Effect of ferrite thermoseeds on destruction of carcinoma cells under alternating magnetic field

YONG-KEUN LEE, SANG-BAE LEE
Department and Research Institute of Dental Biomaterials and Bioengineering, Yonsei University College of Dentistry, Seoul 120-752, Korea; Brain Korea 21 Project for Medical Science, Yonsei University, Seoul 120-752, Korea

YEON-UNG KIM
Department and Research Institute of Dental Biomaterials and Bioengineering, Yonsei University College of Dentistry, Seoul 120-752, Korea

KYOUNG-NAM KIM*
Department and Research Institute of Dental Biomaterials and Bioengineering, Yonsei University College of Dentistry, Seoul 120-752, Korea; Brain Korea 21 Project for Medical Science, Yonsei University, Seoul 120-752, Korea
E-mail: kimkn@yumc.yonsei.ac.kr

SE-YOUNG CHOI
School of Materials Science and Engineering, Yonsei University, Seoul 120-749, Korea

KYU-HO LEE
Medical Research Center, Yonsei University College of Medicine, Seoul 120-752, Korea

IN-BO SHIM, CHUL-SUNG KIM
Department of Electronic Physics, Kookmin University, Seoul 136-702, Korea

High iron-containing silicate glasses were prepared using a conventional melting and quenching process, and ferrimagnetic crystallites were precipitated via a nucleation and crystal growth mechanism. This study attempted to use these ferrite-containing glass-ceramics as thermoseeds for a hyperthermic cancer treatment under an alternating magnetic field. KB and L929 cells were used in the cell lysis experiments, as carcinoma and normal cells, respectively. These cells were mixed with an agar medium and stained prior to the annihilation test. After exposing the cells to the alternative magnetic field for 9 min, the number of carcinoma cells in the vicinity of the ferromagnetic specimen decreased with increasing time and almost all cancer cells were dead after 9 min while they were still alive in a region of 5 cm away from the specimen. When Sprague-Dawley rats imbedded the samples were exposed to a magnetic field, tumor cells disappeared after only 4 treatments of 15 min each. This amazing reduction in the tumor was not observed in any rats without the imbedded sample. It is expected that the prepared ferrite-containing glass-ceramics will be helpful in hyperthermic cancer treatment. Long-term research is needed to confirm this result. © 2003 Kluwer Academic Publishers

1. Introduction
Gilechrist et al. reported localized magnetic hyperthermia using fine magnetic particles more than 40 years ago [1-3]. The heating of tumor tissue as a possible therapeutic modality in cancer treatment has received increasing interest in recent years because it is well accepted that temperatures in the range of 42-45°C are cytotoxic. That is, increasing the temperature of tumor cells from normal body temperature to 42-45°C for certain time periods, approximately one hour, results in the destruction of a very high percentage of tumor cells. When the cells were kept at 37°C, virtually all the cells survived. However, when the cells were kept at 41.5°C for 5 h, only 10% of the cells survived. An increase of temperature by only 1°C to 42.5°C dramatically increased the rate of cell death so that only 0.01% of the cells survived [4-6]. Furthermore, a tumor is more easily heated than the surrounding normal tissues, since the blood vessels and nervous systems are poorly developed. Therefore, the oxygen supplied by the blood vessels in the tumor is not sufficient. Thus, the goal of hyperthermia treatments for cancer therapy...