Annotated Bibliography
Diapulse Research

by

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Dental Surgery

1. Aronofsky DH, Reduction of dental postsurgical symptoms using non-thermal pulsed high-peak-power electromagnetic energy, Oral Surgery, Oral Medicine, Oral Pathology 32(5):688-696, November, 1971. David H. Aronofsky, D.D.S., of the Jefferson Clinic in Dallas, Texas studied three groups of 30 patients each. He reported "Results indicate that the patients given Diapulse therapy pre- and post-operative and those who received it only postoperatively exhibited a statistically and observably significant reduction in pain and inflammation as compared to the nontreated control group." He also stated "The Diapulse-treated patients exhibited a substantial decrease in time required for wounds to heal as compared to the nontreated group. The patients in the group receiving both pre- and postoperative Diapulse therapy required between 3 and 5 days, the patients in the group receiving postoperative Diapulse therapy only required between 5 and 7 days, and the control group receiving no Diapulse therapy required between 10 and 12 days for wounds to heal." The confidence level for the statistical analysis is estimated to be between 90 and 96 per cent.

2. Rhodes LC, The utilization of Diapulse therapy as an adjunctive treatment in oral surgery, Quarterly Journal of the National Dental Association 28(2):101-108, 1970. L. Cecil Rhodes, D.D.S., of Rhodes Dental Hospital, Norfolk, Virginia, reports on 14 months' experience with Diapulse compared to 16 years' practice without Diapulse. Dr. Rhodes concludes: "Used adjunctively, pre and postoperatively, in a prescribed regimen of consecutive treatment, Diapulse therapy has proved that: 1. Pain is reduced by more than 75% ... . 2. Edema is reduced by more than 65%. 3. Hemorrhage is reduced by more than 70%. 4. Trismus is eliminated in complex oral surgical procedures, ... . 5. Granulation tissue formation in areas of acute or chronic infection is rapidly reduced or inhibited. 6. Healing time is reduced as much as 50%. .... 7. Hospital patients need only be hospitalized for one day instead of three to five. 8. There are no contraindications to its use."
3. Rhodes LC, The adjunctive utilization of Diapulse therapy (pulsed high peak power electromagnetic energy) in accelerating tissue healing in oral surgery, *Quarterly Journal of the National Dental Assoc. 39(4):166-175*, July, 1981. L. Cecil Rhodes, D.D.S., Rhodes Dental Hospital, Norfolk, Virginia, compares 254 patients treated without Diapulse to 247 patients treated with Diapulse. Author concludes: "The adjunctive use of Diapulse Therapy (pulsed high peak power electromagnetic energy) has significantly reduced hemorrhage, pain, edema, and healing time. It is simple to apply and has proven to be completely safe in our more than ten years of use, and thousands of treatments. Considering today's soaring medical costs, a safe method of reducing a patient's disability, and returning him or her to normal activity faster, is a welcome addition to any dental and medical practice, whether in office, clinic, or hospital."


**Hand and Ankle Injuries**

1. Barclay V, Collier RJ and Jones A, Treatment of various hand injuries by pulsed electromagnetic energy (Diapulse), *Physiotherapy 69(6):186-188*, June, 1983. Barclay (Nonington College of Physical Education, Nonington, Kent), Collier (Univ. of Kent) and Jones (physician at Guy's Hospital, London) studied a total of 230 patients with hand injuries. They conclude "This randomized trial shows that hand injuries treated with pulsed high power electromagnetic energy (Diapulse) within 36 hours of injury have a definite biological and healing effect. The most marked effect was the reduction in swelling (fig 1). In the treated group, except for two cases, swelling had completely disappeared by the third day, compared with the control group where swelling had greatly increased and dispersed only slowly by the end of seven days." "These results show ... that this form of treatment has both a beneficial effect on the patients' recovery and a considerable saving in hospital expense."

2. Wilson DH, Treatment of Soft-Tissue Injuries by Pulsed Electrical Energy, *British Medical Journal 2*:269-270, 1972. This study at the University of Leeds was David Wilson's first study of Diapulse. Twenty pairs of patients were matched for sex, age, weight, and degree of trauma. They were either treated with an active Diapulse machine or a non-active placebo machine under double-blind conditions. Wilson reported that Diapulse treated patients had significant benefits of Diapulse in reduction of swelling, relief of pain, and reduction of disability.

3. Wilson DH, Comparison of short-wave diathermy and pulsed electromagnetic energy in treatment of soft tissue injuries, *Physiotherapy 60(10):309-310*, 1974. This study compared Diapulse with conventional diathermy, as a followup to the 1972 report. Patients were scored for swelling, pain, and disability. The Diapulse treated group fared significantly better than the
diathermy treated group. I met Wilson in October, 1984, while he was serving as President of the Association of Accident and Emergency Physicians.

4. Pasila M, Visuri T and Sundholm A, *Pulsating short wave diathermy - value in treatment of recent ankle and foot sprains*, Archives of Physical Medicine and Rehabilitation 59:383-386, August, 1978. This study at University Central Hospital in Helsinki, Finland, compared the effects of Diapulse and Curapuls treatments with placebo treatments in 321 patients with ankle or foot sprain. Walking ability in the Diapulse group recovered better than the placebos and reduction of swelling was significantly better for Curapuls than for placebos.


**Neurological Studies**

1. Ionescu D and Ionescu A, *Results of microsurgical suture in 200 nerves*, Acta Chirurgiae Plasticae 26(3):166-183, 1984. Work at the Institute of Medicine and Pharmacology in Bucharest, Rumania. Authors' summary includes the statement "An electromagnetic field [DT therapy] was used in 48 patients with clearly positive effect, the Tinel sign appearing much more distal than usual 48 hours after surgery."

2. Kiwerski J and Chrostowska T, *Clinical trials in the application of pulsating electro-magnetic energy in the treatment of spinal cord lesions*, Chir. Narz. Ruchu Orthop. Pol. 45:273-277, 1980. This uncontrolled study at the famous Rehabilitation Clinic of Professor Marion Weiss in Warsaw, Poland, reported that an unexpectedly high percentage of 97 patients treated with Diapulse exhibited significant improvement. Authors concluded that "a marked improvement was observed in 38 individuals" but "Despite the favorable treatment results, it is impossible to decide unambiguously as to the degree to which the application of EMF was responsible for the improvements." I have independent validation of the quality of the English translation prepared for the Diapulse Corporation.

3. G. Meissl, *Nerve regeneration under the influence of an intermittent electromagnetic energy. An experimental study on rabbits*, Handchirurgie, University of Vienna 11:31-35, 1979. Paper is in German. English summary: "An experiment on healing of transected nerves of rabbits was carried out. Under microsurgical techniques continuity of the nerve was reestablished by end-to-end coaptation without creating a defect, so only the elasticity of the nerve tissue had to be overcome, and by nerve grafting. In both cases treatment with intermittent high frequency magnetic field was applied continuously. Histologic studies revealed that the scar at the suture site matured more quickly than usually and that distal to the site of transection the normal calibre of regenerated axons was reached within a shorter time than previously."


7. Raji ARM and R. E. M. Bowden, Effects of high peak pulsed electromagnetic field on degeneration and regeneration of the common peroneal nerve in rats, *Lancet* :444-445, August 21, 1982. In a series of well-controlled experiments, Raji and Bowden studied the effect of pulsed electromagnetic field energy (PEMF) delivered by Diapulse machines on normal, crushed, sectioned and sutured left common peroneal nerves (CPN) in pairs of male Lewis rats matched for age and levels of lesion. One of each pair received 15 minute daily treatments and the other had sham treatments, for periods ranging from 3 1/2 days to 8 weeks postoperatively. All histological, cytological, and morphometric studies were done blind. The authors state "After crushing of the CPN, the affected limbs were first used in grooming, locomotion, and play at the 14th and 6th postoperative day, respectively, in untreated and treated animals. The mean times of appearance of the toe-spreading reflex were 12.5 (SD±1.0) days and 6.25±0.5 days. After section and primary suture the first use of the limb and appearance of the reflex coincided on the 21st day in untreated animals. In treated ones the limb was first used on the 12th postoperative day and mean time for appearance of the reflex was 12.5±1.0 days. These differences between the untreated and treated animals are significant (p<0.01)." ... "These results provide significant evidence that PEMF has no effect on healthy nerves but that beneficial effects are obtained in treating degenerating and regenerating nerves after crushing (and after section and primary suture) of nerves in rats."


10. Sambasivan M et al, Effect of pulsed electromagnetic field (pemf) in cerebral edema, *Journal of the Neurological Society of India* 34(4):241-247, July, 1986. This paper reported the effects of Diapulse in experimentally induced brain edema in rats. Diapulse treatments led to faster reduction of edema and recovery.
11. Sambasivan M, Use of Diapulse in management of human head injuries, presented at the Eighth European Congress of Neurosurgery, Barcelona, Spain, September, 1987. This paper compares two groups of humans recovering from severe head trauma resulting from accident or brain surgery necessitated by organic disease. 50 patients received two 30-minute Diapulse treatments daily. The other group of 50 patients did not receive Diapulse. The treated group exhibited a significantly improved condition (based on the Glasgow Coma Scale) at 10 days.

12. Sambasivan M, Pulsed electromagnetic field in the management of head injuries, Abstracts: Pulsed C. L. Walters, A. K. Ommaya, D. Rigamonti, et al, The potential for spinal cord regeneration in the rhesus monkey, chapter in Mechanisms of Growth Control, Robert O. Becker, editor, C. C. Thomas, pages 290-310. This study, conducted at the National Institutes of Health, showed that Diapulse therapy appeared to provide beneficial effects in monkeys with spinal cord injury. More research is indicated.

13. Wilson DH, Jagadeesh P, Newman PP and Harriman D, The effects of pulsed electromagnetic energy on peripheral nerve regeneration, Annals of the New York Academy of Sciences 238:575-580, October 11, 1974. The median ulnar nerve in the left forelimb of a series of pairs of rats was divided and sutured under a general anesthetic. Subsequently, one rat from each pair was treated with Diapulse energy. From the author's summary: "Clinical observations showed that the wounds in the treated animals healed in 4 days, whereas they required 7 days to heal in the control animals. Treated rats began to use their left forelimb after 10 days, but 21 days were necessary before the untreated rats reached this point of recovery." Nerve conduction studies also showed that Diapulse had a significantly beneficial effect.

14. Wilson DH and Jagadeesh P, Experimental regeneration in peripheral nerves and the spinal cord in laboratory animals exposed to a pulsed electromagnetic field, Paraplegia 14(1):12-20, 1976. In this study, a 2 mm. section of the median-ulnar nerve was removed in 132 rats. Nerve conduction studies showed that the Diapulse-treated animals had a much faster return of nerve function. In addition, rats were sacrificed at regular intervals for histological examination of the nerves. The recovery of control animals at 60 days was not as advanced as the Diapulse-treated animals at 30 days. In a preliminary study, the investigators performed hemicordotomies in the upper lumbar spinal cord in cats. Diapulse-treated and control animals were sacrificed at three months for histological examination of the injured segment of spinal cord. They report that the scar was smaller in the treated animals than in the untreated.


(Society of Neurological Surgeons, New York City). Cats with a standardized contusion spinal cord injury were studied; 10 animals were untreated, 30 others were in three groups initially treated with Diapulse one hour after injury, four hours after injury, and 24 hours after injury. They were observed for somatosensory evoked potential (SEP), vestibulospinal responses (VSR), and locomotory ability. A highly significant beneficial effect was seen in the SEP of all three treated groups compared with the controls at 30 days post-injury, which was still very significant in the 4-hour group at 60 days. In general, the treated animals fared better than the controls. The author discusses the apparent effects of Diapulse on calcium concentrations in the vicinity of the injury.


**Surgical Applications**

1. Bentall RHC and Eckstein HB, *A trial involving the use of pulsed electro-magnetic therapy on children undergoing orchidopexy*, *Zeitschrift fur Kinderchirurgie und Grenzgebiete* **17**(4):380-389, November, 1975. Study conducted at Queen Mary's Hospital for Children, Carshalton, Surrey; Bentall at Royal College of Surgeons. Studied effect of Diapulse on the recovery of males after surgery for undescended testicle. Authors report diligent attention to experimental design and pairing of patients in the untreated control and Diapulse-treated groups. There were 25 pairs. They conclude "These results further confirm the beneficial biological effects of a non-thermal pulsed electro-magnetic field" and promise that Bentall will conduct further study of the mechanisms.


4. Cameron BM, *A three-phase evaluation of pulsed, high frequency, radio short waves (Diapulse). 646 patients*, *American Journal of Orthopedics*: March, 1964. Bruce Cameron, M.D., at Baylor University, conducted three studies. 1. A 100 patient, double-blind study on wound healing in surgical patients. 2. An 81 patient, non-controlled study on wound healing in orthopedic, surgical patients. 3. A 465 patient study, non-controlled on non-surgical, orthopedic patients. Author's comments too lengthy to cite here, but general impression is that Diapulse therapy was useful.
5. Goldin JH, Broadbent NRG, Nancarrow JD and Marshall T, *The effects of Diapulse on the healing of wounds: a double-blind randomised controlled trial in man*, British Journal of Plastic Surgery **34**:267-270, 1981. In a study at Wordsley Hospital, England, patients were admitted to the trial whenever a medium-thickness split-skin graft was taken from the thigh. They were randomly assigned as placebo treated controls or for Diapulse treatment. 17 of 29 treated patients (59%) had achieved 90% healing at 7 days, versus 11 of 38 patients (29%) on the dummy machine. Authors conclude "this trial indicates that reparative processes are clearly accelerated by pulsed radio-energy therapy."

6. King DR, Hathaways JW and Reynolds DC, *The effect of pulsed, short waves on alveolar healing*, Journal of the District of Columbia Dental Society **42**(1):1-5, February, 1968. These dentists at Georgetown University studied the effects of Diapulse on the recovery of dogs from tooth extractions. They conclude: "Within the limitations of this study, evidence has shown that pulsed high-frequency short wave therapy increased the inflammatory response and the rate of deposition of collagen in dog alveoli during the initial healing phase."

7. Silver H, *Reduction of capsular contracture with 2-stage augmentation mammaplasty and pulsed electromagnetic energy (Diapulse therapy)*, Plastic and Reconstructive Surgery **69**(5):802-805, May, 1982. Harold Silver, M.D., discusses the effects of Diapulse therapy in 231 women who received breast implants. He states that capsular contraction has been a major complication of augmentation mammaplasty, and treatment with Diapulse therapy, massage, and closed capsulotomy completely eliminated all capsular contracture.

**Blood Flow and Hematoma**

1. Erdman II WJ, *Peripheral blood flow measurements during application of pulsed high frequency currents*, American Journal of Orthopedics **2**:8, August, 1960. This study by William Erdman, M.D., at the Univ. of Pennsylvania, in 20 subjects, showed that Diapulse treatment over the epigastrium significantly increased blood flow to the feet.

2. Fenn JE, *Effect of pulsed electromagnetic energy (Diapulse) on experimental hematomas*, Canadian Medical Association Journal **100**:251-254, February 1, 1969. Fenn, an M.D. at St. Michael's Hospital in Toronto, treated experimental hematomas in rabbit ears; color photographs dramatically show faster resolution of hematomas in animals treated with Diapulse. Conclusions: "These experiments demonstrate that Diapulse therapy significantly accelerates the reabsorption of experimental hematomas in the rabbit ear."

effect of pulsed short waves in intermittent claudication, Current Therapeutic Research 8(7):317-321, 1966. Investigators at the Karolinska Institute (prestigious medical center in Stockholm) studied the effects of Diapulse in 18 cases of intermittent claudication (severe pain in the calf during walking, which results from insufficient blood flow). They report that Diapulse treatment significantly increased blood flow.


5. Valtonen EJ, Lilius HG and Svinnuferad U, Effects of three modes of application of short wave diathermy on the cutaneous temperature of the legs, Europa Medico Physica. 9(2):49-52, 1973. The reflex heating effect of short wave diathermy was studied at Meilahti Hospital, Helsinki, Finland. They report that Diapulse was more effective than conventional diathermy (using condenser or coil applicators) in raising temperature of the legs by applying energy to the abdomen. "Because short wave therapy using an athermic mode of treatment (pulsed high frequency current, Diapulse) does not appear to involve any risk for the patient and also gives adequate results, as is shown in this study, its therapeutic use can be recommended especially for the treatment of patients with chronic arterial occlusions."

Podiatric Surgery

1. Braun GS, Pulsed electromagnetic energy: a new therapeutic modality in podiatry, Journal of the American Podiatry Association 55(10):700-705, October, 1965. Gustave Braun, D.S.C., of the Children's Service Bureau in Pittsburgh, describes his study of the literature which lead him to try Diapulse, and his experience with it in his practice. He states "Diapulse was integrated into my practice and was used extensively in my effort to become fully oriented to the modality. Over 600 treatments were given during a 6-month period, covering every clinical condition from dermatosis to irreparable deformity. " Although he saw no improvement in 3 out of 4 cases of bursitis with well-defined spurs, Braun reported encouraging results with arthritis, weak foot syndrome, gout, and Reynaud's syndrome. He summarizes "Local application of Diapulse reduces pain without reaction" and "There seems to be positive evidence that Diapulse application over the epigastrium can significantly affect circulation in the entire extremity, with the promise of a more satisfactory prognosis in a large class of foot pathoses."

2. Erman JJ, Physical Medicine in Podiatry: A New Concept, Journal of the American Association of Foot Specialists, June, 1970. Dr. Erman discusses the various physical medicine modalities which he used in his practice over the years. He states that, after three years' experience with Diapulse, it has superseded most of the physical therapy equipment in his office. He states that its use is indicated in traumatic and inflammatory conditions of the bones and joints, fractures, bursae, painful tissue areas, sprains, strains, neuritis, neuralgia and myalgia, intermittent
Claudication, rheumatoid arthritis, and cysts. He says "After introducing pulsed high frequency electromagnetic energy into my practice, I noticed about a 50% patient increase daily, without any additional physical labor on my part." A table of clinical uses is included in the paper.

3. Hersh BJ, The adjunctive application of Diapulse therapy for foot traumas, Current Podiatry 21(2):15-17, February, 1972. Bernard Hersh, D.P.M., of Dallas, Texas, presents 10 case reports and summary of experience with more than 200 patients in whom Diapulse therapy was used. Author states: "The non-thermal, pulsed, high peak power, electromagnetic energy accelerated post-surgical healing. Post-operative pain and inflammation, which are sometimes encountered, were either eliminated entirely or were markedly reduced."

4. Kaplan EG and Weinstock RE, Clinical Evaluation of Diapulse as adjunctive therapy following foot surgery, Journal of the American Podiatry Association 58(5):218-221, 1968. Earl Kaplan, D.S.C. and R. Weinstock, D.S.C., conducted a double-blind study at Civic Hospital in Detroit to assess the effects of Diapulse therapy in 100 patients undergoing foot surgery. They state: "Diapulse therapy, when administered in conjunction with major foot surgery, exhibited a statistically significant reduction in the amount of postoperative edema. Accompanying this reduction in edema was a concomitant reduction of erythema and pain. ... In our opinion, Diapulse therapy appears to be an excellent adjunct in the postoperative treatment of foot surgery."

5. Richmond EL, Results of pulsed high frequency electromagnetic energy in the treatment of foot disorders and surgery, Journal of the American Association of Foot Specialists, June, 1970. Dr. Richmond describes his use of Diapulse in connection with foot surgery, including bunionectomies, metatarsal head resections, tendon lengthening, calcaneal spurs, heads of proximal phalanxes, and neuromas. He describes the faster recovery of patients since Diapulse therapy was instituted, and that all patients can be kept ambulatory. Most return to work within two days of surgery.

Dr. Richmond states that "Tenosynovitis and thrombophlebitis respond spectacularly to Diapulse. Immediately following treatment, the patient has a great reduction in pain."


7. Zulli LP, Pulsed high frequency electromagnetic energy for adjunctive care of foot lesions, Journal of The American Podiatry Association 58(8):343-344, August, 1968. Louis Zulli, D.S.C., of the Pennsylvania Hospital in Philadelphia, studied 100 patients, all 60 years or older, who presented with a chronic problem with healing. Author states "In our cases we observed that wound healing was uneventful and normal. It was our impression that healing, in most cases, was accelerated by as much as 30% to 50%."
**Decubitis Ulcers**

1. Duma-Drzewinska A and Zbigniew Buczynski A, *High frequency pulse currents in treatment of bedsores*, Polski Tygodnik LeKarski **XXXIII(22)**:885-887, 1978. This paper is in Polish; have not seen an English translation. The English summary states "The best results were obtained in cases of superficial bedsores and in cases in which this treatment was started shortly after the development of bedsores. In cases with deep bedsores and in patients who were treated by this method late results were less convincing and the duration of treatment had to be prolonged."


4. Itoh M, *Healing of Stage II and Stage III pressure ulcers with pulsed high frequency high peak power electromagnetic energy (Diapulse)*, Fifth Annual Symposium on Advanced Wound Care, New Orleans, LA, April 23-25, 1992.


**Miscellaneous Applications**

1. Ginsberg AJ, *Ultra-short radio waves as a therapeutic agent,* Medical Record, 1-8, December, 1934. Ginsberg is the inventor and developer of Diapulse; this paper is probably the first publication on the apparatus that was to become Diapulse.


3. Ginsberg AJ, *Pulsed short wave in the treatment of bursitis with calcification,* International Record of Medicine 174(2):71-74, February, 1961. Paper summarizes treatment of 94 patients for calcified bursitis. Ginsberg reports that 86 achieved partial or complete symptomatic relief, and that of 46 patients in whom x-rays were taken both before and after treatment, there was observable absorption of calcium in 42 cases.


5. Levy H, *Pulsed short wave in sinus and allied conditions in childhood,* Western Medicine 2:246-248, June, 1961. Harold Levy, M.D. treated 75 children for sinusitis, lymphadenosis, and other conditions. Some patients had as many as 3 or 4 of the conditions simultaneously. Levy reported that in 138 symptoms treated, relief was total 109 times, partial 21 times and absent 8 times.

York City to assess the effects of Diapulse therapy in the treatment of women with pelvic inflammatory disease. Group I: 45 women received Diapulse therapy in addition to regular treatment. Group II: 45 received regular treatment. Group III: 10 received placebo Diapulse therapy and regular treatment. From the author's summary: "The patients in Group I responded much more rapidly and more completely than those in Groups II or III. The average hospital stay for the PHF-treated patients was 7.4 days, for the controls 13.5 days."

7. Nadasdi M, Inhibition of experimental arthritis by athermic pulsating short waves in rats, American Journal of Orthopedics 2(3):105-107, 1960. This study, conducted at Hans Selye's institute, consisted of three experiments involving a total of 81 rats. Author states "Our results show that the Diapulse apparatus can significantly inhibit inflammation in rats under our experimental conditions."

8. Smith EM and Blackberg SN, Management of rheumatic diseases in general practice, Southern Medical Journal 56(6):599-602, June, 1963. Euclid M. Smith, M.D., and S. N. Blackberg, M.D., discuss the diagnosis and treatment of patients with rheumatic diseases. This state that Diapulse is far superior to diathermy, partly because it is much safer. This paper was apparently one source for "labeling claims" in FDA's allegations of misbranding.

9. Splitter SR, New approach to the management of subacute sinusitis, Delaware Medical Journal 38(3):83-84, March, 1966. Samuel R. Splitter, M.D., of Hempstead (N.Y.) Medical Center, reports on a study of 110 patients with subacute sinusitis. Author summary includes "There was no evidence of adverse effect, and all of the patients showed positive response to therapy. No contraindications to the use of this modality were apparent."


Two papers where the authors conclude that Diapulse© was not effective in the treatment of tinnitus (included here for completeness).