

# Medical Applications a

by Frank Gollnick

During the meeting of the BEMS in Munich from June 11th to 16th 2000 special sessions dealt with medical applications of electromagnetic fields in the areas „Clinical devices“, „Epilepsy research and therapy“ and „Electrical Medicine“. The focus was not the scientific exploration of possible dangers of electromagnetic waves or magnetic fields, but the medical benefit that may derive from them. Regrettably, some contributions were strongly influenced by commercial interests and therefore of little scientific use.



During the session on clinical devices Wachtel et al. (USA) talked about molecular causes for a finding at Vanderbilt University, USA: Strong magnetic fields in the range from 0,1 to 1 T in a quadrupole setup (four crossing electrodes) are claimed to have a pain-soothing impact on patients. According to Wachtel, there is certain evidence that magnetic fields theoretically may have a strong influence on ion channels in certain human nerves resulting in a partial bloc of the pain stimulus channeling.

The hypothesis that static magnetic fields foster the healing of bone fracture is denied by many scientists. Rogachefsky & Markov (USA) claim to have observed an acceleration of the healing of a certain type of bone fracture of average three weeks in a number of patients. The reason supposedly is to be found in the stimulation

of the metabolism of bone stem cells and an increased blood circulation in the fracture environment.

A new improved design for a 915 MHz catheter antenna for the treatment of tissue with heat was presented by Pisa et al. (USA). Such catheters are used - in part today or at least in future - to carry out minimum invasive heat treatments on cancer foci as well as the removal and shaping of critical tissue through heat treatment inside the body.

A study on 50 mice (30 treated, 20 control group) regarding cancer treatment with a direct 120 Hz magnetic field (10-20 mT) showed that the tumor growth rate and recovering of blood capillaries (for the supply of the tumor tissue) could (at 15 mT) be reduced to around 41% (Williams et al., USA). The reason for this phenomenon is still unknown.

# nd Devices

A possible disturbing impact of electric fields emitted by power supply on pacemakers - 50 and 60 Hz at field strengths of 1,5 kV/m - was claimed by Sastre et al. (USA, Canada) based upon measurements at human body models and computations.

Morrissey et al. (USA) tested the interference protection of selected medical appliances such as EEG devices, infusion pumps etc. against electromagnetic fields in the range from 800 MHz to 1900 MHz. The study particularly examined the emerging development and installment of new wireless communication systems in clinics where a general ban of mobile communication in future will not be necessary. Instead, the technical characteristics of the new systems must be refined considering the sensitivity of medical devices (lack of radiation shielding).

A special focus in analyzing medical applications this year was the topic „epilepsy research“. In four detailed lectures the most important techniques of magnetic detection and therapy were presented.

After an introduction into the topic and the symptoms of epilepsy Fernandez (from the working group C. Elger leading in Germany in this area) explained the procedure of „functional Magnetic Resonance Imaging“ (fMRI). This technique allows an precise localisation of the so-called „epileptic focus“ in the human brain. Its exact size can be determined; different areas of the focus defining certain symptoms can be distinguished. Such information is of utmost significance regarding

the planning and assessment of the efficiency of operations. To this aspect Fernandez referred in detail, too: Only seriously damaged tissue is made visible before operation. The danger to remove valuable healthy tissue thus can be reduced substantially.

Mattson (USA) presented a another method to show not only damaged tissue areas, but above all concentrations of neurotransmitters (connecting the coordinating points in the brain) and the effects of medicine directly in the brain. Besides, this method named „Nuclear Magnetic Resonance Spectroscopy“ (NMRS) helps to find the mechanisms which contribute to trigger seizures or which occur simultaneously. The advantage of this method is the possibility to examine the effects of antiepileptic medicines on neurotransmitters. Therefore, it was presented as a method for „non-invasive biopsy“ of the brain (i.e. preventing an actual sample taking).

With the „magnet encephalography“ (MEG) Stefan (Germany) presented a third method designed for diagnosis of epilepsy. Here, the development of minimal magnetic fields at the brain cells and/or at defined small areas of the brain is measured and made visible in a threedimensional reconstruction. The basis for the reconstruction are the above mentioned NMR recordings. The real measurement is made by „superconducting quantum interferometer devices“ (SQUID's), a computerised technique which makes magnetic field detectors through cooling with helium superconductive and thus highly sensitive. This



method as well as the other mentioned methods contribute to a significant decrease of the dangers of surgical treatment of medically incurable epilepsy types.

The session was concluded with a report on recent developments concerning the „transcranial magnetic stimulation“ (TMS). This method induces local whirl currents in the brain through well-focused magnetic pulses which produce nerve stimulation. Theodore (USA) explained the procedure which shows significant advantages compared with other therapeutical approaches. Next to the theoretical approach background information on the therapy's efficiency and on experiences made was presented. The method is already in use in the clinical practice.

Another topical focus of the meeting was the use of electromagnetic waves or magnetic fields in disease therapy called „electromedicine“. Discussed were methods of magnetic field therapy or results of „electrical hyperthermy“ (heating of tissue through electromagnetic waves, for example in cancer treatment).

Nindl et al. (USA) addressed the nowadays used UVA or UVB light therapy methods in the treatment of skin diseases such as psoriasis. Since the applied UV radiation, however, is known to be potentially cancerigenous, the possibility to reduce the necessary light dose through additional use of static and/or low frequency fields (20 min 40  $\mu$ T static and 100  $\mu$ T 15-100 Hz sinusoidal) was explored. The used model of human lymphocyte cell cultures as well as ceratinocytes (connective tissue cells) from the skin led to the finding that certain frequencies result in an increase of the UVB treatment effects. Thus, an additional use of magnetic fields could reduce the light dose necessary for therapy.

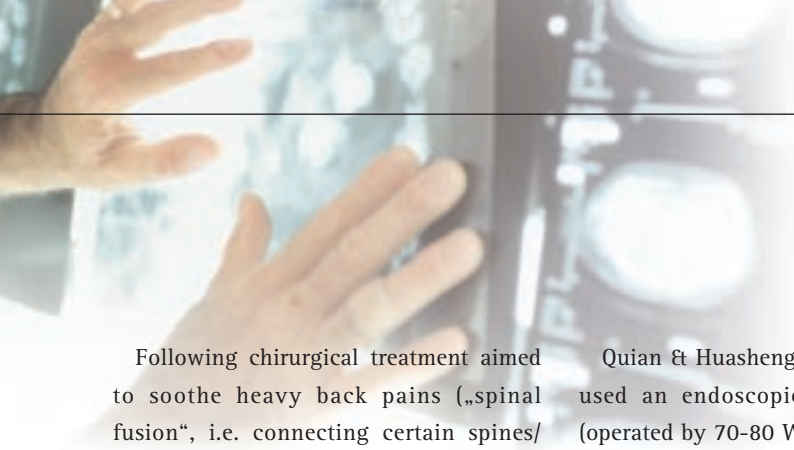
According to Szasz (Hungary), the electro-hyperthermal treatment has important advantages compared with classic heat

treatment methods in tumor therapy operating without the use of electromagnetic waves. In classical methods the inevitably emerging so-called „heat shock proteins“ (albumen which can recondition the affected cells according to the new situation) may prevent the intended destruction of tumor cells. At electro-hyperthermy the heat develops in the cell intervals. Thus, tumor cells are destroyed from the outside, before they can produce heat protecting proteins. Further, specific tumor protecting characteristics of the immune system are activated.

Five other papers dealt with the therapeutical possibilities of a rather fiercely criticized method using devices that produce magnetic fields in the low frequency range (5-3636 Hz, partly with specific pulse patterns): Thomas et al. (Canada) presented a test protocol for rheuma patients which shall help to objectively measure the efficiency of magnetic field therapies and to improve treatment methods. Patients take part in a standing balance test with eyes open and closed. A test with 20 patients using a time-varying pulsed 60 Hz magnetic field (200  $\mu$ T) was supposed to lead to a decrease of the measured differences between the exercises with eyes open and closed.

Two further studies are supposed to have proven that pain symptoms or movement restrictions in patients with arthritis or spinal column diseases could be eased through the use of magnetic field therapy devices. The results are based upon the data of 50,000 arthritis patients (Markoll, USA, Germany) and of 100 patients with back problems (Walzl & Thuile, Austria).

Davey et al. (USA) talked about health improvement in patients with incontinence after a six-week treatment with a 3636 Hz magnetic field (pulsed with 5 Hz and after that 50 Hz) in the area of the sphincter. The statistically significant results are based upon subjective reports (diary) of 66 patients.



Following chiral treatment aimed to soothe heavy back pains („spinal fusion“, i.e. connecting certain spines/ connecting spines with sacrum) after nine months an obviously improved connection of the bones was observed in a group of patients treated with magnetic fields (30 min per day; Ryaby et al., USA). In a blind study on 201 patients a complete healing of 64% of those treated with the field was observed, in contrast to the 43% of the non-treated patients. The reason was identified by the lecturer as an acceleration of the bone healing through the field.

The poster presentations at the meeting also contributed to the topics of magnetic field therapy, epilepsy research and general clinical applications:

Epilepsy patients which can not be treated with medicine were examined by Hofmann et al. (Germany) regarding brain activity (EEG measurements) in preparation for surgical treatment. At an exposure to external low magnetic field stimuli (around 60  $\mu$ T) with complex time patterns the so-called „epileptiform activity“ was measured. The mentioned research study provides a basis for stimulating this special brain activity for diagnosis and/or for reducing it out of therapeutical reasons.

Yukawa et al. (Japan) presented another type of bone fracture healing, this time particularly in humans of old age, through a magnetic field therapy with weak 2 Hz sinusoidal fields. Out of 12 examined patients 9 showed a complete healing, a control group (without magnetic field treatment) was not mentioned.

According to Pasche (Suisse), sleep disturbances can efficiently be cured by a therapy device which, operated by very low energy (battery power supply), emits a 27.12 MHz signal (modulation at certain frequencies between 0,5 and 300 Hz). The treatment of states of panic has been tested under the same conditions in a pilot study which also shows a certain success.

Quian & Huasheng (China) successfully used an endoscopic microwave probe (operated by 70-80 W in 10 sec pulses) in addition to radiation and chemical therapy in treating gullet cancer in 300 patients. Survival rates were increased by this side treatment.

Also from China (Quian & Yaping) comes a microwave application which is claimed to be already widely spread in Chinese hospitals: Reportedly, the additional treatment of hepatitis resulted in accelerated healing. For ten days ten minutes per day a microwave probe was externally placed at the patients' liver area. But again, a control group without microwave treatment was not mentioned.

Feiner et al. (Germany) explored safety aspects of magnet resonance recording used for diagnosis. A relevant test parameter was defined to allow predictions which flux density is needed to provide stimulation of external nerve channels. This stimulation can occur during examination through electric fields induced in the patient. The threshold value lies directly below the limit of a damaging cardiac strain.

Finally, Goldman (USA) presented a provisional study on a electrotherapy method with which blood circulation disturbances in the extremities of arteriosclerosis patients can be successfully treated. The method called „galvanic stimulation with pulsed high voltage“ is supposed to improve blood circulation in tissue and to suppress a progress of the disease with the risk of a later amputation.

One has to bear in mind that some of the lectures and/or part of the studies introduced during poster presentations on therapy methods mainly had provisional character.

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