM）、the american orthopaedic foot and ankle society ankle hindfoot scale（AOFAS-AH）、Activities of Daily Living（ADL）、per 2 weeks.

Results: dorsiflexion、plantarflexion、total ROM、AOFAS-AH and ADL all had improvements, the improvement rate of the first two weeks was much better than the last two weeks. After 2 and 4 weeks of treatment had statistically significant improvements（P<0.05）on dorsiflexion（-3.92±12.98/2.58±12.06/6.19±9.50）、plantarflexion（31.35±11.36/34.23±10.27/34.62±9.89）、total ROM（27.42±15.51/36.81±14.91/40.81±13.63）、AOFAS-AH（55.15±12.77/66.19±14.06/69.58±12.75）and ADL（71.92±19.40/78.65±17.12/81.73±15.55）than pre-treatment. After 4 weeks of treatment had statistically significant improvements（P<0.05）on dorsiflexion、total ROM、AOFAS-AH and ADL than after 2 weeks of treatment.

Conclusion: Traditional joint adhesion mobilization、muscle energy technique combined with shock wave therapy for stiff ankle patients which could improve the ROM and function of ankle, increase activities of Daily Living.

Objective: To observe the effects of traditional joint adhesion mobilization、muscle energy technique combined with shock wave therapy for stiff ankle patients
Treatment of Hypertonia in Multiple Sclerosis: Botulin Toxin Injection and radial Shockwave Therapy

Antonio Ammendolia, Cinzia Marinaro, Oriana d'Esposito, Angelo Indino, Gerardo de Scorpio, Maurizio Iocco

Institution: University of Catanzaro "Magna Graecia" - Physical and Rehabilitative Medicine Residency Program, Catanzaro; Italy
Device and producing company: EMS Dolorclast

Introduction: For treatment of MS hypertonia use of botulinum toxin injection is recommended, but some experiences about radial shockwave therapy are reported. To compare therapeutic efficacy of these therapies in patients.

Material and Method: We enrolled 32 patients and randomly divided in 2 groups: A (treated by ultrasound-guided BoNT-A injections in calf muscles) and B (treated by 4 sessions of rSWT). All patients were evaluated before treatment (T0), 1 month (T1) and 3 months (T2) after the end of the treatments, using MAS, Tardieu Index (TI), and ROM measured by two-camera optoelectronic system and surface electromyography (sEMG) of treated muscles, in passive dorsal flexion and active plantar flexion.

Results: In both groups at T1 we observed: important reduction of MAS and TI score, improvement of ROM active and passive and decrease of tonic stretch reflex. At T2, there was a decrement of results for both therapies, but more statistically significant for rSWT. During treatment and follow-up no collateral effect ascribable to BoNT-A injection and rESWT therapy were recorded.

Discussion: BoNT-A is widely used for the treatment of post-stroke spasticity and has recently gained widespread confirmation of its efficacy in MS, but it is an invasive therapy, painful in injection site. BoNT-A has a limit of presenting a maximum dose of injection for safety and it need a long interval between two injections (>4months). rESWT has the advantage of being a simple, safe and non-invasive therapy, repeatable over time without limits of safety doses. Its efficacy has been found in many studies for the focal treatment of spasticity, in patients with Stroke, in Infantile Cerebral Palsy and in MS.

Conclusion: Both therapies are effective for treating spasticity in MS. BoNT-A injections have prolonged effects. rSWT lost effect shortly after the end of the treatment, but are repeatable without side effects.
Long Term Assessment of Effects of Shock Wave Treatment in Children with Cerebral Palsy Evaluated Using Point Shear Wave Elastography

Carla Di Luise, Mariantonia Albano, Valeria Servodidio, Bruno Corrado, Elena Augusta, Gianfranco Vallone, Sergio Russo

Institution: University of Naples Federico II, Naples; Italy
Device and producing company: Duolith SD1, Storz

Introduction: ESWT has effects on hypertonic muscles. We used point shear wave elastography to assess the effectiveness of ESWT in reducing soleus muscle contracture in children with cerebral palsy, and analysed the correlation between the Modified Ashworth Scale and ultrasound elasticity index.

Material and Method: 21 children with spastic CP received ESWT (5 sessions at weekly interval, 500 defocused shockwaves per session, 0.25 mJ/mm2, 3 Hz). The effects were measured by means of point shear wave elastography 1, 3, and 6 months after therapy.

Results: Linear mixed effects modelling showed significant reduction of muscle stiffness, with the predicted greatest effect at the 13th week after completion of treatment. Analysis of covariance confirmed the correlation between the Modified Ashworth Scale and ultrasound elasticity index.

Discussion: Point shear wave elastography confirmed the effectiveness of defocused extracorporeal shockwaves in reducing muscles contracture in children with cerebral palsy. We recommend the use of this technique for the clinical assessment of spastic patients.
Different Therapeutic Effect of Extracorporeal Shockwave in Spastic Children with Genetic or Non-Genetic Etiology

Ka Kit Michael Siu, Jih Yang Ko, Pi-Lien Hung

Institution: Kaohsiung Chang Gung Memorial Hospital; Taiwan

Device and producing company:

Introduction: Cerebral palsy (CP) represents the motor impairment caused by the damage of a developing brain, whereas Rett syndrome represents motor deficit caused by MeCP2 gene mutation. The pathophysiology of these medical conditions may lead to spasticity, which is being a major cause of disability, affecting daily activities and quality of life. Rett syndrome manifests more severe musculoskeletal problems than cerebral palsy. The traditional rehabilitation program, oral medicine and surgical intervention have some limitations in spastic children with genetic and non-genetic etiology. This study aims to investigate the therapeutic effect of shock wave therapy in spastic children with genetic and non-genetic etiology.

Material and Method: 7 patients with cerebral palsy and 7 patients with Rett syndrome were enrolled in this study. They received electromagnetic shock wave therapy with regimen of 1,500 pulses, 0.03mj/mm2 energy, and 4 Hz of frequency once weekly, lasting for 12 weeks. Modified Ashworth Scale and Gross Motor Function Measure were performed at 0, 4 and 12 weeks as primary outcome measurement. Gastrocnemius ultrasound elastography at 0,4,12 weeks was utilized as secondary outcome measurement.

Results: The lower limbs spasticity in cerebral palsy showed significantly improved after 12-week of shock wave therapy (p=0.049), otherwise the limbs spasticity in Rett syndrome (p=0.32) was not responsive to shock wave therapy.

Discussion: Our study provided evidences that ESWT can improve spasticity over medial gastrocnemius and soleus muscle in patients with cerebral palsy by reducing muscle thickness and stiffness after once weekly, totally 12 sessions of treatment. We hypothesized that the mechanism of reduction in spasticity after ESWT may be due to its direct action on fibrous areas by altering the rheological properties of chronically hypertonic muscles and by reducing intramuscular connective tissue stiffness. Extracorporeal Shock Wave Therapy is beneficial for improving lower limbs spastic in CP patients. The underlying mechanism is worthy of investigation.

Conclusion: The shock wave therapy trended to be better for cerebral palsy rather than Rett syndrome, and the underlying mechanism is worthy to be investigated.
Efficacy of Radial Extracorporeal Shock Wave Therapy Compared To Botulinum Toxin Type A in the Treatment of Lower Extremity Spasticity in Patients with Cerebral Palsy: A Randomized, Controlled, Cross-Over Clinical Trial

Christoph Schmitz (5), Xavi Vidal (1+2), Joan Martí-Fàbregas (3), Olga Canet (1+2), Marta Roqué (4+2), Antonio Morral (1+2), Miriam Tur (1+2)

Institution: (1) Blanquerna School of Health Science, Barcelona; Spain, (2) Ramon Llull University, Barcelona; Spain, (3) Department of Neurology, Hospital de la Santa Creu i Sant Pau; Spain, (4) Global Research on Wellbeing (GRoW) Research Group; Spain, (5) Chair of Neuroanatomy, Institute of Anatomy, Faculty of Medicine, LMU Munich, Munich; Germany

Device and producing company: Swiss DolorClast, Electro Medical System S.A., Nypn, Switzerland

Introduction: This study tested the hypothesis that infiltration with botulinum toxin type A (BoNT-A) is more efficient in reducing plantar flexor muscle spasticity in cerebral palsy than rESWT.

Material and Method: 70 patients were randomly allocated to rESWT (Group A; n=35) or a single infiltration with BoNT-A (Group B; n=35) at time point T0. Six months after T0 (i.e., at T1) patients in Group A received a single infiltration with BoNT-A, and patients in Group B received rESWT. Treatment success was evaluated using V1 and V3 of the Tardieu scale at three weeks (W3), two months (M2) and three months (M3) after both T0 and T1.

Results: In six out of 32 direct comparisons (two muscles [soleus and gastrocnemius], two tests [V1 and V3], two rounds of treatment [starting at T0 and T1] and four times of evaluation per round of treatment [at baseline, W3, M2 and M3 after both T0 and T1]) rESWT resulted in statistically significantly better outcome than infiltration with BoNT-A. The null hypothesis was rejected. There were no significant complications.

Discussion: This study demonstrates that rESWT may be superior to infiltration with BoNT-A in the treatment of plantar flexor muscle spasticity in patients with cerebral palsy. Further studies need to evaluate long-term effectiveness and safety of rESWT in the treatment of plantar flexor muscle spasticity in patients with cerebral palsy.

Conclusion: Our study indicates non-inferiority of rESWT compared with BoNT-A infiltration in the treatment of plantar flexor muscle spasticity in patients with cerebral palsy.
Effectiveness of Corticosteroid Injections versus Extracorporeal Shock Wave for Treatment of Hemplegic Shoulder Pain

Jingjing Zhang, Huizhao Luo, Yang Yang, Hui Xu, Zhiwei Zhao, Yan Li

Institution: Tongren Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai; China

Device and producing company:

Introduction: Objective: To contrast the effectiveness of corticosteroid injections versus extracorporeal shock wave for treatment of hemplegic shoulder pain, and determine which technique was effective for patients with hemplegic shoulder pain.

Material and Method: Sixteen patients with hemplegic shoulder pain were recruited over a 12-month period and all were hospitalized in our ward and clinic. After the baseline screening, all subjects were divided into two groups. One group (eight subjects) received corticosteroid injections, into the subacromial bursa under ultrasound-guided localization. A mixture of 1 ml diprospan + 1% lidocaine 1 ml + 0.9% NaCl 1 ml was injected for one time; another group (eight subjects) received extracorporeal shock wave, once a week for 20 minutes. Daily pain ratings using visual analog scales were assessed at baseline and 1h, 1w, and 1m after therapy. Neer shoulder function score, upper limb Fugl-Meyer motor function score, HAMD scale, SF-36 quality of life score were assessed at baseline and 1m after therapy. Mann-Whitney test was used to compare the efficacy between the two groups. The Wilcoxon signed-rank was used to compare the efficacy before and after treatment in two groups. The level of statistical significance was set at P < 0.05.

Results: After treatment, the effect of two groups of subjects was significantly improved. 1 month later, VAS, Neer shoulder function score, upper limb Fugl-Meyer motor function score, HAMD scale, SF-36 quality of life score were assessed at baseline and 1m after therapy. Mann-Whitney test was used to compare the efficacy between the two groups. The Wilcoxon signed-rank was used to compare the efficacy before and after treatment in two groups. The level of statistical significance was set at P < 0.05.

Conclusion: Our results showed that neither corticosteroid injections was superior to the extracorporeal shock wave in the short time. Both therapy have a similar effect in stroke patients with hemplegic shoulder pain in short time. If necessary, we need to extend our research time.

Keywords: Stroke, hemplegic shoulder Pain, corticosteroid injections, extracorporeal shock wave
Use of Focused Shockwaves in Children Under 18 - is it Justified to Cross the Limit?

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Device and producing company: Direx Orthima

Introduction: For a long time, it was considered that being under 18 years old was a contraindication for the use of focused shockwaves. Currently, this has changed to consider contraindication just the application on an open physis. However, there is no literature analysis of indications, tolerance and results of the use of focused shockwaves in children under 18 years of age.

Material and Method: We retrospectively included patients under 18 years old treated with focused shockwaves due to musculoskeletal pathology from the databases of three centers dedicated to shock wave treatment. We analyse their diagnosis, tolerance to the procedure, results and eventual complications.

Results: 14 cases met the inclusion criteria. The average age was 12.9 years old. The follow-up was between 10 and 42 months with an average of 21.9 months.

Indications were: non-unions in 5 cases, osteochondritis dissecans of the talus in 2 cases, and with one case each: bipartite patella, unicameral bone cyst, non ossificant fibroma, radial agenesis and one bone marrow edema.

13 patients were treated with focused electrohydraulic shockwaves and one with focused electromagnetic. In just one case it was necessary to perform the procedure under sedation. In 13 cases the results were considered favorable. No complications were reported.

Discussion: There is a complete lack of evidence for shockwave in childhood and adolescence, except for urolithiasis (lithotherapy) and spasticity, especially in cerebral palsy patients treated with radial pressure waves. According to our knowledge, an analysis of focused shockwaves indications in childhood has not been previously done in the literature.

The most frequent indication in our series was osteoarticular pathologies. The use of shockwaves has allowed in these cases to avoid complex and expensive procedures, prolonged postoperative and possible complications.

Conclusion: Most of the indications in this age group are related to osteoarticular pathology. Focused shockwaves were a safe and effective procedure in children under 18 years of age. No complications were reported in in the short- and medium-term follow-up.

In most cases the treatment could be carried out without the need for anesthesia.
Low Energy ESWT and Acupuncture, is it the right Combination
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Institution: (1) Center for Rehabilitation, Neurology and Sports Medicine; Czech republic, (2) Charles University Prague, 2nd Medical Faculty, Department of Neurology; Czech Republic

Device and producing company: ESWT device: BTL, BTL SWT6000

Introduction: Authors are describing experience with application of low energy ESWT at various pathological conditions of locomotive system. There are in the West medicine and in the Traditional Chinese Medicine many logical relations- acupuncture point-trigger point, meridian –dermatome, therefore is chance to suggest that combination of these techniques will be beneficial for the treatment of the patients.

Material and Method: We have decided for application of Low energy ESWT -Dynamic myofascial treatment to combine with Acupuncture to try to enlarge the effect of the treatment. Dynamic myofascial treatment is aplicated multisegmentally to the muscle chains, pseudoradicular and radicular projections zones of pain. This application was widen with the stimulation of the regional and distant acupuncture points.

Results: Our presentation is not scientific study, but as practical experiment where we tried to use these techniques to increase therapeutical effect.

Discussion: Disorders of locomotive system are very common in the population, with varying intensity and symptoms. We have again confirmed, that the low energy is effective in treatment of locomotive system, better results were reached in combination with stimulation of acupuncture points.

Conclusion: According the results of this study authors the combination of Dynamic myofascial treatment and Acupuncture can recommend as safe and effective form of treatment.
Unfocused Low Intensity Extracorporeal Shock Wave Therapy, Li-ESWT, for Nocturia and Erectile Dysfunction
Brent A. Sharpe

Institution: Georgia Urology; USA
Device and producing company: MTS / TRT - OrthoGold 100

Introduction: Introduction and Objective: Low energy sounds waves are used to treat a variety of acute and chronic medical conditions and are growing in popularity for the treatment of erectile dysfunction (ED). Since 2007, nearly 350 Shockwave Therapy (SWT) devices have been sold in the USA with a over 250,000 patients treated for ED. While most SWT devices utilize radial/ballistic SWT technology, the recently FDA cleared UroGold SWT device manufactured by MTS Germany and distributed by Tissue Regeneration Technologies utilizes unfocused electro-hydraulic SWT (SoftWaves). Due to the large number of inquiries at our practice, primarily driven by intense radio advertisements from non-urologist providers, we wanted to verify the utility and efficacy of SWT in men with ED prior to its practice wide use. We report the first study utilizing unfocused electro-hydraulic SWT for ED and Nocturia.

Material and Method: Fifteen patients were enrolled to receive 2000 pulses for 6 treatment sessions over a 10 week period. Patient’s ages ranged from 54 to 80 (64 average). SWT was evenly divided between 3 treatment sites on the penis shaft, crura, and perineum area without the use of topical anesthetics. No pretreatment medication was utilized. After 12 weeks, patients were asked to complete the post treatment questionnaire regarding their erectile function. They were specifically asked to quantify their subjective erectile function improvement on a scale of 0-100%.

Results: Average improvement for the ED group was 47% and 86% of patients had at least a 40% improvement. All but one patient had some improvement. No patients reported pain, bruising or other complications during the treatment. Within 2 weeks of their first treatment several patients reported a decrease in nocturia and retrospective data was collected from 11 patients who had preexisting nocturia. 73% of the patients reported a reduction in the number of night time urinations of at least 50%. Three patients decreased bathroom visits from 6 times to 1 time per night and the average decrease in bathroom visits was 64%. All results are statistically significant and no adverse events reported.

Conclusion: We report the first study using unfocused, electro-hydraulic SWT for ED and Nocturia. SWT is a noninvasive treatment which can significantly improve erectile function and Nocturia without pain or complications.
Efficacy of Radial Extracorporeal Shock Wave Therapy for Chronic Pelvic Pain Syndrome: A non-Randomized, Controlled Trial
Zhao-Xuan Zhang, Dai Zhang

Institution: the First Hospital of China Medical University, China
Device and producing company: MASTERPULS® MP100, STORZ MEDICAL AG, Switzerland

Introduction: This study aims to determine the effect of radial extracorporeal shock wave therapy (rESWT) versus drug when treating chronic pelvic pain syndrome (CPPS) (type III B chronic prostatitis).

Material and Method: The study included 45 participants with CPPS, divided into two groups: Group I numbered 25 participants, who were treated with rESWT (3000 pulses each; pressure: 1.8-2.0 bar; frequency: 10 Hz) once a week; Group II consisted of 20 participants who received a combination of an α-blocker and an anti-inflammatory agent. Participants were treated for eight weeks. The assessments were done before treatment, after the 4th and 8th rESWT, and three months after the end of treatment by Visual Analogue Scale (VAS) for pain, National Institutes of Health -developed Chronic Prostatitis Symptom Index (NIH-CPSI), International Prostate Symptom Score (IPSS), quality of life (QoL), and International Index of Erectile Function-5 (IIEF-5).

Results: Both groups of participants showed statistically significant improvement in all the assessments (P<0.001) after the treatment, with significantly better results in the Group I in NIH-CPSI (P<0.001). The recurrence rate of symptoms in the Group I at three months post end of treatment was much lower than that in the Group II (4% vs. 50%, P<0.001).

Discussion: CPPS is a frequently-occurring disease with poor drug efficacy and side effects, posing great challenges for clinicians. This study proved that rESWT is a comparable therapy without side effects for CPPS compared with the combination of an α-blocker and an anti-inflammatory agent, although it did not compare rESWT with fESWT. The possible mechanism through which rESWT can improve CPPS may be partly mediated by the anti-spasm effect and the protective effects on inflammatory reaction. rESWT has a higher frequency than fESWT, and the same number of pulses takes less time. Although rESWT is not as convenient as a drug to be taken at home, it requires hospital treatment, but this non-invasive and convenient physical method provides a new and promising option for CPPS. It will be further explored whether shortening the treatment interval and increasing the intensity will improve the efficacy.

Conclusion: This prospectively non-randomised, control study revealed perineal rESWT as a new therapy option for CPPS with statistically significant effects in comparison to drugs at least for three months after the cessation of treatment.
Treatment of Complications of Radiotherapy and Brachytherapy with Shock Waves
Heriberto Carlos Bickmann, Peter Marinov Mihaylov

Institution: Clinica Sagrada Esperança, Luanda; Angola

Device and producing company:

Introduction: Currently the treatment of CAP is done fundamentally by radical surgery, radiotherapy and brachytherapy that give patients a significant cure of the pathology about 45% of patients are submitted to Radical Prostatectomy, 38% Radiotherapy and 16% brachytherapy

Based on personal experience of shock wave treatment in pelvic inflammation in women and prostatitis in men we decided to treat complications of brachytherapy and radiotherapy to patients that complications such as dysuria, need Imperative of urinating (Polaquiuria), voiding urination, urgency and voiding dissatisfaction, hematuria and urinary incontinence, bladder irritation, discomfort in the perineum, decreased urinary flow This symptomatology that alters the patient's quality of life after of this treatment

Material and Method: Treatment was performed in 4 patients who underwent radiotherapy and 13 treated with brachytherapy were performed 7 sections with 2500 pulses with 2 Bars frequency of 11 to 15 frequencies in the perineum region and 1500 impulses with 2 Bars on the Hypogastro using the MP50 and MP Ultra devices

Results: Most patients presented improvements in the 2-3 section and complete disappearance of symptoms in the 6-7 section

Discussion: Pathophysiology the inflammatory phenomena and fibrosis induced by oncologic treatment, initially cause loss of elasticity of tissues followed by progressive hardening associated with retraction depending on the tissues affected Hypoplasia, sequestration, ulceration and including necrosis, fibrosis and entraining of nervous structures or obliterations of vascular structures were used, accompanying functional alterations depended on the anatomical location of the irradiated area and Included pain, lymphedema, loss of motility of neuropathies

Conclusion: The symptomatology after radiotherapy and very uncomfortable for patients and it is very difficult to treat with medications in the improvement of this symptomatology, after the treatment we obtained about 90% with considerable improvements none of Patients again had the same symptomatology.
Treatment of Renal Partial Staghorn Calculi in Children with Extracorporeal Shockwave Lithotripsy

Jianye Jia, Yi Zhang, Chengfan Yu, Xiaofeng Wang

Institution: Department of Urology, Peking University International Hospital, No. 1, Life Garden Road, Zhongguancun Life Science Park, Changping District, Beijing; China

Device and producing company: Dornier Compact Delta II

Material and Method: From March 2009 to September 2013, 53 children (age 7 months to 12 years) underwent ESWL for treatment of renal partial staghorn calculi using a Dornier Compact Delta II lithotripter. Technical parameters were selected and recorded based on the age of the children. The number of shock waves and energy level used were 1000-3500 and 2.5-45 mJ, respectively. No more than three ESWL treatments were used. The interval between sessions was no less than three weeks. Treatment was considered successful if a patient was free of stones on B ultrasound and CT scan after a 3-month interval. Patient, stone, and kidney characteristics were evaluated as predictors of ESWL success using univariate and multivariate analyses.

Results: Overall, 45 of 53 patients (84.9%) became stone-free after the ESWL treatment. In four cases (7.55%), the stones failed to break after 3 sessions; they were then managed using PCNL. Four other children (7.55%) had residual stones. The statistical analyses revealed that only the CT value had a statistically significant effect on ESWL success. The ESWL success rate was 94.1% in patients with a stone of <800 HU and 68.4% for ≥800 HU (p=0.035). Eventually, we summarized the technical parameters for paediatric renal partial staghorn calculi based on the age of the child being treated.

Conclusion: Monotherapy ESWL is a safe and effective method for treating paediatric renal partial staghorn calculi. We recommend that it be the first-option therapy for calculi of <800 HU. We believe that the technical parameters of ESWL in this study are valuable recommendations for paediatric patients, especially infants, but not for adults.

Objectives: To evaluate the safety and efficacy of extracorporeal shock wave lithotripsy for treating renal partial staghorn calculi in children and to present our experience.

Keywords: staghorn calculi, lithotripsy, children
The Extracorporeal Shock Wave Apply to the Latent Myofascial Trigger Point in the Abdomen for the Primary Dysmenorrhea: A Clinical Study
Li Tang, Yanli >angyang, Huixu Jiaweini

Institution: Tong Ren Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai; China

Device and producing company:

Material and Method: Twenty patients with PD were enrolled and randomly divided into the experimental group (n=10) and the control group (n=10). In the 1-2 days after the end of the menstrual period, the experimental group applied extracorporeal shock wave to the latent trigger points on the rectus abdominis muscle and the external oblique muscle; the control group was irradiated with infrared rays. The pain level was assessed by visual analogue scale (VAS) within 1-2 days of the menstrual period, and anxiety was assessed by the Self-rating Anxiety Scale (SAS).

Results: 1. The experimental group was treated for 2 cycles. After 3 months of follow-up, the effective rate was significantly higher than that of the control group. 2. The mean VAS scores of the experimental group after treatment were significantly lower than those before treatment (P < 0.01). 3. The postoperative self-rating anxiety scale (SAS) score of the experimental group was significantly lower than that before treatment (P < 0.01).

Conclusion: Extracorporeal shock wave acts on the latent myofascial trigger point to treat primary dysmenorrhea, can significantly alleviate the pain symptoms, and has high efficiency, which is worthy of clinical promotion.

Objective: To observe the effect of extracorporeal shock wave apply to the latent myofascial trigger point in the abdomen for the primary dysmenorrhea (PD), in order to provide a new method for clinical treatment of PD.

Keywords: primary dysmenorrhea; latent myofascial trigger point; extracorporeal shock wave
Institution: Department of Osteonecrosis of the Femoral Head, Luoyang Orthopedics Hospital of Henan Province, Luoyang; China

Device and producing company:

A 43-year-old woman with a traumatic right femoral neck fracture of the subcephalic type and Garden3 type. After 13 months of open reduction and screw fixation of proximal femoral locking bone plate, weight bearing and hip pain and discomfort after walking were performed in the local hospital, and X-ray examination showed clear fracture line.

Previous physical history showed no other risk factors for femoral head necrosis. 4 months after the operation, the fracture line was clear, and the improvement was not ideal after 16 months of the use of both crutches and drugs (Chinese Herbal medicine for liver, kidney and bone grafting), and the fracture healing process was slow. The re-examination of the X-ray film 20 months after the surgery showed that the internal fixation was reliable, and the high-energy focused shockwave therapy was started. After 7 times of treatment, the fracture reached the standard of complete healing: the fracture line disappeared, and there was no pain or discomfort after abandoning the crutches.

This case demonstrates that the use of a high-energy focused shockwave can accelerate fracture healing in the context of reliable internal fixation.
Extracorporeal Shock Wave Therapy is Efficient and Safe in the Treatment of Fracture Non-Unions: A Multicenter Retrospective Study
Liang Haojun, Xing Gengyan

Institution: The Third Medical Center of the PLA General Hospital, Beijing; China
Device and producing company: EMS
Material and Method: A multicenter retrospective study was performed for 50 patients of nonunion. All patients were treated with ESWT. Patients were divided into two groups, Group + (complete bone healing) and Group - (incomplete bone healing), based on treatment outcomes. Gender, age, time periods from injury and/or last surgery to ESWT and number of sessions were compared between the two groups.

Results: In 46% of patient complete bone healing was observed after ESWT treatments. The femoral was the most common treated bone in our study (42%). There were no statistically significant gender differences observed among patients with two groups, nor was there a statistically significant difference in the mean number of ESWT sessions applied. There was a statistically significant difference between two groups with regard to the time periods from injury and/or last surgery to the first ESWT.

Conclusion: ESWT proved to be a safe, effective and non-invasive treatment modality in the management of fracture non-unions. The results of this study encourage early application of ESW to intervene in non-unions. More multicenter randomized controlled trials should be conducted in the future.

Objective: A lot of evidence supports the use of extracorporeal shock wave therapy (ESWT) in the treatment of non-unions. On the other hand, there is a lack of multi-center research for this indication. The purpose of present study was to evaluate the effectiveness of ESWT and the role of this therapy in the treatment of non-unions by multi-center research.
Extracorporeal Shock Wave Therapy for Medial Tibial Stress Syndrome in Adolescent Athletes
Hidetaka Murakami (1), Koji Noguchi (2), Takuro Sugiyama (3), Naoto Shiba (3)

Institution: (1) Murakami Surgical Hospital; Japan, (2) Kurume University Medical Center; Japan, (3) Kurume University; Japan

Device and producing company: Duolith® SD 1 (STORZ MEDICAL, Switzerland)

Introduction: Extracorporeal shock wave therapy (ESWT) for sports injuries is used for tendinopathy and stress fracture. In this study, we conducted ESWT for medial tibial stress syndrome (MTSS) in adolescent athletes.

Material and Method: Sixteen cases who resisted conservative treatment for more than 2 weeks in Walsh classification stage 3 or higher were treated. In addition to X-ray, echo and MRI were performed and confirmed thickening and bone marrow edema of the tibia medial periosteum. ESWT was performed with Duolith® SD 1 (STORZ MEDICAL, Switzerland) at weekly intervals. We applied 3000 shocks at an energy flux density of 0.01 to 0.15 mJ/mm² depending on pain. Four weeks after ESWT, NRS (Numerical Rating Scale) with 10 pain before treatment started were evaluated.

Results: The average age was 14.7 years old, 5 girls and 5 boys. The average time from conservative therapy start to ESWT was 4.3 weeks. NRS was 1.6 on average, all cases pain improved and was able to return to the original competition level.

Discussion: ESWT has been used to stimulate bone repair and remodeling with apparent affect in both human and animal trials. There are some studies the effect of ESWT about MTSS. Almost reports are positive result for ESWT. However, there is no report that investigated the effect of ESWT about MTSS in adolescent athletes. In this study, the adolescent athletes who resisted conservative treatment improved and were able to return to the original competition level after ESWT. The limitations of this study were the small number of participants and no control group.

Conclusion: ESWT is also effective for MTSS, and ESWT is recommended when conventional conservative treatment is ineffective.
Short-Term Effects of Extracorporeal Shock Wave Therapy on Bone Mineral Density in Postmenopausal Osteoporotic Patients
Lee Joon (1), Gao Fuqiang (2), Sun Wei (2)

Institution: (1) Beijing Union Medical College, Beijing; China, (2) China-Japan Friendship Hospital, Beijing; China

Device and producing company: Dornier Compact DELTA II

Material and Method: A total of 64 postmenopausal osteoporotic patients were recruited and randomized into 3 groups in 2015. Groups A (n = 20) and B (n = 21) patients received a single-session of low- or high-energy flux density (EFD) ESWT in the left hip, respectively, whereas group C (n = 23) patients served as controls without the ESWT treatment. All patients self-administered alendronate sodium tablets orally for a year. The BMD of the lumbar spine (L2-L4), femoral neck, great tuberosity, and total left hip was measured before ESWT treatment and at 3, 6, and 12 months using dual energy X-ray absorptiometry (DEXA).

Results: At 12 months, the lumbar spine, femoral neck, great tuberosity, and total left hip BMD in all patients had increased (p < 0.01). The increase in lumbar spine BMD in group A patients was higher than that in group B patients (p = 0.03); other between-group differences were not observed (p = 0.73, group A vs. C; p = 0.06, group B vs. C). The femoral neck, great tuberosity, and total left hip BMD increases in group B patients were higher than that in either group A or C (p < 0.01, group B vs. A; p < 0.01, group A vs. C).

Conclusion: This study showed that ESWT could efficiently improve the local BMD; relatively, the high dosage was effective.

Aim: This purpose of this study was to evaluate the short-term effectiveness of extracorporeal shock wave therapy (ESWT) on bone mineral density (BMD).
Experimental Study of Unfocused Extracorporeal Shock Waves on Bone of Osteoprototic Rats

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Institution: Department of Orthopaedic Surgery, The Third Medical Center of Chinese Peoples Liberation Army General Hospital, Beijing 100039; China

Device and producing company: EMS

Material and Method: 18 4-month-old female SD rats were randomly divided into Control group, OVX+HLU group and ESW group. Six rats per group. Every rat in OVX+HLU group underwent ovariectomized as well as tail suspension. The rats in ESW group received ESW treatment after OVX+HLU. The ESW treatment (energyflowdensity: 3bar, frequency:5Hz, 1500 pulses) was applied to the hind leg of osteoporotic rats for four weeks and once per week. One month later all of the rats were sacrificed and the left tibias were collected with soft tissue removed. Then we used Micro-CT, Dual-energy X-ray absorptiometry, three-point bending test and scanning electron microscopy (SEM) to observe the bone. The data were analyzed by SPSS 21.0 statistical software.

Results: The basic search results show that ESW can improve rats’ knee limb function and delay the OA degeneration. Through controlling the rebuilding of rat knee joint cartilage, the mechanism of articular cartilage degeneration has been relieved. According to the clinical research results, ESW can effectively relieve the pain of OA patients and improve limb functions.

Conclusion: Unfocused Extracorporeal shock wave could significantly improve relative trabecular bone volume and trabecular number in the OVX+HLU rats, thereby delaying the progression of osteoporosis. Therefore, Extracorporeal shock wave in the divergent treatment of osteoporosis has great potential. Unfocused ESW might be promising in the treatment of osteoporosis.

Objective: The aim of this study was to investigate whether unfocused extracorporeal shock waves affected bone micro-architecture of a osteoporotic rat model or not, which was established by ovariectomy (OVX) combined with hindlimb unloading(HLU).

Keywords: Osteoarthritis, bone density, Extracorporeal shock wave
Effects of Extracorporeal Shock Wave Therapy on Bone Morphometry and Serum Osteocalcin in Rats with Disused Osteoporosis

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Institution: (1) First Hospital of Harbin City, Harbin Medical University, Harbin; China
Device and producing company: EMS, Dolorclast; XIANGYU, XY-K-shockmaster-500B; XYS.GU-1D

Introduction: To observe the effects of extracorporeal shock wave (ESWT) on bone morphometry and serum osteocalcin concentration in rats with disuse osteoporosis (DOP), and to explore the possible mechanism of ESWT in treating DOP.

Material and Method: Female SD rats weighing 250-280g were randomly divided into four groups: normal control group (INT group), disused model group (DOP group), drug treatment group (ALN group), extracorporeal shock wave treatment group (ESWT group). Twenty rats in each group, except normal control group, were used to establish disused osteoporosis model by tail fixation. ALN group rats were given alendronate sodium (1 mg•kg-1•d-1) After treatment, rats in ESWT group were given shock energy of 1 bar, shock frequency of 6 Hz, 1000 shocks, once every 5 days. Bone morphometry and serum osteocalcin concentration were measured at 4, 8 and 12 weeks after treatment.

Results: Four weeks after modeling, ALN group% Tb. Ar and Tb. N were significantly higher than DOP group, Tb. Sp was lower than DOP group, the difference was significant (P < 0.01). Eight weeks after modeling, ALN and ESWT group% Tb. Ar and Tb. N were higher than DOP group, and Tb. Sp was smaller than DOP group, the difference was significant (P < 0.05 or P < 0.01); Tb. Th was slightly higher than DOP group, the difference was not significant. Four weeks after modeling, the BGP concentration in ESWT group was significantly higher than that in ALN group (P < 0.01). Eight weeks after modeling, the serum BGP concentration in PEMF Group continued to rise, which was significantly different from that in DOP group and ALN group (P < 0.01). At 12 weeks, the concentration in ALN group was lower than that in DOP group (P < 0.05).

Conclusion: Both ESWT and drugs can prevent and treat disused osteoporosis by altering the microstructure of bone tissue. ESWT may influence the process of bone remodeling by promoting the secretion of osteocalcin.

Keywords: Extracorporeal shock wave, Disused osteoporosis, Bone morphometry, Serum osteocalcin, Clinical effect.
Extracorporeal Shock Wave Therapy in the Treatment of Primary Bone Marrow Edema Syndrome of the Knee: A Prospective Randomised Controlled Study

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Institution: Harbin Institute of Medical Sciences, Harbin First Hospital Affiliated to Harbin University of Technology, Harbin; China

Device and producing company:

Material and Method: This study compared the outcomes of ESWT (Group A) (n = 32) and intravenously applied bisphosphonate (Group B) (n = 32) in the treatment of BMES of the knee in our department between 2016 and 2018. The Visual Analog Scale for pain (VAS, 100 mm), the Western Ontario and McMaster University Osteoarthritis Index (WOMAC), the SF-36 scores and MRI scans as well as plain radiographs were obtained before and after therapy between two groups.

Results: Compared with Group B, we found greater improvement in VAS, the WOMAC Osteoarthritis Index and SF-36 score at 1, 3 and 6 months post-treatment in Group A (P < 0.05). Furthermore, MRI scans showed a higher incidence of distinct reduction and complete regression of bone marrow edema at 6 months in Group A (95 vs. 65 %; P = 0.018). The MRI at 1 year follow-up showed complete regression in all patients in Group A. However, two cases in Group B continued to normalize over the subsequent follow-up period.

Conclusion: ESWT can produce rapid pain relief and functional improvement. It may be an effective, reliable, and non-invasive technique for rapid treatment of BMES of the knee.

Objective: The aim of this prospective study was to evaluate the effectiveness of extracorporeal shock wave therapy (ESWT) in normalizing the symptoms and imaging features of primary bone marrow edema syndrome (BMES) of the knee.
High-Energy Focused Extracorporeal Shock Wave Shortens the Natural Course of Bone Marrow Edema Syndrome of the Hip
Leilei Zhang, Dawei Liang, Xiantao Chen, Xiantao Chen

Institution: Department of Osteonecrosis of the Femoral Head, Luoyang Orthopedics Hospital of Henan Province, Luoyang; China

Device and producing company: Dornier Compact Delta II

Introduction: Bone marrow edema syndrome (BMES) of the hip represents a reversible but highly painful finding in magnetic resonance imaging (MRI), and has the risk and possibility of developing to osteonecrosis of the femoral head (ONFH). The aim of this retrospective study was to evaluate the efficacy of high-energy focused extracorporeal shock wave therapy (HF-ESWT) on painful BMES of the hip.

Material and Method: Thirty-four hips in 28 consecutive patients with BMES of the hip were treated with HF-ESWT in our department between August 2017 and July 2018. The progression and treatment results of BMES were evaluated by imaging examination and clinical outcomes. The clinical outcomes include hip pain and function which were measured using the visual analog scale (VAS) for pain and Harris hip score (HHS), respectively. The imaging examination was measured with MRI scans.

Discussion: HF-ESWT can achieve precise localization, real-time monitoring of the impact site and recording the impact energy value in the treatment process, and ultimately achieve the purpose of accurate and efficient treatment. It is a safe, effective, reliable, and noninvasive treatment in patients with painful BMES of the hip, and it can accelerate the recovery of BMES of the hip, shorten the treatment time, reduce the economic cost, improve hip joint function and the quality of life of patients.

Abbreviations: BMES = bone marrow edema syndrome, HF-ESWT = high-energy focused extracorporeal shock wave therapy, VAS = visual analog scale, HHS = Harris hip score

Keywords: bone marrow edema syndrome, MRI, hip, pain, shock wave
High-Energy Focused Extracorporeal Shock Wave Shortens the Natural Course of Bone Marrow Edema Syndrome of the Hip
Xiantao Chen, Leilei Zhang, Dawei Liang

Institution: Department of Osteonecrosis of the Femoral Head, Luoyang Orthopedics Hospital of Henan Province, Luoyang, China.

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Abbreviations: BMES = bone marrow edema syndrome, HF-ESWT = high-energy focused extracorporeal shock wave therapy, VAS = visual analog scale, HHS = Harris hip score

Keywords: bone marrow edema syndrome, MRI, hip, pain, shock wave
Application of High-Quality Nursing Function Exercise in the Rehabilitation of Patients with Early Femoral Head Necrosis Treated By Extracorporeal Shock Wave

Sijiao Yu

Institution: The First Hospital of Harbin Institute of Technology, 8th unit of Orthopedic, Harbin; China

Device and producing company:

Material and Method: Seventy patients with early femoral head necrosis from April 2017 to December 2018 were enrolled. The subjects were divided into two groups by random number method, 35 cases were in the observation group and the control group, respectively. Both groups were treated with extracorporeal shock wave. The observation group used the high-quality nursing function exercise mode developed by the research team, and the control group used the regular care mode. The hip function score and quality of life score were compared between the two groups before and after the study used Harris score and SF-36 quality of life score scale.

Results: There was no significant difference in Harris and SF-36 scores between the two groups before the intervention (P>0.05). After the intervention, the total scores of Harris and SF-36 in the observation group were better than those in the control group, and the differences were statistically significant ( p<0.05).

Conclusion: High-quality nursing functional exercise combined with extracorporeal shock wave treatment of early femoral head necrosis is not only beneficial to the recovery of hip function. At the same time, it can improve the quality of life of patients and it is worthy of promotion and application in clinical nursing.

Objective: To investigate the effect of high-quality nursing function exercise in the rehabilitation of patients with early femoral head necrosis treated with extracorporeal shock wave.

Keywords: Functional exercise; Extracorporeal shock wave; Early femoral head necrosis; Functional recovery
Indications of High-Energy Extracorporeal Shock Wave Therapy for Osteonecrosis of the Femoral Head
Xiantao Chen, Leilei Zhang, Dawei Liang

Institution: Department of Osteonecrosis of the Femoral Head, Luoyang Orthopedics Hospital of Henan Province, Luoyang; China
Device and producing company: Dornier Compact Delta II
Introduction: Non-traumatic osteonecrosis of the femoral head (ONFH) is treated with a series of methods. High energy extracorporeal shock wave therapy (ESWT) is an option with promising mid-term outcomes. The objective of this retrospective study was to evaluate the effects of treatment of early stage ONFH with high-energy focused extracorporeal shock wave therapy (HF-ESWT).
Material and Method: 210 hips in 180 consecutive patients were treated with HF-ESWT in our hospital between May 2018 and January 2019. Each patient underwent three sessions. The Association Research Circulation Osseous (ARCO) staging criteria was used to evaluate the degree of necrosis of femoral head. The visual analog pain scale (VAS), Harris hip score, radiography, and magnetic resonance imaging were used to estimate treatment results. Patients were followed up at 3, 6 months after the treatment.
Results: Most of the patients (87.9% hips) demonstrated pain reduction and improved mobility of the treated joint. A significant reduction in bone marrow edema was observed after treatment and are expected to replace the decompression of the core. Patients with large necrotic area and poor surgical expectation have improved the symptoms and promoted osteogenesis. Patients with bone resorption after bone grafting have played a role in remedial effect and bone density of femoral head has significantly improved. The mean VAS decreased from 4.14±1.81 before ESWT to 2.17±0.76 points at the follow-up (p < 0.001). The mean Harris hip score improved from 59.42±5.88 before ESWT to 87.42±4.78 points at the 6 months follow-up. No femoral head collapse or total hip arthroplasty occurred during follow-up.
Conclusion: There is increasing evidence that high-energy focused shock waves play an increasingly active role in the treatment of femoral head necrosis, which is effective and safe, resulting in pain relief and function restoration. However, the specific mechanism and clinical efficacy of shock waves still require multi-center, large-sample, long-term observational studies.
Keywords: High-energy extracorporeal shock wave therapy, Osteonecrosis, Femoral head, Follow-up studies, Bone marrow edema
Pilot Trial, First Report Worldwide for Li-SWT (unfocused SoftWaves) for the Treatment of Testicles to Improve Testicular Size and Function.

John Warlick

Institution: Tissue Regeneration Technologies, LLC (TRT); USA
Device and producing company: UROGOLD 100; MTS, TRT
Introduction: In the USA, since 2007, 350 SWT devices have been sold for the treatment of erectile dysfunction with over 250,000 patients treated. The average fee for these treatments is $4000 and is most often performed by a non-urologist. Chiropractors perform the majority of the ED treatments in the USA with SWT devices. At least 90% of the devices sold in the USA are radial/ballistic devices. As reported by physicians from the Mayo clinic at the 2018 ISSM conference in Lisbon, the average success rate is about 50%. To improve the outcomes of these ED treatments, it was hypothesized that the testicular health and function could be improved with SWT.

Material and Method: A four patient pilot trial for the treatment of the testicles was conducted in 2018 with four (4) subjects enrolled. The subjects average age was 62 (range 57 – 71). All subjects reported typical symptoms of low testosterone. No subjects utilized other Low – t therapies during the pilot study. The average pre-treatment testosterone level for the study cohort was 207 (range 180 – 227). The treatment sessions consisted of 400 – 500 pulses to each testicle at energy levels ranging from .08 mj/mm 2 - .1 mj/mm 2. Patients received either one or two treatments over two weeks and retested their testosterone after an average of 14 days from the first treatment.

Results: The post treatment average testosterone was 299 for an improvement of 45%. No patients reported pain during or after treatment. No analgesic was required during therapy. No adverse events were reported immediately after the treatment or observed after a 4 month follow up.
All of the patients continue to use the therapy and report continued satisfaction and improved libido. Two of the patients, previously on extensive Low t therapy (creams/injections) reported that their previously atrophied testicles returned to normal appearance. Another 85 year old subject (not included above) reports that his testicles and shaft significantly increased in size after multiple treatments and that his erectile dysfunction is greatly improved as a result of this therapy as well as additional treatments to the penis shaft and crura.
The therapy was performed with the FDA cleared UroGold SoftWave therapy device manufactured by MTS, Konstanz, Germany, www.mts-medical.com; and distributed by TRT, Woodstock, GA, www.trtllc.com. TRT has filed a US patent on this new procedure.
Discussion: Additional study is obviously required to determine improved protocols and to determine the quality and duration of the therapy. The testicles appear to be producing natural testosterone and return to near normal size and improve in function.
Conclusion: Based on the results of this pilot trial, TRT is sponsoring an IRB study to expand the number of patients and the scope of the study. IRB partners are being recruited at this time. It appears as if the added treatment of the testicles during ED therapy may support improved outcomes and patient satisfaction.
Characteristics of Pain Changes in Cases in which Extracorporeal Shock Wave Therapy was Effective for Chronic Plantar Fasciitis

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Hisafumi Kobayashi (1), Hidetoshi Hayashi (3)

Institution: (1) Nagano Orthopedic Clinic; Japan, (2) Morinomiya University of Medical Sciences; Japan, (3) Toritsudai Orthopedic Clinic; Japan

Device and producing company: DUOLITH®SD1; STORZ MEDICAL AG

Introduction: There is a report that effective treatment of extracorporeal shock wave is effective for chronic plantar fasciitis, but there are few reports on characteristics of pain change in successful cases.

Material and Method: Comparison of pain changes in success cases of extracorporeal shock wave treatment for chronic plantar fasciitis. Nine patients (mean age: 54.0; range: 34-88) with chronic plantar fasciitis 6 months after onset were treated with extracorporeal shock wave therapy (ESWT). Outcome measure was the visual analog scale (VAS). Subjects were assessed at baseline, before the second ESWT, and before the third ESWT.

Results: At before second ESWT, participants showed significantly less pain (baseline VAS, 8.2 ± 2.1 versus before the second ESWT VAS, 5.3 ± 1.3; P<.001).

Discussion: Successful cases with ESWT of chronic plantar fasciitis had significantly lower pain before the second ESWT than baseline pain. If pain does not change in the first ESWT, the success rate of ESWT may be low.
Treatment Outcomes of Extracorporeal Shock Wave Therapy on Patients with Lateral Epicondylitis – Treatment Efficacy by Occupation

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Institution: (1) Hyakutake Orthopedic and Sports Clinic; Japan, (2) St. Mary's Hospital; Japan

Device and producing company: Duolith SD1, Storz

Introduction: We examined differences in the effectiveness of treatment with focused extracorporeal shock wave therapy (F-ESWT) based on the level of load exerted in different professions.

Material and Method: The subjects were 17 cases 18 elbows who were diagnosed with lateral epicondylitis (LE) and performed F-ESWT. Based on their occupations, the subjects were divided into heavy-load group and the low-load group by metabolic equivalents (METs) groups.

F-ESWT was performed for a total of 9 sessions once in 2 weeks. Clinical evaluation was performed using the VAS and the Japan Orthopedic Association (JOA score).

Results: VAS improved significantly in both groups. Comparison between the heavy-load group and the low-load group did not show any significant difference. The JOA score showed a significant improvement in both the groups. Comparison between the heavy-load group and the low-load group did not show any significant difference.

Discussion: According to some reports, one of the factors for failure of LE treatment is the patient being in an occupation that involves carrying or lifting heavy physical loads. In the present study, however, no significant difference was observed between the treatment outcomes in terms of load level based on occupation. Our results thus demonstrated that when F-ESWT is accurately applied with ultrasonography guidance, the same efficacy can be achieved for heavy-load cases as low-load cases.

Conclusion: F-ESWT for LE can also produce favorable results for patients engaged in occupations that involve carrying or lifting heavy physical loads.
Effects of Focused Extracorporeal Shock Wave Therapy on Calcific Tendinitis by Gartner Classification Type
Shuichiro Sakai (1), Yasuhiro Motsui (1), Tazusa Matsuse (1), Hirofumi Tanaka (1), Hisao Shimokobe (2), Kosuke Hyakutake (1)

Institution: (1) Hyakutake Orthopedic and Sports Clinic; Japan, (2) St. Mary's Hospital; Japan
Device and producing company: Duolith SD1, Storz

Introduction: We conducted a comparative investigation of changes in calcific tendinitis of the shoulder (CTS) and clinical assessment after focused extracorporeal shock wave therapy (f-ESWT).

Material and Method: Subjects were 32 patients (32 shoulders) who were diagnosed with Gartner type 1 (T1 group: 16 shoulders) or type 2 (T2 group: 16 shoulders). f-ESWT was conducted a total of 9 sessions once in two weeks. Clinical assessment was performed with the Visual Analogue Scale (VAS) and Japan Orthopedic Association score (JOA score); for image assessment, calcium deposits were assessed by plain X-ray films.

Results: VAS and JOA score improved significantly for both groups after f-ESWT. There was no significant difference between T1 group and T2 group. A comparison of JOA score for complete resorption and incomplete resorption in the both groups showed significantly higher values for complete resorption. VAS didn't have a significant difference with or without calcium deposits in either of the two groups.

Discussion: Some literatures reported that calcium deposits are more difficult to eliminate with type 1 than with type 2. In this study, the T1 group had a lower rate of elimination of calcium deposits, but a significant difference wasn't demonstrated between the 2 groups. The use of ultrasonography to determine the location of the calcium deposits is believed to have yielded more accurate intonation. Incomplete resorption have been implicated in pain and limited range of motion. In this study as well, JOA scores were shown to be significantly higher complete resorption in both groups.

Conclusion: F-ESWT for CTS had equivalent effects on Gartner type 1 and type 2. Where residual calcium deposits remained, results suggested a decline in functional aspects.
Institution: China Japan Friendship Hospital; China
Device and producing company: Compact Delta II
Introduction: Osteonecrosis of femoral head (ONFH) is an incapacitating disorder with high morbidity. Though extracorporeal shockwave therapy (ESWT) provides a noninvasive healing option, controversial subjects still exist about its efficacy, indication and mechanism.

Material and Method: 1278 patients (2003 hips) were treated with shockwave therapy in our center between Jan 2012 and Jan 2018. The hips were staging and typing according to ARCO Stage and China Japan Friendship Hospital (CJFH) type. Patients were followed up at 3, 6, and 12 months and every year after the treatment.

Results: Most of the patients (79.8%) demonstrated pain reduction and improved mobility of the treated joint. During the follow-up period, 404 hips failed following femoral head collapse and even required hip arthroplasty.

Discussion: For most patients, the lesion size decreased after ESWT, however, the differences were statistically not significant. A significant reduction in bone marrow edema was observed after treat, imaging revealed that bone marrow edema was significantly relieved but the necrotic bone could not be reversed after ESWT. For patients with ARCO III and CJFH type L2 and L3, ESWT treatment failure rate increased obviously.

Conclusion: We could conclude that ESWT could act as a safe and effective method to improve the mobility and relieve the pain of patients with ONFH, especially those at early-stage. This technique could slow or even block the progression of ONFH and therefore reduce the demand for surgery but should be selected with strict indications. There is demand for the RCT to establish the stature of ESWT in the treatment of ONFH.

Arif Soemarjono, Ferius Soewito, Gaby Venera

Institution: Bandung Musculoskeletal Rehabilitation Care, Jakarta FlexFree Musculoskeletal Rehabilitation Clinic, Bandung; Indonesia

Introduction: Intra articular platelet rich plasma (PRP) injection has proven effective treatment modalities for knee OA. PRP could release essential growth factors and cytokines to provide a regenerative stimulus that augments healing and promote repair in tissues with low healing potential.1,2 The most frequent patient complaint of PRP injection was pain.3 We shouldn’t give anesthetic agents, as it was stated in some resources that anesthetic agents could not only have toxic effects on chondrocytes but could also influence the platelet function.4 Extracorporeal shockwave therapy (ESWT) could give instant pain relief and promote healing process by triggered cell specific responses which release of several growth factors as well.5,6,7 Here we present a case report of five grade 3 knee OA patients treated with intra articular PRP injection and radial shockwave therapy before injection and 4 times after injection with the outcome measurement is pain VAS score.

Material and Method: Knee OA patients with radiologic evidence of grade 3 (grade 1-4 of Kellgren-Lawrence scale), without signs of knee joint effusion, synovitis or infection, no contraindication for PRP injection and ESWT, no NSAIDs 6 weeks before and during the PRP and ESWT were included in this study. The treatment performed by a physiatrist with more than 10 years experiences and certified in musculoskeletal ultrasound, ESWT and regenerative injection. The treatments were ultrasound-guided intra articular PRP injection and radial shockwave therapy immediate before injection, 3 days after injection and continue 3 times in two weeks. The PRP processing was done using Magellan arteriocyte produced 4 cc of PRP from 52 cc of whole blood with PRP concentration 10 times than baseline. The radial shockwave therapy using EMS swissdolorclast with 2500 shock, 10 Hz frequency, 4 bar pressure, power plus handpiece, treatment area around the medial to superior knee with the knee in 30 degrees of flexion. The intra articular PRP injection were performed using ultrasound-guided in plane lateral approach technique. We measure the pain VAS score at baseline before intra articular PRP injection and radial shock wave therapy, immediate after intra articular PRP injection and 2 weeks after intra articular PRP injection and radial shock wave therapy.

Results: We treated 5 grade 3 tibiofemoral medial OA patients, 4 female and 1 male, 4 right knee and 1 left knee, age > 60yo, obesity (BMI : >31) with the mean pain VAS score was 7,5 at baseline. The pain VAS score was significantly decreased immediate after intra articular PRP injection (mean VAS score 3,5) and 2 weeks after intra articular PRP injection and (mean VAS score 2,1) radial shock wave therapy.

Discussions: The most frequent patient complaint from PRP injection was injection site pain. In some cases pain lasted up to 10 minutes post injection, decreased gradually and continued as a dull pain at the injection site which lasted from3 days to 2 weeks. In the Patel et al. study, it was stated that increase in amount of platelet concentration in PRP leads to an increase in patient’s pain after injection which can explain the increased consumption of pain killers the first few days after injection.3 We shouldn’t give anesthetic agents, as it was stated in some resources that anesthetic agents could not only have toxic effects on chondrocytes but could also influence the activation of platelet by changing the pH of the environment. In this study we could observed there was significantly decreased of pain immediate after intra articular PRP injection and the pain continue to decreased to 2 weeks after intra articular PRP injection, it corresponding with the ESWT molecular and cellular mechanism for instant pain relief and to promote healing process by triggered cell specific responses which release of several growth factors. Since the short period of this study and small sample size we still don’t know the significantly decreased of pain due to the effect of ESWT healing process synergistic with the effect of the PRP or just the effect of ESWT for instant pain relief. However this study could open the new insight for further study with appropriate sample size dan study design to investigate the effectiveness of combination of ESWT with PRP in treating many musculoskeletal disorders.

Conclusions: Radial shock wave therapy immediate before intra articular PRP injection could give instant pain relief, minimized the post PRP injection pain, avoid anesthetic agents and pain killer medication which will increase the effectiveness of PRP injection.