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## Editorial

## ESWT is a force to be reckoned with



Extracorporeal shock wave therapy (ESWT) was first used *in vivo* for the disintegration of renal and ureteric calculi in 1980 followed shortly by its use for gallbladder calculi in 1985.

In 1988, the use of these acoustic waves was tried successfully for the treatment of nonunion of long bone fractures in Germany. In the nineties, shock wave therapy was used for the treatment of plantar fasciitis, lateral epicondylitis (tennis elbow) and calcific rotator cuff tendinitis.

Over the last two decades the use of ESWT has grown by leaps and bounds, and this special issue with twenty invited articles will try to inform you of the current concepts in the use of ESWT.

There are five original full-length articles and 15 review articles covering the cellular mechanisms and the clinical uses of ESWT. The first invited article is a prospective study by Gerdesmeyer et al. [1] showing that bone mineral density (BMD) increased six weeks after ESWT, and was statistically significant at twelve weeks. However it is not clear whether this effect on BMD is permanent or regresses after a few months. This study is very exciting as it indicates the possibility of treating osteoporosis with ESWT.

The experimental study by Santos et al. [2] from Brazil showed an increase of sulfated glycosaminoglycan in rat femurs after the application of ESWT. This suggests that shock waves can prolong anabolism of GAGs and also may have systemic effects. This study helps us to understand the multifactorial effects of ESWT on bone healing. Sukubo et al. [3] studied the effect of low dose shock waves on macrophages *in vitro* and showed their probable role in the prevention of fibrosis.

In this article from Taiwan, Kuo et al. [4] showed that the union rate was 100 percent after the application of ESWT twelve months from initial surgery (8 out of 8 patients), and 42.9 percent when applied after twelve months (6 out of 14 patients). This study albeit small is very encouraging for this difficult condition of atrophic nonunion. It also showed that ESWT could be followed by additional surgeries without any adverse effects. Atrophic nonunion is due to compromised vascularity, and ESWT through its neovascularization effect facilitates bony union.

This original paper on radial shock wave treatment in patients with plantar heel pain by Rompe et al. [5] is significant as it validates the successful use of radial as compared to focused shock waves. It also shows that a simple programme of manual stretching exercises after ESWT produces significantly better results at four months after initial therapy.

The blasting of urinary and biliary calculi is purely mechanical but low energy shock waves have shown a mechanotransduction effect on the biochemistry of the cell. This has helped us to

understand the healing powers of ESWT in various tissues. Cheng and Wang [6] acknowledge that the biological mechanism of shock waves in bone is still unknown. In this review they cite many studies on the molecular basis of bone healing, improvement of osteonecrosis and osteochondrogenesis. Shock waves do not induce cracks or micro damage the bone. ESWT may replace surgery for nonunion of long bone fractures without the surgical risks.

The review by d'Agostino et al. [7] traces the history of ESWT to its present status, where the concept of mechanotransduction helps us to understand why acoustic waves can lead to tendon and bone healing. This article and its many references will help us to understand how ESWT is a healing procedure.

ESWT in Achilles tendinopathy is a well-established indication and this review by Gerdesmeyer et al. [8] of the current evidence updates our knowledge of this fairly common condition. The article documents the high evidence of published studies of the efficacy of ESWT in Achilles tendinopathy and concludes that shock wave therapy is the most effective modality of treatment for chronic Achilles tendinopathy.

The review of the treatment of chronic patella tendinopathy with ESWT by Leal et al. [9] reinforces the excellent results of ESWT in the treatment of various tendinopathies in the last fifteen years. The best results are achieved when used in combination with eccentric exercises and standardized physical therapy protocols. The title of this review on lateral condylitis (tennis elbow) says it all. This is an overuse syndrome and is one of the most treated conditions with ESWT. This article by Thiele et al. [10] documents the historical use of shock wave for lateral condylitis since 1996 with mixed results in initial studies. Later studies showed more positive results. Efficacy has been well demonstrated and treatment procedures standardized. Only Level 1-b studies were included in this overview and the authors concluded that repeated applications of ESWT should be performed before resorting to surgery.

The review by Moya et al. [11] on current knowledge of evidence based ESWT for shoulder pathology emphasizes the excellent results for calcific shoulder tendinopathy. This is one of the two main indications for the use of ESWT in musculoskeletal disorders together with plantar fasciitis. However shock wave therapy is being increasingly used for non-calcific shoulder tendinopathies. The review also highlights the rare complication of humeral head necrosis (two reports). It has also been often used for frozen shoulder, bicipital tendinitis and postoperative shoulder stiffness. However these indications are still controversial.

Is ESWT the first choice treatment for fracture non-unions? Schaden et al. [12] believe it to be so after long personal experience

and an extensive review of the literature in this article. There are more than twenty publications reporting on the good results of ESWT in fracture non-unions with practically no side effects. A non-union gap of more than 5 mm in long bones is a negative factor for a successful outcome. ESWT should be used after failed internal fixation or with the addition of a plaster cast, orthosis or an external fixator.

Two reviews on the use of ESWT for avascular necrosis of the femoral head by Wang et al. [13] and Russo et al. [14] describes this fairly new therapy for this difficult condition. Although the exact mechanism is unknown, histopathological studies of retrieved femoral heads have shown viable bone and cellular proliferation after ESWT. Studies have shown that ESWT is more effective than the gold standard of core decompression and bone grafting for early avascular necrosis of the femoral head.

The good results have led surgeons to extrapolate the use of ESWT in adult osteochondritis dissecans. This review by Thiele et al. [15] on osteochondritis of the knee and talus published studies on this relatively new indication. The authors conclude that shock wave should be considered before any surgical intervention in early cases.

We continue on our journey on bone treatment with the use of ESWT in stress fractures by Leal et al. [16]. This comprehensive review of stress fractures in general is worth reading. ESWT is a relatively new treatment modality. There are several case reports and series with encouraging results for the use of ESWT in stress fractures.

Myofascial pain syndrome and fibromyalgia always evokes mixed feelings among doctors and this comprehensive review by Ramon et al. [17] helps us to understand the pathophysiology of this common disorder. ESWT is a novel therapy for these painful conditions and should be done together with a supervised exercise programme. These indications are still under investigation.

We leave the field of musculoskeletal disorders for other fields like the skin and the heart. ESWT is also used for erectile dysfunction but this special issue did not include this indication as it is still under experimental use.

The review on the use of ESWT for diabetic foot ulcers by Wang et al. [18] shows that shock wave, both radial and focused is effective in the treatment of diabetic foot ulcers. It has also been used in non-diabetic ulcers and skin flaps to improve flap survival. This review also highlights that ESWT is more effective than hyperbaric oxygen therapy for diabetic foot ulcers.

A metaanalysis of the treatment of cellulite with ESWT by Knobloch and Kraemer [19] reviews eleven clinical studies with five randomized controlled trials. Both focused and radial devices were used, and there was improvement of the cellulite severity scale (CSS) in the treated groups after twelve weeks. However the studies used various mixed techniques that have been listed in the metaanalysis. Long term follow up beyond one year was lacking.

Shock wave therapy of the heart is still in its infancy and this review by Holfeld et al. [20] is a comprehensive review of this new and exciting indication. If ESWT can regenerate ischaemic heart muscle, it will be a milestone in cardiac treatment.

In 1997, Haupt [21] wrote 'In patients in whom conservative treatment has failed, surgery used to be the only choice, but its success rate barely exceeds that of shock wave therapy and surgery can still be done if shock wave therapy fails. Extracorporeal shock waves will have an impact on orthopedics comparable to its effect in urology.'

Almost twenty years after Haupt wrote this, sadly many surgeons, doctors and allied medical personnel are unaware of ESWT or believe it to be akin to alternative medicine.

The FDA approved the use of ESWT for the treatment of plantar fasciitis in 2000 and the treatment of lateral condylitis in 2002. I hope that this special issue will be a valuable tool and a reference to the further study of ESWT in the coming years.

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