

# Superparamagnetic iron oxide for sentinel lymph node biopsy

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentligens försvaras i Hjärtats aula, Vita Stråket 12, Sahlgrenska Universitetssjukhuset, fredag den 24:e maj 2024, klockan 09:00.

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## Avhandlingen baseras på följande delarbeten

- I. Mirzaei N\*, Katsarelias D\*, Zaar P, Jalnefjord O, Johansson I, Leonhardt H, Wärnberg F, Olofsson Bagge R. Sentinel lymph node localization and staging with a low-dose of superparamagnetic iron oxide (SPIO) enhanced MRI and magnetometer in patients with cutaneous melanoma of the extremity - The MAGMEN feasibility study. *Eur J Surg Oncol.* 2022 Feb;48(2):326-332. \*Joint first authors.
- II. Mirzaei N, Wärnberg F, Zaar P, Leonhardt H, Olofsson Bagge R. Ultra-Low Dose of Superparamagnetic Iron Oxide Nanoparticles for Sentinel Lymph Node Detection in Patients with Breast Cancer. *Ann Surg Oncol.* 2023 Sep;30(9):5685-5689.
- III. Mirzaei N, Wärnberg F, Zaar P, Diniz MO, Karakatsanis A, Leonhardt H, Olofsson Bagge R. The effect of an ultra-low dose of superparamagnetic iron oxide (SPIO) injected intradermally on postoperative skin discoloration and breast MRI artefacts in patients with breast cancer undergoing sentinel lymph node biopsy. Manuscript.
- IV. Mirzaei N\*, Christenhusz A\*, Wärnberg F, Olofsson Bagge R, Karakatsanis A, Staffan Eriksson, Job van der Palen, Simanowski J, Salamzadeh S, Dassen A, Alic L. Magnetic Sentinel Lymph Node Biopsy in Early Breast Cancer Patients: An Individual Patient Data Meta-Analysis of Tracer Uptake. Manuscript. \*Joint first authors.

**SAHLGRENKA AKADEMIN**  
**INSTITUTIONEN FÖR KLINISKA VETENSKAPER**



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## Abstract

Superparamagnetic iron oxide nanoparticles (SPIO), used as a tracer for sentinel lymph node (SLN) detection, offer several logistical benefits over the standard method using radioactive technetium-99m and blue dye. The aim of this thesis was to explore SPIO as a tracer for SLN biopsy in patients with cutaneous melanoma or breast cancer. In *Paper I*, we demonstrated that SLN detection with an ultra-low dose of 0.02-0.5 mL SPIO injected intradermally in patients with melanoma was feasible, and we also showed that SPIO-enhanced MRI could have potential as a non-invasive modality to predict SLN status in vivo. In *Paper II*, an ultra-low dose of 0.1 mL of SPIO was investigated in patients with breast cancer and demonstrated to be feasible. In *Paper III*, MRI artefacts and skin discoloration caused by the ultra-low dose of SPIO were evaluated. The MRI artefacts were small with minimal skin discoloration not affecting patient-reported outcomes. In *Paper IV*, individual patient data were evaluated for optimal SPIO dose, injection site, and timeframe as well as quantifying the iron content in the retrieved lymph nodes. An intra-tumoral injection and SPIO administered less than 2 hours before surgery appeared to be less optimal for SLN detection.

In conclusion, SLN detection with an ultra-low of SPIO was found to be feasible in patients with melanoma or breast cancer, not compromising MRI results and with only small skin discoloration. These results lay a foundation for larger trials that may ultimately change future clinical practice for patients undergoing SLN biopsy.

**Keywords:** melanoma, breast cancer, sentinel lymph node biopsy, superparamagnetic iron oxide nanoparticles