PRESENTED AT
THE SIXTH INTERNATIONAL
CONGRESS ON BURNS
AUGUST 31, 1982 — SAN FRANCISCO, CALIF.

STUDY OF EFFICIENCY OF DIAPULSE® THERAPY ON THE DYNAMICS OF ENZYMES IN BURNED WOUND

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INTRODUCTION

Starting in 1974, we used pulsed high frequency electromagnetic energy, Diapulse therapy, to prevent the development of oedema and pain, as well as to reduce local postaggressive phenonema in burns. As the preliminary results were positive, we applied this treatment to over 2000 patients with: traumatic lesions; before and after surgery; with burns; different inflammatory diseases; severe evolutive necrotic lesions and radionecrosis.

In our previous papers, we reported the beneficial results obtained applying Diapulse in the treatment of burned patients, in surgery of the hand, reconstructive surgery, radionecrosis, etc.

The purpose of this therapy is to improve local circulation. The immediate effect is reduction of oedema, pain and a better local evolution. We consider that, monitoring the local electrical activity, modified by trauma, Diapulse therapy repolarizes the cell membrane.

Because the clinical results were significantly positive, we tried to find some objective proofs for them.

Several types of investigations on the epidermal proteins are reported, Weber (1962) published studies on the enzymes in the normal skin, using standard biochemical techniques. Similarly several workers performed histochemical studies in order to identify the enzymes of the epiderm (Montagna and co-workers, 1962).

The oxydative enzymes of the Krebs cycle, the lactic dehydrogenase and the cytochromoxidase were identified in the epiderm (Pomerantz, 1961). The enzymes of the glycolytic way and those of the hexozophosphate shunt were also identified in the epiderm (Halprin and Ohkawara, 1966). Besides glucose, as a source of energy, the skin also uses glycogen (Braun Falco, 1956, 1961, which can be identified in the Malpighi layer and in those cells that contain keratohyaline — (Ferreira-Marques and Para, 1960). By glycolysis, the glucose is broken up to pyruvic acid, by the lactic dehydrogenase. The existence of glycolysis in the skin was demonstrated by identifying the activities of the enzymes that participate in this process.

The carbohydrate metabolism in the epiderm presents a particular interest from the biochemical point of view, because of its connections at that level with the other metabolisms under the direct influence of some enzymes, linked to multiple systems.

The connection between the protein and the carbohydrate metabolisms is achieved in several ways, one of these being the transamination between the pyruvate and alanine under the influence of glutamic pyruvic transaminase, (GPT), or between oxalacetate and aspartate under the influence of glutamic oxalacetic transaminase (GOT). Both these transaminases were identified in the epiderm by Weber and Teisen (1959).

The epiderm contains also proteolytic, lypolytic and hydrolytic enzymes as well as phosphatases (Bradchaw and co-workers, 1963). We have also some evidence (Broks and co-workers, 1966), that many enzymes implicated in the lipidic synthesis are also present in the epiderm.

Considering the normal local enzymatic activity as an indicator of the viability of the tissue, we checked the amount of proteins and some principle enzymes in normal and burned tissue, before and after Diapulse therapy.

The data thus obtained demonstrate that, compared to normal skin, in burned tissues the activities of lactate dehydrogenase (LDH), glutamic-oxalacetate transaminase (GOT), glutamic-pyruvic transaminase (GPT), and alkaline phosphatase are significantly modified, after Diapulse therapy. The earlier Diapulse therapy treatment is applied, the more rapidly the normal enzymatic activities are restored.

MATERIALS AND METHODS

The Diapulse equipment produces pulsed high peak power electromagnetic energy. It operates on a radio frequency of 27.12 megahertz. Its output is pulsed at a rate of 80 to 600 times per second in 6 steps. The interval between pulses is from 1600 microseconds at maximum setting to 12,400 microseconds at its lowest setting. Each pulse is 65 microseconds in duration. Peak power ranges from 293 to 975 watts in 6 steps and average power from 1.5 to 38 watts.

The electromagnetic field is induced through a drum-shaped treatment head which is placed in direct contact with the area being treated. The patient is then tuned to resonance with the energy by means of a tuning knob located on the treatment head. Treatment can be effectively applied through bandages and surgical dressings. We have found Diapulse therapy to be completely safe.

Patients in this study were treated once daily, over each burned area for ten (10) minutes at a setting of 600 pulses per second and 6 peak power.

The study was performed on 20 burned patients brought to the hospital as emergencies. Enzymatic changes in epidermal cells were studied in three samples of skin, 100 to 300 mg. in size, taken from each patient; one sample was taken from the burned area before treatment; a second from a nearby unburned area, considered as being the control; a third from the burned area, 24 hours after the burn and after Diapulse was applied.

Each sample was washed in saline physiological solution, broken and homogenized for 30 minutes, then centrifuged for 20 minutes and filtered. From the extract obtained, the proteins were quantified and the LDH, GOT, GPT and alkaline phosphatase determined. The determinations were made by spectrophotometry in ultraviolet light with a kinetic method. The enzymatic determinations were performed in the biochemical laboratory of the Postgraduate Medical School.

RESULTS

The concentration of proteins and enzymes in healthy tissue, and burned tissue, treated with Diapulse therapy is reproduced on Table 1.

TABLE 1

	NORMAL					BURNS					DIAPULSE TREATED				
	Proteins	GOT	GPT	ALK. PH.	LDH	Proteins	GOT	GPT	ALK. PH.	LDH	Proteins	GOT	GPT	ALK. PH.	LDH
1.	1.138	43.94	30.04	1.75	163.4	0.756	178.57	18.75	6.61	121.3	1.333	23.25	16.50	6.00	348.8
2.	1.187	106	18	1	917	1.009	43.94	10.54	0.87	78.20	0.810	72.55	25.49	1.96	58.82
3.	0.644	161.49	38.82	15.52	875.7	1.138	30.75	14.94	1.75	96.66	1.333	20.25	9.	6.75	183.79
4.	0.608	273	49.34	21.38	1097.3	0.382	196.3	28.79	20.94	643.97	0.244	49.18	4.09	16.39	459.
5.	0.568	237.67	61.62	12.32	1378.5	0.657	101.97	22.83	10.65	663.62	0.537	199.25	22.35	18.62	877.09
6.	1.350	28.88	9.28	3.70	822.2	1.724	33.06	6.05	1.74	311.4	2.097	30.52	6.67	3.81	300.9
7.	2.906	98.76	11.69	3.09	465.5	2.261	7.96	3.98	1.32	122.5	2.475	15.75	3.63	2.02	545.4
8.	1.666	90.03	9.6	6	567.82	1.702	42.30	5.28	4.11	192.71	2.981	40.25	6.37	2.01	471.98
9.	3.310	80.96	11.48	4.53	568.8	2.817	18.46	3.55	1.06	135.25	1.111	12.60	7.20	7.20	206.1
10.	1.046	37.28	32.94	7.65	672.8	0.737	59.70	23.06	5.42	324.50	0.913	19.71	24.24	25.19	479.8
1.	1.230	19.07	14.63	11.63	478.86	0.624	16.02	20.83	4.80	172.11	1.164	24.91	17.73	10.31	376.28
2.	1.564	142.58	7.67	3.19	802.43	2.022	79.13	7.91	10.38	649.35	2.399	71.69	4.16	9.58	622.76
3.	0.533	118.19	11.25	15.62	819.88	0.408	51.47	9.80	7.35	276.96	1.719	69.22	5.81	11.63	399.65
4.	1.928	119.8	6.22	13.20	948.65	1.621	49.21	4.57	6.48	505.91	1.928	47.71	11.92	6.22	502.44
5.	1.222	35.18	9.82	13.91	652.20	0.768	22.03	14.32	10.41	281.25	2.222	24.6	4.50	20.25	456.79
6.	1.804	118.07	10.53	11.64	648	1.155	112.76	12.99	16.24	622.73	1.826	93.09	10.40	20.81	558.59
7.	1.359	95.65	16.92	14.71	710.67	1.226	79.12	26.91	16.31	657.42	1.564	54.98	7.03	31.96	698.8
8.	1.224	100.65	15.15	4.33	809.52	1.090	76.14	13.76	2.75	575.23	0.826	78.70	75.06	14.52	707.02
9.	1.190	143.70	24.37	19.32	857.98	1.119	53.62	20.55	17.87	412.86	1.235	97.16	22.67	18.62	652.63
10.	1.137	114.33	21.10	10.55	872.3	0.799	90.11	17.52	7.51	504.25	1.186	101.18	20.24	12.65	877.1

Average values of concentration of proteins and enzymes referred to proteins (Iu/ mgP) in healthy and burned tissue before and after Diapulse therapy.

TABLE 2

	TISSUE		
	NORMAL	BURNED	DIAPULSE TREATED
PROTEINS	1.38	1.20	1.49
GOT	108.26	67.13	57.33
GPT	20.52	14.34	15.25
ALK. PHOSPHATASE	9.75	7.73	12.32
LDH	756.47	367.41	489.20

We note in the case of proteins, GPT, alkaline phosphatase and LDH, a decrease in burned tissue versus healthy tissue, i.e., for proteins, the decrease is from 1.38 Iu/ mgP in healthy tissue to 1.20 Iu/ mgP in epidermal burned tissue; — 13%.

—GPT decreases from 20.52 Iu/ mgP in healthy tissue to 14.34 Iu/ mgP in burned tissue; — 30%.

—Alkaline phosphatase decreases from the average value of 9.75 Iu/ mgP in the control tissue to 7.74 Iu/ mgP in the burned tissue; — 21%.

—LDH decreases from 756.47 Iu/ mgP to 367.41 Iu/ mgP; — 51%.

After Diapulse therapy we note a return to normal; even greater values for proteins, GPT, alkaline phosphatase and LDH.

Versus burned tissue, the proteins increased 19%, the average value in burned tissue treated by Diapulse therapy (1.49 Iu/ mgP) versus healthy tissue (1.38 Iu/ mgP). GPT increased 6% in treated tissue versus burned tissue.

Alkaline phosphatase increased 37% in treated tissue versus burned, the average value after treatment (12.32 Iu/ mgP), higher than the average value in healthy tissue (9.75 Iu/ mgP).

All the same, LDH increased 25% in treated tissue versus burned, the average value after Diapulse therapy (489.20 Iu/ mgP) being lesser than the average value in healthy tissue (756.47 Iu/ mgP).

Differing from proteins and the other three enzymes, GOT decreases 38% in burned tissue versus the healthy one and continues to decrease after Diapulse therapy in the burned tissue, 57%.

Percent variations of the average concentration of protein GOT, GPT, alkaline phosphatase and LDH in burned tissue versus normal tissue and in the Diapulse treated versus burned tissue.

TABLE 3

	Normal/Burned	DIAPULSE Treated/Burned
PROTEINS	-13%	+19%
GOT	-38%	-57%
GPT	-30%	+ 6%
ALK. PHOSPHATASE	-21%	+37%
LDH	-51%	+25%

DISCUSSION

In the case of burned tissue compared to healthy tissue, proteins decreased by 13%, GOT decreased by 38%, GPT decreased by 30%, alkaline phosphatase decreased by 21% and LDH decreased by 51%.

In the case of burned tissue treated with Diapulse compared to burned tissue untreated, proteins increased by 19%, GPT increased by 6%, alkaline phosphatase increased by 37% and LDH increased by 25%. Differing from proteins and the other 3 enzymes, GOT continued to decrease from -38% to -57%.

The ratios of the concentrations of proteins and enzymes in treated tissue versus those in burned tissue are noted in Table 4.

TABLE 4

No. cases	PROTEINS	GOT	GPT	ALKALINE PHOSPHATASE	LDH
1	1.76	0.13	0.88	0.90	2.87
2	0.80	1.65	2.42	2.25	0.75
3	1.17	0.66	0.60	3.85	1.90
4	0.64	0.25	0.14	0.78	0.71
5	0.82	1.95	0.98	1.75	1.32
6	1.21	0.92	0.10	2.19	0.96
7	1.09	1.98	0.91	1.53	4.45
8	1.75	0.95	1.20	0.49	2.45
9	0.39	0.68	2.03	6.79	1.52
10	1.24	0.33	1.05	4.64	1.48
11	1.86	1.55	0.85	2.15	2.19
12	1.18	0.90	0.53	0.92	0.96
13	4.21	1.34	0.59	1.58	1.44
14	1.19	0.97	2.60	0.96	0.99
15	2.89	1.11	0.31	1.94	1.62
16	1.58	0.83	0.80	1.28	0.90
17	1.27	0.69	0.26	1.96	1.06
18	0.76	1.03	5.45	5.28	1.23
19	1.10	1.81	1.10	1.04	1.58
20	1.48	1.12	1.15	1.68	1.74
a)	65%	40%	35%	70%	65%
b)	10%	25%	20%	20%	20%
c)	25%	35%	45%	10%	15%

On Table 4, we can observe three distinct groups of variations:

a) cases with an increased concentration of the proteins and enzymes studied;
b) cases in which Diapulse therapy does not modify these concentrations;
c) cases with a decreased concentration of the proteins and enzymes.

We find the following:

For a:

- in 65% of the cases, the proteins have an average increase of 75%;
- in 45% of the cases, GOT have an average increase of 56%;
- in 35% of the cases, GPT has an average increase of 127%;
- in 70% of the cases, alkaline phosphatase has an average increase of 177%;
- in 65% of the cases, LDH has an average increase of 98%;

For b:

Proteins and enzymes in the treated tissues/ burned tissues are not modified:

—in 10% of the cases for the proteins;
—in 25% of the cases for the GOT;
—in 20% of the cases for the GPT;
—in 20% of the cases for the alkaline phosphatase;
—in 20% of the cases for the LDH.

For c:

There is a decrease in the ratio between Diapulse therapy-treated versus burned tissue, as follows:

—in 25% of the cases for proteins, in average with 35%;
—in 35% of the cases for GOT, in average with 49%;
—in 45% of the cases for GPT, in average with 44%;
—in 10% of the cases for alkaline phosphatase, in average with 36%;
—in 15% of the cases for LDH, in average with 21%.

In 1977, we performed an analogous study on injured tissues in 21 traumatized patients, using the same methods described herein. Comparing the results obtained with Diapulse treatment of traumatized tissue (Fig. 1, 2, 3, 4, 5) to those obtained with Diapulse treatment of burned tissue (Fig. 6, 7, 8, 9, 10), we observed that enzymatic activity decreases under the influence of trauma and burns. The return to normal values takes place in all the Diapulse treated cases of trauma, the same occurs in burns, except for GOT.

SUMMARY

For more than 9 years, we have used Diapulse therapy to ameliorate the local and general status of burned patients, especially in treatment of deep burns of the face and hands; smoke inhalation burns; severe extensive burns and a number of other indications. Because the results were significantly positive, we tried to find some objective proofs for them.

Considering the normal enzymatic activity as an indicator of the viability of tissue, we checked the amount of proteins and principal enzymes in normal and burned tissue, before and after Diapulse therapy.

The data thus obtained demonstrated that compared to normal skin, the activities of proteins, LDH and alkaline phosphatase are considerably and significantly increased after Diapulse therapy. GPT is increased to a lesser degree while GOT continues to decrease. We have noted that the earlier Diapulse is applied to the injured tissue, the more rapidly the normal enzymatic activities are restored.

This data demonstrates the beneficial effect of Diapulse therapy on traumatized tissues.

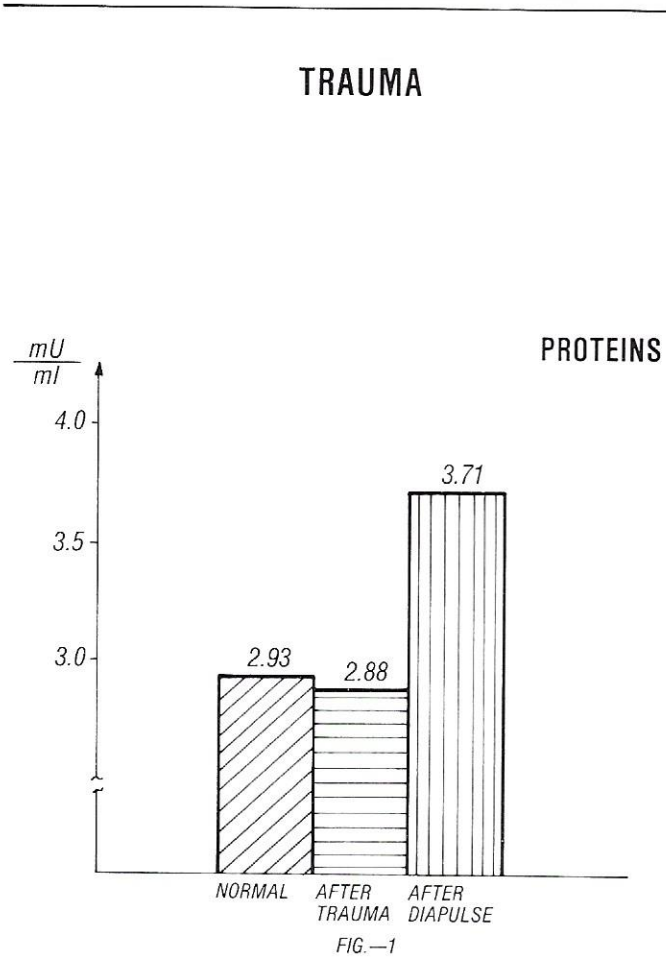

FIG.—1

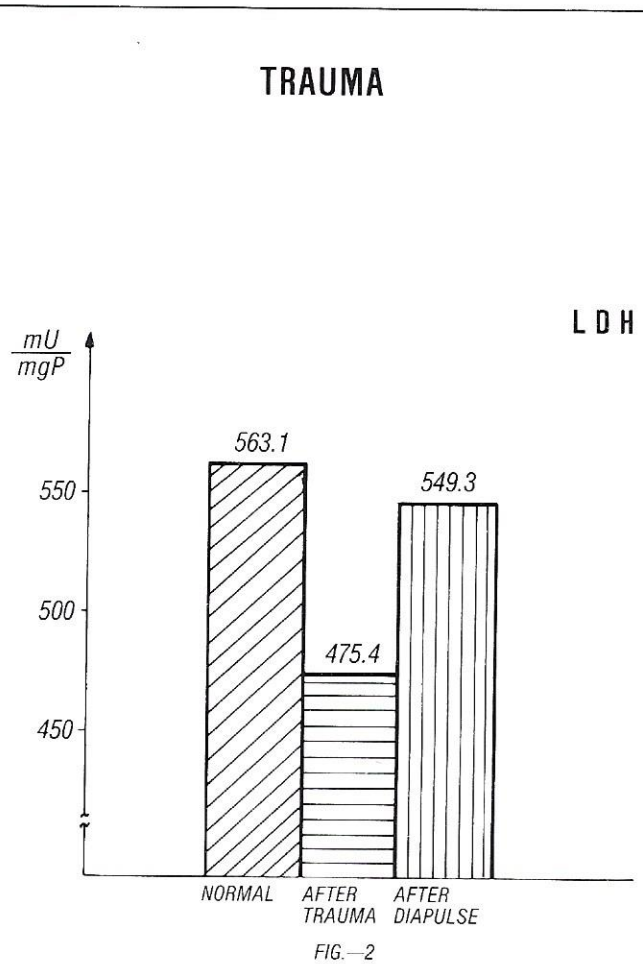

FIG.—2

TRAUMA

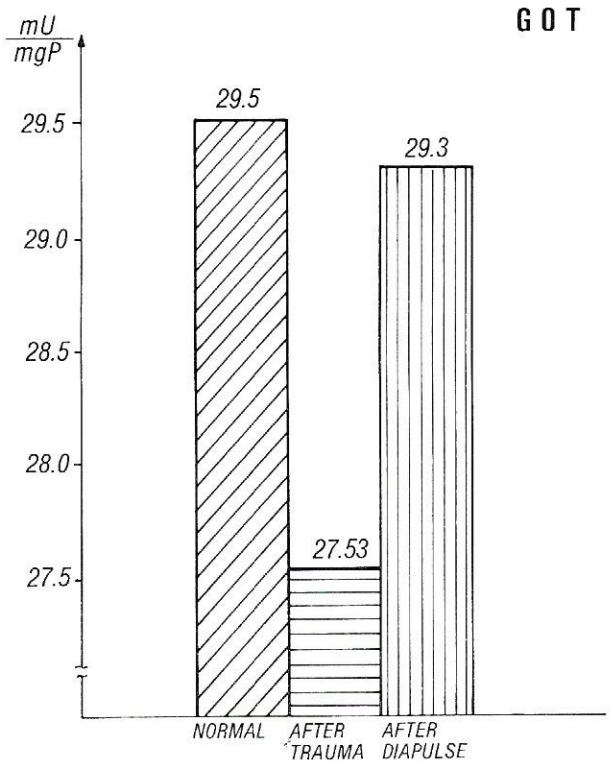

FIG.—3

TRAUMA

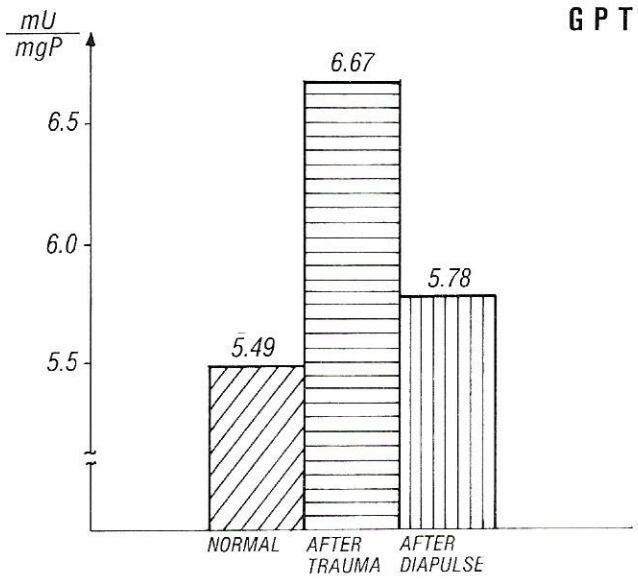

FIG.—4

TRAUMA

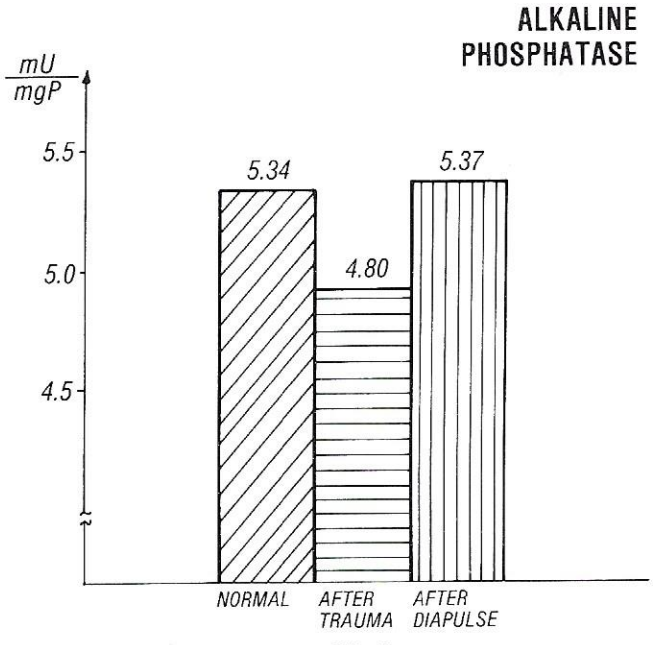

FIG.—5

BURNS

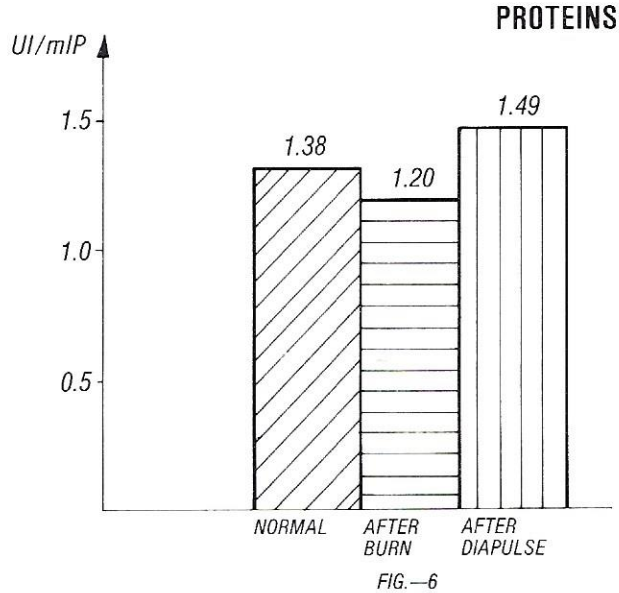

FIG.—6

BURNS

GOT

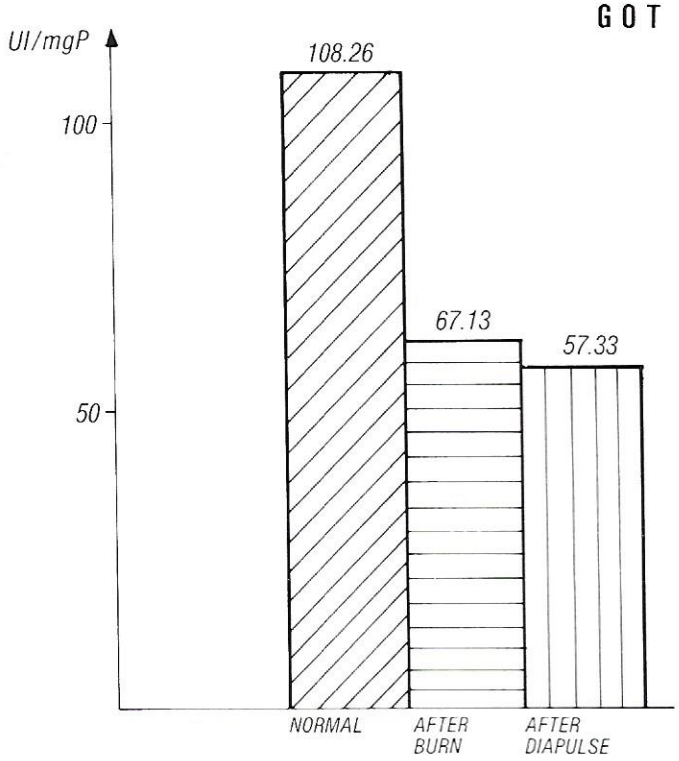

FIG.—7

BURNS

GPT

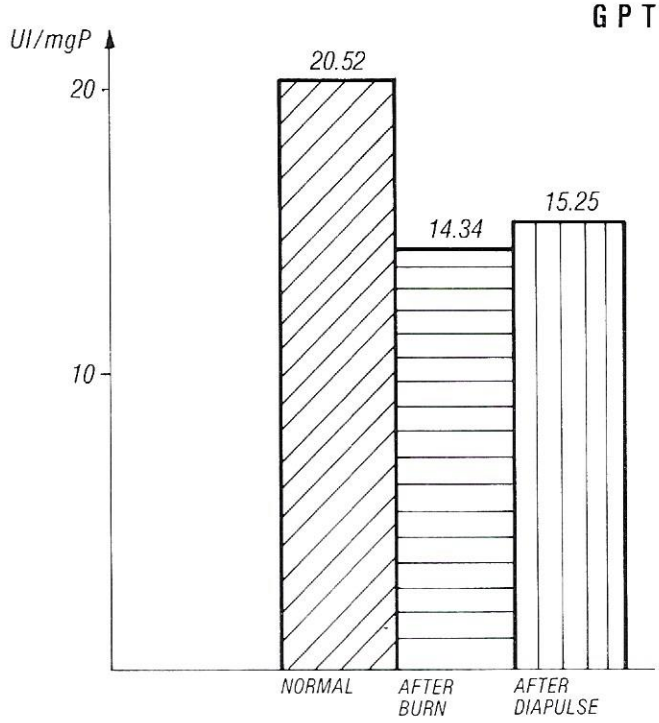

FIG.—8

BURNS

ALKALINE PHOSPHATASE

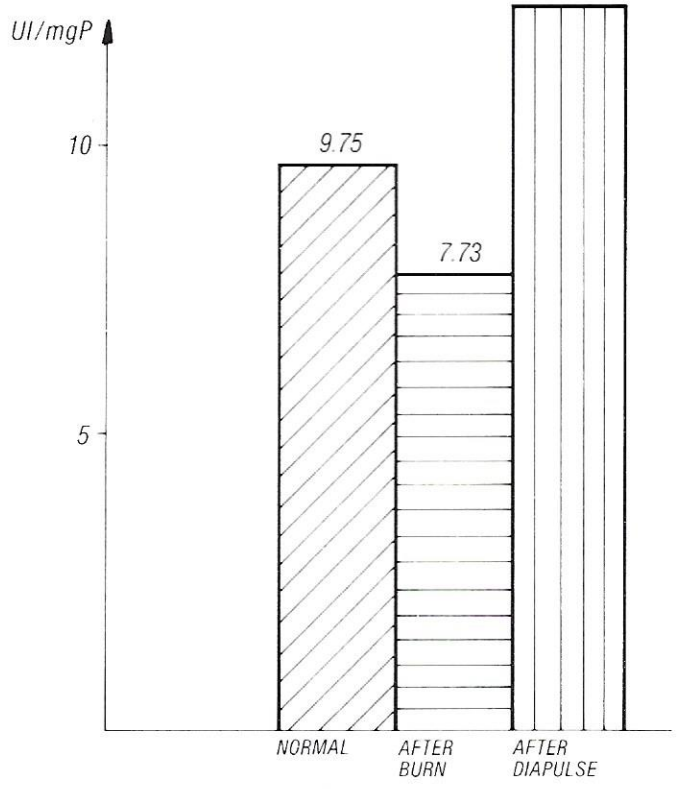

FIG.—9

BURNS

LDH

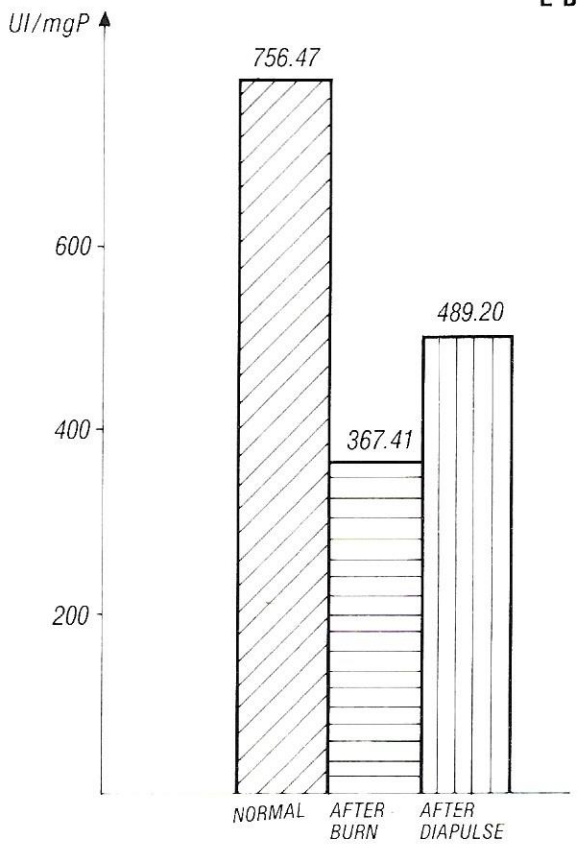

FIG.—10