

TREATMENT OF EXPERIMENTAL CORNEAL INJURY WITH IMPULSE MAGNETIC FIELD

E. Kontrova, A. Angelov*

Department of Ophthalmology, *Department of Pathological Anatomy,
Higher Institute of Medicine, Varna

Key-words: *Corneal trauma - impulse magnetic field - treatment - morphology - regeneration*

Investigations of the influence of constant and alternating magnetic fields (MF) in the course of healing process after corneal injuries are relatively scanty [1,4,6,7,9-11]. Studies of the effect of impulse MF (IMF) on corneal traumatic lesions are almost absent although many authors report that these IMF possess the highest biological activity among all kinds of MF [2,3,5,12-17]. We failed to find any communication in the literature available about the influence of IMF of various shape and frequency of impulse reiteration on perforations of the cornea.

This was the reason for the decision to perform an experimental investigation of the role of IMF of saw-like shape and different frequency of impulse reiteration on the course of healing process in cases with perforative corneal trauma.

MATERIAL AND METHODS

Our experimental trial covered 45 rabbits (or 90 eyes) of California breed with body weight of 1.5 - 2 kg. A penetrating corneal injury of both eyes by means of Elliot's trepane with a diameter of 1,8 mm was inflicted to all experimental animals. In concordance with experimental purposes animals were divided as followed:

Ist series: they underwent a magnetotherapy (MT) with sawlike IMF (SIMF) of frequency of 50 Hz and induction of 8 militesles (mT);

IInd series: they underwent a MT with SIMF of frequency of 200 Hz and induction of 8 mT;

IIIrd series: control animals without any MF treatment.

MT is carried out in any series since the second day after injury with duration of exposition of 10 min. There is no accompanying medicamentous therapy. Animals from each group were divided into subgroups of 15 ones (or 30 eyes) to carry out a dynamic follow-up of results obtained. Animals of each subgroup are then killed on the corresponding day after injury (i.e., on the 4th, 10th and 25th day after injury for the first, second and third subgroup of each group) by air embolism.

The analysis of data obtained is based on the follow-up of numerous clinical eye symptoms of experimental animals by using of inspection, focal lightening, staining with fluorescein and biomicroscopy.

Morphological examination is performed on the enucleated rabbit eyes - on paraffin cuts stained with HE, Azan after Cruchay, PTAH, PAS-reaction, toluidine blue of pH 2 and pH 4, alcyan blue and colloidal iron for glycosaminoglycans (GAG). We also carry out a quantitative (linear morphometry) and semiquantitative evaluation of several basic parameters: thickness of edges of the defect in μm ; lumen of wound channel (WC) in μm ; thickness of granulation tissue (GT) or of cicatrix in μm ; amount of GAG in the edges of the defect and in three degrees: slightly elevated (+), elevated (+ +), and considerably elevated (+ + +).

RESULTS AND DISCUSSION

Dynamic follow-up of basic clinical symptoms characterizes the peculiarities of healing process in the three animals' groups observed (table 1). It is evident that on the 4th day after injury healing

process develops considerably more favourably in eyes under MT than in these of the control group. Closing of WC, restoration of the anterior chamber (AC) and intraocular pressure (tension) (IOP), more accelerated corneal oedema reduction and iritis phenomena in some eyes argue for it.

Table 1:

Dynamic follow-up of main clinical symptoms in the Ist, IInd and IIIrd experimental series.

Clinical symptoms Series Number of eyes	Day after injury								
	4 th			10 th			25 th		
	I 30	II 30	III 30	I 20	II 20	III 20	I 10	II 10	III 10
Intraocular pressure (low,normal)	9* 21	9 21	9 0	0 20	1 19	18 2	0 10	0 10	0 10
Corneal oedema (yes,no)	6 24	15 15	30 0	1 19	6 14	19 1	0 10	0 10	1 9
Corneal neovascularization (yes,no)	0 30	0 30	0 30	0 20	0 20	0 20	0 10	1 9	2 8
Anterior chamber (flat,restitut.)	6 24	8 22	30 0	0 20	0 20	1 19	0 10	0 10	0 10
Exsudate in the ant. chamber (yes,no)	0 30	2 28	0 30	0 20	0 20	18 2	0 10	0 10	1 9
Iris prolapse (yes,no)	0 30	0 30	3 27	0 20	0 20	0 20	0 10	0 10	0 10
Iritis (yes,no)	6 24	9 21	30 0	1 19	19 1	19 1	0 10	0 10	2 8
Neovascularization of the iris (yes,no)	0 30	0 30	0 30	0 20	2 18	0 20	0 10	3 7	8 2

Note: * means that numerator indicates the number of eyes where the healing process has taken an unfavourable course concerning the corresponding symptom.

Tendency towards an accelerated course of healing process in the eyes under MT remains on the 10th day after injury. However, certain differences in dependence on the frequency of MF application expressed by a strong increase of the number of cases with iritis of eyes treated with SIMP of frequency of 200 HZ can be established.

Regeneration process is terminated on the 25th day after injury in both groups under MT. However, there are some complications such as neovascularization of the iris and cornea when SIMP of frequency of 200 HZ is used which are absent when SIMF of frequency of 50 HZ is applied. There are some cases in the control group with corneal oedema and iritis. The number of cases with neovascularization is much greater than that in the other two groups of experimental animals.

Posttraumatic oedema determines the thickness of the edges of the defect (table 2.1). It is noteworthy that already on the 4th day after injury cornea in the region of the edges of the defect

is considerably thinner when MT with SIMF of frequency of 50 Hz is administered. This difference remains later on, too. The thickness of edges reduces later on, on the 10th day when the second series is concerned. The same is valid to the control series, too.

Changes of WC width and adaptation of wound edges (table 2.2) display the most favourable

Table 2:

Dynamic follow-up of main parameters characterizing corneal healing process expressed both semiquantitatively and quantitatively.

Parameters	Day after injury								
	4 th			10 th			25 th		
	I	II	III	I	II	III	I	II	III
Thickness of corneal edges in the area of the defect (in μm)	500-600	700-900	600-700	500-600	500-600	600-	500	700-600	600
Width of WC (in μm)	400-500	700-800	1000-1500	400-500	700-800	1000	400-500	700	800-1000
Thickness of GT (in μm)	-	-	-	GT/150-300	GT/fibr./150-400	fibr./GT up to 1000	350-500		500
Amount of GAG in the edges of the defect and in GT	+++	++	+/-	+++	++	++	++	++	++

and the earliest dynamics when a treatment with SIMF of frequency of 50 Hz is administered. In this group WC is most constricted already on the 4th day and till the end of healing process. WC is considerably wider on the 4th day when MT with SIMF of frequency of 200 Hz is applied. Results become close to these obtained for the first experimental series only on the 10th and 25th day after trauma. WC remains considerably broader in the control group.

GT thickness (table 2.3) reflects directly the expressedness of the regenerative process and the degree of wound defect restoration. GT growth is stimulated already in the early terms after injury - till the 10th day when the 1st series is concerned. This process is more significantly expressed in the second experimental group where there is a considerable GT thickness and not seldom an anterior epithelium hyperregeneration can be observed. The regenerative process is stimulated later (on the 25th day) in the control group. However, GT is immature yet, it is rich in GAG and strongly vascularized. Cicatrix is closest according to thickness to normal cornea and has the most insignificant vascularization on the 25th day after injury when the series of eyes under MT with SIMF of frequency of 50 Hz is concerned (fig.1).

Semiquantitative GAG estimation demonstrates that GAG are most early (already on the 4th day) and most strongly (on the 10th day) elevated when SIMF of frequency of both values - 50 and 200 Hz is used (fig.2). GAG amount decreases on the 25th day. GAG are very slightly elevated on the fourth day in the control group. However, in contrast to the aforementioned groups, GAG quantity increases significantly only on the 25th day which is a sign of delayed course of the regeneration process.

Despite the frequently occurring communications [4,6,7,11] about favourable results from MT use in corneal injuries MT has not been widely introduced into the ophthalmological practice yet.

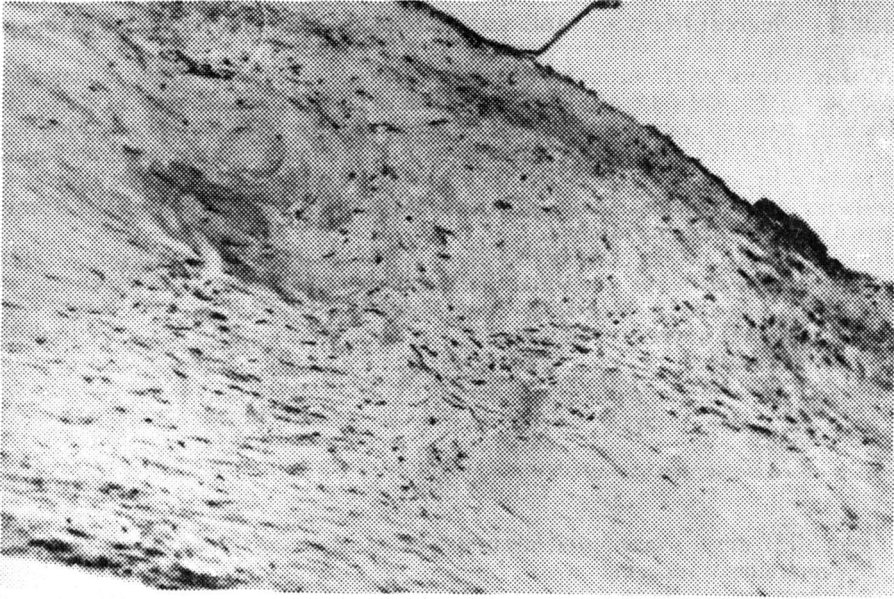


Fig.1 Staining with haematoxylin-eosin. Magn. x 10 x 6.3



Fig.2 Staining with haematoxylin-eosin. Magn. x 10 x 6.3

Besides investigations are mainly devoted to constant MF influence [6,7]. There are insufficient data about the influence of the shape of MF and the frequency of impulse reiteration on the course of healing process.

Results obtained not only from our previous investigations [8,9] of sinusoid and rectangular MF but also from the present study of SIMF of different frequency indicate that the shape of MF impulses is of essential importance for the course of the regenerative process. Besides the increase of the frequency of impulse reiteration (up to 200 Hz) influences unfavourably upon the wound surface by means of induction of hyperregeneration of the epithelium and iris neovascularization. It is evident that a skilful combination of various IMF parameters is required to achieve a maximal therapeutic effect.

However, the problem of the exact mechanism of action of MF on the healing process remains unclarified yet. Most probably, stimulation of metabolism of tissue liquids in the cornea which leads to oedema reduction and early GAG augmentation characterized by a high degree of polymerization plays an important role in this process. GAG increase in the edges of wound defect established by us already in the first days after treatment initialization argues for this assumption, too. Besides it seems obvious that SIMF stimulates fibroblast proliferation. This results in rapid closure of the defect by GT and thus a well-formed slightly vascularized cicatrix appears on the 25th day after injury.

CONCLUSIONS

1. MT with SIMF exerts a manifested favourable influence on the course of healing process in cases with penetrating corneal injury.

2. SIMF frequency exerts an essential effect on the outcome of healing process and on complications in the late posttraumatic period. Healing process is stimulated most early and no complications occur in the late posttraumatic period when impulse frequency of 50 Hz is used while one observes more frequently iritis ending in some cases with neovascularization of both iris and cornea when impulse frequency of 200 Hz is applied. Besides there is a more intensive GT growth and a hyperregeneration of the anterior corneal epithelium.

REFERENCES

1. Балабански, П., Р. Кюркчиева, Е. Контрова. Год. ВМЕИ-Варна, 2, 1985, 31-35.- 2. Берлин, Ю.В., А.В. Коротков, В.И. Белькевич, и соавт. В: Магнитное поле в медицине. Всесоюз. науч.-практ. конф. Сборник научных трудов. Фрунзе, 1974, 20-21.- 3. Берлин, Ю.В., В: Применение магнитных полей в медицине, биологии и сельском хозяйстве. Саратов, 1977, 17-18.- 4. Вайнштейн, Е.С., Л.В. Зобина. В: Применение магнитных полей в ультразвука в лечебных целях. Ленинград, 1985, 40-43.- 5. Войнтский, Е.Н., Б.С.Гендельс, В.И.Гольцман, и соавт. В: Магнитное поле в медицине. Всесоюз. науч.-практ. конф. Сборник научных трудов. Фрунзе, 1974, 21-22.- 6. Кальметьев, Г.Г., Т.С. Иванов, Ю.И. Кийко. *Вестн. офтальмол.*, 1978, No. 3, 34-37.- 7. Кальметьев, Г.Г. Автореферат канд. дисс. Москва, 1979.- 8. Контрова, Е., А. Ангелов, С. Контров, и др. Авт. свид. рег. No. 78355/05.02.1987 г.- 9. Контрова, Е., А. Ангелов. *Офтальмология*, 1989, No. 1, 5-10.- 10. Кюркчиева, Р., С. Витанов, Е. Контрова. Год. ВМЕИ-Варна, 2, 1985, 25-30.- 11. Ларина, Л.А. Автореферат канд. дисс. Москва, 1985.- 12. Скринник, А.В., Н.Е. Думбарова. *Офтальмол. ж.*, 1981, No. 6, 331-334.- 13. Торопцев, И.В., Г.П. Гарганеев. В: Магнитное поле в медицине. Всесоюз. науч.-практ. конф. Сборник научных трудов. Фрунзе, 1974, 8-10.- 14. Торопцев, И.В., Г.П. Гарганеев, Т.И. Горшенина, Н.Л. Теплякова. В: Влияние магнитных полей на биологические объекты. Москва, 1971, 98-108.- 15. Becker, R.O. *Med. Electron. Biol. Engin.*, 1, 1963, 293-296.- 16. Gouquelin, M. *Anal. Biol.*, 1966, ser. 4, No. 11-12, p. 595.- 17. Highton, R., A.A. Caputo, M. Pessoli, J. Mantos. *J. Prosthet. Dent.*, 56, 1985, No. 1, 104-106.

ЛЕЧЕНИЕ ЭКСПЕРИМЕНТАЛЬНОЙ ТРАВМЫ РОГОВИЦЫ ПРИ ПОМОЩИ ИМПУЛЬСНОГО МАГНИТНОГО ПОЛЯ

Е. Контрова, А. Анжелов

РЕЗЮМЕ

Исследовано влияние импульсного магнитного поля, имеющего форму пики и различную частоту при повторении импульсов, на протекание оздоровительного процесса при экспериментальной травме роговицы.

Клиническое и морфологическое исследование проведено на 45 кроликах (90 глазах). Оно доказывает, что наиболее раннее стимулирование оздоровительного процесса наблюдается при применении импульсного пилообразного магнитного поля с частотой 50 Хц. Увеличение частоты повторения импульсов оказывает неблагоприятное влияние на регенераторный процесс, так как вызывает гиперрегенерацию переднего эпителия роговицы и неоваскуляризацию радужной оболочки.

С целью достижения оптимального лечебного эффекта необходимо умелое сочетание различных параметров магнитного поля.