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Impact of full field digital mammography on the classification and mammographic characteristics of interval breast cancers

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ABSTRACT

Objective: Full field digital mammography (FFDM) is increasingly replacing screen film mammography (SFM) in breast screening programs. Interval breast cancers are an issue in all screening programs and the purpose of our study is to assess the impact of FFDM on the classification of interval breast cancers at independent blind review and to compare the mammographic features of interval cancers at FFDM and SFM.

Materials and methods: This study included 138 cases of interval breast cancer, 76 following an FFDM screening examination and 62 following screening with SFM. The prior screening mammogram was assessed by each of five consultant breast radiologists who were blinded to the site of subsequent cancer. Subsequent review of the diagnostic mammogram was performed and cases were classified as missed, minimal signs, occult or true interval. Mammographic features of the interval cancer at diagnosis and any abnormality identified on the prior screening mammogram were recorded.

Results: The percentages of cancers classified as missed at FFDM and SFM did not differ significantly, 10.5% (8 of 76) at FFDM and 8.1% (5 of 62) at SFM ($p = .77$). There were significantly less interval cancers presenting as microcalcifications (alone or in association with another abnormality) following screening with FFDM, 16% (12 of 76) than following a SFM examination, 32% (20 of 62) ($p = .02$).

Conclusion: Interval breast cancers continue to pose a problem at FFDM. The switch to FFDM has changed the mammographic presentation of interval breast cancer, with less interval cancers presenting in association with microcalcifications.

1. Introduction

The primary objective of breast screening is to reduce mortality from breast cancer through early detection. In order to achieve the maximum benefit from a breast screening program, sensitivity and specificity need to be optimized and adverse effects minimized [1,2]. Interval breast cancers are cancers diagnosed after a negative screening examination but prior to the next round of screening, 2 years for the purpose of this study. There are several methods of reviewing and classifying interval breast cancer, ranging from un-blinded group consensus discussion to fully blinded review of prior screening mammograms mixed with normal mammograms. The classification of interval breast cancer has been shown to vary according to the type of review method [3–7].

Full field digital mammography (FFDM) is increasingly replacing screen film mammography (SFM) in breast screening programs, however there have been few studies on the effect of FFDM on the classification and mammographic characteristics of interval breast cancers. A study of interval breast cancers following screening with FFDM or SFM by Nederend et al. found that interval cancers were more likely to be categorized as a true negative when patients undergo screening with FFDM rather than SFM [8]. However it should be noted that the reviewers in this study had access to the diagnostic mammogram performed at the time of interval cancer diagnosis, during their assessment of the prior screening mammogram. This could potentially adversely affect the categorization of interval breast cancers due the introduction of bias, especially in

Abbreviations: FFDM, full field digital mammography; SFM, screen film mammography; INBSP, Irish National Breast Screening Program; DCIS, ductal carcinoma in situ; BIRADS, breast imaging reporting and data system.

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the assessment of FFDM as a relatively new technology. A review of missed cancers in the Norwegian Breast Cancer Screening Program found that cancers missed at FFDM trended to a higher percentage of asymmetry and a lower percentage of calcifications compared to those missed at SFM, but found no significant difference in the classification of interval breast cancers at FFDM and SFM [9]. However this study included both missed interval and screen detected cancers in their analysis.

The purpose of our study was to assess the impact of FFDM on the classification of interval breast cancers at independent review, blinded to the site of the subsequent cancer and to compare the mammographic features of interval cancers at FFDM and SFM in BreastCheck, the Irish National Breast Screening Program (INBSP).

2. Materials and methods

Institutional review board approval was obtained. All women signed a consent form to participate in the screening program and agreed in writing to the collection, storage and exchange of their health records for audit and quality assurance purposes.

2.1. Definition

For this study, the definition of an interval breast cancer was as per the 'European guidelines for quality assurance in breast cancer screening and diagnosis'. As such any primary breast cancer diagnosed in a woman who had a screening test, with or without further assessment which was negative for malignancy, either before the next invitation to screening or within a time period equal to a screening interval for a woman who has reached the upper age limit for screening, was included in the study [2]. The screening interval for the INBSP is 2 years, therefore all cancers diagnosed within 2 years of a negative screening episode were included for review.

BreastCheck, the INBSP has been described previously [10,11]. Briefly, the INBSP commenced in 2000 and offers biennial screening mammography for women between the ages of 50 and 64 years, it became fully digitized in April 2008. Two-view screening is performed for both initial and subsequent examinations and interpretation is by independent double reading with consensus performed by at least 3 radiologists in the case of discrepant readings. Computer aided detection software is not used. The Eccles Unit of the INBSP covers north Dublin and the central and eastern regions of the country, along with 2 southern counties (Carlow and Kilkenny) of the INSBP. Between 2006 and 2008 the Eccles Unit, INBSP transferred to digital mammography alone.

The INBSP is notified of interval breast cancers by the diagnosing center at the time of presentation or by the annual cross-checking of the breast cancer cases from the Irish National Cancer Registry with the INBSP register. Patients may also directly notify the INBSP of a breast cancer diagnosis at any time.

2.2. Study population

SFM images were acquired on either a GE 800 T (GE Medical System, Buc, France) using a molybdenum anode and molybdenum–rhodium filter or a Mammomat 3000 (Siemens Healthcare, Erlangen, Germany) using a molybdenum–tungsten anode and molybdenum–rhodium filter. The FFDM images were acquired using one of two machines: Sectra MDM (Sectra, Stockholm, Sweden) or Lorad Selenia (Hologic, Danbury, CT, USA).

We performed a retrospective review of 147 cases of interval breast cancer. Seventy-eight consecutive cases of interval cancer following a FFDM examination and 69 cases following a SFM examination were included in the study. The interval cancers were previously audited in our department from January 2006 to January 2012. The preceding SFM screening mammograms were performed between January 2004 and December 2007 and the FFDM screening mammograms were performed between October 2006 and June 2011.

There were 291,936 screening mammograms performed in our unit during the study period. Recall rates prior to and subsequent to the changeover to FFDM were 5.7% and 9.4% for initial screening mammograms and 2.1% and 2.3% for subsequent screening mammograms, respectively. Invasive cancer (and DCIS) detection rates following screening with SFM were 6.3 (1.4) and 4.2 (0.9) per 1000 women at initial and subsequent screening examinations. Detection rates at FFDM were 7.2 (2.3) and 4.4 (1.3) per 1000 women at initial and subsequent screening FFDM examinations. The interval breast cancer rate in our department for the 7-year period from 2001 to 2007 was 17.0 per 10,000 negatively screened; this is within the calculated standard for our population of 20 per 10,000 negative screenings.

For the purposes of this study, the date of diagnosis was determined to be the date of the diagnostic mammogram. Nine cases (2 FFDM and 7 SFM) were excluded, as while they had been included in our database, the diagnosis of cancer was made more than 2 years after the prior screening episode. The age of the patient at the time of diagnosis and the number of prior screening mammograms was recorded. Tumor histology was also recorded for each cancer, full histological results were not available for 9 cases (1 FFDM and 8 SFM). Only cases of core biopsy or excision proven invasive breast cancer were included. For this study, our definition of interval cancers includes cases of invasive disease only, as cases of ductal carcinoma in situ (DCIS) alone are not included in our final interval cancer rate as per European breast cancer screening guidelines [2]. While cases presenting as interval DCIS alone were not included in this study they are reviewed as part of our national interval cancer audit for quality control.

2.3. Review design

The two view screening mammogram preceding the diagnosis of interval breast cancer was assessed on an individual basis by each of five consultant breast radiologists. Each of the reviewers had at least five years experience reading mammograms and read more than 10,000 mammograms per year. Prior screening mammograms were provided for comparison, if available. The diagnostic mammograms performed at the time of cancer diagnosis and histopathological reports were not available, however the reviewer was aware of the subsequent diagnosis of interval breast cancer.

Each reviewer was asked to assess the screening mammogram for the presence of an abnormality requiring patient recall for further assessment. If an abnormality was identified, the site and mammographic features of the abnormality were recorded. A modified version of the Breast Imaging Reporting and Data System (BI-RADS) (12) was used to classify the mammographic features as mass, asymmetry, microcalcifications (alone or in association with another abnormality) or architectural distortion. If multiple mammographic features were identified in an individual case these were recorded separately.

The diagnostic mammogram performed at the time of interval cancer diagnosis was subsequently reviewed in consensus by two radiologists. One of the radiologists had previously participated in the separate blinded review of prior screening mammograms, and the other radiologist had one year dedicated experience in reading mammograms. All available imaging and histopathological reports were available during this review. The site and mammographic features of the interval cancer were identified and recorded as mass, asymmetry, architectural distortion or microcalcifications (alone or in association with another feature). Cases were classified as mammographically occult if they were not visible on the