MagnerPlus
Magnetic therapy unit

Medical assessment

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Medical assessment of the MagnerPlus unit manufactured by Astar ABR s.c., Bielsko-Biała

The influence of magnetic field on living organisms and on humans in particular has always aroused interest. The healing properties of magnetic field have been known since antiquity. The ancient cultures of Egypt, Assyria and Greece applied magnetic field therapy by moving magnetite stones over the human body or by administering powdered magnetite orally. Hippocrates also described the beneficial tonic effects of magnetite on the human body. The healing properties of magnets were used by Aesculapius — the teacher of Hippocrates and by Claudius Galenus in Rome. In the sixteenth century, Paracelsus attempted to use magnetic field therapy. In 1856, James Maxwell obtained a patent for the medical use of magnetic field. The beginnings of modern magnetotherapy date back to the turn of the 50s and 60s of the twentieth century; major research centres were established in the United States, the Soviet Union (Russia), Japan, Italy and England. In 1978, the U.S. Food and Drug Administration (FDA) permitted the use of magnetic field for medical applications [4, 6, 8, 10, 15, 24, 25].

Nowadays, despite the lack of completely convincing scientific evidence for its therapeutic effects, magnetotherapy is commonly applied in physical medicine and used for therapeutic, preventive and biological regeneration purposes as a method of biostimulation [8, 15, 24, 25, 29, 31, 32, 33, 39, 40, 46, 47, 54].

The market of therapeutic devices generating low-frequency magnetic fields has also developed [54, 55, 18-22].

The beneficial effects of magnetic field on the human body are associated with geomagnetism. The values of the Earth's magnetic field induction range from 30 to 70 μT and vary depending on the location on the globe. The strength of the Earth's magnetic field depends greatly on the structure and geological composition of the Earth's crust. It seems that living organisms need external electromagnetic fields for the proper functioning of their metabolic processes [33, 39, 40]. Magnetic fields are used on astronauts during space flights. The experiments on mice conducted in the outer space proved that the animals would die after several weeks of electromagnetic field deprivation [30, 49].

The second factor demonstrating the importance of magnetic fields for the functioning of organisms is biomagnetism, i.e. the generation of magnetic fields by living
organisms. According to Sieroń et al., biomagnetism results from the aggregation of the magnetic fields of single ions and the particles of individual structures, as well as the presence of currents (mainly ionic) in the body [39].

An example of the electromagnetic phenomena occurring in the human body are the mechanisms of bone growth and differentiation during the process of fracture healing. The application of external forces on the bone causes the piezoelectric effect which involves the excitation of small positive and negative electric charges resulting from bone deformation. It was proved that those charges control the growth of bones. Mechanical load is converted into current pulses which ensure proper reconstruction of the bone microstructures. Only appropriate mechanical load of the bone ensures proper morphological structure formation; the processes of growth and healing are controlled by small electromagnetic fields. Similar phenomena occur during the exchange of information between cells. It was observed that electromagnetic energy is used for the transmission of cellular signals and is responsible for cell divisions.

According to some reports [12, 28, 36, 37, 40, 43, 45], electromagnetic fields affect the exchange of gases in the blood, which is crucial for maintaining the homeostasis. Another phenomenon is the electromagnetic interaction within nerves and muscles, which regulates the metabolic processes in the cells [23, 27, 41, 49, 50].

The supporters of magnetotherapy also argue that healthy tissues can function properly in the presence of appropriately active electromagnetic fields. Under appropriate conditions, activity and increased metabolism are a source of energy, which stimulates muscle growth and strengthens the activity of organs and the immune system. Nowadays, people do not engage in enough physical activity, therefore, they often suffer from chronic energy deficiencies. Appropriately selected pulsating magnetic field may, according to some reports, physiologically eliminate the deficiencies [39, 45, 49, 50, 54, 55].

Apart from the positive aspects of magnetic fields, the existence of electromagnetic smog, i.e. the fields generated uncontrollably by transmission lines, household appliances, industrial machinery and transport equipment, is also stressed. This may have adverse effects on live organisms, causing regulatory disorders and, consequently, the destabilization of the biological systems which are sensitive to the changes of the intensity and frequency of electromagnetic field (the cells of the nervous system in particular), the disturbance of the activity of synapses.
or the secretory functions of the pineal gland and, consequently, the dysfunction of the biological rhythm regulation [6, 14, 23, 33, 35].

Treatment with low-frequency magnetic field, unlike most physiotherapy methods, does not involve the stimulation of the body with mechanical, thermal or electrical factors. Also, there is no photochemical activity, as in the case of ultraviolet irradiation. Magnetotherapy, however, can be applied for the treatment of many conditions due to its assumed specific effects stimulating the activity of the body, referred to as biostimulation [1–5, 7–13, 14, 15, 23–25, 27–33, 37–47, 50–52, 54, 55].

It should be noted that the field in question still evolves and is subject to continuous development, therefore it is not uniform. Due to the differences of the field parameters and its biological effects, some Polish researchers [40, 33, 12] suggest that two therapeutic methods should be distinguished — magnetotherapy, as a method using low-frequency magnetic fields with higher induction values, and magnetostimulation using fields with low induction values (30 to 70 μT). In accordance with this classification, MagnetherPlus is a magnetotherapy device; magnetostimulation devices include devices such as Bemer 3000 [30, 53, 54], Panax [3], Quantron Resonance System [37], Viofor JPS [35, 54]. This classification was introduced by acknowledged scientific experts and its adoption would organize the field in question. Still, in international publications there is no uniform terminology — for example, in the Entrez-PubMed/Medline database, the magnetic stimulation keywords refer to the scientific reports on transcranial magnetic stimulation applied in psychiatry.

According to specialist publications, the biological effects of therapeutic magnetic fields affect the following levels: molecular, cellular, subcellular and tissular and, according to Sieroń et al. [39], they stimulate “the uncompensated magnetic spins of paramagnetic elements and free radicals and the diamagnetic molecules, the structure of liquid crystals formed by cholesterol and its derivatives, including those in biological membranes, the physicochemical properties of water as the tissue filler, the depolarisation of cells with intrinsic depolarisation abilities and the tissue structures with piezoelectric and magnetostrictive properties.” Presumably, the utilization of oxygen and the processes of tissue respiration are also intensified. Moreover, the processes of vasodilatation and angiogenesis can be observed [8, 24, 25, 31, 32, 39, 40].
Initially, magnetotherapy was most commonly recommended for the treatment of locomotor injuries (fracture healing). Magnetotherapy proved to be very effective in the treatment of fractures and osteoporosis and as a preventive measure in the hip joint prosthesis. In several cases bone tumours were reduced [1, 2, 5, 11, 38]. Nowadays, the range of recommended magnetic field therapy applications is much wider. A number of processes which are regulated by electromagnetic fields and which combine individual functions of the organism have been described. Stemme proved that electromagnetic fields improve the blood flow, the partial oxygen pressure, the oxygen saturation of haemoglobin and the tissue oxygen utilization. Electromagnetic waves increase the enzyme activity and the ATP synthesis. These phenomena stimulate the metabolic processes in the whole body [30]. Magnetotherapy increases the DNA synthesis and stimulates the formation of prostaglandin E [52]. The magnetostimulation of the cerebral cortex showed that magnetic fields have significant effects on the frequency and amplitude of brain rhythms. The effects on concentration as a part of memory capacity were proved [36]. It was established that the analgesic effects of magnetostimulation result from the increase of the secretion of endogenous opioids from the β-endorphins group which raise the pain threshold and from the preservation of the level of endogenous melatonin due to the effects of the magnetic field. It was observed that the analgesic effects persisted even after the exposure to the magnetic field was ceased and that the period of reduced reaction to pain lasted from 2 to 4 weeks after the treatment completion [49, 50, 52]. Another beneficial effect of the pulsed magnetic field is its influence on the process of post-exercise restitution, presumably resulting from the effects of the magnetic field on the microcirculation and the processes of oxygen transfer and diffusion [49, 50, 54].

The supporters of magnetotherapy argue that “since every disease causes microcirculatory disturbances and impairs the gas exchange, it is obvious that the use of specific magnetic fields can significantly accelerate the treatment and in some cases become the treatment of choice” [30]. Hence, magnetotherapy has analgesic, anti-inflammatory and antioedematous effects; moreover, it accelerates the processes of fractured bone union and soft tissue regeneration. Magnetotherapy can be also applied for post-exercise
psychosomatic regeneration (many sports clubs include magnetotherapy into their training programmes [30]), as well as during convalescence and asthenia.

Magnetostimulation is recommended for the treatment of the following conditions [1, 2, 4, 5, 7–13, 15, 16, 23–25, 27–33, 35–55]:

- locomotor diseases: delayed union of fractured bone (pseudarthrosis), complications of the Ilizarov limb lengthening procedure (decalcification), osteoporosis and juvenile osteoporosis, arthrosis and acute and chronic arthritis;

- neurological diseases: conditions related to cerebral stroke — due to the increased cerebral circulation and the development of collateral circulation, muscle strength is increased (paresis reduction), active limb movements occur, the locomotion and the control of bladder sphincters are improved; migraine and vasomotor headache; multiple sclerosis at different stages — magnetostimulation is expected to reduce spasticity, to increase muscle strength and bladder control and to have analgesic effects; peripheral nerve dysfunctions of various aetiologies;

- eye diseases: cornea infections, optic nerve atrophy, diabetic retinopathy;

- respiratory diseases: infections of the upper respiratory tract, the sinuses and the trachea, acute and chronic laryngitis, bronchitis, bronchial asthma aggravation, lung infections (severe pneumonia) — the therapy increases the pulmonary flow and has anti-inflammatory effects;

- cardiovascular diseases: hypertension — the systolic and diastolic arterial blood pressure is increased, headaches, dizziness, retrosternal pain and the feelings of irritability and nervousness subside; ischaemic heart disease (coronary heart disease) — effort tolerance increases and retrosternal pain subsides; heart arrhythmia; paroxysmal tachycardia;

- digestive tract diseases: gastric and duodenal ulcer disease, chronic pancreatitis — the elimination of pain, bloating and diarrhoea and the improvement of laboratory indices (trypsin);

- gynaecological diseases: acute and chronic genital inflammation;

- skin and soft tissue diseases: purulent arthritis, infected wounds, burns, keloids, ulceration and lower leg trophic lesions, bacterial infections — the purpose of the therapy is the acceleration of the healing process.

The use of magnetotherapy on patients with cardiac pacemakers and other electronic implants, on patients suffering from cancer and on pregnant women is strongly
contraindicated. It should be noted, however, that new magnetostimulation methods which can be applied on patients with cardiac pacemakers and which are recommended for the treatment of oncological diseases, have been recently developed [53, 54]. Relative contraindications are: active pulmonary tuberculosis, juvenile diabetes, hyperthyroidism, gastrointestinal bleeding (ulcers), severe viral infections and the presence of metal implants. Moreover, long-term exposure to magnetic fields is not recommended as it may cause irritability, headaches and insomnia. It should be noted that this method is very effective in the treatment of acute inflammation and that it can be combined with other forms of therapy, which is a definite advantage. The procedures may be performed through clothing and even through plaster casts; this concerns the whole body — the position of the patient is of no great importance. The application of magnetic fields around the head and the endocrine glands, however, is still controversial [8, 24, 25, 33, 39, 40, 46, 47, 49, 50].

MagnerPlus is a typical magnetotherapy device as far as the parameters of generated magnetic field are concerned [26, 34]. The device has a wide range of available parameters and is equipped with solenoid applicators, which makes it similar to the most common Polish therapeutic devices, such as Magnetronic manufactured by Elektronika i Elektromedycyna [21]. This is undoubtedly an advantage of the unit and it enables a relatively precise selection of procedure parameters on the basis of widely available publications on the subject. The device does not generate magnetic fields with extremely low induction values like the magnetostimulation devices, in which the source of the magnetic field is a small mat, a spot applicator or a magnetic cushion and the selection of the course of treatment involves simply the selection of an appropriate programme or a level of stimulation (Bemer 3000 [30, 53, 54], Panax [3], Quantron Resonance System [37], Viofor JPS [35, 54]). The effectiveness of the treatment depends on, apart from the patient-related factors, the following therapy parameters: the shape of the waveform of the magnetic field, the frequency and the strength of the field (magnetic induction), the type of applicator and the duration and number of procedures. The mode of operation is also important (continuous or intermittent) — the possibility to select the mode enables the user to dose the intensity of the stimulation and to perform procedures on the patient's head. MagnerPlus generates a variable bipolar or unipolar magnetic field with an appropriately rectangular or semi-rectangular, triangular or semi-
triangular, sinusoidal or semi-sinusoidal waveform in the frequency range of 2 to 60 Hz in the continuous or intermittent mode. In the manual mode, the user can determine the treatment duration, the frequency and the shape of the field (and the polarity) and the mode of operation (by selecting the field flow interval). The manufacturer offers three solenoid applicators (coils) with a diameter of 600 mm, 350 mm and 200 mm. Four applicators may be connected to the device simultaneously, however, only one applicator or a combination of two applicators may be used at a time. If the applicator is not selected, the procedure cannot be commenced. This ensures full control of dosage and treatment planning, in accordance with the rules adopted for this type of equipment. The device is manufactured in a two-channel version, which enables the user to perform procedures on two patients or on two body areas simultaneously, with fully independent programming of the time and procedure parameters in both channels. It is possible to connect two applicators in each channel, however, prior to the commencement of the procedure, one applicator must be selected. The purchaser of the device may also choose from low-current and high-current applicators (with higher maximum induction) [26, 34].

In comparison with Magnetronic MF-10 and MF-20, MagnerPlus generates magnetic field with a higher maximum frequency (50 Hz and 60 Hz respectively). This enables the efficient use of coils with relatively large diameters for applications typical for small coils. Magnetic field generators with higher induction values and similar size of induction coils (Accuro's Magnetus [18]) and devices emitting higher frequency fields (Magnoter D56 — MARP Electronic, R-980, MG Port — Cosmogamma [19, 20, 22, 29]) are also available on the market.

The R-980 and MG Port units generate higher frequency (up to 100 Hz) magnetic fields but the value of magnetic induction in these devices is lower than in MagnerPlus. Also, the Astar ABR device has more solenoid coils than devices manufactured by the Italian company.

The device has 76 predefined treatment programmes for 46 different conditions [48]. It is possible to select the magnetic induction unit (gauss or militesla), which simplifies the operation of the unit and proves that the device can be adapted to the approved dosage methods. The user may determine the therapeutic dose without the need to convert the units, which simplifies the process of procedure parameters selection. With the possibility to enable (or disable) the acoustic signals, the user may improve the patient's comfort during the procedure. The manufacturer provides a
stable (welded profiles) aluminium couch as the standard equipment. The material used has been carefully selected — it does not affect the spatial distribution of the generated field. The design of the applicator plug-ins, protecting them against being pulled out during the procedure, proves the quality of the workmanship. The manufacturer also ensured high quality of the electronic design of the device by employing microprocessor technology which ensures accuracy, parameter consistency and reliability. Similarly to other devices manufactured by the company, MagnerPlus runs a test of the efficiency of all components at the time of its activation. In the event of a failure of the device, treatment procedures cannot be performed. The device is equipped with an automatically activated fan and a temperature sensor which switches off the device in adverse ambient conditions (very high temperatures with high values of magnetic field induction). The device is supplied with a detailed and comprehensible user manual, consisting of 32 pages with illustrations and tables. Apart from technical data and information regarding the operation of the device, the manual includes a brief summary of the indications and contraindications for magnetotherapy [17, 26, 34].

The manufacturer provides a 24-month warranty on MagnerPlus [17].

MagnerPlus is definitely a valuable addition to the range of the magnetotherapy devices available on the market. The wide range of parameters and the relatively large number of available accessories improve the therapeutic and operational capabilities of the device and make it very competitive in comparison with other devices. The quality of the workmanship, the manufacturer's warranty and the availability of professional maintenance are also important.

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