Field Cycling Imaging in ovarian cancer - a novel technology

Nanak Bhagat[1], Lionel Broche[2], Shylasree TS[1], Anne E. Kiltie[3], Siladitya Bhattacharya[4] and Mahalakshmi Gurumurthy[1]

Affiliations:

1. Department of Gynaecological Oncology, Aberdeen Royal Infirmary, Aberdeen, United Kingdom
2. Aberdeen Biomedical Imaging Centre, School of Medicine Medical Sciences and Nutrition, University of Aberdeen, Aberdeen, United Kingdom
3. Rowett Institute of Nutrition and Health, University of Aberdeen, Aberdeen, United Kingdom
4. School of Medicine and Dentistry, University of Aberdeen, Aberdeen, United Kingdom

Author for correspondence:

Dr. Nanak Bhagat

Ward 315,

Department of Gynaecological Oncology

Aberdeen Royal Infirmary,

Aberdeen, AB25 2ZN

nanakbhagat@gmail.com

Commentary

Ovarian cancer causes more deaths than any other cancer of the female reproductive system (1). Management of advanced high-grade serous ovarian cancers has relied on a combination of effective chemotherapy and optimal debulking surgery which have been identified as key prognostic factors.

When optimal primary debulking surgery is not feasible in the presence of extensive disease, neoadjuvant chemotherapy followed by interval debulking surgery is advocated. The results of randomised trials have shown this approach to be associated with reduced surgical morbidity and mortality with survival rates are similar to primary debulking surgery.(2) . However, at the time of interval debulking surgery, areas where the disease has responded to chemotherapy but has left thickened fibrotic unhealthy tissue present a major challenge for surgeons. Uncertainty about the extent of tissue excised has led to variations in care amongst surgeons, with some opting for extensive peritonectomy and visceral resections with others choosing to undertake selective resection of areas where residual disease is visible as fibrotic tissue. The presence of active tumour tissue in such areas is often not obvious on inspection and can only be confirmed by histopathology, leading to either extensive sampling or resection leading to increased surgical morbidity.

In contrast to the stable magnetic field employed in most Nuclear Magnetic Resonance spectrometers and Magnetic Resonance Imaging scanners, Field Cycling Imaging, a novel technique developed at the University of Aberdeen, can discriminate between suspicious areas *with* and *without* cancer by identifying differences in the interaction of altered water and protein content in cancer cells. Field Cycling Imaging can generate rapid changes in the magnetic field during a pulse sequence, thus allowing observers to study the behavior of tissues over a range of magnetic strengths. Field cycling imaging results report nuclear magnetic resonance dispersion profiles, a graphical representation of T_1 values (the characteristic time taken for proton spins to reach their equilibrium state) plotted against the strength of the magnetic field. T_1 is closely linked to molecular motion, offering an unique

opportunity to study molecular dynamics noninvasively (3,4) with variations in the T_1 dispersion curve linked directly with physical properties of tissues and cells (5).

To date, field cycling imaging work has shown promise in identifying the margins between malignant and non-malignant tissue in women with breast cancer undergoing surgery (6), and can potentially be utilised to differentiate active tumour from chemotherapy-induced fibrosis in women with ovarian cancer.

This technology has the potential to change current practice in cancer detection, particularly in treatment delivery and surgical planning. In the first instance we propose a pilot study to assess the accuracy of field cycling imaging in identifying areas of active cancer in tissues of women undergoing interval debulking surgery. These results could help us determine the potential for further application of this technology in ovarian cancer.

References:

1. Ovarian cancer statistics [Internet]. Cancer Research UK. 2015 [cited 2022 Dec 13]. Available from: https://www.cancerresearchuk.org/health-professional/cancer-statistics/statistics-by-cancer-type/ovarian-cancer

2. Vergote I, Coens C, Nankivell M, Kristensen GB, Parmar MKB, Ehlen T, et al. Neoadjuvant chemotherapy versus debulking surgery in advanced tubo-ovarian cancers: pooled analysis of individual patient data from the EORTC 55971 and CHORUS trials. Lancet Oncol. 2018 Dec;19(12):1680–7.

3. Broche LM, Ismail SR, Booth NA, Lurie DJ. Measurement of fibrin concentration by fast field-cycling NMR. Magn Reson Med. 2012 May;67(5):1453–7.

4. Broche LM, Ross PJ, Davies GR, MacLeod MJ, Lurie DJ. A whole-body Fast Field-Cycling scanner for clinical molecular imaging studies. Sci Rep. 2019 Jul 18;9(1):10402.

5. Broche LM, Ashcroft GP, Lurie DJ. Detection of osteoarthritis in knee and hip joints by fast field-cycling NMR. Magn Reson Med. 2012 Aug;68(2):358–62.

6. Bitonto V, Ruggiero MR, Pittaro A, Castellano I, Bussone R, Broche LM, et al. Low-Field NMR Relaxometry for Intraoperative Tumour Margin Assessment in Breast-Conserving Surgery. Cancers (Basel). 2021 Aug 17;13(16):4141.

Authors response:

I confirm that I have not made any changes to the submission beyond those requested in this decision letter. **[Yes]**

-All co-authors have reviewed and approved these changes. **[Yes]**