Pulsed Magnetic Fields in Therapy

Introduction and Background

The application of magnetic fields in therapy has a long and substantial history, though it has largely failed to 'take off' as a mainstream intervention. Partly this is related to the multiple levels of confusion - the mix up between magnetic, electromagnetic and RF (e.g. shortwave type) therapies - and partly on the basis that it is a confused field, of which the manufacturers appear to take advantage with some pseudo science linked in with their marketing and 'glossy' blurb. Even of this brief paper went through all 4500 papers in my own collection relating to magnetic therapy (which I assure you I will refrain from doing) you would still not get the ultimate 'clarified' picture at the end of it - and that is a fundamental problem with magnetic and PEMF based therapies - confusion and uncertainty reigns. If one wants to, one can make the picture sound clear as can be - and some of the manufacturers do just that. The reality is that the 'whole' picture remains much more confused than one would ideally like.

In many respects, magnetic field based therapy involves the delivery of a particular form of energy to the tissues, much like ultrasound (which happens to be mechanical energy) or laser (which happens to be light based electromagnetic energy). The application of energy to the tissues will result in a physiological change or stimulation, which can in turn be used to generate therapeutic effects (Watson, 2008, 2010). Each type of energy will have different absorption in the tissues, so that even if their effects have a commonality, where those effects are achieved will be different for the various energies.

Ultrasound therapy for example will be most effective when applied to the tissues which strongly absorb (respond to) this (mechanical) energy - which is the dense collagen based tissue - such as ligament, tendon, fascia etc. Laser light is preferentially absorbed in the superficial, preferably vascular tissue, and thus, this is the site of its dominant effect in the clinical environment.

Magnetic energy will have an effect on the tissue along these same lines. This paper will explore the basic principles, the tissue responses to the applied energy and the clinical uses for which there is clinical evidence of efficacy.

An interesting but relatively succinct review of the historical development and uses of magnets in medicine and therapy can be found in Giordano et al (2009).

Field Types and Fields Measurements : Relevance to Clinical Dose

It is suggested that the method of magnetic field production (the device), and various field parameters (such as strength, static or dynamic, continuous or pulsed, power, energy delivery) may all be critical. As with other energy forms (laser and pulsed shortwave for example) there is not yet absolute agreement with regards the critical parameter(s) when it comes to clinical dose. Different research programmes, journal publications and manufacturers cite different components of the therapy dose, which makes meta analysis and dose generalisations particularly problematic.

Much of the confusion arises because of the link between magnetism and electricity. Maxwell, in the 1860's, identified that an electric field is accompanied by a magnetic field, and conversely, that a varying magnetic field (i.e. pulsed) will be accompanied by an electric field (see Trock, 2000 for

further review). Importantly, there needs to be relative movement of either the magnetic or electric energy for this 'induction' to be achieved. An electrical conductor in a static magnetic field (derived from a static magnet -not pulsed, not moving) will not exhibit any response. Conversely, a static electric field will not induce magnetic responses in a material - one or the other has to be moving in order for the effect to be achieved. The 'movement' need not be physical - in that turning the electric current on-off, or reversing its polarity would constitute movement. By using a 'pulsed magnetic field', relative movement will be achieved.

It is argued by some that a static magnet, held in proximity to the tissues will bring about bioelectric changes. The magnetic field may be 'static' but the blood moving through the tissues is a conductor, contains ions, and is moving relative to the magnet. The use of static magnets over trigger points (e.g. Valbona et al, 1997) achieves significant pain relief when compared with a placebo application and static magnets, embedded in footwear have been shown to achieve pain relief in patients with peripheral neuropathy (Weintraub, 1998). In these cases, the static magnet will have moved relative to the tissue by virtue of either blood flow in the case of the trigger point, or by virtue of foot loading and activity in the case of the peripheral neuropathy.

Colbert et al (2008) provide a comprehensive argument with regards the complexity of magnetic therapy dose. Whilst this level of detail will be more than most clinicians will elect to sift through, the importance (as with other modalities) is that IF magnetic energy is delivered at optimal 'doses' then it would appear to be effective. Simply reporting the 'strength' of the magnetic field and the treatment duration, is almost certainly insufficient for true dosage evaluation. In their review, Colbert et al identify 56 clinical studies involving magnetic therapy in which the majority fail to provide sufficient dose information for the actual field being delivered to be evaluated. Interestingly, in the Al Mandeel and Watson (2006) audit on pulsed shortwave therapy by therapists in the UK, when examining clinical records for the therapy being used, not one of the treatment note records examined included all dose related information that would be necessary for replication of the treatment dose. The point is that this is not confined to magnetic therapy - though of course this does not excuse the problem.

TABLE 1. 10 ESSENTIAL STATIC MAGNETIC FIELD DOSING PARAMETERS

1	Target tissue(s)
2	Site of magnet application
3	Distance of magnet surface from target tissue(s)
4	Magnetic field strength
5	Material composition of permanent magnet
6	Magnet dimensions: Size, shape, and volume
7	Magnet polar configuration
8	Magnet support device
9	Frequency of magnet application
10	Duration of magnet application

The 10 essential parameters that should ideally be recorded (for research purposes) when using static magnetic therapy (from Colbert et al, 2008) are reproduced on the left.

Magnetic Field Strength

One of the most commonly reported parameters relating to magnetic therapy devices is the strength of the applied magnetic field. Whilst this is clearly (as above) not the only significant measure, it remains one of primary importance.

Magnetic field strength is expressed in Gauss (G) or Tesla (T) :

10,000G = 1T. 1G = 0.0001T (or 0.1mT or 100μT)

The strength of the Earth's magnetic field is approximately 0.5G (or 0.05mT). An MRI scanner (by way of example) operates at something like 15,000 - 30,000G - or 1.5 - 3.0T). Therapy doses are typically in the range of 0.5 - 50mT (10 - 1000 x 'stronger' than the Earth's magnetic field). Physiological processes in animals generate small magnetic fields - in the order of 10^{-6} to 10^{-12}T (Clark 1994)

One of the biggest issues with the clinical application of magnetic therapy is that the strength of the magnetic field that is needed to achieve therapeutic benefit has yet to be fully resolved, hence making clinical decision making remarkably problematic.

The other significant issue is the treatment duration. In the systematic reviews (see Colbert et al, 2008 for details) the treatment durations varied from 3 minutes at the lower end of the scale right through to a continuous application for 6 months! Some treatments were delivered on a 'one off' basis, others several times a week, and others daily or indeed, continuously over a period of days, weeks or months. These provide VERY different energy 'doses' to the patient, and can not be comparable - even if the same energy is delivered. Sending XX amount of energy into the body in a single 45 minute session can not be expected to have the same effect as delivering it 24 hours a day over say a 1 week period. There is currently no 'optimal' treatment time / frequency data available, though some of the clinical trials identified later in this paper will provide some indication of effective dose protocols.

Therapeutic Windows

The existence of therapeutic windows is not a new concept, nor is it confined to magnetic field therapy (Watson, 2008, 2010). Deliver of the energy is such a way as to 'hit' the optimal window has substantial evidence amd includes parameters such as field strength (amplitude, intensity), pulsing (frequency), treatment time, and thus energy delivery. The optimal bio and clinical effects are achieved with this combined optimal dose combination. The further one moves away from this optimal position, the less effective the intervention.

For **static magnetic fields** the optimal window(s) have been identified by various authors thus :

Amplitude : 2 - 20 ; 150-200 and 450-500 G (0.5-2.0; 15-20 and 45-50mT)

(Bawin et al, 1975; Markov et al, 1975; Zukov and Lazarovich, 1989; Markov 2004, a,b, Bassett, 1987 - reviewed in Markov, 2007; 2009)

Whether there is one broad therapeutic window or in fact several smaller windows has yet to be resolved.

Given that the output of the device is simply a measure of the emitted field strength, the important issue is that of field strength at the tissue target (much as it is for ultrasound and laser therapies) as opposed to what comes out of the machine per se. Energy delivery at the target may involve manipulating the machine parameters to get the desired field at the target depth.

Dynamic electromagnetic fields

Whilst the static magnetic field (above) can be delivered using some kind of permanent magnet, electromagnetic fields (EMF's) and pulsed electromagnetic fields (PEMF's) are also reasonably widely used in therapy, and probably have a stronger body of evidence in their support. It is often suggested that 'Life is an electromagnetic event' - we will reference it to Markov (2011) though he certainly is not the first person to have postulated such a concept - just a convenient, recent reference). There are geomagnetic fields (related to the Earth's magnetic core) but we will concentrate on electromagnetic fields generated or applied as a therapy tool or device.

An **electric field** is the region of space surrounding electrically charged particles (and time-varying magnetic fields). The electric field depicts the force exerted on other electrically charged objects by the electrically charged particle the field is surrounding. The units used to measure the E field are most commonly described as : **volts per metre (V m^{-1})** though others are used such as Newtons per coulomb, which most therapist find less helpful!. A **magnetic field** is a mathematical description of the magnetic influence of electric currents and magnetic materials - it all starts to get a bit tricky! There are B and H magnetic fields, but we will leave them to one side for the moment - you can always look them up in a physics text (or good old Wikipedia of course!).

An electric field that changes with time, influences the local magnetic field. The electric and magnetic fields are not completely separate phenomena - and it is therefore most commonly to explain them as a combined phenomenon - the electromagnetic field - which includes both components.

It is strongly argued that with this type of therapy, it is not possible to entirely separate out the effects of the magnetic and electric components of the applied energy. Both exist, both are delivered to the tissues, and both have been shown to have a therapeutic effect. Some devices deliver predominantly electric or magnetic energies, but it is difficult to argue that they are purely one or the other. Even for a simple static magnet, the delivered energy will bring about some induced electric effects based on relative movement between the magnetic field and the underlying tissue. For the sake of this paper, we will assume that both energy fields are in some way responsible for the therapy effect.

Biological and Cellular Effects

Markov provides summary and review information in several papers including (Markov 2009). It is suggested that there are hundreds of cell, animal and clinical studies which have identified the mechanism(s) through which magnetic therapy is capable of having an effect. Probably the most comprehensive recent review (other than in textbooks) is that by Funk et al (2009) who look at

electromagnetic effects from a cellular level right through to medical applications. Be warned - this (unusually) is an 87 page review - just before you hit the print key and then regret it! Markov (2013) provides a rather shorter review.

Some of these effects are described at sub-cellular levels (including ion binding and molecular conformation at cell membrane level), with an ever increasing scale of effect through to whole organism (or 'organism wide') bioeffects.

There are numerous proposals and theoretical models to explain how the magnetic field is capable of interacting with biological tissue. Whilst none of these have, as yet, achieved full consensus amongst researchers, that would be common to other energy based modalities. Markov (2007) has provided a reasonable review of the current state of these models for those with an interest.

It would appear that the **cell membrane** is the primary target of the magnetic energy (Adey 2004). The likely (proposed, most strongly supported and reasonably evidenced) pathway is that the magnetic field affects the **signal transduction pathway**, **ion binding** and **ion transport**. Ca ions are the strongest evidenced (as they are with ultrasound, laser, microcurrent and other therapies). Ca^{++} binding to CaM (calmodulin) is modulated as a result of the applied energy. Myosin light chain kinase (MYLK or MLCK) is an enzyme strongly associated with muscle activity, though its role is not confined to muscle biochemistry. Calmodulin activates this enzyme, so if the magnetic field effect increases Ca^{++} ion transport, resulting in a change of calmodulin activity, and thus an alteration of enzyme activity, a potential chain reaction linking therapy to biological effect can be recognised.

In non-muscle cells MLCK activation of myosin II is implicated in a wide range of cellular processes, including cell spreading, migration and cytokinesis, as well as cell type specific processes such as neurite outgrowth and platelet morphogenesis. Shen et al (2010) provide some useful insight with regards the role of MLCK outside the muscle contraction effects, relating to pathology, inflammation and microvascular flow. There certainly appears to be a strong relationship between MLCK and microvascular permeability. Whether this is relevant to therapeutic effects remains to be seen, but it is currently a strong contender.

Many references have considered and described the mechanism, or hypothesised about it including the Markov and Funk papers identified previously, plus Rosen, 2010 and Volpe and Eremenko, 2007.

It has also been argued that the effects of the applied energy relate solely to heat generated in the tissues - i.e. there is no such thing as a 'non thermal' effect. There is clear and unequivocal evidence that non thermal effects are 'real' and the heat does not have to be generated in the tissues in order to achieve physiological change (cellular or gross tissue level). It is estimated that with a modern PEMF device the power delivered to the tissues is in the order of 10^{-10} W/mm^3 - which is just a VERY small power and not sufficient to generate any significant heating at all (see Bassett 1987). There is an argument that the effects are 'micro-thermal' in nature - beyond the scope of what might be covered here. Whatever the final outcome (non-thermal or micro-thermal), there is no significant heating of the tissue with these therapies, even when applied for prolonged periods of time.

Clinical Applications

The strongest evidenced clinical application of magnetic fields appears to be related to ***bone healing, wound healing and facilitated repair in musculoskeletal lesions, pain management*** and ***oedema resolution***. One would certainly not want to restrict the clinical applications to these fields, just that they are the strongest evidenced to date. Colbert et al (2009b) write some useful notes with regards running clinical trials with magnetic field therapy - and even if you are not inclined to run a trial, they are useful if you, as a reader, want to evaluate the quality of a trial that is in print.

Markov (2009) suggests that the overall success rate for these musculoskeletal issues is at around 80% (though there is an effects rage with different clinical problems) and that the literature identifies no side effects or adverse events of significance.

The use of EMF type application as a means to stimulate bone healing was initially achieved using electrode systems directly implanted at the fracture site (clearly outwith the 'therapy' type of application). More recently (last 20 years or so), systems are applied externally, using a time varying (pulsed) electric signals, driven through a magnetic coil placed around the limb. The resulting pulsed magnetic field induces a small electric field in the tissues (in the order of several μV/cm) which is in the physiological range which is known to stimulate fracture healing. ***Essentially an electric current in the applicator drives an electromagnetic field, and this in turn brings about small electric field changes in the tissues - induced - not direct - which are responsible for the physiological and therapeutic effects.*** Typically, these generating currents will be applied at what we will call low frequency, typically up to 100Hz, though technically, these fall into the 'extreme low frequency' (or ELF) band.

The applied energy fields operate at 'strengths' which have been demonstrated to bring about significant cellular / subcellular and hence gross physiological change. It is certainly a case of 'more is not necessarily better' (or less is more). There are literally hundreds of cell based studies which have reviewed and demonstrated cell level effects from these therapies at these low doses. They include membrane effects (like the Ca ion channel changes) and cytokine mediated effects (e.g. TGF-β, PGE2). Funk et al (2009) provide a reasonably succinct summary as do other reviews identified in the ref list. Funk et al identify at least 7 different cell membrane based mechanisms through which magnetic and electric fields can influence activity (see figure 34 page 242). Bassett (1987) provides a simpler, but none the less useful consideration of how pulsing EM fields influence physiological activity.

Bone Healing

This is a massive topic and whole books have been written on it. Most of the work has involved the delivery of PEMF energy using dynamic fields, and it is considered (Bassett 1987) that it is the electric component rather than the magnetic component that has the primary effect. Certainly there has been little research with regards the application of predominantly magnetic energy on bone healing, post fracture or with delayed / non unions.

Pickering et al (2002) review this field and identify (as have others) the complexity of dose, application method and mixed reporting of the intervention making dose estimation problematic and replication of the treatment almost impossible in some cases. This does not deny the benefit, or

at least the potential benefits of magnetic therapy. At the present time, the weight of the evidence falls in favour of PEMF applications, using a dynamic electric current to generate a varying electromagnetic field. This is sent to the tissues in which local bioelectric currents are induced, and it is these that are believed, and most strongly evidenced to positively influence bone repair.

Shi et al (2013) evaluated the effect of pulsed magnetic fields in cases of delayed union (post operative) demonstrating an effective healing rate of almost 78% with treatment compared with 45% in the control group - a significant difference BUT the therapy was delivered for an average of almost 5 months for 8 hours a day.

An example of a currently running clinical trial, in humans, evaluating PEMF application (fresh scaphoid fractures) can be found in Hannemann et al (2011). This type of trial should provide useful clinical data on which to base future intervention.

OA and Degenerative Conditions

Many patients purchase home based magnetic therapy devices for their 'arthritis'. The adverts (web, newspapaer) to which they respond make a variety of interesting claims, some of which are probably supportable from the evidence, others rather less so.

Sutbeyaz et al (2006) evaluated the effect of PEMF based therapy on pain, movement and functional capacity for a patient group with cervical OA. The therapy was delivered via a mat which the patient used (laid on) for 30 minutes a session, 2 x daily for 3 weeks. The treatment group showed significant pain reduction whilst the placebo group did not. Similarly, there were significant changes in range of movement and functional capacity. The mat produced an EM field with a mean strength of 40μT delivered in a pulsed mode at a range of frequencies between 0.1 and 64Hz.

Whether magnetic field therapy has an effect on degenerative joint problems beyond pain relief and symptom / functional improvement is doubtful. There is nothing 'wrong' with pain relief and functional improvement - it is to be welcomed. Despite some 'popular' claims about magnetic therapy halting the progress of arthritis, or even restoring the joint condition to normal (which are not evidenced claims), it remain probable that the benefits of magnetic therapy for this patient group relates to pain relief - which is the primary complaint they have anyway.

Local Circulatory Effects

Several papers have evaluated the circulatory responses of various PEMF type therapies. Ohkubo and Okano (2011) evaluated static magnetic field effects (1-600mT), linking NO and Ca^{++} mechanisms plus sympathetic nerve responses. Their review is primarily related to animal studies, though it does provide potentially useful information relating to therapy effects. This is an extension (update) of an earlier review (Ohkubo et al, 2007) which considers static magnetic fields at 0.3 - 180mT, PEMF's at 0.1 - 30mT plus some microwave evaluations.

In animal therapy, the effects of static magnetic fields on local circulation (especially in horses) is often cited as an 'effect' of treatment. Steyn (2000) evaluated a static magnetic field on blood flow in the horse metacarpus using a magnetic wrap for 48 hours. They were not able to identify any significant difference between treated and control limb blood flow (perfusion). The wraps used were 'commercially available' and whilst the authors do not identify the power output, they do report that

at 7mm from the wrap, the magnetic field was not greater than the 0.5G of the Eath's magnetic field. The lack of significant effect may therefore simply be a demonstration that sufficient magnetic energy needs to be delivered in order for therapy based effects to be achieved.

Wound Healing

Aziz et al (2011) has provided a Cochrane review on electromagnetic therapy for treating venous leg ulcers. As ever with Cochrane reviews, there is a risk the useful trials are not included and secondly that there is commonly no 'dose' consideration. The authors conclude (almost predictably) that there is no strong evidence of benefit. The three studies that they included delivered PEMF at

(A) (Ieran et al, 1990) 75Hz;2.7mT 4 hours a day)

(B) (Kenkre 1996) 600Hz; 25mT, 30 minutes; 5 days a week, 3 weeks or 600Hz days 1-5 then 800Hz days 6-30)

(C) (Stiller 1992) 0.06mV/cm; pulsed with polarity reversal, 25% duty cycle; 3 hours a day; 12 weeks).

Without trying too hard, it is easy to see that these are not the 'same' treatments.

Results indicated at 67% of the treated ulcers healed in 90 days with treatment (A). The Kenkre study did not show a difference between treated and sham treated ulcer healing. The Stiller study showed no ulcers healing in the sham group and 50% healed or showed marked improvement in the treatment group. The Cochrane paper teases these results further, but this is the essentials of it.

Other studies provide equivocal evidence. Isahov et al (1996) used static magnetic therapy as a means to influence the healing of stump wounds in diabetic amputee patients. They demonstrated no significant difference in healing times between treated and control groups, though their measurement of healing was 'different' to the normal, based on measured vs estimated repair time. The magnetic therapy was delivered for almost 48 hours on average.

Jing et al (2010), Milgram et al (2004), Glinka et al (2002) are amongst a group of researchers who have evaluated mangnetic based therapy in animal healing models, some providing positive results and some not. It would appear that magnetic based therapy has the potential to positively influence wound healing, though the difference in positive and negative outcomes may simply reflect a dose based function which has yet to be resolved.

Musculoskeletal Injury, Soft Tissue Injury and Repair

Numerous and varied trials have been conducted on soft tissue type problems. Owegi et al (2006) demonstrated a positive effect on tendon problems (tendonitis). Lee et al (1997) also evaluated the effects of PEMF based therapy on (Achilles) tendinitis

Both Reeser et al (2005) and Mikesky and Hayden (2005) failed to demonstrate a beneficial effect for magnetic therapy on DOMS pain - but having looked at all the evidence on DOMS pain, almost nothing makes any real difference to it.

There is a lot of anecdotal evidence with regards the efficacy of magnetic based therapies for soft tissue injury, but a dearth of clinical trials in real patients which are (a) meaningful and (b) demonstrate positive outcomes. It may transpire that magnetic based therapiees are effective in this clinical domain, but the evidence is not there yet.

Pain Relief

Eccles (2005) provides a useful critical review for the use of static magnets in trials, looking at pain relief issues. He identified 21 studies for inclusion in the review. 13 of the 21 (about 2/3) reported a significant analgesic effect. He looked at the 'better' and less good studies, and of the 'better' ones, 11/15 demonstrated a capacity to generate analgesia.

The pain types reported in the positive studies included in the Eccles review covered OA (mainly knee), dysmenorrhoea and menstrual pain, diabetic polyneuropathy (foot pain), RA joint pain, fibromyalgia, chronic back pain, trigger points, pain post surgery, post polio pain.

In terms of dose, the trends appear thus :

- The magnet power in the positive studies varied from 150-almost 4000G (0.015 - 0.4T)
- Pain relief was generally reported at 400G (0.04T)and above
- Duration : 45 minutes was the shortest beneficial application through to 6 months at the other extreme. Most of the positive studies involved wearing the magnets 24 hours a day for periods of at least 2-3 weeks
- Short treatments (<1hour) and infrequent treatments (once only or 2-3 times a week) appear less effective.
- Power of at least 400G (0.04T) appears necessary

Del Seppia et al (2007) also provide a review of pain and EM fields. They consider both changes in nociception and analgesia (not the same thing). They consider therapy effects together with environmental exposure to EM fields in an insightful review.

Hazelwood and Markov (2009) review the use of EMF based therapy for trigger points and various other pain related conditions. They consider the options of treating pain locally and using the therapy at trigger points in order to achieve a 'distant' effect. They also consider (in a review style) treatment for chronic back pain and soft tissue injury.

Trigger points

Vallbona et al (1997) used a static magnetic field (at between 300 and 500G) in a single 45 minute treatment of trigger points for a group of post polio pain sufferers. The real therapy generated significant reduction in pain (over 4 points on a 10 point VAS scale - which is highly clinically significant). The placebo group demonstrated an average reduction of just over 1 point.

Post Operative Pain :

Heden and Pilla (2008) used PEMF for post op pain (plastic surgery) demonstrating significant pain relief over sham treatment. Their device delivered a pulsed shortwave (27.12MHz) at 2 burst/sec and at 0.05G peak power (SofPulse). The device was battery powered and incorporated into a dressing system. Treatment was for 30 minutes every 4 hours (automatic) for days 1-3, 30 minutes every 8 hours for the next 3 days then 30 minutes every 12 hours thereafter till 8 days.

Similarly Rohde et al (2010) evaluated a PEMF application on post op pain and various wound cytokines, including interleukin-1β, TNFα, VEGF, FGFβ2 in a breast surgery group. Significant reductions in pain (57% at 1 hour, 300% at 5 hours and a 2.2 fold reduction in pain medication use when treatment and placebo groups were compared. There were no major changes in wound cytokines other than a reduced interleukin-1β (27%) in the treated group. The device employed was a SofPulse (as per the Heden and Pilla study).

Strauch et al (2009) review the use of PEMF based therapy in various plastic surgery issues including pain, post op oedema, wound healing and enhanced repair.

Carpal Tunnel and Tennis Elbow

Weintraub and Cole (2008) report the outcome of an RCT evaluating static and dynamic magnetic fields in Carpal Tunnel. The demonstrated significant pain relief in the treated group compared with the placebo group. The device was small, worn on a wrist strap and delivered both static and varying (20Hz) magnetic fields. The static field was measured at 0.5G as was the dynamic field. Therapy was delivered for 2 hours each, twice daily for 2 months. Various nerve conduction tests were included, though no significant changes were identified between treatment and sham groups.

Deveraux et al (1995) compared real with placebo PEMF for tennis elbow patients, treating for at least 8 weeks. Patients used the device for at least 8 hours a day (overnight). It was small and portable. The electrical power of the device is identified, but not its applied field strength, thus it is difficult to identify the strength of the PEMF therapy received by the patient. The results show better improvement in the treatment group compared with the placebo group, though they did not generally reach statistical significance.

Back Pain

Lee et al (2006) conducted an RCT, placebo based study with chronic low back pain patients. Therapy was delivered 3 times weekly for three weeks. The treatment group demonstrated significant pain relief compared with the placebo group and functional improvements were also significant for the treatment group. The treatment was clinic based (no a small portable device - more like a classic pulsed shortwave in terms of size). It delivered pulses at 5 and 10Hz for 15 minutes at between 1.3 - 2.1T - which is clearly a much stronger field than that delivered by the small portable devices.

Lo et al (2011) report the outcome of a pilot clinical study using magnetic therapy for patients with lumbosacral spondylosis. Treatment was compared with a placebo intervention. This was 'different' in that the treatment was only delivered once. The machine Medtronic R30) delivers 2T per pulse

with 200 trains of 5 pulses delivered at 10Hz. The pain reduction in the treatment group was at over 60% compared with 6% in the placebo group. This is not a 'gentle' therapy - the power was adjusted such that visible muscle twitching was minimised!

Clinical Application Summary

There is a wide mix of research papers covering clinical applications and potential benefits. The most strongly supported applications relate to recovery after bone damage/fracture, pain management and to a lesser extent, wound healing. It may transpire that this therapy is useful for local vascular and microcirculatory effects and for soft tissue problems (after injury) but the supportive published evidence is not yet available.

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