ULTRA SONO GRAPHY

Screening women with a personal history of breast cancer: overview of the evidence on breast imaging surveillance

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REVIEW ARTICLE

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This work reviews the evidence on breast imaging for screening (surveillance) in women with a history of breast cancer (BC). Early detection of second BCs in these women improves their prognosis based on studies using mammography (usually with clinical examinations) for surveillance. Cohort studies have estimated that mammography surveillance has moderate sensitivity (65.4%) and good specificity (98.3%), and have shown that these women are at a higher risk of interval BC than age- and breast density-matched women without a history of BC. Studies of adjunct imaging (ultrasound, magnetic resonance imaging) for surveillance that have reported detection and accuracy measures have generally shown that adjunct imaging detected more second BCs than mammography and added substantially to the amount of false-positive results; however, little evidence exists regarding screening efficacy of adjunct imaging as part of routine surveillance.

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Introduction

From a global perspective, breast cancer (BC) is the most common cancer in females, with an estimated 2.4 million incident cases in 2015 [1]. Vast improvements in BC treatments, population-level early-detection strategies for BC, and burgeoning longevity in countries with developed health systems have contributed to a growing population of women with a personal history of BC, also referred to as BC survivors. Women with a personal history of BC have a sustained long-term risk of experiencing another BC diagnosis, which may be another primary BC or an in-breast (local) recurrence in the treated conserved breast (an ipsilateral BC), or a contralateral BC [2–4]; for simplicity, these may be collectively referred to as a second BC. The risk of developing a second BC in either the treated or previously unaffected breast varies according to tumour-related and therapeutic factors associated with the first cancer. In general, women with early-stage invasive BC treated with breast conservation and adjuvant radiation, with long-term follow-up, are reported to develop ipsilateral BC at rates ranging from 0.4% to 1% per year [5–7]. A large population study by Gao et al. [8] reported contralateral BC rates of 6.1% at 10 years and 12% at 20 years, which approximates an annualised rate of 0.6% for contralateral BC in women with a personal history of BC. In a more

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recent study, Lee et al. [2] reported the cumulative risk of a second BC at 5 years, counting events in either breast, as 54 per 1,000 women, corresponding to a rate of approximately 1% per annum in cohorts with a history of stage 0–II first BC. Hence, guidelines for the follow-up of women with a history of BC recommend breast screening for the early detection of second BC events; however, it should be noted that breast surveillance represents only one component amongst the various physical and psycho-social health needs that merit ongoing follow-up in women with a personal history of BC [9–11].

This review summarizes the evidence on breast imaging for screening women with a personal history of BC. Imaging surveillance in this population supports the early detection and treatment of second BC events, with potential benefits for the prognosis and quality of life in women who have already experienced BC.

Is Breast Screening in Women with a Personal History of BC Effective?

No randomised controlled trials (RCTs) have examined the effect of breast screening on BC mortality in women with a personal history of BC. Further, most of the evidence on the effects or efficacy of breast screening in women with a personal history of BC relates to mammography, combined mammography and clinical examinations, or symptomatic versus asymptomatic detection in strategies that use mammography as the primary imaging modality [12]. The potential benefit of screening this special population of women has been based on an extrapolation of the likely benefit from RCTs of population-level mammography screening, complemented by evidence from observational studies [12–14]. Extrapolation of the benefits of population-level mammography screening trials to women with a personal history of BC requires making substantial assumptions, since the early detection of second BCs may not confer the anticipated benefit if the risk of mortality in these women is determined by the first BC. This possibility would be expected to diminish the benefit of early detection of a second BC. However, a number of non-randomised studies have examined the impact of breast screening or early detection of second BCs, generally using mammography as the primary imaging modality, and these studies have provided evidence that earlier detection of second BCs, before symptoms have developed, is beneficial in women with a history of BC [12–14].

When the literature that specifically focuses on the detection of second BC events is considered, excluding studies of in-breast recurrences occurring simultaneously with metastases, the evidence of benefit is frequently estimated as a hazard ratio (HR), and the reported HRs range broadly. The study-specific HRs for the detection of ipsilateral or contralateral BC in women with a history of BC range between 0.19 and 0.82 for early or asymptomatic detection, based on surveillance strategies that use mammography, relative to symptomatic or clinical detection [13,15–21]. This means that early or asymptomatic detection is associated with a beneficial effect in the range of an 18% to 81% *relative* reduction in the hazard of BC death, relative to symptomatic or clinical detection of second BCs [13,15–21]. This broad range should be interpreted cautiously, due to the limitations of lead-time and length-time bias inherent in non-randomised studies of cancer screening assessing survival, which could over-estimate the benefits.

A further methodological issue in this particular context is whether studies measure survival or follow-up time from the time of diagnosis of the first or the second BC: measuring BC survival from the first BC helps minimise lead-time bias in estimating the effect of detection of the second cancer [15,17]. Estimates of the early detection of ipsilateral BC or contralateral BC, however, are likely to be affected by length-time bias [15,17], and this bias has only been specifically considered in a single study by Houssami et al. [15]. That study examined the effect of asymptomatic versus symptomatic detection of second BCs in a cohort of 1,044 women with a history of BC who received mammography surveillance and were diagnosed with second BCs [15]. It showed that asymptomatically-detected second BCs were significantly associated with earlier detection and had a more favourable stage than symptomatic second BCs, as they were smaller and had fewer node metastases [15]. The HR for asymptomatic relative to symptomatic detection was 0.53, allowing for lead-time bias by measuring disease-specific survival from the first BC; when this estimate was also adjusted for length-time bias, the HR ranged from 0.53 to 0.73 [15]. Buist et al. [13] reported on a cohort of 1,235 women aged 65 years or older with stage I-II BC who had received long-term follow-up, and showed that a modest reduction in BC-specific death (HR, 0.82) was associated with receipt of surveillance mammography (vs. none) in the preceding year. These two studies most likely provide more robust results on the efficacy of surveillance mammography than some of the earlier studies that showed relatively large estimated benefits.

Is Mammography Accurate?

Although the evidence on screening efficacy in women with a history of BC, outlined above, is based on using mammography as the imaging modality for surveillance, several studies have reported that mammography has a modest detection capability in this population. The majority of studies of mammography in women with a history of BC have reported the proportion of second BCs detected by mammography (which may be the equivalent of sensitivity,

depending on the methods used and whether there was follow-up to identify missed cancers), but few studies have reported interval cancer data in this setting, which limits information on sensitivity, and few studies have reported the specificity of surveillance. Studies generally have reported the proportion of ipsilateral BCs detected by mammography to range between 50% and 80% [6,15,22–28] if any detection by mammography is counted in the analysis. Given that data from screening mammography and clinical examination are often reported jointly, this should be distinguished from the proportion of "mammography-only" detected ipsilateral BCs, which is usually lower than the above-reported range, typically in the range of 10%–51% [6,21,22,25,27–34]. As an example, van der Sangen et al. [35] reported that 51% of ipsilateral BCs were detected by clinical examination with or without mammography, while 38% were detected by mammography alone.

Published estimates of the proportion of contralateral BCs detected through mammography surveillance in women with a personal history of BC range from 45% to 90% [6,15,31,33,36–38]. Lu et al. [38] reported estimates of programme sensitivity and specificity for surveillance mammography. A sensitivity of 59.6% was shown for the detection of contralateral BC, while in women who complied with annual mammography, it increased to 70.8%; the specificity of mammography was high, at 98.3%. This study also found that 34% of contralateral BCs in women with a personal history of BC were diagnosed as interval cancers [38].

Large cohort studies of women with a personal history of BC have been reported in relatively recent years from the Breast Cancer Surveillance Consortium [39], providing major insights into the accuracy of screening mammography in these women. One of these studies examined screening mammograms from 19,078 women with a history of stage I–II BC who received follow-up to identify second BCs, including interval cancers [39]. This study matched 58,870 screens in women with a history of BC by age-group and breast density to 58,870 screens in women without a history of BC, thereby providing robust comparative data on screening outcomes. The BC detection rate was significantly higher in women with a history of BC than in women without a history of BC (6.8 vs. 4.4 per 1,000 screens, respectively), as was the interval BC rate (3.6 vs. 1.4 per 1,000 screens, respectively). Furthermore, screening sensitivity was significantly lower in women with a history of BC than in women without such a history (65.4% vs. 76.5%, respectively), as was specificity (98.3% vs. 99.0%). In women with a history of BC, the sensitivity of mammography was lower in the initial 5 years after the first BC treatment (60.2%) than afterwards (70.8%), and was similar for detection of ipsilateral BC (66.3%) and contralateral BC (66.1%).

Subsequent studies [2,40], also conducted within the Breast Cancer Surveillance Consortium, aimed to identify risk factors for interval second BCs after surveillance mammography in women with a history of BC. One of these studies, reported by Houssami et al. [40], was based on 67,819 screening mammograms in women with a history of BC. It identified age <40 years at the first BC diagnosis, extremely dense breasts, and treatment with breast conservation without radiation as significant predictors of an interval invasive BC within 1 year of negative mammography [40]. Since the majority of in-breast recurrences occur within 5 years of treatment, Lee et al. [2] estimated the 5-year risk of an interval invasive second BC amongst a cohort of 15,114 women with a history of stage 0-II BC, and showed that four variables were significant independent predictors of interval BC risk: first BC grade, the mode of detection of the first BC (whether screening-detected or an interval BC), treatment with breast conservation without radiation, and heterogeneously dense breasts on mammography. Knowledge of the risk factors for interval (second) BCs in women with a history of BC following negative surveillance mammography can guide recommendations on the potential use of adjunct imaging in this setting.

It should be noted that many of the studies of mammography in women with a history of BC used relatively old technology. An overview by Montgomery et al. [41] suggested a temporal increase across surveillance studies in the proportion of second BCs that are detected through mammography, as did a study from Tuscany that showed that the proportion of second BCs detected through mammography increased significantly over time, almost doubling from 33% to 60% [15]. Lu et al. [38] found a significant trend in which contralateral BC was more likely to be detected by mammography surveillance in women who had their first BC diagnosed after 1994 relative to the earlier time period (P=0.005). Presumably, this relates to improvements in mammography technology or possibly improved uptake of surveillance. Thus, it is important to acknowledge that some of the evidence summarised in this review, and in earlier reviews of this topic [41,42], may not reflect the detection capability of digital mammography screening of women with a history of BC. This possibility underscores the need for new studies using digital mammography platforms, particularly tomosynthesis.

Digital Breast Tomosynthesis

The evidence on digital breast tomosynthesis (DBT) for population-level screening has evolved rapidly in recent years, as DBT screening has been shown to improve BC detection rates and/or to reduce recall rates (compared to mammography), with some variability in the evidence related to the screening context [43]. However, there are very few data on the application of DBT for screening women with a history of BC. One study of DBT in the surveillance setting,

based on 618 women with a history of BC, showed that the addition of DBT to digital mammography reduced the rate of indeterminate results from 13.1% to 10.5% (P=0.018) [44]. Given the evidence on DBT from population screening studies, research on the use of DBT to screen women with a history of BC would make a valuable contribution to breast surveillance practice.

Which Breast Imaging Modalities Are Recommended in Surveillance Guidelines?

A review of guideline recommendations on breast imaging surveillance in women with a history of BC (summarised in Table 1) shows that they consistently recommend mammography as the primary modality. This is not surprising, since breast screening efficacy in women with a history of BC is established on the basis of mammography, as described earlier in this review. In contrast, recommendations for adjunct breast imaging, ultrasound, and magnetic resonance imaging (MRI) in this setting vary considerably, as shown in Table 1. To place this in context, the evidence on adjunct imaging in women with a history of BC will be summarized and discussed next.

Adjunct Imaging for Breast Surveillance

Breast Ultrasound

In breast imaging practice, ultrasound is a key modality for investigating women with symptoms or screen-detected findings. Although generally not recommended for routine surveillance in women with a history of BC (as indicated earlier in this review, only 1 guideline [45] recommends ultrasound) (Table 1), its use as an adjunct to mammography is not uncommon, especially in women with dense breasts. However, there are no data on how often ultrasound is used in the surveillance setting. The application of ultrasound to screen women with dense breasts on mammography is based on evidence of incremental (additional) BC detection using ultrasound after "negative" mammography in women with dense breasts [46,47]. However, the majority of studies of ultrasound screening in women with dense breasts on mammography either do not include women with a history of BC, or include only a small proportion of such women [46]. An exception to these studies is a prospective study of women with dense breasts by Berg et al. [48] in which around 54% of participants also had a history of BC; that study evaluated the combination of mammography and hand-held ultrasound compared to mammography alone in women with dense breasts and additional risk factors that placed them at a moderately increased risk of BC, and reported results for the subgroup of women with a history of BC. The cancer detection rate for mammography alone was 8.2 per 1,000 screens, whereas combining mammography with ultrasound detected an additional 4.3 cancers per 1,000 screens. It should be noted that ultrasound alone did not have better detection (BC detection rate, 8.7 per 1,000 screens) than mammography alone, but the combination significantly increased the cancer detection rate (BC detection, 12.5 per 1,000 screens) in women with a history of BC. Adding ultrasound to mammography in the surveillance setting, however, increased the burden of unnecessary recall and biopsy, increasing recall by 8.6%, the biopsy rate by 4.7%, and recommendations for short-term review by 5.2% [48], at minimum doubling these outcomes.

A retrospective study from a Korean centre, reported by Suh et al. [49], that used mammography and ultrasound for surveillance of

Table 1. Guideline recommendations on breast imaging surveillance in women with a personal history of breast cancer

Guideline	Mammography	Ultrasound	MRI
Chinese Anti-Cancer Association (Breast Cancer Committee) [50]	Annual mammography	Not specified	Not recommended
American Cancer Society/American Society of Clinical Oncology, 2016 [9]	Annual mammography	Not specified	Recommends against routine MRI unless the patient meets high-risk criteria[a]
National Comprehensive Cancer Network (NCCN), 2016 [11]	Annual mammography	Not specified	Not specified
European Society for Medical Oncology (ESMO), 2015 [45]	Annual mammography	Annual ultrasound	May be used (young patients with dense breasts and genetic history)
National Institute for Health and Care Excellence (NICE), 2014 [51]	Annual mammography	Not recommended	Not recommended
American College of Radiology (ACR), 2014 [52]	Annual mammography	Based on risk assessment (if MRI is contraindicated)	Based on risk assessment
American Society of Clinical Oncology (ASCO), 2013 [10]	Annual mammography	Not specified	Not recommended

MRI, magnetic resonance imaging.
[a]High-risk (>20% lifetime risk of second cancer).

women with a history of BC, highlighted the capability of ultrasound to detect BC recurrences not detected on mammography. However, in many instances these cases were in regions not accessible to mammography, such as the axilla or the mastectomy bed. In that study, ultrasound detected most second BCs in the contralateral breast of women who had received mastectomy (sensitivity, 95%), but had limited sensitivity for ipsilateral cancers in women who had breast conservation (sensitivity, 43%), and detection was at the trade-off of many false-positive findings [49]. In practice, false positives on ultrasound can be promptly addressed with ultrasound-guided needle biopsy, but they nonetheless add to the burden of screening-related interventions in this population of women. Further, it can be hypothesised that the integration of elastography into ultrasound practice may potentially reduce ultrasound-related false positives in the breast surveillance setting, but that remains to be demonstrated.

A key study of adjunct surveillance imaging was reported recently by Cho et al. [44], who undertook a prospective multi-centre trial in Korea, directly comparing ultrasound and MRI with mammography surveillance in a well-defined cohort of 754 women with a history of breast-conserving therapy. The trial focused on women whose initial BC was diagnosed at age ≤50 years, a group in whom mammography has been shown to have suboptimal sensitivity in women with a history of BC [39]. The study findings, which are summarised in Table 2, showed that ultrasound and MRI each yielded additional BC detection (not detected on mammography) in these women. It can be seen from the data in Table 2 that the detection capability of ultrasound is intermediate between mammography and MRI, and that each adjunct modality imposes a substantial recall and biopsy proportion compared to screening with mammography alone.

Clinical Aspects of Breast Ultrasound in the Surveillance Setting

Although there is no robust evidence to support routine implementation, ultrasound screening has been widely used in imaging practice to screen women with a history of BC in some Asian countries, particularly in Korea [49,53–55] (Table 3). Several retrospective studies have reported BC detection rates between 6.4 and 21 per 1,000 examinations in women with a history of BC [49, 53–55] (Table 3). However, these studies did not consistently clarify which modality contributed to cancer detection: mammography, ultrasound, clinical breast examination, or a combination thereof.

A recent study by Song et al. [56] reported the performance of ultrasound surveillance, including standardized monitoring parameters, amongst 6,584 women with a personal history of BC who had negative mammography results. They found an additional cancer detection rate of 2.88 per 1,000, and reported the following estimates: interval cancer rate, 1.50 per 1,000; sensitivity, 67.9%; specificity, 91.2%; abnormal interpretation rate, 9.1%; and positive predictive value (PPV) for biopsy (PPV_3), 22.6%. In addition, 79.0% (15 of 19) of the detected cancers were stage 0 or I. Based on the reported interval cancer rate (1.50/1,000), ultrasound surveillance might not fully overcome the sensitivity limitation of mammography. Regarding the disadvantages of ultrasound surveillance, the abnormal interpretation rate was 9.1% (596 of 6,584) and the PPV for recall (PPV_1) was 1.7% (22 of 1,278); the abnormal interpretation rate is similar to that of 10.6% reported for screening mammography by the Breast Cancer Surveillance Consortium [57]. The relatively low PPV_1 was caused by a high proportion of Breast Imaging Reporting and Data System category 3 lesions (which had no cancer detection yield) on ultrasound screens in this study. Thus, the low PPV_1 of ultrasound screening might be improved

Table 2. Direct comparison of surveillance modalities in 754 women (2,065 screens) with a history of breast-conserving therapy at age ≤50 years (Cho et al.) [44]

Detection or accuracy metric	Mammography	Ultrasound	MRI
Cancer detection rate per 1,000 screens	4.4	Stand-alone 5.3	Stand-alone 7.3
		Adjunct 6.8 (P=0.03)[a]	Adjunct 8.2 (P=0.003)[a]
Sensitivity	53%	Stand-alone 65%	Stand-alone 88%
		Adjunct 82% (P=0.07)[a]	Adjunct 100% (P=0.01)[a]
Specificity[b]	96%	Stand-alone 90%	Stand-alone 90%
		Adjunct 88% (P=0.001)[a]	Adjunct 87% (P=0.001)[a]
Recall rate	4.4%	10.1%	10.7%
Biopsy rate	0.5%	1.1%	2.5%

MRI, magnetic resonance imaging.
[a]P-value for comparison of adding each modality (ultrasound or MRI) to mammography versus mammography alone. [b]Sensitivity and specificity estimates are shown for each modality as stand-alone and for the combination of each modality (ultrasound or MRI) with mammography versus mammography alone.

by reclassifying category 3 lesions as category 2 lesions to avoid unnecessary recall.

Given the potential to reduce abnormal interpretations of ultrasound, the easy applicability of ultrasonography in screening and its tolerability for women, the absence of ionizing radiation and contrast agents, and the availability of ultrasound-guided biopsy to resolve the status of detected lesions, ultrasound surveillance remains a practical supplement to mammography in women with a personal history of breast cancer.

Illustrative examples of true-positive and false-positive detection using ultrasound in the surveillance setting are shown in Figs. 1 and 2, respectively.

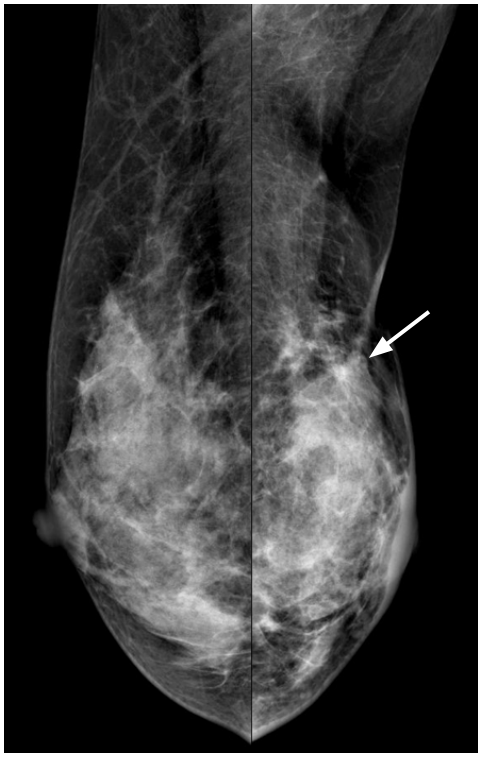
MRI of the Breast

There are two sources of evidence on breast MRI in women with a history of BC that provide data on detection capability or accuracy, but no studies have been conducted of MRI screening efficacy in the surveillance setting. Studies of breast MRI in women at a high risk of

Table 3. Studies of US screening in women with a personal history of BC

Study	Study design[a)]	Recall or abnormal US	US-related biopsy	No. of detected BCs	Cancer detection rate per 1,000 screens
Kim et al., 2010 [53]	Retrospective study of records of women with a history of BC (874, 1,796)	NR	NR	15	8
Kim et al., 2011 [54]	Retrospective review of records of women with a history of BC (3,945)	NR	NR	74	19
Lee et al., 2013 [55]	Retrospective study of records of women with a history of BC (468, 1,180)	82/468 (17.5%)	19/468 (4.1%)	10	21
Suh et al., 2013 [49]	Retrospective study of records of women with a history of BC (390, 4,081)	117	NR	26	6.4
Song et al., 2018 [56]	Retrospective study of database of women with a history of BC (6,584, 6,584) compared with those in women without a history of BC	596/6,584 (9.1%)	181/6,584 (2.7%)	19	2.88

US, ultrasonography; BC, breast cancer; NR, not reported.
[a)]Numbers in parentheses indicate number of women and exams.



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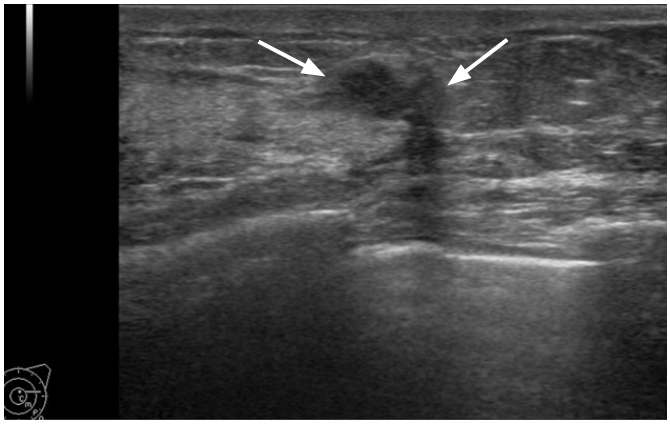
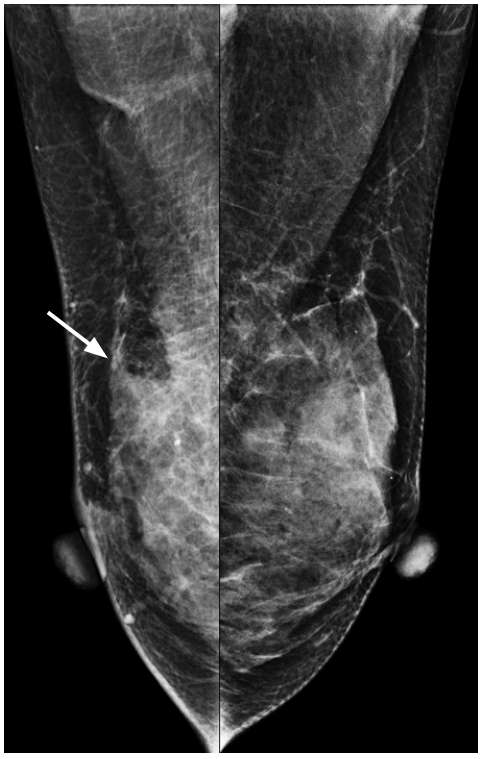


B

Fig. 1. True-positive screening breast ultrasound in a 49-year-old woman with a personal history of breast cancer, who had breast-conserving surgery 12 months prior to the surveillance imaging shown.
Surgical histopathology of the initial cancer revealed a 2.5-cm high-grade ductal carcinoma *in situ* (DCIS) with negative resection margins. She also received radiation therapy following surgery. A. Mammography shows a postoperative deformity without a specific abnormality (arrow) in the left upper outer breast. B. Ultrasonography shows an irregular hypoechoic mass (arrows) near the postoperative scar in the 2-o'clock position, which was confirmed to be a 2.2-cm high-grade DCIS on surgical histology following total mastectomy.



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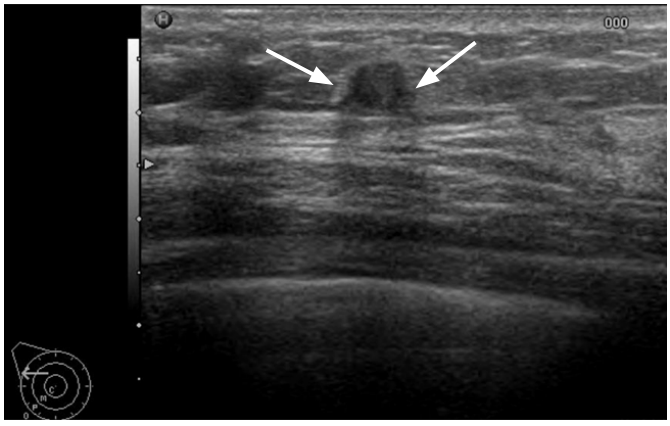

B

Fig. 2. **False-positive screening breast ultrasound examination in a 38-year-old woman with a personal history of breast cancer.**
Previously, she had undergone breast-conserving surgery. Surgical histopathology of the initial cancer revealed a 0.8-cm invasive ductal carcinoma without axillary lymph node metastasis. A. Mammography shows a postoperative deformity without an abnormality (arrow) in the right upper outer breast. B. Ultrasonography shows a 0.7-cm irregular hypoechoic mass (arrows) in the 10-o'clock position, which was confirmed as fat necrosis by ultrasound-guided core needle biopsy. On 58-month follow-up imaging, including ultrasound, there was no recurrent cancer.

BC due to *BRCA1* or *BRCA2* mutations provide relevant information. A meta-analysis of 1,951 women with *BRCA1/2* mutations from six prospective MRI screening studies, which included 345 women with a personal history of breast or ovarian cancer [58], showed that MRI had higher sensitivity than mammography (85.3% vs. 39.6%, P<0.001), although MRI had lower specificity than mammography (84.7% vs. 93.6%, P=0.01). The current evidence on breast MRI surveillance in women with a history of (sporadic) BC comes from relatively small, retrospective studies of women who underwent MRI, and these studies generally suffer from both selection bias and lack of comparative data. The results of studies focusing on MRI screening in women with a history of BC are shown in Table 4. The broad range of BC detection rates (range, 9.9 to 39.4 per 1,000 screens) (Table 4) may be attributed to the differential selection of women for MRI surveillance, the predominance of prevalent screens in some studies, and the inclusion of women with additional risk factors for BC in some studies, all of which can increase the underlying BC rates and detection rates. The consequence of selection bias is that those selected for MRI surveillance in different practices may not represent the majority of women with a history of BC, who receive mammography without being further selected for MRI, so the results of these studies may not be generalizable to the broader population of women with a personal history of BC. Table 4 also shows heterogeneity in the reported data on recall and biopsy rates, although not all studies provided these data; the abnormal interpretation rate for MRI was in the range of 10.7% to 19.4% (Table 4).

Only one prospective trial of adjunct imaging has directly compared MRI and ultrasound with mammography across several surveillance rounds in a cohort of women with a history of BC. This study, by Cho et al. [44], is discussed in the ultrasound section of this review (Table 2), and used better methodology than the studies summarized in Table 4. Notably, although Cho et al. [44] showed a significantly higher BC detection rate for MRI (combined with mammography) than for mammography alone (8.2 vs. 4.4 per 1,000 screens, respectively), it is clear that the estimated MRI detection rate in this study is below the above-described range for MRI studies shown in Table 4, most likely because Cho et al. [44] included a representative (unselected) cohort of women with a history of BC in the trial.

Conclusion

Evidence that early detection of second BCs in women with a personal history of BC improves prognosis comes from studies that used mammography (usually with clinical examinations) as the main surveillance strategy. Well-executed cohort studies have estimated that mammography screening in this population of patients has

moderate sensitivity (65.4%) and good specificity (98.3%), and have also shown that women with a history of BC are at a higher risk of experiencing an interval BC following screening mammography than age and breast density-matched cohorts without such a history. The latter finding is likely due to the higher underlying risk of BC and the lower sensitivity of mammography in women with a history of BC. Knowledge of the risk factors for interval cancers after negative surveillance mammography in women with a history of BC has evolved considerably, and we now have evidence on patient-related factors (e.g., young age) and first BC tumour- and/or treatment-related factors (e.g., receipt of breast conservation without radiation) that contribute to interval BC risk.

Table 4. Studies of MRI screening in women with a personal history of BC

Study	Study design[a]	Recall or abnormal MRI (%)	MRI-related biopsy (%)	No. of MRI-detected BCs	Cancer detection rate per 1,000 screens
Elmore et al. [59]	Retrospective review of records of women with a history of BC who had an MRI screen (141[b])	11.3	4	2	9.9
Brennan et al. [60]	Retrospective review of MRI examinations in women with a history of BC (144)	NR	31	17 (5 DCIS)	11.8[c]
Schacht et al. [61]	Retrospective review of MRI examinations in women with a history of BC (208)	NR	NR	6 (2 DCIS)	28.8[c]
Gweon et al. [62]	Retrospective study of records of women with a history of BC who had negative mammography, ultrasound, and also had MRI (607)	19.3[d]	NR	11 (3 DCIS)[d]	18.1[d]
Giess et al. [63]	Retrospective review of database of MRI examinations to identify women with a history of BC who had MRI (691[b])	10.7	5.6	12	10.1
Weinstock et al. [64][e]	Retrospective review of MRI database to identify women with a history of BC who had MRI (249)	NR	10.8	11 (2 DCIS)	19.3
Destounis et al. [65]	Retrospective review of MRI examinations in women with a personal history of pre-menopausal BC (131[b])	19.4	13.7	15 (4 DCIS)	39.4
Lehman et al. [66]	Retrospective review of MRI database to identify women with a history of BC who had MRI (915)	14.3	7	18 (4 DCIS)	19.7

MRI, magnetic resonance imaging; BC, breast cancer; NR, not reported; DCIS, ductal carcinoma *in situ*.
[a]Numbers in parentheses indicate number of women. [b]Denotes studies including women with additional risk (family history or gene mutations). [c]Calculated per 1,000 women. [d]Calculated for first (prevalent) screening round. [e]Only study reporting comparative sensitivity for MRI (84.6%) and mammography (23%).

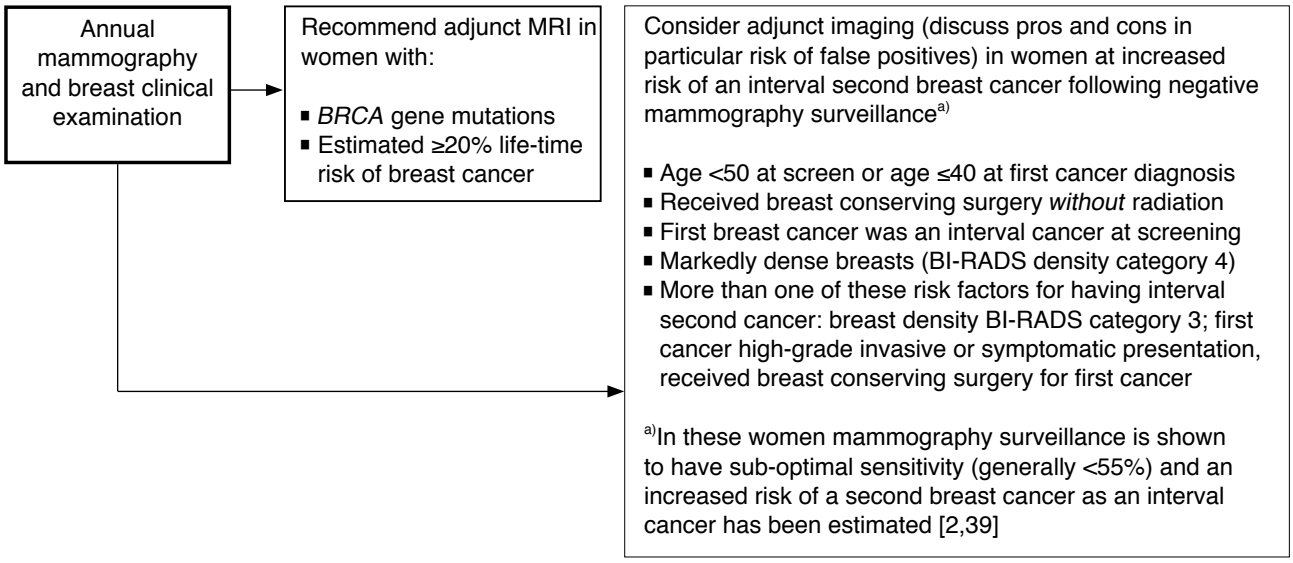

Fig. 3. A framework for breast imaging surveillance in women with a personal history of breast cancer. MRI, magnetic resonance imaging; BI-RADS, Breast Imaging Reporting and Data System.

Studies that have examined adjunct imaging surveillance of women with a history of BC, primarily ultrasound or MRI, report on detection or accuracy measures, hence there is limited knowledge on the efficacy of adding these imaging tests as part of routine breast surveillance. These studies show that using adjunct imaging detects more second BCs (MRI more so than ultrasound) but also add substantially to the burden of recall and false-positive screening. Although MRI has higher additional detection yield than ultrasound in the surveillance setting, choice of adjunct imaging needs to consider access, cost and local imaging expertise – ultrasound may be more feasible and is generally more available and more acceptable to women than MRI. Regardless of which adjunct imaging test is used, women should be informed about the additional risk of false-positives. Drawing on the evidence outlined in this review, a framework is shown in Fig. 3 to inform screening in women with a personal history of BC.

Future Research

Studies comparing digital mammography with DBT screening in women with a history of BC merit research effort, and could provide much-needed evidence in the surveillance setting. This can be expedited by large national or international collaborations to ensure sufficiently large datasets of second BC events; hence, collaborative DBT screening studies in women with a history of BC should be a research priority. A future transition to DBT would require new studies comparing additional detection from ultrasound or MRI in women with a personal history of BC who receive DBT surveillance. Because of the heterogeneity in the risk of developing an interval BC following mammography screening, risk models or calculators that reliably identify women with a history of BC who are at a higher risk of interval BC (following negative mammography) would be valuable, and could help tailor screening and support discussion of the advantages and disadvantages of adjunct imaging for breast surveillance.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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