Effect of Pulsed Electromagnetic Energy (Diapulse) on Experimental Hematomas

J. E. FENN, M.D., C.R.C.S.[C], F.A.C.O.G.,* *Toronto*

ALTHOUGH the therapeutic value to be derived from the use of pulsed high-frequency electromagnetic energy in medicine is not generally accepted,[1-3] it would appear that it is of possible value in certain circumstances[6-8] and that its potential has not been investigated adequately.[4, 5]

Experiments were undertaken to discover whether such energy could have any effect upon hematomas as observed under controlled laboratory conditions.

MATERIAL AND METHODS

The electromagnetic field was produced by a short radio-wave generator† containing a circular coil 6.2 cm. in diameter and operating on an assigned frequency of 27.12 megahertz. The energy waves, lasting 65 microseconds, were pulsed at a frequency of 80 to 600 per second, thus producing an average power output of 1.52 to 38 watts (peak power 251 to 975 watts).

Sixty New Zealand white male rabbits,† weighing from 1500 to 2000 g., were housed in individual cages under a controlled environment which contained an insecticide and bacteriocide‡ and were given water and food§ *ad lib.*

Twenty-four hours after shaving the ears, a hematoma was produced by injection of 0.2 c.c. (30 animals) or 0.5 c.c. (30 animals) of each animal's blood into the left ear at a point 5 mm. proximal to the arterial arch, 15 mm. from the anterior edge and 30 mm. from the tip of the ear. The two groups were divided again for control (15) and treatment (15). For the control group a sham or "dead" unit was used.

In order to confine the animal for photography and treatment, a holding box was devised that allowed the energy source to be applied directly to the ear which was lightly taped to the animal's back (Fig. 1).

The treated animals were exposed to the "live" unit twice daily for 30 minutes at a setting of 400 pulses per second and a penetration setting of "4".

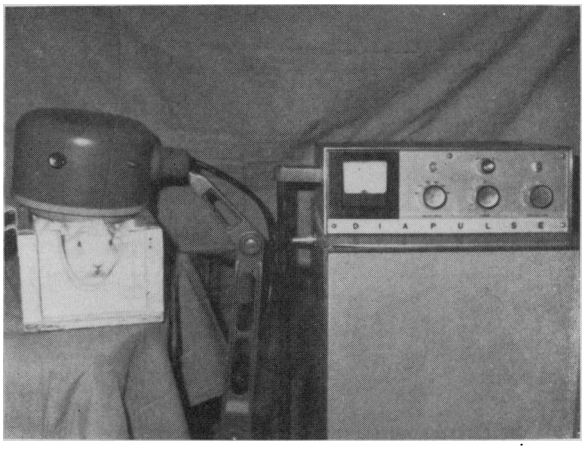

Fig. 1.—Method of treatment using the Diapulse unit.

Photographs of the hematoma were taken daily before treatment, using the Polaroid CU 5 camera (Fig. 2). The ear was taped to a ground glass screen behind which was a synchronized flash. (The camera settings were: F22: 1/60 second; ear to flash 15.2 cm.; ear to camera 7.5 cm. Polaroid colour film 108 was used with an AS rating of 75.)

The ear with the hematoma was amputated on the ninth day of treatment from 10 animals in each group. The tissue was fixed in Bouin's solution until prepared for staining with hematoxylin and eosin for histological examination

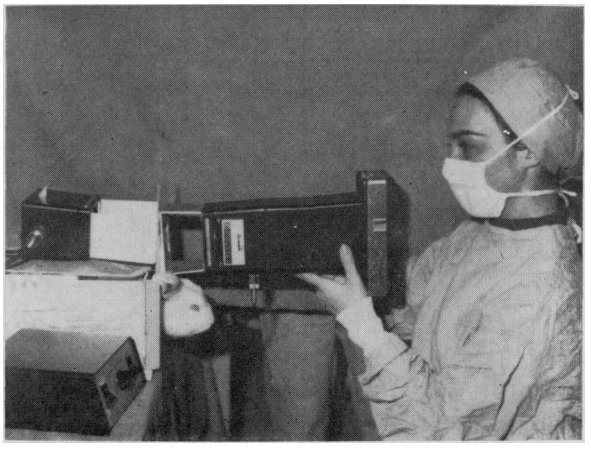

Fig. 2.—Method of photography using the Polaroid CU 5 camera.

*Department of Obstetrics and Gynecology, St. Michael's Hospital, Toronto, Ontario.

†Diapulse Units supplied by Diapulse Corporation of America, 4 Nevada Drive, Lake Success, N.Y., U.S.A.

†Supplied by High Oaks Ranch, Richmond Hill, Ontario.

‡Konk and Kancel, supplied by Air Guard of Canada, Downsview, Ontario.

§Master Feed rabbit pellets.

Reprint requests to: Dr. J. E. Fenn, Suite 903, 1849 Yonge Street, Toronto 7, Ontario.

Canad. Med. Ass. J.
Feb. 1, 1969, vol. 100

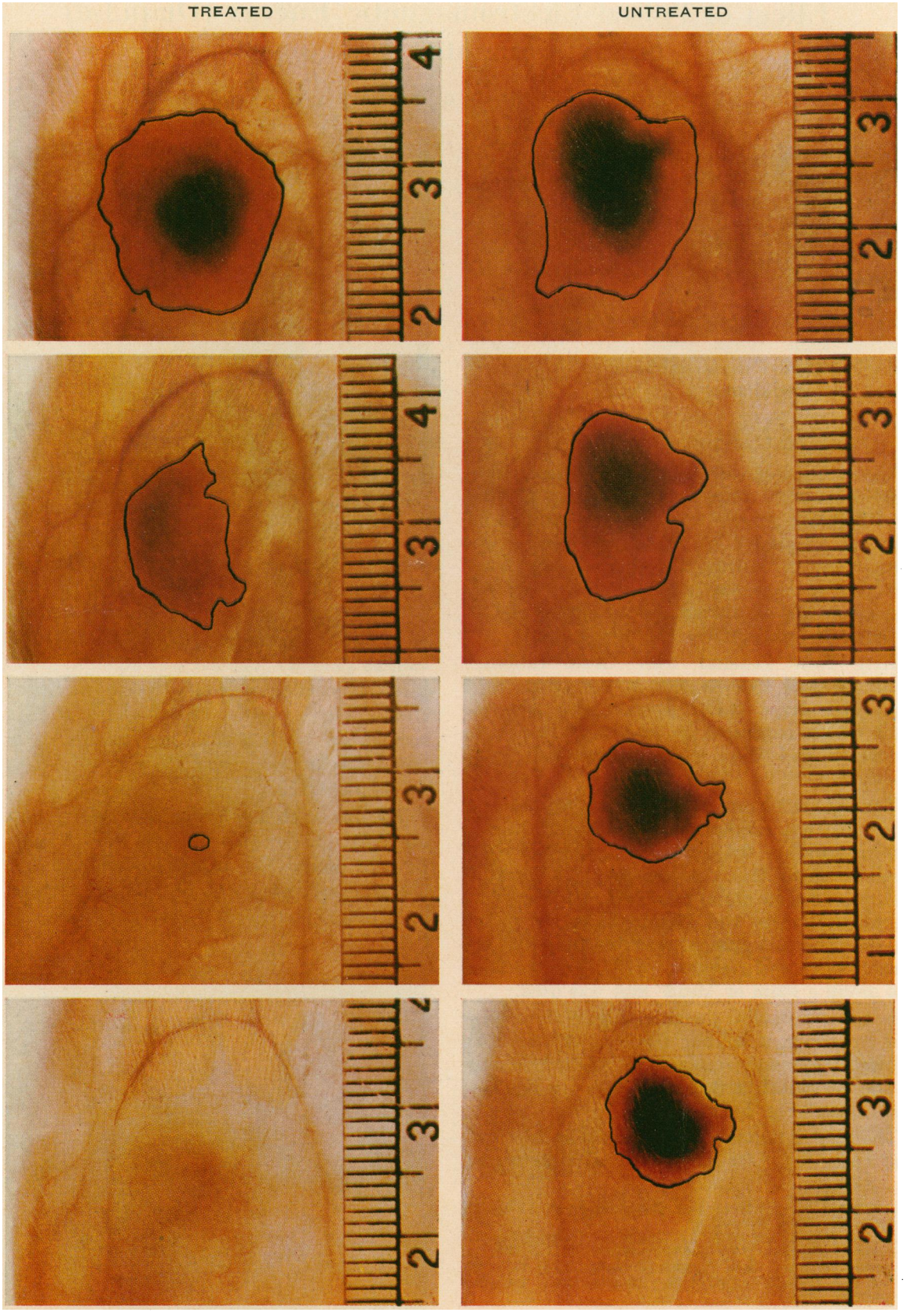

Fig. 3.—Representative Polaroid photographs showing the resolution of hematomas in both the treated (left) and the control groups (right) over an eight-day period.

which located the hematoma between the dermis and the cartilage.

RESULTS

The Polaroid photographs (Fig. 3) were examined for:

(1) The area of the hematoma as measured by a planimeter in square millimetres (Table I).

TABLE I.—PLANIMETER READINGS
THE SUM IN mm.² OF THE AREAS OF THE HEMATOMAS IN ALL SPECIMENS

Day (after injection, before treatment)	*Control*	*Treated*
0	2902 mm.²	2972 mm.²
2	1843	1844
5	1101	718
8	670	281

(2) The longitudinal axis of the hematoma in millimetres.

(3) The colour changes occurring during the resolution of the hematomas. The changes in the density of red, blue, green, yellow, white and neutral were measured in reflected light at the darkest point of the photograph by the Densichron (Fig. 4), which is an instrument used for measuring the intensity of reflected light.

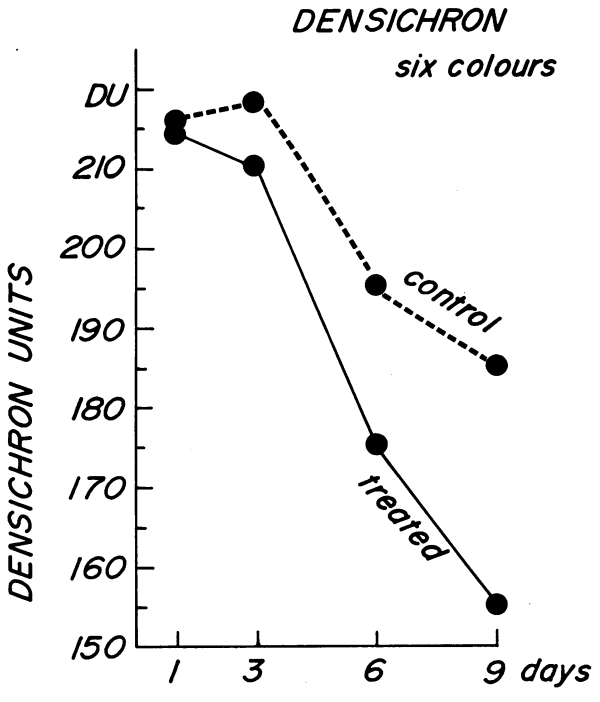

Fig. 4.—Illustration showing the results of the Densichron measurements in all six colours: red, blue, green, yellow, white and neutral.

The differences between the means of the control and treated groups as far as planimeter measurements, length and Densichron readings are concerned were significant at the 1% level by the "t" (Table II) and Chi-square tests.

TABLE II.—RESULTS OF "t" TESTS

Days (after treatment)	*Planimeter*	*Length*	*Densichron (neutral colour)*
0	0.273	0.625	0.207
2	0.611	1.879	0.194
4	0.884	0.862	1.087
6	3.907**	3.770**	2.206*
7 and 9	3.448**	3.851**	3.249**

*5% level of significance.
**Significant at 1%.

DISCUSSION

Comparison of the data from the two groups of animals used in this experiment indicates that when hematomas are treated by pulsed high-frequency electromagnetic energy as delivered by the Diapulse generator, resolution is accelerated. This acceleration becomes statistically significant on the sixth day (Table II) and can be noted not only in reduction of the area of involvement but also by the more rapid removal of pigments as indicated by the colour changes measured by the Densichron.

No attempt has been made to investigate the mechanism by which this form of energy influences the rate of resolution of hematomas.[9] This should be the subject of further laboratory investigations because of the potential clinical value of this form of energy in acute injuries.

CONCLUSIONS

These experiments demonstrate that Diapulse therapy significantly accelerates the reabsorption of experimental hematomas in the rabbit ear.

Summary Experimental hematomas produced in rabbits' ears were treated with pulsed high-frequency electromagnetic energy as delivered by the Diapulse generator. Resolution of the hematomas was found to be accelerated in the treated group as compared with resolution in controls. The acceleration became statistically significant on the sixth day.

Résumé Des hématomes expérimentaux occasionnés sur des oreilles de lapins ont été traités au moyen de l'énergie électromagnétique pulsatile à haute fréquence produite par le générateur Diapulse. La résolution des hématomes a été accélérée par ce procédé dans le groupe traité par rapport à la résolution constatée chez les témoins non traités. L'accélération de la résolution est particulièrement nette, du point de vue statistique, dès le sixième jour.

The author would like to express his thanks to:

Dr. Harding le Riche, Professor of Biometrics and Epidemiology, University of Toronto; Dr. E. Lewellyn Thomas, Associate Director of the Institute of Biomedical Electronics, University of Toronto; Dr. Walter Zingg and Dr. E. Nagy of the Research Institute of The Hospital for Sick Children, for their advice and constructive criticism.

Mr. Glen Jones of the Department of Biometrics, University of Toronto, for his statistical analysis.

Mr. Arthur Smialowski, Director of Photography, St. Michael's Hospital, and Mr. Barry Skopit of the Polaroid Company of Canada, for their advice on photography.

Mr. S. W. Wright, Director of Photography, The Hospital for Sick Children, for his help on the Densichron results.

Messrs. William Wilson and Brian Watkins of the Department of Research Histology, The Hospital for Sick Children, for their advice and for histological preparations.

Mr. J. E. McCutcheon, J. E. McCutcheon Ltd., for his assistance in photographic supplies.

Mrs. Lita Graham, Miss Susan Allison and Mr. Leslie Starmer for their planimeter readings and drawings.

REFERENCES

1. GOLDBLITH, S. A.: *Advances Food Res.*, 15: 277, 1966.
2. DEICHMANN, W. B.: *Archiv. Toxik.*, 22: 24, 1966.
3. VALTONEN, E. J.: *Acta Rheum. Scand.*, 12: 291, 1966.
4. WILDERVANCK, A. *et al.*: *Arch. Phys. Med.*, 40: 45, 1959.
5. NADASDI, M.: *Amer. J. Orthop.*, 2: 105, 1960.
6. ERDMANN, W. J., II: *Ibid.*, 2: 196, 1960.
7. CAMERON, B. M.: *Ibid.*, 3: 336, 1961.
8. *Idem*: *Ibid.*, 6: 72, 1964.
9. WALSH, R. J. AND CANTRILL, S.: *Aust. J. Exp. Biol. Med. Sci.*, 39: 381, 1961.

SHORT COMMUNICATION

Monoamniotic Twin Pregnancy:
A Review of the World Literature and a Report of Two New Cases

FERDINAND PAULS, B.Sc.(Med.), M.D., D.T.M.(Antwerp),*
Winnipeg, Man.

MONOAMNIOTIC twin pregnancy is an unusual form of twinning in which both twins occupy a common amniotic sac. The condition was first described in the 17th century by Boccalini (1612), Jackob von Bock (1648) and Viardel (1671). Only a single case was reported from 1805 to 1903.[2] The first comprehensive review of the literature on monoamniotic twinning was made in 1935 by Quigley,[1] who found 109 cases. The next review by Raphael[3] in 1961 added a further 74 cases, bringing the total reported in the world literature to 183 (Table I). Since that time many isolated case reports have appeared, and it is the purpose of this paper to review the world literature to the end of 1966 and to add two new cases.

TABLE I.—CASES OF MONOAMNIOTIC TWINS REPORTED TO DATE IN THE WORLD LITERATURE

Author and date		*Number of cases*	*Double survivals*
Raphael (review)[3]	1961	183	51
Wensinger and Daly[14]	1960	3	3
Tafeen, Freedman and Kahane[15]	1960	3	2
Green, Jackson and Miller[16]	1960	1	
Pedlow[13]	1960	1	1
Menchovsky and Hirsch[17]	1960	1	
Zuckerman and Brzezinski[18]	1960	2	
Stolk[19]	1961	1	
Goplerud[20]	1962	1	1
Timmons and De Alvarez[21]	1963	4	1
Vashchilko[22]	1963	1	
De Leew[23]	1965	1	1
Simonsen[24]	1966	2	2
Wharton, Edwards and Cameron[7]	1968	18	10
Winnipeg General Hospital	1967	2	1
		224	73

CASE 1.—Mrs. Y. was a 32-year-old white multipara whose expected date of confinement was December 20, 1966. The prenatal course was uncomplicated. Twins were suspected and confirmed radiographically at the 29th week. At the 34th week the fetal heart sounds were no longer audible and a diagnosis of death *in utero* was made. The patient was admitted to hospital on November 15, 1966, for an oxytocin induction, and two macerated fetuses were delivered at 9:46 p.m. on that day. The cords were noticed to be intertwined and monoamniotic twinning was discovered.

*Resident, Department of Obstetrics and Gynecology, University of Manitoba and Winnipeg General Hospital, Winnipeg, Manitoba.
Reprint requests to: Dr. F. Pauls, Winnipeg General Hospital, 700 William Avenue, Winnipeg 3, Manitoba.