Neuroendocrinology Letters Volume 36 No. 2 2015
ISSN: 0172-780X; ISSN-L: 0172-780X; Electronic/Online ISSN: 2354-4716
Web of Knowledge / Web of Science: Neuroendocrinol Lett
Pub Med / Medline: Neuro Endocrinol Lett

The effects of extracorporeal shock wave therapy on pain patients

Jitka Fricová [1], Richard Rokyta [2]

1 Charles University in Prague, First Faculty of Medicine and General University Hospital, Pain Management Center, Prague, Czech Republic
2 Charles University in Prague, Third Faculty of Medicine, Department of Normal, Pathological and Clinical Physiology, Prague, Czech Republic

Correspondence to: Jitka Fricová, MD., PhD.
Charles University in Prague
First Faculty of Medicine and General University Hospital
Pain Management Center
Karlovo Namesti 32, 120 00 Prague 2, Czech Republic.
TEL: +420 224966370; E-MAIL: jitka.fricova@vfn.cz

Submitted: 2015-02-12 *Accepted: 2015-03-18* *Published online: 2015-05-18*

Key words: **shock wave therapy; chronic pain syndromes; relief of pain**

Neuroendocrinol Lett 2015; **36**(2):161–164 **PMID:** 26071587 NEL360215A01

Abstract

The method of shock wave therapy (ESWT) was used for the treatment of several symptoms of chronic pain. There were especially: cervical syndromes, lumbago, plantar fasciitis, achillodynia, metatarsalgia and humeral epicondylitis. We confirmed the positive effect of shock wave therapy for pain relief on these syndromes. This method is also effective in other pain syndromes. The effect of this application is very individual and therefore it is necessary to indicate differing numbers of therapeutic applications. We recommend this method as a very useful tool for completion possibilities in the treatment of chronic pain.

INTRODUCTION

Based on the background of above mentioned finding, we decided to study the effect of shock wave therapy in the treatment of several syndromes of chronic pain. The aim of the study was also establish various methodological approaches identifiable in the course of pain relief.

Extracorporeal shock wave therapy (ESWT) was introduced in Germany in 1980s. It has been used for the management of urolithiasis, cholelithiasis and sialolithiasis (Ogden *et al.* 2001).

With its wide range of clinical applications, ESWT is a unique treatment method which is gradually being recommended in the treatment of diseases of musculoskeletal system. It is being implemented in a diverse range of areas due to its usefulness in clinical application since it is non-invasive and can be repeated and utilized in a relative safer manner (Jeon *et al.* 2012).

Extracorporeal shock wave therapy (ESWT) has been increasingly used as a safe alternative treatment option since many published papers have reported a beneficial effect (Malay *et al.* 2006).

In ESWT, extracorporeal shockwaves are applied to lesions to help revascularization and stimulate or reactivate the process of connective tissue and bone healing, thereby relieving pain and improving functions (Lee *et al.* 2004).

ESWT can be used for pain relief as well as improving muscle strength through appropriate motor simulation of the muscles and tendons with extracorporeal shockwaves (Svernlöv & Adolfsson 2001).

The ESWT equipment currently used in clinical settings is divided into radial and focused methods

ORIGINAL ARTICLE

in accordance with the manner in which the shock wave reaches the target. There are three methods of generating a focused-type shock wave; namely, piezoelectric, electromagnetic and electrohydraulic. The shock wave is generated using the principle by which electricity is converted into a shock wave through rapid physical movement of the electricity through a liquid medium. Each type of equipment uses charged condensers with variable voltage from each other, and conversion into shock wave is achieved as electricity becomes rapidly discharged in a acoustic transducer (McClure & Dorfmuller 2003).

Although the mechanisms of action of shock waves are still not fully clear yet, the surprising clinical benefits induced by ESWT resulted in a continuous increase of requests for such treatment, which is recently starting also to be used in regenerative medicine. Nevertheless, further experimental studies are needed to better elucidate the exact mechanisms triggered by ESWT in healthy and pathological human tissues (Padulo *et al.* 2014).

METHODS AND PATIENTS

A shock wave is a single-impulse acoustic wave generated by an electromagnetic, electrohydraulic or piezoelectric source. The energy at the focal point is recorded in millijoules per area (mJ/mm2) and based on this value; shock waves are classified as low, medium, or high energy (Rompe *et al.* 1998).

In our study, we used to the device Duolith Ultra SD1 produced by Storz Medical AG.

Patients

The measurements were provided in total number of 18 patients, 6 men and 12 women. The average age was 54.3 years (for men 50.5 women 57.2). The patients were selected according their pain syndromes and special complaints. The most frequent diagnosis was cervical syndromes (8), lumbago (5), plantar fasciitis (2), achillodynia (1), metatarsalgia (1) and radial/ulnar humeral epicondylitis (1): the total number of patients being 18.

Duolith Ultra SD1 produced by company Storz medical AG.

RESULTS

In all patients the pain was measured before the application of shock wave therapy and after this application. The numbers of applications were different and we quantified the first and last application.

In the column treatment period in the Table 1 the numbers represent the interval between the first and last application. In the column before the application, the number represents the intensity of pain before the therapy; in the column after are the levels after the application.

Pain Δ % documents the percentage of pain relief after the shock wave therapy. The relief was positive in 16 cases; in two cases there was no amelioration.

DISCUSSION

In general, it is known that the effect of an extracorporeal shock wave in living tissues induces characteristic changes within the cells due to the conversion of the mechanical signal into biochemical or molecular biologic signal – mechanotransduction (Zimmermann et al. 2009).

Tab. 1. The column treatment period. The numbers represent the delay between the first and last application.

Patients	Pain syndromes	treatment period	pain before	pain after	pain Δ %	Δ pain
1	Achillodynia	17	80	60	25,00	20
2	Cervical syndrome	7	32	11	65,63	21
3	Cervical syndrome	10	52	43	17,31	9
4	Cervical syndrome	11	43	50	−16,28	−7
5	Cervical syndrome	13	50	51	−2,00	−1
6	Cervical syndrome	25	62	35	43,55	27
7	Cervical syndrome	39	32	20	37,50	12
8	Lumbago	7	33	11	66,67	22
9	Lumbago	15	89	73	17,98	16
10	Metatarsalgia	11	79	58	26,58	21
11	Plantar fasciitis	7	60	20	66,67	40
12	Plantar fasciitis	10	24	19	20,83	5
13	Radial epicondylitis	35	21	19	9,52	2
14	Cervical Syndrome	10	21	11	47,62	10
15	Cervical Syndrome	52	70	48	31,43	22
16	Lumbago	9	20	13	35,00	7
17	Lumbago	10	99	92	7,07	7
18	Lumbago	42	81	39	51,85	42

There is currently great interest in the use of ESWT, and in ascertaining the mechanism of action of this kind of treatment, keeping in mind the favorable results reported in clinical practice (Rebuzzi et al. 2008). Some authors speculate that shockwaves relieve pain in insertional tendinopathy by hyper-stimulation analgesia (Hausdorf et al. 2004).

The experimental results show that ESWT significantly stimulated the ingrowth of neovascularization associated with increased expressions of angiogenic growth indicators in tendon, bone and tendon-bone interface. Neovascularization may play a role in the improvement of blood supply and healing of tendon. There is a close relationship between the decrease of substance P release and clinically known treatment pain, with consecutive pain reduction in the shockwave treatment of tendon insertion diseases. Nitric oxide appears to play an essential role in the molecular mechanisms of ESWT (Notarnicola & Moretti 2012).

Low energy shock wave treatment induces angiogenesis in acute ischemia via VEGF Receptor 2 stimulation and shows the same promising effects as known from chronic myocardial ischemia. It may therefore develop an adjunct to the treatment armentarium of acute muscle ischemia in limbs and myocardium (Holfeld *et al.* 2014 a,b).

Wang *et al.* (2003) demonstrated that ESWT induces neovascularization, as confirmed by early release of angiogenesis-related markers, including Vascular Endothelial Growth Factor (VEGF), endothelial nitric oxide synthase (eNOS) and proliferating cell nuclear antigen (PCNA) at the Achilles tendon-bone junction. Therefore, these authors suggested that neovascularization can improve blood supply and induce tissue regeneration at the tendon-bone junction.

The recent study, which investigated the potential impact of ECSWT on reducing AIC in rat, provided several valuable implications. First, the in vitro results showed that ECSW therapy remarkably inhibits inflammatory reaction and the productions of ROS and oxidative stress. Second, ECSWT treatment substantially reduced the hematuria and the urine levels of proteinuria and IL-6. Third, the inflammatory response at the cellular, gene and protein levels were markedly reduced in the bladder after ECSW therapy. Finally, the generation of ROS and oxidative stress in bladder were suppressed, whereas the integrity of urinary bladder (i.e., including epithelial and smooth muscle layers) was preserved after ECSW therapy (Chen *et al.* 2014).

It was found that SN acts as an endogenous enhancer of VEGF-binding to its co-receptor neuropilin 1 and to heparan sulfate proteoglycan binding sites. They propose SN as a novel agent in the treatment of ischemic cardiomyopathy for several reasons: SN acts

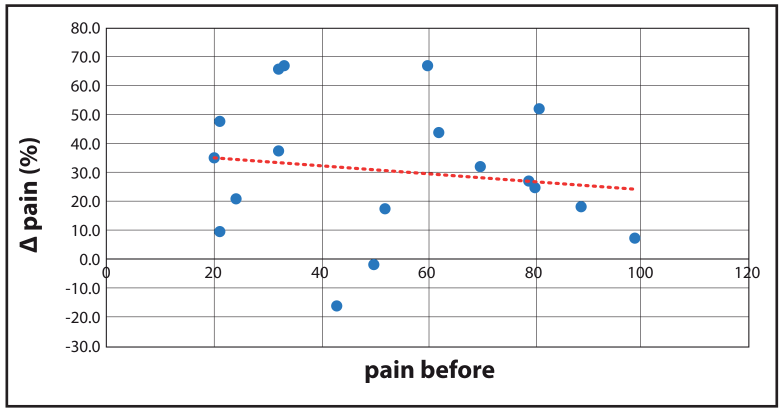

Fig. 1. The dependence on pain relief on the starting value (the percentage of starting value). The dependency of pain relief on the starting value (the absolute difference is demonstrated).

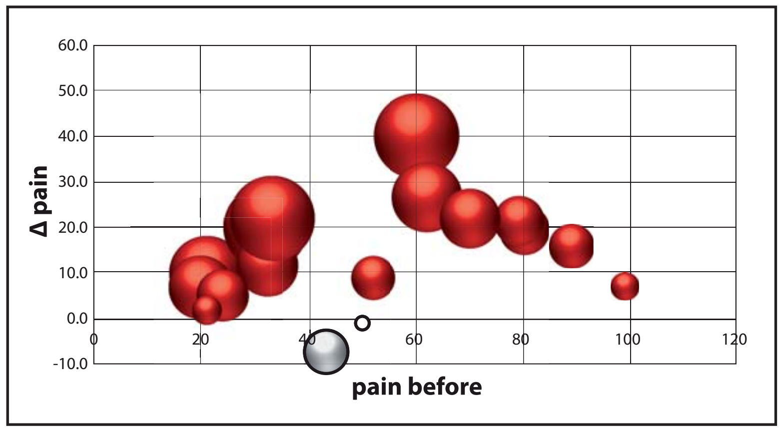

Fig. 2. The sizes of bubbles (in red color) represent the changes in percentage

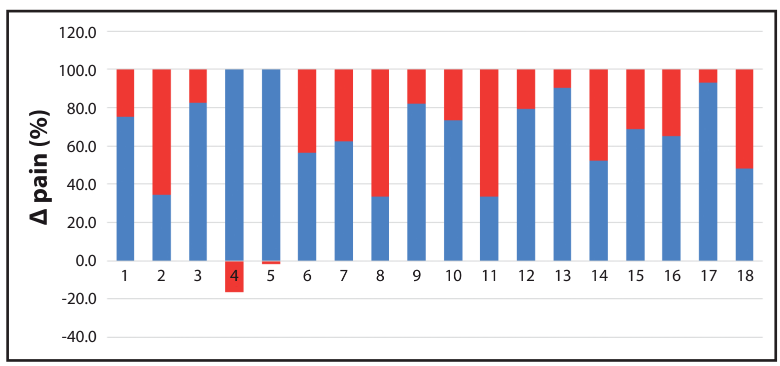

Fig. 3. The changes of pain reliefs in individual patients in the percentage of starting value (Δ pain)-percentage. The whole columns (red and blue) represent the starting value of pain. These blue columns represent the decreasing of pain relief after the shock wave therapy. The positive effect of treatment was measured in 16 patients from 18 patients.

as stimulator of several growth factor RTKs known to play essential roles in angiogenesis, i.e. VEGFR2 and FGFR3 in the coronary vasculature (Albrecht-Schgoer *et al.* 2012). Furthermore, SN also affects coronary artery SMCs as was shown in this and previous studies, to induce growth of SMC-covered blood vessels known to be more stable than capillaries. Finally, SN improved LV-function and -remodeling in an *in-vivo* model of MI. Future studies also should be able to determine appropriate vectors for efficient delivery of this peptide in large animal models and in human trials (Wang *et al.* 2003).

Nedelka *et al.* (2014) presented retrospective study which was done on 62 selected patients with unilateral chronic lumbar facet pain. There were 32 women and 30 men, divided into SWT group, corticosteroid injections group, radiofrequency group. Nociceptive and neuropathic pain intensity and severity of pain were measured. *Results*: Shockwave therapy had shown better long term results compared to the facet joint injections group and little inferior efficacy compared to radio frequency medial branch neurotomy. We did not observe any adverse effects and complications in the ESWT group. Moreover, in ESWT and radio frequency medial branch neurotomy groups, significant long term improvement in daily activities limitation, was observed (Nedelka *et al.* 2014).

CONCLUSIONS

We confirmed the positive effect of shock wave therapy for the pain relief in several types of chronic pain syndromes. It was especially useful in cervical syndrome: lumbago and plantar fasciitis. This method is also effective in other pain syndromes. The effect of this application is very individual and therefore it is necessary to indicate different numbers of therapeutic applications. We recommend this method as a very useful tool for completion possibilities in the treatment of chronic pain.

ACKNOWLEDGEMENTS

Supported by the Charles University Project P34/LF.3. We thank to RNDr. Jan Nedvídek, CSc. for his help with statistical evaluation

REFERENCES

1 Albrecht-Schgoer K, Schgoer W, Holfeld J, Theurl M, Wiedemann D, *et al.* (2012). The angiogenic factor secretoneurin induces coronary angiogenesis in a model of myocardial infarction by stimulation of vascular endothelial growth factor signaling in endothelial cells. Circulation. **126**: 2491–2501
2 Han H, Lee D, Lee S, Jeon C, Kim T (2015). The effects of extracorporeal shock wave therapy on pain, disability, and depression of chronic low back pain patients. J Phys Ther Sci. **27**(2): 397–9
3 Hausdorf J, Schmitz C, Averbeck B, Maier M (2004). Molecular basis for pain mediating properties of extracorporeal shock waves. Schmerz. **18**(6): 492–497.
4 Holfeld J, Tepeköylü C, Blunder S, Lobenwein D, Kirchmair E, Dietl M, Kozaryn R, Lener D, Theurl M, Paulus P, Kirchmair R, Grimm M (2014a). Low energy shock wave therapy induces angiogenesis in acute hind-limb ischemia via VEGF receptor 2 phosphorylation. PLoS One. **9**(8): e103982.
5 Holfeld J, Zimpfer D, Albrecht-Schgoer K, Stojadinovic A, Paulus P, *et al.* (2014b). Epicardial shock wave therapy improves ventricular function in a porcine model of ischemic heart disease. J Tissue Eng Regen Med. doi: 10.1002/term.
6 Chen YT, Yang CC, Sun CK, Chiang HJ, Chen YL, Sung PH, Zhen YY, Huang TH, Chang CL, Chen HH, Chang HW, Yip HK (2014). Extracorporeal shock wave therapy ameliorates cyclophosphamide-induced rat acute interstitial cystitis though inhibiting inflammation and oxidative stress-in vitro and in vivo experiment studies. Am J Transl Res. **6**(6): 631–48.
7 Jeon JH, Jung YJ, Lee JY, Choi JS, Mun JH, Park WY, Seo CH, Jang KU. (2012) .The effect of extracorporeal shock wave therapy on myofascial pain syndrome. Ann Rehabil Med. **36**(5): 665–74.
8 Lee SB, Kwon DJ, Song YJ, *et al.* (2004). Shockwave Therapy for Tennis Elbow. The Journal of the Korea Orthopaedic Association. **39**: 142–145.
9 Malay DS, Pressman MM, Assili A, Kline JT, York S, Buren B, *et al.* (2006). Extracorporeal shockwave therapy versus placebo for the treatment of chronic proximal plantar fasciitis: results of a randomized, placebo-controlled, double-blinded, multicenter intervention trial. J Foot Ankle Surg. **45**: 196–210.
10 McClure S, Dorfmuller C (2003). Extracorporeal shock wave therapy: theory and equipment. Clin Tech Equine Pract. **2**: 348–357.
11 Nedelka T, Nedelka J, Schlenker J, Hankins C, Mazanec R (2014). Mechano-transduction effect of shockwaves in the treatment of lumbar facet joint pain: Comparative effectiveness evaluation of shockwave therapy, steroid injections and radiofrequency medial branch neurotomy.Neuro Endocrinol Lett. **35**(5): 393–7.
12 Notarnicola A, Moretti B (2012). The biological effects of extracorporeal shock wave therapy (ESWT) on tendon tissue.Muscles Ligaments Tendons J. **2**(1): 33–7.
13 Ogden JA, Toth-Kischkat A, Schultheiss R (2001). Principles of shock wave therapy. Clin Orthop Relat Res. **387**: 8–17.
14 Padulo J, Oliva F, Frizziero A, Maffulli N (2013). Muscles, Ligaments and Tendons Journal. Basic principles and recommendations in clinical and field science research. MLTJ. **4**: 250–252.
15 Rebuzzi E, Coletti N, Schiavetti S, Giusto F (2008). Arthroscopy surgery versus shock wave therapy for chronic calcifying tendinitis of the shoulder. J Orthop Traumatol. **9**: 179–118.
16 Rompe JD, Kirkpatrick CJ, Küllmer K, Schwitalle M, Krischek O (1998). Dose-related effects of shock waves on rabbit tendo Achillis. A sonographic and histological study. J Bone Joint Surg Br. **80**(3): 546–52.
17 Svernlöv B, Adolfsson L (2001). Non-operative treatment regime including eccentric training for lateral humeral epicondylalgia. Scand J Med Sci Sports. **11**(6): 328–34.
18 Wang CJ, Wang FS, Yang KD, *et al.* (2003). Shock wave therapy induces neovascularization at the tendon-bone junction. A study in rabbits. J Orthop Res. **21**: 984–989.
19 Zimmermann R, Cumpanas A, Miclea F, Janetschek G (2009). Extracorporeal shock wave therapy for the treatment of chronic pelvic pain syndrome in males: arandomised, double-blind, placebo-controlled study. Eur Urol. **56**: 418–424.