

Variable magnetic fields in the conservative analgesic treatment of peritoneal adhesions

Abstract. In the study the therapeutic effects of variable magnetic fields applied as magnetotherapy and magnetostimulation were estimated in 20 patients with chronic abdominal pains resistant for routine pharmacological treatment caused by a creation of peritoneal adhesions after surgical interventions. As a result of 2 cycles of 15 daily procedures of both magnetostimulation and magnetotherapy, a significant decrease in pain intensity (from 9,05 to 2,05 points in VAS scale) and improvement of quality of life (increase from 23,25 to 87,75 points in EuroQol scale) were achieved.

Streszczenie. W pracy oceniano efekty terapeutyczne zmiennych pól magnetycznych stosowanych w formie magnetoterapii i magnetostymulacji u 20 pacjentów z przewlekłymi bólami jamy brzusznej opornymi na rutynowe leczenie farmakologiczne, wywołanymi przez zrosty otrzewnowe po zabiegach operacyjnych. W wyniku 2 cykli terapeutycznych obejmujących po 15 codziennych zabiegów magnetostymulacji i magnetoterapii uzyskano znaczne zmniejszenie nasilenia bólu (z 9,05 do 2,05 pkt. w skali VAS) oraz poprawę jakości życia (wzrost z 23,25 do 87,75 pkt. w skali EuroQol). (Zmienne pola magnetyczne w zachowawczym leczeniu przeciwbólowym zrostów otrzewnowych).

Keywords: variable magnetic fields, magnetotherapy, magnetostimulation, pleural adhesions, abdominal pain.

Słowa kluczowe: zmienne pola magnetyczne, magnetoterapia, magnetostymulacja, zrosty otrzewnowe, bóle brzuszne.

Introduction

Most of internal organs in the abdominal cavity is covered by a thin membrane, which is called peritoneum. Even small injury of peritoneum during surgical intervention can contribute to increased risk of creation of the peritoneal adhesions [1]. Peritoneal adhesions are a postoperative incorrect connections, that are sometimes formed upon or among particular internal organs from connective tissue (Fig. 1).



Fig. 1. Peritoneal adhesions in the abdominal cavity

The peritoneal adhesions are observed in about 5-14% of patients subjected to surgical treatment. They occur most frequently after surgical operations performed in the lower part of the abdomen (intestinal operations, laparoscopy, gynecological operations). Caesarean section can also be the reason of peritoneal adhesions formation, and in this case it is practically very hard to avoid them [2]. It seems, that the most important factor producing the adhesions is material of thread used for surgical suture, however the total quantity of this material does not influence the extent nor the kind of adhesion [3]. The clinical consequences of peritoneal adhesions can be very differentiated. Usually little peritoneal adhesions can exist for many years without causing any complaints. However, sometimes the adhesions lead to appearance of chronic or recurrent strong pains of abdomen, which often require a wide clinical diagnostics and sometimes repeated hospitalizations. Besides, in young women the peritoneal adhesions could be a cause of infertility.

The mechanism of pain sensation caused by peritoneal adhesions is presented in figure 2.

In case of renewed operations the existing adhesions prolong the time of surgical intervention, cause technical

difficulties during separation of fused tissues, and in consequence they bring about further damage of various abdominal organs, which enlarges the risk of serious postoperative surgical complications. The most serious consequence of peritoneal adhesions, occurring in about 5% of patients, as late complication after surgical intervention is a mechanical intestinal obstruction [4].

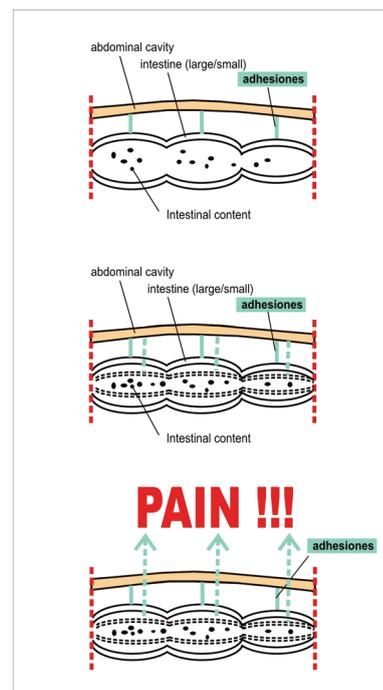


Fig. 2. Mechanism of pain sensation caused by peritoneal adhesions

Actually the most common method of the treatment of pleural adhesions (especially in a case of complications) are next, repeated sometimes many times, surgical interventions leading in some patients paradoxically to formation of new adhesions and multiple skin scars (fig. 3). Taking into account that peritoneal adhesions cause higher costs of surgical procedures, due to a longer time of interventions – sometimes repeated many times - and an increased number of postoperative complications, the investigations regarding the mechanisms of formation, as well as the prevention and especially treatment of peritoneal adhesions are actually of a great importance [5].



Fig. 3. A patient after repeated surgical interventions in abdominal cavity resulting in multiple skin scars and peritoneal adhesions

Regarding the confirmed in experimental and clinical studies analgesic, antiphlogistic, regenerative and anti-spastic effect of variable magnetic fields [6],[7] the aim of the study was to estimate the therapeutic efficacy of magnetotherapy and magnetostimulation in the treatment of chronic abdominal pains caused by multiple pleural adhesions as a complication of surgical interventions in the region of abdomen, which were resistant for routine pharmacotherapy with use of non-steroid analgesic drugs and also opioids.

Material and methods

In this clinical trial 20 patients (15 women and 5 men) in mean age $49,2 \pm 15,8$ years were involved. All patients suffered from strong, chronic, recurrent or continuous abdominal pains as a result of multiple peritoneal adhesions after surgical interventions (in 12 patients repeated 2-5 times) in the lower region of abdomen. The patients were previously for a long time unsuccessfully treated by means of routine pharmacotherapy.

12 patients from first group were exposed to a cycle of magnetotherapy, that consisted of 15 daily 12-minute lasting exposures to variable magnetic field of sinusoidal course of impulse, frequency 40 Hz and induction 10 mT and next, and after 2-week interval, they were exposed to a cycle of magnetostimulation, that consisted of 15 daily 12-minute lasting exposures to weak variable magnetic field using JPS System basing on ion cyclotron mechanism and therapeutic program M2P2 with intensity level 8 (two modal pulses with frequency 180 – 195 Hz and induction 100 μ T). 8 patients from second group were exposed to 2 cycles of magnetostimulation each consisting of 15 daily exposures to weak variable magnetic field with physical parameters described above, performed with 2-week interval between them.

Before the beginning of first therapeutic cycle and next after the end of last therapeutic cycle all patients made a self-estimation of pain intensity (using a typical 10-point Visual Analogue Scale VAS - in which 0 point means lack of pain and 10 point means a maximal intensity of pain) as well as a self-estimation of quality of life (using 100-point EuroQol Scale, in which 0 points mean completely

unsatisfactory quality of life and 100 points mean completely satisfactory quality of life) [8].

Results

As a result of 2 cycles of repeated daily procedures of magnetostimulation applied separately or a cycle of magnetotherapy with subsequent cycle of magnetostimulation, respectively, in all patients a significant decrease in pain intensity estimated by means of 10-point Visual Analogue Scale VAS was observed. The initial intensity of pain was in average $9,05 \pm 0,94$ points, while after the treatment it decreased to $2,05 \pm 1,23$ points ($p < 0,001$).

Moreover in all treated patients a significant improvement of quality of life estimated in 100-point EuroQol analogue scale was obtained. The initial score in EuroQol scale was $23,25 \pm 13,21$ points in average, while after the end of treatment it increased to $87,75 \pm 13,23$ points ($p < 0,001$).

The obtained effects were comparable in patients exposed to both therapeutic procedures. The initial intensity of pain in first group of patients was in average $8,83 \pm 0,94$ points vs. $9,37 \pm 0,91$ points in second group ($p > 0,05$). After the treatment it decreased to $1,92 \pm 1,38$ points in first group of patients vs. $2,25 \pm 1,04$ points in second group ($p > 0,05$).

The initial score in EuroQol scale in first group of patients was $29,17 \pm 13,11$ points in average vs. $14,38 \pm 7,29$ points in second group ($p > 0,05$). After the treatment it increased to $89,17 \pm 13,79$ points in first group of patients vs. $85,63 \pm 12,94$ points in second group ($p > 0,05$).

Both therapeutic methods were well tolerated and no side-effects of treatment were observed.

The results of the treatment in particular patients are presented in table 1.

Discussion

In spite of many prolonged, intensive experimental and clinical investigations, so far no sufficiently efficient and generally accepted method of treatment of postoperative peritoneal adhesions was found. Pharmacological analgesic and relaxant treatment seems to be promising, but advantages related to its application are still not fully confirmed [9].

Nowadays, the most effective form of prevention of postoperative complications due to peritoneal adhesions is delicate and anatomical surgery, accurate hemostasis, exact asepsis, as well as the choice of the optimum surgical methods and applying the low-invasive surgical procedures [9]. There are some surgical methods preventing the excessive formation of peritoneal adhesions as folding of the intestine wall or splitting of the intestine, but they always require next surgical intervention [10]. So far, the avoidance of injury of peritoneum during the surgical intervention is considered by many authors as the most important preventive factor against formation of adhesions [10].

Table 1. The results of treatment with use of magnetotherapy and magnetostimulation in particular patients with chronic pains as a result of peritoneal adhesions after multiple surgical interventions regarding analgesic effect estimated in 10-point Visual Analogue Scale VAS and quality of life estimated in 100-point EuroQol analogue scale (F - female, M - male)

Sex	Age	Therapeutic procedure	Pain intensity in VAS scale [points]		Quality of life in EuroQol analogue scale [points]	
			Before treatment	After treatment	Before treatment	After treatment
F	26	Magnetotherapy and Magnetostimulation	10	1	20	100
F	49	Magnetotherapy and Magnetostimulation	9	0	20	100
F	26	Magnetotherapy and Magnetostimulation	9	4	40	80
F	55	Magnetotherapy and Magnetostimulation	9	3	30	80
F	59	Magnetotherapy and Magnetostimulation	10	2	40	100

F	58	Magnetotherapy and Magnetostimulation	10	4	50	100
F	56	Magnetotherapy and Magnetostimulation	7	2	60	20
F	27	Magnetotherapy and Magnetostimulation	8	1	10	90
M	69	Magnetotherapy and Magnetostimulation	8	0	30	100
M	67	Magnetotherapy and Magnetostimulation	9	1	20	90
M	58	Magnetotherapy and Magnetostimulation	8	3	50	70
M	66	Magnetotherapy and Magnetostimulation	9	2	20	100
F	44	2 cycles of Magnetostimulation	10	3	30	100
F	23	2 cycles of Magnetostimulation	10	1	10	100
F	50	2 cycles of Magnetostimulation	10	3	10	85
F	24	2 cycles of Magnetostimulation	10	2	5	90
F	53	2 cycles of Magnetostimulation	10	4	10	80
F	66	2 cycles of Magnetostimulation	8	2	10	80
F	62	2 cycles of Magnetostimulation	9	1	20	90
M	46	2 cycles of Magnetostimulation	8	2	10	60

Since first use of microsurgical techniques in end of XIX age, it was confirmed in numerous experimental and clinical studies, that application of those procedures enabled to diminish the injuries of peritoneum, and in consequence to reduce the occurrence of peritoneal adhesions [11].

The most nasty and usually drug resistant symptoms of the peritoneal adhesions are strong, chronic or recurrent pains of abdomen, muscular hypertonia of the abdomen integument and reduced mobility of organs in the abdominal cavity.

Magnetotherapy and magnetostimulation with use of extremely low frequency and low induction variable magnetic fields, respectively, are commonly recognized methods of treatment of pain syndromes of various origin and spasticity [6],[7].

In our study both protocols of treatment in patients with peritoneal adhesions contributed to significant regression of pain intensity and improvement of quality of life.

Moreover no side-effects of treatment were observed and the only inconvenience of this form of therapy was its long duration, as the total time of treatment was above six weeks. Basing on the results of experimental studies, it seems that the obtained analgesic effect was caused probably by the decrease of nerve impulse conduction in afferent neural fibers as a result of the hyperpolarization of cellular membranes, as well as by the stimulation of cerebral secretion of endogenous opiates (beta-endorphins), both resulting in a rise of threshold of pain sensation [6],[7],[12].

The regression of muscular hypertonia in abdominal integument in patients with peritoneal adhesions exposed to magnetotherapy and magnetostimulation is related to the antiphlogistic and antispasmodic effect of magnetic fields.

We can suspect as the mechanism of those effects the influence of variable magnetic fields on the structure of liquid crystal components of muscle cell membranes, resulting in the change of permeability of membrane ion channels, especially for calcium ions, with subsequent changes in the distribution of those ions between cytoplasm and extracellular space [6],[7],[13].

In turn the regenerative effect of variable magnetic fields in those patients is related to dilatation of blood vessels due to decrease in smooth muscles tension in the muscular coat of vessels, as well as the acceleration of process of the angiogenesis, both resulting in the intensification of blood supply and perfusion in tissues [6],[7],[14].

Conclusions

Magnetotherapy and magnetostimulation using variable magnetic fields are an effective methods of treatment of chronic abdominal pains caused by multiple peritoneal adhesions after surgical interventions, especially due to high therapeutic efficacy, good tolerance, lack of side-effects and easiness of applying, also in ambulatory conditions.

REFERENCES

- [1] Scott-Coombes D.M., Vipond M.N., Thompson J.N., General surgeons' attitudes to the treatment and prevention of abdominal adhesions, *Annals of the Royal College of Surgeons of England*, 75 (1993), n.2, 123-128
- [2] Vrijland W.W., Jeekel J., van Geldorp H.J., Swank D.J., Bonjer H.J., Abdominal adhesions. Intestinal obstruction, pain and infertility, *Surgical Endoscopy*, 17 (2003), n.7, 1017-1022
- [3] Bakkum E.A., Dalmeijer R.A., Verdel M.J., Hermans J., van Blitterswijk C.A., Trimboos J.B., Quantitative analysis of the inflammatory reaction surrounding sutures commonly used in operative procedures and the relation to postsurgical adhesion formation, *Biomaterials*, 16 (1995), n.17, 1283-1289
- [4] Ellis H., The clinical significance of adhesions: focus on intestinal obstruction, *The European Journal of Surgery Supplement*, 577 (1997), 5-9
- [5] Tingstedt B., Johansson J., Nehez L., Andersson R., Late abdominal complaints after appendectomy - readmissions during long-term follow-up. *Digestive Surgery*, 21 (2004), n.1, 23-27
- [6] Sieroń A., Cieślak G., Kawczyk-Krupka A., Biniszkiwicz T., Biliska A., Adamek M., Application of magnetic fields in medicine, *α-medica press*, Bielsko-Biała (2002), 39-93
- [7] Sieroń A., Pasek J., Mucha R., Magnetotherapy. *Rehabilitacja w Praktyce*, 3 (2006), n.3, 29-32
- [8] Pasek J., Opara J., Pasek T., Szwejkowski W., Sieroń A., Significance of research on quality of life in rehabilitation, *Fizjoterapia*, 15 (2007), n.3, 3-8
- [9] Jackson E.K., Intraperitoneal administration of adenosine inhibits formation of abdominal adhesions, *Diseases of the Colon and Rectum*, 47 (2004), n.8, 1390-1396
- [10] Kutlay J., Ozer Y., Isik B., Kargici I., Comparative effectiveness of several agents for preventing postoperative adhesions, *World Journal of Surgery*, 28 (2004), n.7, 662-665
- [11] Swank D.J., Hop W.C., Jeekel J., Reduction, regrowth, and de novo formation of abdominal adhesions after laparoscopic adhesiolysis: a prospective analysis, *Digestive Surgery*, 21 (2004), n.1, 66-71
- [12] Cieślak G., Mrowiec J., Sieroń A., Plech A., Biniszkiwicz T., Changes in reactivity of rats to thermal pain stimulus under influence of variable magnetic field. *Balneologia Polska*, 36 (1994), n.3-4, 24-28
- [13] Lyle D.B., Wang X.H., Ayotte R.D., Sheppard A.R., Adey W.R., Calcium uptake by leukemic and normal T-lymphocytes exposed to low frequency magnetic fields, *Bioelectromagnetics*, 12 (1991), n.3, 145-156
- [14] Gmitrova A., Ivanco I., Gmitrov J., Murin M., Biological effect of magnetic field on laboratory animals, *Journal of Bioelectricity*, 7 (1988), 123-124

Authors: prof. dr hab. n. med. Aleksander Sieroń, Śląski Uniwersytet Medyczny, Katedra i Oddział Kliniczny Chorób Wewnętrznych, Angiologii i Medycyny Fizykalnej, ul. Batorego 15, 41-902 Bytom, E-mail: sieron1@tlen.pl; dr n. kult. fiz. Jarosław Pasek, Śląski Uniwersytet Medyczny, Katedra i Oddział Kliniczny Chorób Wewnętrznych, Angiologii i Medycyny Fizykalnej, ul. Batorego 15, 41-902 Bytom, E-mail: jarus_tomus@tlen.pl; dr hab. n. med. Grzegorz Cieślak, Śląski Uniwersytet Medyczny, Katedra i Oddział Kliniczny Chorób Wewnętrznych, Angiologii i Medycyny Fizykalnej, ul. Batorego 15, 41-902 Bytom, E-mail: cieslar1@tlen.pl.