

## REPORT ON A STUDY OF PRESENCE OF VOID ARTIFACTS ON POSTOPERATIVE MRI BREAST SCANS AFTER SUPERPARAMAGNETIC IRON OXIDE SENTINEL LYMPH NODE BIOPSY

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### Summary

Sentinel lymph node biopsy (SLNB) is the gold standard in surgical treatment of early-stage breast cancer. Since June 2015 we have been performing SLNB in our hospital with a new technique which uses superparamagnetic iron oxide (SPIO), commercially known as Sienna+, as tracer and device-magnetometer (SentiMag) for locating axillary lymph nodes which accumulated SPIO particles. Artifacts resulting from SPIO accumulation in the breast tissue were observed on post-operative breast magnetic resonance imaging (MRI) scans in all patients who underwent postoperative breast MRIs. Artifacts were observed on T1-weighted images, as well as on dynamic and subtraction sequences. We have designed a study that will include a three-year post-operative follow-up of these patients with MRI breast scans in order to evaluate presence or absence of these artifacts and change of artifacts over time. Upon completion of the study indications for using magnetic SLNB may need to be revised.

KEY WORDS: *breast MRI artifacts, Sienna +, SentiMag, magnetic SLNB*

### PLAN ISTRAŽIVANJA PRAZNIH ARTEFAKATA NA POSLIJEOPERACIJSKIM NALAZIMA MAGNETNE REZONANCE DOJKE NAKON PRIMJENE SUPERPARAMAGNETIČNOG ŽELJEZNOG OKSIDA U BIOPSIJI LIMFNOG ČVORA STRAŽARA

### Sažetak

Biopsija limfnog čvora stražara je zlatni standard u kirurškom liječenju ranog stadija raka dojke. Od lipnja 2015. godine, u našoj ustanovi koristi se nova metoda obilježavanja superparamagnetičnim željeznim oksidom, komercijalnog imena Sienna+. Za pronalaženje limfnog čvora s nakupljenim česticama željeznog oksida koristi se detektor – SentiMag. Kod bolesnica kod kojih je učinjena poslijeoperacijska magnetna rezonanca dojki uočeni su artefakti na T1 mjerenim snimkama, a također i na dinamičkim i subtrakcijskim sekvencama. Osmislili smo studiju kojom će se tri godine magnetnom rezonancom pratiti operirane bolesnice. Odredit će se prisutnost artefakata, te njihova prisutnost tijekom vremena. Očekuju se nove spoznaje korisne u biopsiji limfnog čvora stražara.

KLJUČNE RIJEČI: *artefakti MR dojki, Sienna +, SentiMag, magnetna SLNB*

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Sentinel lymph node biopsy (SLNB) today is the gold standard for treatment of early-stage breast cancer, and it is unavoidable in planning further therapy and/or surgical treatment (1), since the status of axillary lymph nodes is known

to be the most important prognostic factor for these patients (2). The usual procedure includes using a radioisotope with or without the blue dye to detect a sentinel lymph node. In addition to an obvious down side to this procedure i.e. irradiation



Fig 1. Artifacts on postoperative MR scan of the breast on subtraction sequence (A), dynamic sequence (B) and on T1-weighted image (C).

tion for the patient and medical staff, there is also a need for very precise interdepartmental cooperation with a nuclear medicine department which in practice, is sometimes difficult to obtain.

The SentiMag technique is a relatively new, effective radioisotope-free detection system which uses superparamagnetic iron oxide (SPIO), commercially known as Sienna+, as tracer and device-magnetometer (SentiMag) for locating axillary lymph nodes which accumulated SPIO particles. Sienna+ is a dark solution containing dextran-coated SPIO particles, size of 60 nm each (3). After injecting the solution in subareolar region, particles drain through the lymphatics and accumulate in the sentinel lymph node. This takes place at least 20 minutes before the actual SLNB procedure. Then the probe is inserted into the incision and identifies the sentinel nodes by their high reading on Sentimag and coloration change. Currently, there are nine studies and multicentric trials showing equal value of magnetic technique compared to radioisotope method of locating sentinel lymph nodes (4,5,6,7,8,9,10,11). The SentiMag manufacturer emphasizes the proximity-based detection of the magnetic probe, meaning that the probe sensitivity varies exponentially with distance, unlike gamma probe detects with linear and angular sensitivity which can result in receiving intermittent signal, making localisation more challenging (1).

We have been performing SLNBs in our hospital since June 2015, during that period we performed 320 procedures. Upon performing postoperative breast MRI scans for a number of these patients we observed void artifacts on pre and

postcontrast T1-weighted images, as well as artifacts on the dynamic and subtraction sequences (Fig. 1). After reevaluating 9 patients with postoperative breast MRIs, we found artifacts on every performed study. These MRIs were performed in the time frame of 6 months after surgery, until 12 months after surgery.

Breast MRI is an important diagnostic procedure for detection of breast cancer, with a high sensitivity (over 90%) and as of yet still moderate specificity (72%), (2).

There are no firm guidelines on MRI indications. According to the most recent guidelines for managing breast cancer patients from American College of Radiology (ACR) from 2013 and European Society for Medical Oncology (ESMO) from 2015 (3) breast MRI is a valuable tool in detecting early stage disease in population with higher risk, which most predominantly includes women with genetic predisposition (4). Furthermore MRI breast scans are used in case where mammography and ultrasound (US) findings are inconclusive as can often be in women with *dense* breasts, and in case of ductal carcinoma in situ (DCIS). DCIS is usually seen as mammographic abnormality presented as clusters of microcalcifications. US is in many cases either inconclusive or shows only mild abnormality or even normal results. Even though, the sensitivity of breast MRI in cases of DCIS may vary, it is still an important tool for definitive diagnosis of this condition (5). Another important indication for breast MRI is scanning when there is a high suspicion of breast cancer recurrence i.e, the recurrence of malignancy within the same breast at or close to the resection bed

more than two years following surgical excision. The risk of local recurrence can be as high as 19% in the first five years (6). In these cases, especially if involving younger patients with higher percentage of glandular parenchyma in breasts, artifacts on MRI scans may result in partialy or completely missing the diagnosis thus postponing the needed treatment.

In our hospital we aim to include MRI exam in mos preoperative examination for every patient. Also, we use it in the follow-up of patients who underwent neoadjuvant chemotherapy. Furthermore, it is used as a follow-up examination for some years after the treatment for patients with increased risk of recurrence. There are as of yet no studies describing presence or absence of artifacts in patients who underwent SLNB using Sienna+ tracer in longer follow-up period. After reviewing the literature we have come across an abstract of a single study that followed small number of patients up to 24 months after surgery(7).

There is a definite need to obtain more data with regards to this issue. We have designed a study, in which we plan to perform preoperative MRI scan and at 12, 18, 24, 26 and 36 months. The scans will be evaluated in order to confirm or exclude the long standing presence of these artifacts on MRI scans including T1-weighted images as well as dynamic and subtraction sequences. Other parameters which will be investigated are the size of the artifact, location of the artifact in the breast tissue, change of artifact size over time. We also plan to take patients age and percentage of glandular parenchyma shown on pre-operative scans into account and try to evaluate if it would be possible to single out patients who are expected to show larger artifacts on postoperative MRI breast scans.

We believe this study will generate valuable data for the use of the technology which enabled a

more widely used conservative axillary treatment for early breast cancer. The study was approved by the Hospital Ethics Committee.

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