Medical Engineering Laboratory

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General Summary

The Medical Engineering Laboratory has developed new ultrasonic therapeutic technologies. This year, we focused on the development of new thrombolytic treatments for patients with acute ischemic stroke; research work was supported by a research grant from the Ministry of Health, Labor and Welfare. Basic research studies in molecular medical engineering have also been continued to develop an ultrasonic transdermal drug delivery system. We have contributed to the establishment of a national nanomedicine database that includes nanothechnology information from around the world and gathers the needs of clinicians. We have also improved previously developed diagnostic techniques for measuring cerebral circulation and hemodynamic variables by means of noninvasive transcranial ultrasonography. In addition, safety problems related to electromagnetic compatibility between medical equipment and mobile telecommunication equipment have been investigated in collaboration with telecommunications and medical-equipment associations and government-related organizations.

Research Activities

Integrated system of diagnosis, analysis, and treatment for acute stroke
This system can enhance thrombolytic effects using low-frequency therapeutic ultrasound. For clinical application of this system, we have developed an instrument for holding the US probe near the patient's head and have studied the detection rate of intracranial arteries with transcranial color flow imaging. The patients with an insufficient temporal bone window can be treated with this system and a virtual sonography method.

Ultrasonic thrombolysis
We have developed a much safer and more efficient method of dual-mode ultrasonic thrombolysis combining the diagnostic power of M-mode Doppler ultrasound with low-frequency ultrasound-mediated thrombolysis with tissue plasminogen activator. We have shown that lipid bubbles produced by mixing liposomes and perfluoropropane can enhance the thrombolytic effect of recombinant tissue plasminogen activator by low frequency, 500-kHz, continuous-wave ultrasound.

Study of an ultrasound drug delivery system
We have been developing novel strategies of drug delivery using physiological energy, which includes focused ultrasound and microbubbles of acoustic cavitation, to approach the target as quickly as possible.

Ultrasonic generation of nitric oxide in tissue
We measured the nitric oxide (NO) concentration of the thigh adductor muscle of rabbits in real time using an NO electrode. The NO concentration increased with the intensity of ultrasound exposure. Ultrasonic NO generation was inhibited by inhibitors of NO synthase.

Development of a new antithrombotic stent using ion beam surface modification
Twelve commercially available bare-metal stents were implanted into the coronary arteries (left anterior descending, circumflex, and right coronary arteries) of 4 swine to compare the thickness of the neointima 1 month after implantation with administration of antiplatelet drugs. There was no significant difference in the thickness of the neointima between bare-metal stents and He^{+}-ion-coated bare-metal stents.

Establishment of a nanomedicine database
A database for nanomedicine was established to gather various nanotechnologies and various clinical requirements. This database can be accessed via the Internet and includes a special nanomedicine forum.

Electromagnetic compatibility between various types of radio-wave devices and medical electrical devices
Electromagnetic interference with cardiac pacemakers by radio frequency identification devices and electric assurance systems was investigated in collaboration with associations related to such equipment. The rate of electromagnetic interference was low at short distances with several electric assurance systems and was diminished in radio frequency identification systems.

Publications

Ogihara M*[1]*, Kubota J*[1] *(*[1]*Hitachi Med Corporation), Azuma T (Hitachi, Ltd.), Ando K, Tanihuji Y, Umemura S (Kyoto Univ), Furuhata H. Verification of ultrasonic thrombolisis effect by *in vitro* experiments. *Jpn J Appl Phys* 2006; **45:** 4736–9.

Nakagawa K, Tanihuji Y, Amaki K, Matsuyama Y, Furuhata H, Harada G*[1]*, Hutagami S*[1] *(*[1]*Nihon Kohden Corp). Electromagnetic intensity measurement in a hospital located near Tokyo Tower. *Jpn Soc Med Instr* 2006; **76:** 8–9.

Shiozawa Y*[1]*, Gomi S*[2]*, Furuhata H, Takada H (Nagoya Univ Sch Med), Iwase S (Aichi Med Univ), Kamiya A (Natl Cardiovasc Cent Res Inst), Kawasaki H*[2] *(*[2]*Aoyamagakuin Univ), Hirayanagi K*[1]*, Iwasaki K*[1]*, Yamaguchi N*[1] *(*[1]*Nihon Univ), Yajima K (Sano Coll). Changes in dynamic cerebral autoregulation during graded orthosatatic stress in humans. *Neurosonology* 2006; **19:** 17–24.

Reviews

Kubota J (Hitachi Med Corp), Furuhata H. Transcranial ultrasonic thrombolysis technique. *Med Technol* 2006; **34:** 441–2.

Zenitani T, Furuhata H. Hemodynamic theory in vascular sciences. *Vascular Lab* 2006; **3:** 124–7.