

MEETING REPORT

Pulsed Signal Therapy®: An overview

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Abstract

Pulsed Signal Therapy® (PST®) is a unique form of therapy that entails directing a specific physiological signal carried on a series of magnetic field pulses to the treatment site. These uniquely specific energy parameters are transmitted through the injured tissue to target the affected area via direct induction. The corrective PST® signal, carried on the magnetic wave-pulse, induces a tiny electrical signal that mimics the physiological signaling normally occurring in healthy living organisms. In this way, it exerts its therapeutic effects by stimulating cellular repair. Double-blind clinical trials and other open label randomized studies conducted in over 100,000 patients have consistently confirmed the long term efficacy and safety of PST® in patients suffering from osteoarthritis of the knee, cervical and lumbar spine. Data was collected over a 10 year period in the USA, Canada, France, Italy and Germany, by qualified specialists at major medical centers, or their affiliated teaching hospitals and other facilities.* Extensive studies in patients with temporomandibular joint disorder (TMJ) and tinnitus, not responsive to other therapies, have shown significant improvement, following PST®. Ergo PST has been successfully used in the treatment of chronic pain associated with connective tissue (cartilage, tendon, ligaments and bone) injury, osteoarthritis (OA or arthrosis) and also in the treatment of joint-associated soft tissue injury (traumatic, including soft tissue injury). In effect, PST® has been shown to exert positive effects on both cartilage and dense connective tissue, and in stimulating the repair of bone-tissue.

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INTRODUCTION

Astounding as it may sound, statistics have shown that lower back pain and osteoarthritis, are among the most common of public health disorders.^{1,2} In fact, at some point in one's life, there is bound to be a need for medical assistance due to disorders of the musculoskeletal system. These disorders are associated with considerable pain, often hinder mobility, and so too, very often interfere with the normal activities of daily living. Numerous medical solutions are currently available to treat joint and spinal complaints, but these are most often associated with undesirable side-effects, high costs, and short duration of results. A detailed overview of most of the conventional treatments available for osteoarthritis, is provided in Table 1. In light of this, decades of intense research have instigated an awakening, perhaps a revolution of conventional treatment modalities.

Table 1 Specific cost comparison of osteoarthritis treatments^{24–34}

Treatment	Duration of effect	Cost	Negative side-effects
Common home treatments (external application)			
Heat heat and cold, paraffin baths, rest and exercise	several hours	minimal	none
Capsaicin (hot pepper)	variable duration when effective	minimal	burning sensation at the site of application
Dimethyl sulfoxide (DMSO)	a few hours	minimal	imparts a garlic odour to breath
Common home treatments (oral administration)			
Glucosamine: chondroitin sulphate preparations	Effective for several hours in some double blind studies, but not others. Continuous administration warranted	approximately \$30–\$45 per month or \$360–\$540 per patient per year	concerns about possible development of insulin resistance and/or diabetes
Methyl sulphonyl methane (MSM) and various herbal products	variable and no good double-blind studies; must be administered continuously	minimal	none
Homeopathic preparations	unknown; no good double-blind studies	minimal	none
Non prescription NSAIDs and analgesics	2–8 h; requires chronic administration	\$500–2000 per patient per year	gastrointestinal ulcerations, bleeding
Prescription medications			
NSAIDs (including Nabumetone)	3–12 h; requires chronic administration	\$500–2000 per patient per year. The cost of treating the gastrointestinal (GI) events associated with the use of NSAIDs is not included	gastrointestinal ulceration, bleeding not uncommon. May also, affect the rate at which damaged cartilage regenerates
Glucocorticoid steroids	4–8 h depending on dose; requires chronic administration	varies	fluid retention, gastric ulceration, diabetes
Codeine and its congeners	6 h; requires chronic administration up to 6 months	varies	dependency and addiction
Viscosupplementation-hyaluronic acid (HA) injection		cost of therapy – according to practitioners	long-term effects are unknown; benefits are controversial
Chondrocyte culture implantation	variable and still experimental	NA – experimental	expensive and long-term benefits or complications are not known

Table 1 Continued

Treatment	Duration of effect	Cost	Negative side-effects
Surgery			
Arthroscopy	Due to many possible complications, the positive effects are questionable	approximately \$5000–\$6000 per procedure	Soft tissue, bone and articular complications, as well as unexplained pain occur. In one study of 71 patients, there were 82 complications in 50 wrists.
Osteotomy	negative side-effects often outweigh positive	varies	decrease in muscle mass
Resection	negative side-effects often outweigh positive	varies	rehabilitation required
Arthrodesis	negative side-effects often outweigh positive	varies	loss in flexibility
Resurfacing	negative side-effects often outweigh positive	varies	type of arthroplasty
Total joint replacement (arthroplasty)	approximately 10 years, but risky if performed more than once. Not advisable in younger patients	hip: cost in North America is in excess of \$20,000 per case and \$2.5 billion per year. Knee: the total hospital and physician cost for the procedure is generally \$25,000 to \$30,000	long rehabilitation, not long lasting enough for younger people
Electrical stimulation			
Transcutaneous electric nerve stimulation (TENS) and cranioelectrical stimulation (CES)	variable; if effective, multiple treatments are required	\$650–\$900 per unit, cost of therapy is practitioner's judgement	none – does not affect cartilage loss which will cause pain to reoccur
High voltage pulsed galvanic stimulation (HVPGS)	variable but not long lasting, with repeated treatment required	NA – experimental	none – does not affect cartilage loss which will cause pain to reoccur
Interferential electrical stimulation, Minimal electrical noninvasive stimulation (MENS)			
Pulsed Signal Therapy	sustained pain relief, and continued cartilage growth post-treatment	\$600 for nine 1 h treatments (including three post-treatment evaluations) not a continuing cost, but ends with the treatments	none

The above is not intended to be a comprehensive list of therapies for osteoarthritis but rather an indication of the diverse treatments available. It is important to emphasize that unlike PST, most of these and other popular remedies provide inconsistent benefits and must be used on an ongoing basis.

A signalling device capable of restoring the natural physiologic stimulus, crucial for cartilage production and bone-formation, and for successful treatment of connective tissue lesions, was developed over 20 years. This treatment modality, known as Pulsed Signal Therapy® (PST®), has been commercially available since 1994 and has shown not only to be safe and effective, but is conveniently painless, non-invasive, and non-pharmacological. Furthermore, it has added benefits that include a long-term follow-up, sustained efficacy and an absence of adverse effects.³

ELECTROPHYSIOLOGY OF THE JOINT

Perhaps, prior to seeking an understanding of the underlying principle of PST®, it is best to begin with an understanding of the electrophysiology of the joint.

It has been well established, that under physiological conditions, the healthy joint-cartilage retains virtually wear-free functionality. In retrospect, under non-physiological loads, including incorrect positioning, inactivity and changes in the synovia caused by infection, progressive wearing of the joint surface occurs, causing attrition and destruction of the cartilage.

Cartilage is a structural tissue, with an extracellular matrix composed of 60–80% water and an intercellular matrix composed of basic substances manufactured by the chondrocytes (cartilage cells), namely proteoglycans, glucoproteins and collagen (filaments).⁴ The proteoglycans are macromolecules, to which several glycosaminoglycan (GAG) chains are bound, possessing negatively charged sulphate (SO_4^{2-}) and carboxyl (COO^-) groups. When a joint is subjected to a load or mild stress, as for example, on walking, it is massaged; or biophysically, the hydrogen protons (of water) are forced through the extracellular matrix causing a small pulsed energy signal to occur. In part, the underlying science is explained by the Donnan effect, which states that the fixed negative ion concentration (imposed by the sulphate and carboxyl groups), determines the effect of the counter-ion, which in this case is sodium (Na^+). The resulting piezoelectric signal generates a so-called 'streaming potential' in the extracellular matrix, which is responsible for stimulating the growth and repair, as well as the healing of cartilage defects.⁵

THE BIRTH OF PULSED SIGNAL THERAPY

The eventual bridging of the vast interdisciplinary gap between biophysics and medicine was already evident

in the work championed by Bassett, Becker, Liboff, and other pioneers many decades ago. Bassett clearly predicted this in saying:

Before the next century is out of its infancy, physics will be as important in the treatment of disease as pharmacology and biotechnology are today ... The future holds exciting and rewarding prospects for those ... who use their diverse knowledge and skills as teams to forge the principles for a new era of medical therapeutics. Without interdisciplinary effort, however, success will be elusive ... Herein lies our challenge. C. Andrew L. Bassett, Applications of electromagnetic fields in Medicine. *Bioelectromagnetic Society Newsletter* 1993; 110:1, 4.

Pulsed electromagnetic fields (PEMF) have been used in the treatment of non-union and related problems in bone healing and pain relief, due to osteoarthritis and traumatic joint damage, since the 1970s with a relatively consistent success rate of 70–80% in several countries.^{4,6} Since most of these claims were based on anecdotal observations, and different PEMF devices had varied characteristics, an effort was made to determine whether a pulsed electromagnetic field with specific parameters might provide superior and more consistent results.⁵ In the mid-1970s, Dr Markoll (PST® patent holder) and colleagues completed a 4 year pilot study of 1000 patients with various types of musculoskeletal disorders characterized by persistent pain. Each patient was treated for half an hour, over 18 days, with a specific energy signal formulated from basic science research.⁷ Since then, the protocol has been optimized, and today provides safe and effective pain relief in about 80% of patients.⁷

THE PRINCIPLE OF PULSED SIGNAL THERAPY

PST® is an extension of PEMF therapy, modified to correspond to the body's own stimulatory energy parameters and designed to stimulate growth and repair of connective tissue. It is based on the application of a very specific type and form of signal that is carried on a pulsed electromagnetic field to the affected joint, or area to be treated. The device consists of a magnetic field generator, or control box, connected to a ring-shaped coil, or other applicator, by means of an electronic interface, that emits a proprietary signal via a pulsed electromagnetic field. Different coil sizes have been designed to treat peripheral joints (knees, shoulders and wrists), the spine (cervical, thoracic and lumbar vertebral bodies), tinnitus and dental disorders, and for veterinary applications. It employs direct current (DC) with unidirectional, low biological frequencies in

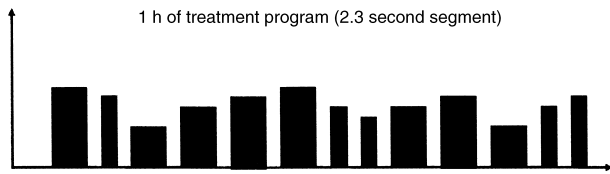


Figure 1 Pulsed signal therapy with alternating pulses as physiological stimuli.

the range 10–20 Hz. The ‘wave-form’ is quasi-rectangular, as opposed to sinusoidal, with measured field strengths (intensity) predominantly in the 0.5–1.5 milliTesla range (or 5–15 Gauss), as illustrated in Fig. 1.

A free-wheeling diode serves to optimize the inductance characteristics. Various frequency/amplitude combinations are switched over automatically and transmitted under continuous control during the treatment period. In this way, PST® mimics the electrical activities occurring in living organisms. Induction of treatment takes place during the first 10 min, followed by a configuration of pulsed signals that delivers the therapy over the remaining 50 min.

What distinguishes PST® from conventional magnetic field therapies, including the Krause–Lechner type system, can therefore be summarized as in Table 2.

Although conventional PEMF devices do deliver a direct current signal, it varies neither in amplitude nor frequency, and is therefore inconsistent with the natural electrical signalling of living organisms (Figs 2, 3).

By delivering modulating pulsed electromagnetic signals in an alternating fashion, PST® mimics the signals generated in the body to stimulate chondrocyte activity, without subjecting the affected tissues to any load, as illustrated diagrammatically in Fig. 4. The physiologically optimal ranges epitomize both effectiveness and safety in treatment with PST®.

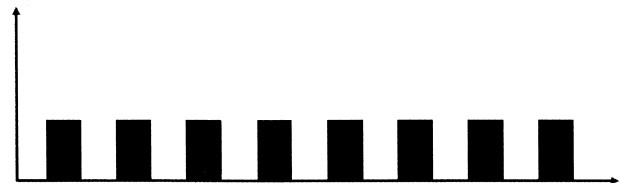


Figure 2 Conventional pulsed electromagnetic field (PEMF) devices.

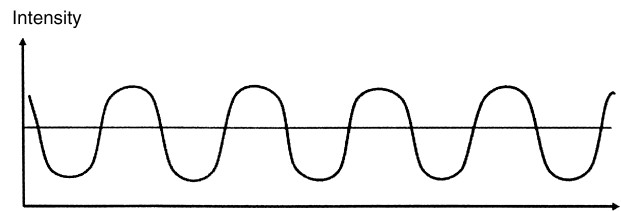


Figure 3 Krause–Lechner type system with alternating current oriented magnetic field.

Studies validating PST therapeutic potential

Pulsed Signal Therapy patented signal (pulsed DC magnetic field: 0.28 W, max 20 gauss; 5–24 Hz; quasi-rectangular wave-form) is the only electromagnetic stimulus with proof of efficacy in rigorously controlled clinical trials, a high safety profile based on long-term follow-up, and whose mechanism of action have been confirmed by extensive scientific research, including *in vitro* and *in vivo* studies.⁸

Clinical trials

Double-blind and other open-label randomized clinical trials conducted in over 100,000 patients globally, including the United States, Canada, France, Italy, and

Table 2 Comparison of energy characteristics

Device parameter	Magnetic field therapy	PST
Electromagnetic properties	piezoelectric	biological signal
Energy form	alternating current	direct current
Frequency	44–77 Hz	1–30 Hz
Wave-form	sinusoidal	quasi-rectangular
Field strength	2 Gauss	12.5 Gauss
Energy driver	voltage control	pulsed DC
Duty cycle	< 50%	> 50%
Pulse frequency	continuous	pulse-modulated
Frequency source	fixed frequency source	six frequency sources
Implementation	diode (biasing)	free-wheeling diode

Comparison of the properties of basic magnetic field therapy and PST®.

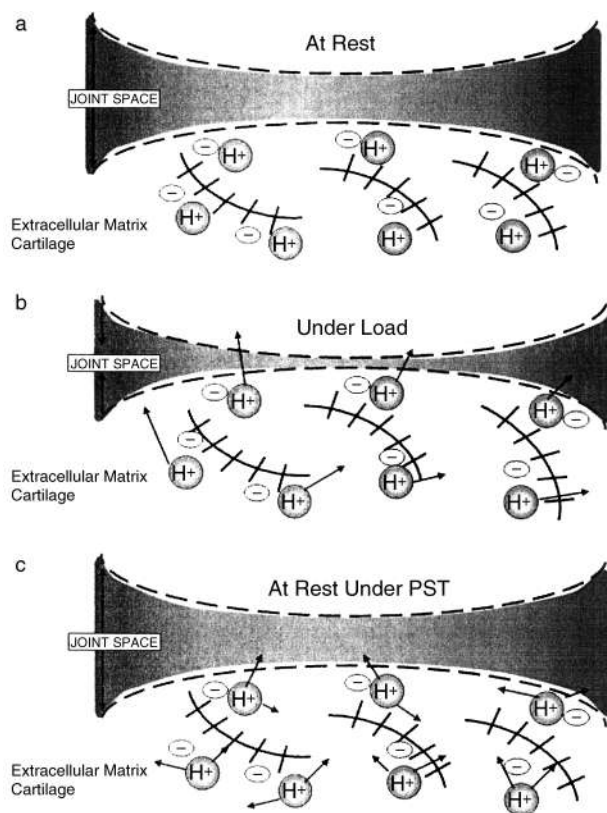


Figure 4 Mechanism of action of Pulsed Signal Therapy (a) charge equilibrium between hydrogen protons and negative charge carriers in the extra-cellular cartilage matrix, no streaming potential (b) creation of a streaming voltage potential in the ECM during loading caused by the 'compression' of fixed negative charged fluid forced out of cartilage tissue with forced movement of hydrogen protons (c) generation of streaming potentials in the joint caused by forced movement of hydrogen protons in the ECM through alternating PST® signals stimulating chondrocytes in the matrix connective tissue.

Germany, have confirmed the long-term efficacy and safety of PST®. A tabulated précis of these completed clinical trials is provided in Table 3 and Table 4. Although the trials pertain to osteoarthritis, numerous studies for a variety of disorders have been performed, and others are currently in process (Table 5).

Temporomandibular joint disorder (TMJ) and morbus tinnitus have widely been studied in Europe, leading to regulatory approval under the international Medical Device Directive 93/42/EEC and ISO 9001.⁹ Sports and other traumatic joint injuries showed especially gratifying results, following a 4 year study of these disorders, launched in 1990, at a Yale University affiliated teaching hospital.^{10,11} Since 1996, a large

number of sport-type injury clinics have been established in Europe and Asia, and PST® is available to most European soccer teams, within their club's medical facility. Indeed, its documented success prompted a request, and its subsequent availability to the German athletic team at the Sydney 2000 Olympic Games.

The clinical study protocol initially used 30 min treatment periods for 18 days, but clinical studies determined that a 1 h treatment daily, for nine consecutive days was more effective.⁵ Administering therapy for 1 h twice a day for five successive days, due to time constraints, has also provided good results, but as yet, insufficient data has disallowed confirmation of this as a satisfactory option. Pain was evaluated using WOMAC, and later OMERACT III, validated instruments of outcome measurements. Functionality was measured using WOMAC and modified Ritchie scales, as well as global evaluations of improvement by the patient and physician. Of emphasis, is the concession that only qualified physicians and health professionals are licensed to administer PST® and only upon successful completion of a training course in the treatment protocol with each specific device: knowledge on how to conduct a double-blind trial, how to obtain an accurate history of the patient, and also how to perform a thorough physical examination, before and after treatment. In addition, doctors are required to apply a specially developed computer software program, VITAL (Visual Therapy Log), which captures all relevant baseline and follow-up data using a form of WOMAC evaluation criteria.

IN VITRO STUDIES

The clinical efficacy of PST® is strongly supported by five published *in vitro* studies.

The first *in vitro* effect of PST®, as evidenced by us, was reported in the study by Grande *et al.* 1992.¹² This study sought to investigate the potential effect of the unique PST® pulsed electromagnetic fields, on *in vitro* Bovine cartilage explants, maintained in organ culture. A statistically significant effect ($P < 0.05$) was observed, as measured by sulphate incorporation. This is perhaps the most significant parameter for assessment of repair or relief, as proteoglycan is one of the principle matrix molecules lost in OA.

In later studies, PST® also showed to significantly stimulate metabolic activity of human articular cartilage chondrocyte cultures, assessed by both quantitative and qualitative analysis of proteoglycans in studies conducted at both the University of Siena's Institute of Rheumatology¹³ and Humboldt University, Berlin.¹⁴

Table 3 Completed clinical studies/USA

Nature of study	Institution where study was implemented	Study directors	Publication	Comments
A double-blind trial of the clinical effects of pulsed electromagnetic fields in osteoarthritis	Yale University School of Medicine Teaching Hospital Waterbury, Connecticut (Greco, Markoll)	Thomas P. Greco Richard Markoll	Journal of Rheumatology 1993; 20 ³ : 456–60	Pilot study
A double-blind trial of the clinical effects of pulsed electromagnetic fields in osteoarthritis	Yale University School of Medicine Teaching Hospital Waterbury, Connecticut	David H. Trock, Alfred Jay Bollet, Richard H. Dryer, L. Peter Fielding, W. Kenneth Miner, Richard Markoll	Journal of Rheumatology 1993; 20 ³ : 456–60	Good to very good results, with high statistical significance
The effect of pulsed electromagnetic fields in the treatment of osteoarthritis of the knee and cervical spine	Yale University School of Medicine Teaching Hospital, Melville, NY	David H. Trock, Alfred Jay Bollet, Richard Markoll	Journal of Rheumatology 1994; 21: 1903–1911	Good to very good results, with high statistical significance
Treatment of painful osteoarthritis with pulsed electromagnetic waves	Yale University School of Medicine Teaching Hospital, Danbury, Connecticut	David H. Trock, Alfred Jay Bollet, Susan H. De Witt, Richard Roseff, Michael Spiegel, Richard Markoll	Yale Danbury Clinical Journal	Good to very good results, with high statistical significance
Comprehensive report of all patients treated with magnetic therapy	Yale University School of Medicine Teaching Hospital, Waterbury, Connecticut	David H. Trock, Alfred Jay Bollet	Yale Clinical Presentations	Good to very good results, with high statistical significance
Diagnostic profile of Pulsed Signal Therapy patient population treatment of degenerative joint disease, muscle/ligament/tendon injuries, disc-degeneration-herniation	McGill University Vancouver, Canada	Cecil Hershler, Ana Sjau	Canadian Presentation Vancouver, Montreal International Medical Journal. 1999; 6(3)	High statistical significance

Table 4 Completed Clinical Studies/Europe

Nature of study	Institution where study was implemented	Study Directors	Publication	Comments
Efficacy of pulsed electromagnetic therapy (PST) in painful knee osteoarthritis	Cochin Hospital, Paris, France	C.-J. Menkés, S. Perrot	American College of Rheumatology presentation November 1998; Arthritis Rheum. 1998; 41(3) (suppl): S. 357 arthritis + rheuma, 2/02, S. 101-103	Good to very good results, with high statistical significance
Prospective clinical study of osteoarthritis of the knee	Niguarda Hospital, Milano, Italy	M. Cossu N. Portale	La Riabilitazione-Revista di Medicina Fisica e Riabilitazione, April-June, 1998, Volume 31	High statistical significance
Prospective clinical verification study of PST in osteoarthritis of the knee and hip, and degenerative LWS changes	PST Treatment Center, Munich Technische Universität München, Germany	Stephan Frhr Von Gumpenberg, Knut Pfeiffer, Harald Martin	Submitted for publication	High statistical significance
Multi-Center-Study of the clinical effect of PST in arthrosis of the knee (Gonarthrosis, grade II and III, Kellgren)	Ludwig-Maximilian-University, Munich	Stephan Frhr Von Gumpenberg, R. Breul M. Faensen H. Cotta	Orthopädische Praxis. 2001; 1(XI)	Further documentation and analysis of the patient data
Permanent prospective study (VTAL) significance. Further	Ludwig-Maximilians University, Munich	R. Breul, F. Hahn, D. Rost	Submitted for publication	High statistical documentation and analysis of the patient data
Procedural proposal for patients suffering with osteoarthritis of the knee by means of PST vs. placebo	University of Siena, Siena	Roberto Marcolongo	Submitted for publication	High statistical significance

Table 5 Current clinical studies

Nature of study	Institution where study was implemented	Study Directors	Publication	Comments
Study of the clinical effect of PST with trials of the synovial liquid in gonarthrosis	Auguste-Victoria-Hospital Berlin, University of Erlangen	D. Schuppan, M. Faensen R. Markoll	Study in progress to be submitted for publication	Commenced: December 1998. Terminated: December 2001
Trial of the medium-term effect of the PST therapy vs. placebo in gonarthrosis	Hospital Ranguell, Toulouse 31 E. Vignon, Hospital E. HerriotPST® Lyon 69	Prof Kahan	Study in progress to be submitted for publication	Commenced: September 2001. Terminated: Spring 2002
Definitive tinnitus double-blind clinical trial	Johannes Gutenberg, University of Mainz, Germany	Prof Mann	Study in progress	Commenced: December 2002 Expected to terminate December 2003
Studie zum Nachweis der Wirksamkeit der PST® bei Patienten mit gesicherter Osteoporose	Infinomed – institut für Innovative Medizin, München, Germany	K. Pfeiffer H. Radspieler R. Markoll	Pilot study in progress	Commenced: 21 May 2002. Expected to terminate 1 or 2 years thereafter

Gierse *et al.* in another study, conducted in Cologne, Germany, exposed human chondrocyte cell cultures to PST® and reported a statistically significant higher mitosis rate (almost two-fold), compared to chondrocytes in untreated cultures.¹⁵

In a preliminary study, conducted at the University of Erlangen, the matrix proteinases (collagenase) MMP-1, MMP-3, MMP-8 and the MMP inhibitor, TIMP (tissue inhibitor of metalloproteinase), were investigated, in relation to connective tissue proliferation, associated matrix protein Tenascin (experimental investigations generally employ Tenascin to provide data on the synthesis and proliferation of cartilage, MMP-2, on collagen degradation, and TIMP, on matrix synthesis¹⁶) and PIINP, in addition to cytokines in the synovial fluid of OA patients, prior to, and 6 months post-PST® treatment.⁹ In normal physiology, metalloproteinases (MMPs) produced by connective tissue are thought to contribute to tissue remodelling in development, in the menstrual cycle, and as part of the repair processes following tissue damage.¹⁶ However, their destructive capability is evident from their association with diseases that involve breakdown of connective tissues, for example, rheumatoid arthritis, cancer and periodontal disease.¹⁶ A decrease in MMP levels and increase in TIMP levels obtained, in comparison to controls, illustrates the positive effects of PST® on cartilage metabolism and restoration. Such promising findings urge continued investigations to elucidate PST® biochemical effects in this, and other, regards.

Commencing in 1999, another study, at the University of Siena, focused on the biochemical and morphological analysis of human articular chondrocytes cultured in the presence and absence of interleukin- β (IL- β) and subjected to PST®. The presence of large vacuoles in the cytoplasm, devoid of other cellular structures, confirmed the marked cellular damage, caused by IL- β .¹⁷ Stimulation of these cells by PST® was found to restore cell structures, and so too, proteoglycan synthesis by chondrocytes.¹⁷ The increase in metabolic activity was further supported by morphologic assessments carried out with a transmission electron microscope (TEM) and a scanning electron microscope.¹⁷ These results collaborate with studies showing electric stimuli and PEMF enhanced cartilage repair processes, increased [³H] Thymidine incorporation into chondrocyte DNA (proliferation), as well as ³⁵SO₄ uptake (glycosaminoglycan production).^{12,18–20} A feasible postulate for this observation has subsequently been proposed. It suggests that PST® causes the electric and magnetic stimulation of receptors, resulting in ion fluxes, including calcium, across cell

membranes, ultimately stimulating DNA transcription, and therefore protein synthesis.^{18,19,21}

Owing to the potential therapeutic effects of PST® as evidenced by these studies, an investigational study was conducted in order to seek whether the effect of PST® on energy fields in osteoarthritic patients, could be corroborated by other techniques, specifically Kirlian photography. This technique produces photon images in the presence of a high frequency electrical field to generate a spark discharge around animate or inanimate objects that are believed to reflect its energy flow characteristics.²² Data obtained in our > 300-patient study, following Kirlian photography before and after PST® treatment, confirmed significant changes in energy fields following PST® treatment.²² This study served to confirm PST® ability to restore the efficient transmission of the electromagnetic stimulus, hampered in damaged tissue.

Despite the corroboration of obtained data, further studies, including *in vivo* and *in vitro* studies, will be performed in order to ultimately verify and ascertain PST® mechanism of action.

INDICATIONS AND CONTRAINDICATIONS

The therapeutic effects of PST in osteoarthritis, tinnitus, and temporomandibular joint disorder, have already been well documented. However, much anecdotal information on potential applications of PST® in other medical disorders, has been made available, such that in some instances, pilot studies have been conducted to verify results. These disorders include:

- anterior cruciate ligament surgical repair and rehabilitation, tendinitis, fresh bone fractures and stress fractures, ankylosing spondylitis, meniscus tears, spondylolisthesis and hernia disci;
- fibromyalgia, aseptic necrosis, bilateral avascular necrosis of the femur neck;
- metatarsalgia, carpal tunnel syndrome;
- osteoporosis;
- Morton's syndrome (Morton's neuroma), epilepsy (non-responsive to medication);
- referred sciatic nerve pain;
- delayed poliomyelitis syndrome (sequela);
- plantar fasciitis;
- diabetic neuropathy;
- migraine headaches;
- atrophy of the plantar metatarsal fat pad;
- acute burns.

There are no known contraindications to PST® and it has been successfully used in haemophiliacs with joint

problems. However, despite no reported adverse effects in patients who are pregnant or have pacemakers, treatment is avoided for potential medico-legal implications

THE LATEST MILLENNIUM 'PULSE' ...

The gratifying aspects of PST® treatment include no known adverse effects and long-term efficacy, as well as a lack of pain or discomfort associated with the treatment, where the patient sits, or lies back in a relaxed atmosphere. The only 'hiccup' in the entire treatment procedure, might be the undesired disruption in a busy executive's already hectic schedule. Currently, the patient is obligated to wait in a physician's, or therapist's, consulting rooms, and thereafter, another hour for administration of treatment. In view of this inconvenience to patients, BMTS has designed the PST® Mobil. This new concept is essentially an embodiment of the PST® original equipment in a conveniently portable, miniaturized format, essentially a user-friendly, easy-to-store 'carry-kit'. In this way, the patient is able to administer treatment at his/her own discretion. Prospects indicate that the PST® Mobil will be available in the spring of 2003.

EPILOGUE

In an executive summary, by Professor Lars Lidgren, entitled 'The Global Economic and Healthcare Burden of Musculoskeletal Disease', cited and approved by the World Health Organization (WHO) and the Bone and Joint Decade (BJD) International Steering Committee, it is documented that in the developed world, musculoskeletal disorders are the most frequent causes of physical disability, with an increase in prevalence, as the ageing global population increases.¹ About 43 million individuals (1 in 6), in the US, have arthritis, and most are older than 45 years.² By the year 2020, it is estimated that 59.4 million people in the US, will be affected by arthritis, thereby increasing chronic disability and costs by more than 25%.² The annual cost to society in medical care and lost wages in 2000, for musculoskeletal disorders alone, was estimated at US\$245 billion.¹ Globally, WHO reports that on average, 40% of people over 70 suffer from osteoarthritis of the knee, 80% of patients with osteoarthritis have some degree of limitation of movement, and 25% cannot perform their activities of daily living (ADL).¹ With the current statistics, improved therapeutic modalities to reduce arthritis-related disabilities, hospitalizations, and complications related to therapy, in addition to

minimizing the risk of adverse drug reactions, and to preserve function, are in high demand.

For centuries, there has been a fine balance between energy and health. If one surveys history, even the era before Christ hints at the use of energy-forms in therapy: electric catfish in Egyptian mural paintings, dating back to 4000 BC; and lodestones, used by Cleopatra, as a means to maintain natural youth, and avoid ageing. Into the Middle Ages, lodestones were ground up to make powders, to be applied as a magnetic salve and promote wound healing; and by the middle of the 18th century, a magnetic mania had swept through Europe. Franz Anton Mesmer (1734–1815) for example, after whom ‘mesmerism’ is coined, professed that by increasing the flow of ‘animal magnetism’, any ‘bodily imbalance’ could be healed. Moreover, powerful carbon magnets were produced, and magnets were consequently adopted as therapeutic tools to relieve pain. However, in the advent of the pharmaceutical endemic and surgical procedures, their usage declined. Nevertheless, despite this lapse, the use of energy fields have once again resurged and sparked popularity as alternative therapies.

Indeed, we are all aware of the vast number of alternative therapies available, to name a few, acupuncture, hypnosis, kinesiology, healing, hydrotherapy, music and sound-wave therapy. Some of us may be guilty of sneering at a few of these, while accepting others. As the famous German poet, scientist and philosopher, Johann Wolfgang von Goethe (1749–1832) remarked:

We are accustomed to having men jeer at what they do not understand.

Where health is concerned, it is indeed vital not to falter and be misled by approaches that profess to be authentic and promising, but yet have no scientific rationale, and are merely anecdotal reports based on speculation. Vast research has prompted the century to embark on an ‘electroceutical’ era, as scientists unravel the complexities of the human body, and understand the nature of the electric and magnetic energies that exist within. Undoubtedly, many will seek to take advantage of the ‘bioelectromagnetic mania’, and cash in at the expense of desperate patients, for whom conventional therapies have failed. However, with PST® you can be assured of the facts.

Pulsed Signal Therapy® has been shown to be an effective and harmless alternative that requires only one course of treatment to provide sustained relief of pain and restoration of normal mobility, as demonstrated in long-term follow-up studies. It has been found to be effective in tinnitus, for which there is no

satisfactory treatment; periodontal disease, an established risk factor for heart attacks and stroke; temporomandibular joint syndrome; other types of joint disorders and particularly trauma resulting from sports injuries and accidents.²³ It has undergone strict scientific research, including clinical trials in diverse sectors of the globe, has been certified and accepted, and is currently available in over 500 PST® Therapy Centers worldwide.⁵ Furthermore, it is administered only by trained physicians and therapists, using the original PST® therapy equipment, and is protected by worldwide patents. It is non-invasive, painless, and, to date, no known adverse effects have been reported. In essence, it focuses on using ‘nature’s healing benefits’, by stimulating the body to restore its natural rhythm and ‘heal itself’, such that continued therapy is often not warranted. Continued extensive *in vitro* and *in vivo*, studies, supported by scientific clinical and research data, seek to unravel its various therapeutic potentials in several diverse disorders, for which there are currently no available treatments, or for which conventional treatments are met with rather harsh adverse side-effects, as well as to elucidate its mechanism of action more fully.

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Appendix I TRIBUTE TO C. ANDREW L. BASSETT

Andy, as he was better known, undeniably pioneered the use of electromagnetic fields for the treatment of non-healing fractures, and prophesized that, in decades to come, these would be used for diverse clinical disorders. He devoted much of his life to research in this area, and encouraged others to share in his foresight. In 1955 he became professor of orthopedic surgery at the College of Physicians and Surgeons, later founded ElectroBiology Inc. of Parsippany, NJ and the Osteodyne Co. in the Research Triangle Park in NC, USA applying the influence of electromagnetics on the human cell. He also designed an equine device that resembled a shinguard, and used it to heal injured thoroughbreds. Although a good friend, and supportive of PST-associated research, he unfortunately did not live long enough to see a manifestation of his life-long devotion.