THE EFFECTS OF PULSED SHORTWAVE THERAPY ON LATERAL LIGAMENT SPRAIN OF THE ANKLE

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Ankle sprain, physiotherapy, pulsed shortwave therapy.

ABSTACT
This paper describes the methodology and results of a double blind trial to assess the efficacy of pulsed shortwave therapy in the treatment of lateral ligament sprains of the ankle.

A total of 37 patients were allocated into placebo and treatment groups in a double blind manner. Each patient received three sessions of treatment, lasting 15 minutes each on three consecutive days. Pain and ankle swelling were used to measure progress.

No difference between the treatment and placebo groups was detected, in terms of an earlier reduction in swelling, less pain, or shorter period to full weight-bearing. Given the vast combination of treatment frequencies and durations possible with a short pulse wave machine these results should be considered conclusive only in regard to the specific course of treatment given here.

INTRODUCTION

The beneficial effects of high frequency currents applied to the body were discovered at the turn of the century.[1] These benefits were thought to be due to the thermal effects of the electromagnetic waves produced when absorbed by the body. In 1940 Nagelschmidt[1] hypothesised that "there must be some other effect, not as yet realised to account for the phenomenon which would not be attributed to heat alone". He proposed that "The production of small currents in the body through the influence of external magnetic fields must have some definite effect on general and local muscle tone, on conductivity of nerves in both directions, on the shape of the electrocardiogram, on the brain waves and probably on the balance of the vegetative nervous system. The colloidal system must undergo changes in the size of the disperse phase, the permeability of membranes must vary and ion concentrations must be influenced".

In the 1950s Diapulse, the first pulsed shortwave apparatus was developed in the USA. Since 1970 other pulsed short-

wave machines have been manufactured, these include Megapulse, Carapuls, Ultramed and Therafield Beta, but only in the past decade have these come into general use in physiotherapy. Hayne[2] contains a summary of these machines and their capabilities in relation to pulse width, intensity, pulse repetition and output. Studies into the effect of Diapulse suggest there are several beneficial effects including acceleration of wound healing[3], reduction of pain and swelling in soft tissue injuries[4 5] and haematoma resolution. These effects are all claimed to be due to non-thermal phenomena.

With the pulsed shortwave there are bursts of electromagnetic waves followed by a set rest period, which allows dissipation of any heat produced. Hayne[2] describes an electrical effect from the production of E and H fields. Electrical or E fields may cause cell oscillation and the attraction of parallel currents towards each other in liquid, resulting in a squeezing effect. An E field is normally applied by means of condenser or pad electrodes. An H field is delivered to the tissues via an inductothermy cable or monode head. Magnetic or H fields are thought to alter cell potential and ionic interchange. "Sick" cells have a loss of electric potential, giving them an altered ionic balance. The influence of a pulsating magnetic field over a period of about four days restores the negative charge of abnormal cells, this leads to an accompanying reduction in swelling and a decrease in the overall time needed for cell regeneration and healing.[2] Of the common forms of pulsed shortwave apparatus Diapulse, Megapulse and Therafield Beta emit both E and H fields simultaneously, while Curapuls and Ultramed machines deliver either E or H fields separately. However, in the tissues neither E nor H fields exist purely in isolation, with any E field creating an H field and vice versa.

The perceived advantage of using pulsed shortwave therapy compared to continuous shortwave therapy, is that it may be used immediately for treatment of acute conditions. Any adverse effects caused by heating traumatised tissue are avoided, with the rapid dissipation of any heat generated by the pulse phase during the inter-pulse phase.

Three previous studies exist which have used shortwave pulse therapy for the treatment of physiotherapy related injuries. Wilson[4 5] using a Diapulse machine for one hour on three consecutive days, showed a reduction in swelling, pain and general disability over controls for 20 patients in a matched trial on lateral ligament ankle sprains. Barclay et al[6] showed reduced swelling within 36 hours, for patients who had injuries treated twice daily for 30 minutes with a Diapulse machine, when compared to those on control. Barker et al[7] could find no significant difference on any outcome criterion, between patients with lateral ligament ankle sprains treated for 45 minutes on three consecutive days with Therafield Beta Machine and those used as controls.

In 1986, the Physiotherapy Department of Christchurch Hospital was given the use of a Bosch Ultramed Shortwave machine for evaluation. To assess the value of this machine it was decided to undertake a double blind study on lateral ligament sprains of the ankle, a common injury treated within the department.

METHOD

Patients of both sexes between the ages of 16 to 60 years (inclusive) who had sustained a lateral ligament sprain of the ankle within 48 hours were referred from the Orthopaedic Outpatient Department of Christchurch Hopsital. They participated in the trial if they were willing and fulfilled the admission criteria (see Table 1).

Patients were randomly allocated to placebo or treatment groups by using a patient selector box. This was made by the Engineering Department Electronics Section. This unit was attached to the back of the short wave machine. The only visible control was a thumb wheel and the instruction "Select Patient Number". Each patient in the trial was allocated a number and each time they had treatment their number was selected on the thumb wheel. The selector box

Table 1 — PATIENT ADMISSION CRITERIA

1. The patient had sustained a lateral ligament sprain of the ankle within the previous 48 hours.
2. Radiographs showed no body damage.
3. Neither ankle had been injured in the previous 9 months.
4. There was no other condition affecting the feet, ankles or gait.
5. There were no open wounds or skin infections in the lower limb of feet.
6. There was no vascular disease.
7. The patient was not pregnant.
8. The patient did not wear a pacemaker.
9. The patient was not taking anti-inflammatory or anticoagulant drugs.
10. The patient was willing to participate and had signed a consent form.

was configured in such a wav that normal output, adjustable by "Dosage" control was given to any patients whose number ended 1, 2, 5, 6 or 9. For the patients whose numbers end in 0, 3, 4, 7 or 8 the output was set to a very low level below the minimum position on the "Dosage" control. This was fixed regardless of the position of the "Dosage" control. The therapist was unaware of this configuration and so was "blind" to the placebo or treatment groups. All patients received the same treatment except the placebo group received nil output from the machine.

A circuplode electrode was used on the Bosch Ultramed shortwave unit to generate the H field effects. It can be used in direct contact with the damaged tissue being treated which helps standardise the treatment procedure. There are few guidelines on the dosage (intensity, pulse length, pulse frequency and duration) for the use of any pulsed shortwave machines. The manufacturers recommended frequency to use for the circuplode was between 60 and 110 hertz, with the intensity setting between 5 and 7. For the trial it was decided to use a frequency of 82 hertz and intensity of 6 — this resulted in 19.6 watts power output. The recommended duration of treatment varied from five minutes up to one hour, with the average recommendation being 10 to 20 minutes. In this trial each patient received three sessions of treatment, lasting 15 minutes each, on three consecutive days. the patient was positioned inside lying with the effected leg uppermost, resting on a pillow. The circuplode was centred over the lateral ligament of the ankle, almost in contact.

On day 1 the patient was assessed before and after treatment. On day 2 and 3 pain and ankle volume measurements were recorded after treatment. On day 8 and 15 only pain and ankle volume measurement were taken — there was no treatment.

All patients received the same general management:

1. A single thickness low tension Tubigrip support stocking (from metartarsal heads to tibial tubercle) was supplied.
2. Patients were advised to rest the injured leg in elevation whenever possible, and to move the ankle when resting.
3. They were given axillary crutches and instructed to only bear weight as they felt able A record was kept of the day on which the stopped using the crutches. instruction were given on how to use crutches, but no specific gait training was given until completion of the trial.
4. Patients were prescribed analgesia (500mg Paracetomol) by the doctor at Orthopaedic Outpatients.
5. Patients were asked not to use ice, sprays or ointments on the injured ankle during the trial. they were not excluded if ice had been applied at the time of the injury.
6. Patients who, in the opinion of the physiotherapist, required alternative forms of treatment during the trial were to be withdrawn.

Each patient was given a questionnaire to be completed daily for the duration of the trial. This was to record:

1. The number of Paracetomol tablets taken each day.
2. The number of hours spent with the ankle elevated.

Each patient was assessed prior to treatment by the research physiotherapist. Subjectively, the patient was questioned on the history and mechanism of the injury, past

Table 2: PRE-TREATMENT SUMMARY OF GROUPS: Means and Standard Deviations

Group	Number of patients	Sex male : female	Age (years)	Time since injury (hours)	Initial Pain analog.	Size injured leg (mls)	Size non-injured leg (mls)	Ratio of volumes (injured/non)	Injured leg (R) (L)
Treatment	19	8 : 11	22.9 6.3	22.5 14.1	4.68 1.49	1426.3 275.6	1352.6 231.7	1.053 0.081	12 : 7
Placebo	18	2 : 16	26.8 9.7	22.5 13.5	4.50 2.43	1469.4 190.9	1356.9 158.1	1.084 0.079	8 : 9

medical history, social history, xrays, medications and current pain level and distribution. Pain was recorded as a number between 0 and 10, where 0 was no pain at all, and 10 being the worst pain ever experienced. Objectively, the physiotherapist recorded general observations — gait (weight bearing status), colour of the ankle, ankle mobility (active range of dorsiflexion, plantarflexion, inversion and eversion). Static muscle power of the ankle muscles was checked, to eliminate any muscle pathology. Ankle volume was measured by water displacement, using a purpose-built Perspex tank. The design was based on the one used in a similar trial by Barker *et al*[7]. The tank consisted of two identical chambers with an overflow at one end, 20cm from the bottom of the tank. The dimensions of the base of each chamber were 19cm x 41cm. the overall height was 25.5cm. The overflow chamber base dimensions were 6cm x 19cm. Both chambers were filled with water at a temperature of 30°C +/- 2°C to the point of overflow. The overflow chamber was graduated at 50ml intervals to 2000mls. The patient placed one foot in each chamber, taking care that the sole of the foot was flat on the bottom and the lower leg was vertical. The water overflow was collected in the overflow chamber, and the volumes recorded. Subsequently, the ratio of volume of the injured leg to the uninjured leg was calculated. To assess the accuracy of the measuring technique, a pre-experimental trial involving four subjects was set up. This trial measured both legs of these normal subjects on three consecutive days, each measurement was replicated three times. A mixed-model ANOVA revealed that inter-subject variability was the major variance component, accounting for approximately 90% of the variation. Two components, the replication and the subject-day interaction contributed equally to the major (90%) proportion of the remaining variation. The estimate of the standard error associated with any single replicate was 39.7mls, giving a coefficient of variation of approximately 3%. These results vindicated the technique as being accurate enough to detect differences of the magnitude required to compare the two techniques.

STATISTICAL METHOD

All statistical analyses were performed using the BMDP statistical package.[8]

Independent variable comparisons between the placebo and treatment groups, both before and after treatment were made using the t-test and Chi-square test of independence.

Comparisons of the times from injury to treatment, and from treatment to full weight bearing were made using survival analysis, specifically the Breslow test, program PIL.

The comparative recovery between the two groups was assessed using repeated measures ANOVA with the treatment effect as a between subjects grouping factor. Given initial parity between the two groups any differences in the rate of reduction in leg swelling as a result of the treatment will emerge as a group-time interaction effect.

RESULTS

A total of 37 patients met the admission criteria during a five month period and entered the trial. One patient did not return for the third day of treatment and subsequent checks, and has been excluded from the analysis. None were withdrawn by the physiotherapist from the trial. Eight patients went on to have further treatment on completion of the trial — four of these were in the treatment group. Three patients failed to return for their check ups on day 8 and 15, and a further two patients failed to return on day 15. Therefore a total of six patients were not included in the analysis of variance, only one was in the treatment group.

The initial comparisons between the two groups revealed no significant differences (Table 2) in terms of age, time since accident, size of injured leg, ratio of injured leg to non-injured leg, initial pain analogue and the status of the injured leg being right or left. The mean number of hours the injured leg was elevated during the trial was not significantly different between the two groups. There was however a significant difference in the sex ratio between the two groups (p 0.05).

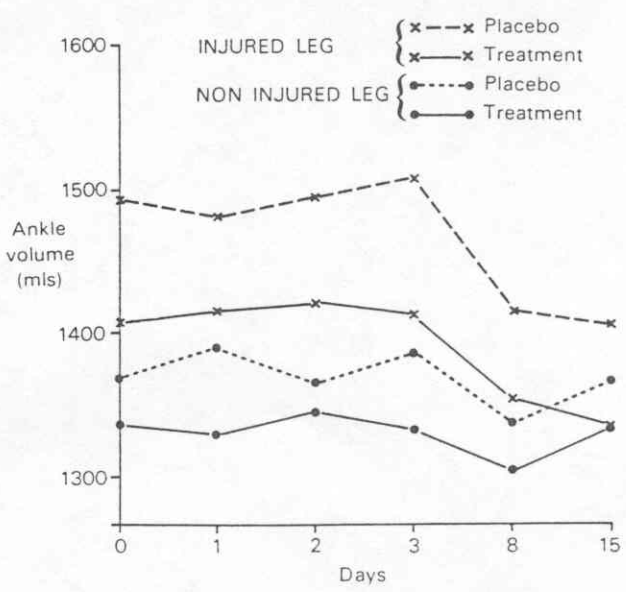
Table 3: OUTCOME VARIABLES: Means and Standard Deviations

	Pain score/day	Elevation/day (hours)	Number analgesics/ day	Time to weight bearing (days)
Treatment	2.37 1.19	1.87 0.77	0.44 0.51	3.78 3.20
Placebo	2.34 1.47	1.77 0.57	0.29 0.55	2.88 1.50

Comparisons at each day during the course of three days of treatment and the total 15 days of the trial (Table 3) revealed no significant difference between the two groups in relation to the average pain score, the amount of analgesia taken, and the time to full weight bearing. Figure 1 shows the change in ankle volume for both groups injured and non-injured leg over the 15 days of the trial. One patient in the treatment group was still not weight beaing at the end of the trial (15 days). When he was excluded from the analysis the mean time to full weight bearing of the treatment group dropped from 3.78 to 2.12, neither were significant when compared to the placebo group.

A significant correlation was shown between the pain scores and the amount of analgesia taken (p 0.01). The repeated measures analysis of variance showed no consistent treatment effect, or any treatment by time interaction. There was, naturally, a significant time effect with the leg size being reduces significantly at four days post-injury.

Fig.1 CHANGE IN ANKLE VOLUMES FOR PLACEBO & TREATMENT GROUPS, INJURED & NON-INJURED LEGS



DISCUSSION

The results of this study indicate that both groups were evenly balanced in age and in terms of their degree of injury, as demonstrated by initial ankle volume measurements and pain analogue score. The control group contained a greater proportion of females, but it is unlikely that this would influence any of the outcome variables. The two groups were balanced in the number of hours spent with the ankle elevated each day. The self management in both groups was thus the same, and so the pulsed shortwave treatment was the only differing aspect likely to be directly affecting their recovery.

The data has been extensively dredged at the risk of type I errors and there is no significant difference in the reduction in swelling between the two groups at any time point. There is also no significant difference in pain as measured on the pain analogue score and the amount of analgesia required, again at any of the time intervals. There was no reduction in the time to full weight bearing for the treatment group compared to the placebo group.

It was expected that the ligament sprains treated in the trial would heal within 15 days, as they were Grade I or II injuries.

The Circuplode attachment generates primarily an H field compared to the Diapulse which emits both E and H fields together. Studies using the Diapulse[3 4 5] demonstrate a reduction in swelling and accelerated healing. It may be a combination of the E and H fields which is more beneficial in restoring ionic cellular balance, than the H field alone.

Comparable studies[4 5 6 7] have used different treatment times (up to one hour daily) with differing intensities and outputs, which may have different effect on outcome. A comparison of the effect of varying such parameters as pulse width, duration, frequency and intensity on each machine may clarify which setting are optimal for healing in the acute stage.

CONCLUSION

No significant differences in terms of pain, swelling, or time to full weight bearing have been shown in 37 patients allocated in a double blind manner to either a pulsed shortwave treatment or to placebo.

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