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## PRELIMINARY COMMUNICATIONS

### Treatment of Soft-tissue Injuries by Pulsed Electrical Energy

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#### Summary

Twenty pairs of patients matched for sex, age, weight, and degree of trauma were treated either with an active Diapulse machine emitting pulsed, high-frequency electrical energy or with a non-active placebo machine. They were examined for swelling, pain, and disability before treatment and after three days under double-blind conditions. The results show that the pulsed, high-frequency electrical treatment has a definite biological effect on recently injured soft tissues, especially in the reduction of pain and disability.

#### Introduction

The interrelation of mechanical stress and electrical charges in collagen fibres has been examined in vitro in both tendon and bone (Fukada and Yasuda, 1957, 1964; Bassett and Becker, 1962; Bassett, 1965; Shamos and Levine, 1967) and attempts have been made to use electrical energy to stimulate the repair of collagen fibres in vivo (Ginsberg, 1961). Recently J. M. Fitton and S. Hulman (personal communication, 1971) reported favourably on a subjective trial of pulsed, high-frequency electrical energy in the treatment of soft-tissue injuries. In view of this a double-blind trial was planned to make a statistical assessment of this treatment in patients suffering from a recent sprain of the lateral ligaments of the ankle joint.

#### Patients and Method

Patients who had sustained an inversion injury of the ankle during the preceding 36 hours were examined physically and radiologically to exclude a bony injury or a ligamentous instability of the ankle. They were then graded for swelling, pain, and disability and paired for age, weight, sex, and degree of injury.

Diapulse machines were used to give the patients pulsed, high-frequency electromagnetic radiation. These machines give

a 975-watt emission for 65 microseconds at 27·12 megacycles with a resting interval between successive pulses of 1,600 microseconds. Patients received continuous treatment for one hour and were treated daily for three days. After each treatment crêpe bandages were applied from the toes to the calf and the patients were given walking instruction and exercises by an experienced physiotherapist.

#### DETAILS OF DOUBLE-BLIND TRIAL

Six Diapulse machines were used, designated by random letters from the alphabet and arranged in three pairs. A fuse was removed from one of each pair of machines so as to have one functional and one placebo machine in each pair. The code indicating which machines were functional was placed in a sealed envelope by the electrician and it was not opened until the trial had been completed. Patients receiving treatment from a Diapulse machine are not aware of any sensation as there is no heating of the tissues. Thus neither the patients nor the clinician who examined them knew which patients had received electrical treatment and which had the placebo.

#### GRADING OF PATIENTS' SIGNS AND SYMPTOMS

Patients were examined before treatment on the first day and after treatment on the third day, and on each occasion were graded on a 0-4 scale for swelling, pain, and disability (Table I).

TABLE I—Numerical Grading of Signs and Symptoms

Signs	Grade	Symptoms
Swelling	0	No increase of ankle circumference compared with uninjured ankle
	1	Increased circumference of 0- $\frac{1}{2}$ in (1·3 cm)
	2	Increased circumference of $\frac{1}{2}$ -1 in (1·3-2·5 cm)
	3	Increased circumference of 1-1 $\frac{1}{2}$ in (2·5-3·8 cm)
	4	Increased circumference of over 1 $\frac{1}{2}$ in (3·8 cm)
Pain	0	No pain
	1	Pain only after walking some distance
	2	Pain on taking even one step
	3	Pain when at rest on couch
	4	Pain severe enough to require analgesics
Disability	0	No disability
	1	Walks with slight limp
	2	Walks with considerable difficulty
	3	Can walk only with help of supporting arm
	4	Cannot walk at all

#### Results

The scores of the 20 placebo patients (Table II) and the 20 treated patients (Table III) in each of the measured categories of swelling, pain, and disability were added together. In each category the percentage improvement in the treated patients was about twice that of the placebo patients.

TABLE II—Total Grades of 20 Placebo Patients

	Swelling	Pain	Disability	Total
Before treatment first day ..	38	37	41	116
After treatment third day ..	26	25	23	74
Percentage improvement ..	31.6	32.4	43.9	36.2

TABLE III—Total Grades of 20 Treated Patients

	Swelling	Pain	Disability	Total
Before treatment first day ..	38	43	46	127
After treatment third day ..	14	11	6	31
Percentage improvement ..	63.2	74.4	86.9	75.6

## STATISTICAL ANALYSIS

With a non-sequential method of analysis the Diapulse treatment was found to be significantly preferable to the placebo treatment on all four counts—that is, swelling, disability, pain, and total scores.

A Bross plan B chart for sequential analysis of matched pairs was used and Diapulse was found to be a preferable treatment compared with placebo, statistically speaking, with respect of improvement in disability scores, pain scores, and total scores. No significant difference between the two groups was found as regards improvement in swelling scores, although the trend of results seen looked likely to produce a significant result, given more results.

The outcome of awarding a positive sign when the treated patient's progress was better than his or her matched pair and a

TABLE IV—Results of Treatment in 20 Matched Pairs of Patients

	No. Positive	No. Negative	P Value
Swelling .. .. .	9	2	0.033
Disability .. .. .	12	2	0.006
Pain .. .. .	13	1	0.002
Total Scores .. .. .	13	2	0.011

negative sign when the placebo patient made more progress is shown in Table IV. No sign was awarded when there was no clear preference between the two patients. The P values in all four categories are less than 0.05.

## Discussion

This investigation shows that so far as sprained ankles are concerned pulsed, high-frequency electrical treatment has a biological effect on recently-injured soft tissues. This is particularly noticeable in the reduction of pain and also disability. The treatment is time consuming, however, both for the patient and for the physiotherapist and it is probably not justified in treating minor sprains where the patient can walk on the ankle after the application of an adhesive bandage, but for the patient who is more severely injured it has been shown to be a valuable method of treatment.

I wish to express my thanks to the Principal and Governors of Nonington College of Physical Education for making available the services of Miss V. Barclay, who gave the physiotherapy treatment.

The Diapulse machines were loaned by the Diapulse Corporation of America.

The statistical analysis of the results was prepared through the good offices of Messrs. Smith & Nephew Limited.

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## MEDICAL MEMORANDA

## Fatal Hypoglycaemia Occurring after Peritoneal Dialysis

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This report illustrates a potentially fatal complication of peritoneal dialysis which has received little attention in the medical literature.

## Case History

A 52-year-old Negro man was first admitted to hospital on 29 December 1970 because of chest pain. A diagnosis of uraemic

pericarditis was made. He had been subjectively well until a few hours before admission and there was no personal or family history of diabetes, hypertension, or renal disease. A suprapubic prostatectomy had been performed seven years previously at another hospital.

On admission he was found to be acutely ill, cachectic, and dehydrated, and a loud pericardial friction rub was heard. Haematocrit reading 20%; white cell count 8,800/mm<sup>3</sup>; blood urea nitrogen (B.U.N.) 177 mg, creatinine 18.5 mg, glucose 140 mg, and uric acid 11.6 mg/100 ml; serum potassium 6.9 mEq/l, bicarbonate 20 mEq/l. Urine analysis showed proteinuria, pyuria, and many white blood cell casts. E.C.G. was consistent with pericarditis and hyperkalaemia.

He was immediately treated by peritoneal dialysis with 1.5% glucose dialysate. This produced noticeable subjective and objective improvement, with disappearance of the friction rub and chest pain, regression of the E.C.G. abnormalities, and reduction of the B.U.N. to 90 mg/100 ml. Subsequent isotope renography showed symmetrically shrunken kidneys with severely reduced function but no obstruction. Cystoscopy showed a stricture in the area of the prostatic urethra, which was dilated.

Ampicillin, allopurinol, polystyrene sulphonate resin, dietary restriction of protein and potassium, transfusion of packed erythrocytes, and two further peritoneal dialyses comprised the subsequent therapeutic regimen. Multiple blood glucose determinations, including the periods while dialyses were in progress and

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