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Detection of Magnetic Nanoparticle Tracers in the Body for Sentinel Lymph Node Biopsy

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Presence of lymph node metastasis is an important indication for treatment planning of patient with breast cancer. Normally tumor cells spread through the lymphatic channels to the lymph nodes. Sentinel lymph nodes are the first lymph nodes to receive lymphatic drainage from a primary tumor. Purpose of sentinel lymph node biopsy is to identify, excise and examine the presence or absence of metastatic disease. If no metastatic disease is present, which is the case in the majority of patients, the other lymph nodes are preserved, thereby avoiding further unnecessary excision of lymph nodes and accompanied side effects such as edema. Current standard technique consists of injecting a radioisotope tracer and a blue dye tracer in the vicinity of the tumor. These tracers will drain through the lymphatic channels and accumulate in the sentinel lymph nodes. The sentinel lymph nodes can be detected using a gamma probe during surgery and visually recognizing blue nodes, after which they are excised. However, this technique has limitations. Medical institutions that can handle radioisotope tracers are limited, and there are concerns about the radiation exposure as well.

We are developing a novel magnetic technique for sentinel lymph node biopsy. Instead of conventional radioisotopes, sentinel lymph nodes are identified using a tracer containing magnetic nanoparticles and a dedicated magnetic probe. The magnetic probe provides easy handling during surgeries because of its compact and wireless design. The probe can be covered with a sterile bag for intraoperative use. Information about the magnetic field intensity would be provided as a number on the display and as an audible signal. The dedicated non-magnetic retractor does not interfere with the magnetic probe. The efficacy and safety of the magnetic technique had been evaluated through a clinical trial; the results showed that the identification rate of magnetic technique was non-inferior to that of the radioisotope method. Conditions for injection and detection of magnetic nanoparticles have been investigated in detail in animal studies. The basic structure of the magnetic probe consists of a cylindrical permanent magnet and a magnetic sensor (hall element).

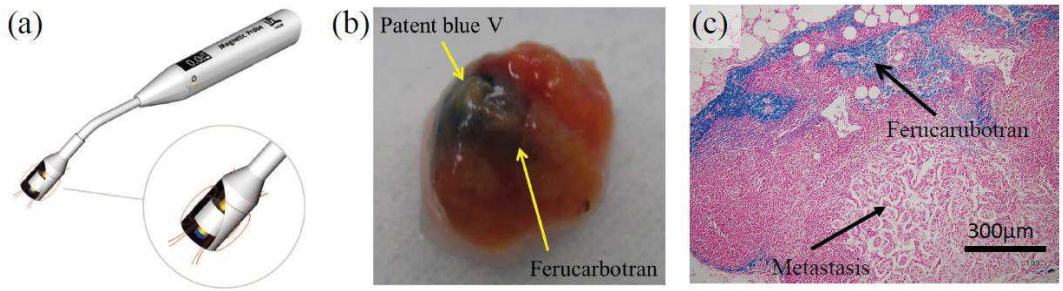

Figure 1. (a) Magnetic probe for sentinel lymph node biopsy. (b) Excised lymph node containing magnetic nanoparticles (ferucrbotran) and blue dye [1]. (c) Phathological section of sentinel lymph node with ferucarbotran stained with Prussian blue [1].

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