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Technical report

Margin determination of two-view specimen radiography in breast cancer

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Background: Specimen radiography (SR) is most useful for confirming complete excision of a lesion in the breast conservation therapy. The radiologist is expected to evaluate the margin status for possible additional tissue removal by the surgeon.

Objective: To develop the technique of specimen radiography to obtain the accurate marginal assessment in breast cancer.

Materials and methods: A retrospective review was performed on 12 patients who underwent wire-localized partial mastectomy for malignant breast lesions at the University of Texas Medical Branch at Galveston between May and September 2007. The specimen was oriented to obtain the correct margin using different color stitches. Based on two-view specimen radiography on anteroposterior and lateral planes, the margin status was assessed and compared with final histopathology.

Results: Eighty-three percent cases had discordance by the one-view SR, and 67.0% by the two-view SR with pathological findings. One-view SR has a sensitivity of 25.0%, specificity of 25.0%, positive predictive value (PPV) of 40.0%, and negative predictive value (NPV) of 14.3%. Two-view SR has a sensitivity of 37.5%, specificity of 25.0%, PPV of 50.0%, and NPV of 16.7%. The false negative rate is 50.0% for one-view specimen and 42.0% for two-view. The false positive rate is 25.0% for one-view specimen and 25.0% for two-view. The concordance rate between SR and HP in two-view SR was higher compared with one view SR.

Conclusion: Specimen radiography could aid in the intraoperative assessment of margin status in patients undergoing excision of a breast mass.

Keywords: Breast cancer, breast-conserving surgery, mammography, margin assessment, specimen radiography.

Screening mammography has become widely used worldwide since it can detect small tumors. Breast conservation therapy (BCT), including segmental mastectomy and radiotherapy, is now standard treatment for most breast tumors.

There is a life-long risk of local recurrence after BCT. This often occurs at the original tumor site with histological characteristics similar to the primary tumor. This suggests that local recurrence comes from the residual tumor at the resection margin [1-3]. Thus, obtaining tumor-negative margins is the standard of care to prevent local recurrence. According to Obedian and Haffty [4], breast cancer patients are conservatively managed to improve local control based on the margin status. In addition, patients with satisfactory margins at the initial excision have a higher rate of successful breast conservation [5] and a better cosmetic result [6].

Specimen radiography (SR) is most useful for confirming complete excision of a lesion in wire-localized BCT [7]. It can help to reduce reoperation rates by identifying patients who need additional margin excision at the time of initial surgery for breast
conservation therapy [8]. The radiologist is expected to evaluate the margin status and to suggest the surgeon about possible additional tissue removal.

This study aimed to develop the technique of specimen radiography to obtain the accurate margin assessment in breast cancer. After obtaining one- and two-view specimen radiography (anteroposterior and lateral), we assessed the marginal status and compared to the concordance with histopathologic findings.

Materials and methods

A retrospective review was performed on patients who underwent wire-localized partial mastectomy for malignant breast lesions at University of Texas Medical Branch at Galveston between May and September 2007. The lesions consisted of intraductal carcinoma (IDC), ductal carcinoma in situ (DCIS), invasive lobular carcinoma (ILC), and metastasis. Prior to surgery, all patients had standard two-view mammograms (mediolateral and cranio-caudal views). All lesions were localized for surgical excision by stereotactic or ultrasound-guided wire placement (for example, see Fig. 1).

Following excision of the main tumor, a blue surgical suture was performed to mark the anterior margin, a long black stitch at the lateral margin, and a short black stitch at the superior margin, of the specimen. The specimen was inked as anterior-red, posterior-black, inferior-green, lateral-orange, medial-yellow, and anterior-blue. A purple mark was made at the position of the 18-gauge needle, representing the lesion on SR. The localizing wire was placed in the specimen, and the specimen was sent on a grid container as shown in Fig. 2. This procedure was used to magnify two views radiography and to assess the margin status.

The first view specimen was obtained by anteroposterior projection and the second was by lateral projection. Figure 3 shows two-view radiographic images obtained by anteroposterior and lateral projection.

The radiologists interpreted the two views of the specimen radiography as follows. Margins were considered as “positive” by-mammography, if suspicious calcifications or remaining mass presented at the edge of the specimen. In the case of a positive radiologic margin, the surgeon was informed so that additional tissue was removed intraoperatively. The specimens, including any extra tissue that had been excised, were then prepared for histologic analysis. In the analysis, pathologic type, lesion size, histologic grade, and margin status were determined as follows. Histologic grade was determined according to the Nottingham-Bloom-Richardson grade system for breast carcinoma [9]. These are: (grade 1) well-differentiated breast cells, (grade 2) moderately-differentiated breast cells, and (grade 3) poorly-differentiated breast cells. Margins were considered as “positive” by histopathology (HP), if tumor cells resided two mm (or less) from the cut edge of the specimen. The pathologic reports documented the individual margin status for the first and second specimen.

Fig. 1 A mammogram confirming the stereotactic localization for surgical biopsy of a cluster of microcalcifications in the right breast.

Fig. 2 The right breast specimen put in a grid container where two needles were placed at the lesions seen on SR.
Statistical analysis

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and false negative rate of specimen radiography were determined using histopathology as the gold standard for margin assessment. False negative rate was calculated as the ratio (percent) of number of false negatives to total number of women. These statistical calculations were applied to data derived from both one- and two-view SR.

Results

Twelve women with a mean age of 59.3 years (age range: 46-81 years) underwent twelve localized breast biopsies for mammographical suspicious lesions. Out of the 12 women, five (42.0%) had IDC, five (42.0%) had DCIS, one (8.0%) had invasive lobular carcinoma and one (8.0%) had metastasis. Size of the lesions, as determined by histology was 11.4 mm (range: 3-40 mm). The average histologic grade was one. Preoperative mammograms demonstrated microcalcifications in two patients (16.6%), masses in eight patients (66.7%) and combination of these two findings in two patients (16.6%). Out of the twelve patients that underwent localized wire excision and one-view SR in AP view, seven patients (58.0%) had negative margins, while five patients (42.0%) had positive margins. Out of the seven patients with negative margins on SR, six patients (86.0%) had pathologically positive margins. Five patients with close margins by SR had additional tissue removal. This resulted in a negative histopathology of additional tissue in four (80.0%) and a persistently positive margin in one (20.0%). Out of the 12 patients, 10 (83.0%) had incorrect SRs (discordance of the one-view SR with the pathological findings). Out of the
twelve patients who underwent localized wire excision and two-view SR, six patients (50.0%) had negative margins, while six patients (50.0%) had positive margins. Out of the six patients with negative margins on SR, five patients (83.0%) had pathologically positive margins. Only one patient (17.0%) had pathologically negative margins as shown in Fig. 4 (A, B).

Six patients with close margins by SR had additional tissue removal, resulting in a negative histopathology (HP) of additional tissue in three (50%) and a persistently positive margin in three (50%) (Fig. 5A, B).

Table 1 and 2 summarize results of one-and two-review SR compared with the histopathology, respectively. Interestingly, incorrect SR’s, these are discordance of the two-view SR with the pathological findings, are 67.0% out of the 12 patient. One-view SR has a sensitivity of 25%, specificity of 25.0%, PPV of 40.0%, and NPV of 14.3%. Two-view SR has a sensitivity of 37.5%, specificity of 25.0%, PPV of 50%, and NPV of 16.7%. Accordingly, our false negative rate is 50.0% for one-view SR and 42% for two-view SR. On the other hand, our false positive rate is 25% for one-view SR and 25.0% for two-view SR. Sixty percent of the false negatives contained DCIS, 20.0% had invasive ductal carcinoma, and 20.0% had metastatic carcinoma.

Fig. 4 Needle-localization of solid mass with calcifications in two-view SR (A: anteroposterior, B: lateral) of the left breast: SR (−) margins/HP (−) margins. Note calcifications in the middle of the specimen radiography.
Fig. 5 An example of two-view SR (A: anteroposterior, B: lateral) for suspicious right breast mass. The SR showed positive margin on posteromedial margin confirmed by HP: SR (+) margins/HP (+) margins. Note the mass was close to margin of the specimen radiography (indicated by arrows).

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Breast conservation with appropriate adjuvant therapy constitutes standard treatment of suitable in-situ and invasive breast cancers. According to recent studies with long-term follow-up [10, 11], local recurrence rates are acceptable following BCT without significant difference in overall survival. Survival rates after BCT are equivalent to those obtained after radical mastectomy. The performance of the primary excisional biopsy as well as its pathological evaluation is a key component in the successful implementation of breast conservation. Cosmetically, the best results are obtained at the time of the initial operation with a single excision. The volume of resected breast is directly correlated with the ultimate cosmetic outcome [12]. According to the American College of Radiology, SR is the “standard of care” for localization breast biopsy [13]. Intraoperative radiography of lumpectomy specimens may be useful for assessing the margin status and for identifying the location of micrcalifications within tissue slices [14].

Several studies have examined whether specimen radiography is useful for intraoperative assessment of surgical margins of excised breast lesions [8, 14-16]. However, their findings have been not fixed but variable [16, 17]. Furthermore, a consensus has not yet been reached as to how radical, or wide, the surgical margin should be before considering it negative [18]. Ideally, it should be wide enough to indicate that the entire lesion has been excised, while not being too wide as to compromise cosmetics. Graham et al. [15] stated that, in their hands, specimen radiography yields a positive predictive value of 98% but a negative predictive of only 32%, providing little assurance of complete therapeutic excision [15]. Dixon et al. [19] reported complete excision rates of 86%. The authors credit this success to accurate specimen orientation for the specimen radiography, which can be used as a guide for additional excision at areas with close margins. Others have corroborated the importance, describing the nuances of specimen-handling [5, 20-22].

We have described our technique to clarify the role of radiography in determining the margin status. Meticulous attention to specimen-handling and a collegial relationship between surgeon and mammographer are a paramount to the success of intraoperative specimen radiography.

The radiologist may play an active role in monitoring the good results of conservative breast surgery. There should be standardization of how the specimen was obtained and how all margins of the specimen were studied. The specimen should be labeled in a standardized manner on a grid container. This could help the radiologist to precisely interpret the margin status. In our study, the specimen was oriented using the stitches to obtain the correct margin as follows: a blue surgical suture-marking the anterior margin, a long black stitch-marking the lateral margin and a short black stitch-marking the superior margin, of the specimen. Two-view specimen radiography (anteroposterior and lateral) was used to grossly assess all tumor margins intraoperatively. This two-view SR may provide a useful method to determine the adequacy of excision in six margins of the specimen (superior, inferior, medial, lateral, anterior and posterior).

In our study, disconcordance between SR and HP was approximately 67%. Compared to 83% in one-view specimen, this level was much lower. One-view SR also yielded a lower sensitivity, positive predictive value, and negative predictive value compared to those in two-view specimen. The specificity in one and two-view specimen is equal (25%). It is likely that two-view SR yields a higher concordance rate between SR and HP than one-view. Our false negative rate was 42% for two-view specimen. This rate was the same level with 44% by Weyant et al. [23], but higher compared to 22% by Goldfeder et al. [7] and 32% by Graham et al. [15]. If our technique for specimen radiography is improved, this false negative rate will be further reduced. While specimen radiography cannot guarantee negative margins, it does assist the surgeon intraoperatively in obtaining more tissue if the initial margin appears radiographically close [18].

In conclusion, specimen radiograph could aid in the intraoperative assessment of margin status in patients undergoing excision of a breast mass. Further study and experience with a larger sample size is warranted to further assess the concordance between SR and HP.

Acknowledgement

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References


