Intraoperative digital specimen mammography: a significant improvement in operative efficiency

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KEYWORDS:
Nonpalpable breast cancer; Core biopsy; Specimen; Wire localization; Image-guided biopsy

Abstract
BACKGROUND: The goal of this study was to determine the length of operative time and its effect on surgeon productivity with the use of intraoperative digital specimen mammography (IDSM) compared to standard specimen mammography (SSM).

METHODS: A retrospective chart review was performed on 344 consecutive patients from a single breast surgeon from 2003 to 2010. Operative time was compared between procedures using SSM vs IDSM. Surgeon productivity was evaluated by the number of wire-localized excisions performed prior to and after implementation of IDSM.

RESULTS: Two hundred thirty patients underwent SSM and 114 underwent IDSM. Average operative time in the SSM group was 78 minutes vs 68 minutes in the IDSM group ($P < .0001$). In the first 2 years after implementation of IDSM, the number of wire-localized excisions performed increased by 20%.

CONCLUSIONS: Operative times were significantly shorter with the use of IDSM vs SSM, and this was associated with an increase in surgeon productivity.

The management of breast disease has evolved significantly over the past several decades, with advances in science and technology resulting in improved patient outcomes and quality of care. The image-guided percutaneous biopsy has substantially reduced the number of open surgical procedures for benign disease. Patients who are diagnosed with malignancy, have indeterminate lesions, or have lesions that are not amenable to image-guided percutaneous biopsy still require excisional biopsies or lumpectomies. Many of these excisional biopsies or lumpectomies require wire localization prior to surgery, most commonly performed with the insertion of a hook wire under mammographic, ultrasound, or magnetic resonance imaging guidance. The localization wire allows surgeons to accurately identify and remove with precision abnormalities that are otherwise not palpable or visible. This procedure involves multiple...
steps and close communication between the surgeon and radiologist.

It is standard procedure to obtain a specimen mammogram to confirm the presence of the clip or target, indicating proper excision of the target lesion along with the complete removal of the wire.\textsuperscript{15,16} This typically involves transporting the specimen to the radiology department to be imaged, with subsequent review of the image by a radiologist to confirm accurate excision of the target lesion, confirm complete removal of the wire, and in some cases to estimate the adequacy of margins. Alternatives to standard specimen mammography (SSM) are being explored, and intraoperative digital specimen mammogram (IDSM) has the benefit of providing immediate specimen evaluation in the operating room (OR) and potentially decreasing operative time.\textsuperscript{17–20} We sought to compare IDSM vs SSM with respect to the length of operative time and its effect on surgeon productivity.

## Methods

We performed a retrospective chart and electronic OR record review of patients from a single breast surgical oncologist at a quaternary care academic center. Our institutional review board approved this study. Data from 344 consecutive patients who underwent wire-localized excisional biopsy or wire-localized lumpectomy without lymph node evaluation from 2003 to 2010 were analyzed. During this time, the surgeon performed postexcision specimen evaluation using either SSM or IDSM. With SSM, the procedure is as follows: (1) the specimen is removed in the operating room by the surgeon; (2) a technician is called to the room to transport the specimen to radiology; (3) the specimen is imaged in radiology and the image is reviewed by the radiologist; (4) the radiologist calls in to the OR to communicate the findings to the surgeon; and (5) after confirmation that the target lesion has been removed, the surgeon is able to close the wound, awaken the patient, and leave the OR.

Our radiology department purchased a Bioptics machine (Faxitron Bioptics, Tucson, AZ) for the operating room and we began use of IDSM in November 2008. With IDSM, the following procedure is used: (1) the specimen is removed in the OR by the surgeon; (2) the circulating nurse images the specimen in the Bioptics machine (located in the OR); (3) the surgeon is able to review the image immediately to confirm excision of the target lesion; and (4) the surgeon is then able to close the wound, awaken the patient, and leave the OR. The Bioptics machine wirelessly transmits the specimen image to the radiologist, but the timing of review of the specimen radiograph by the radiologist is at his or her discretion.

Operative time was defined as time of patient entry into the OR until time of patient exit from the OR. The average OR time was calculated prior to (corresponding to the SSM group) and subsequent to (corresponding to the IDSM group) the institution of IDSM in November 2008. Surgeon productivity was evaluated by comparing the number of wire-localized excisions performed prior to and after implementation of IDSM. The probability values were calculated using a 2-tailed $t$ test.

## Results

In this cohort of 344 patients, the majority of patients (181 or 53%) underwent a wire-localized excisional breast biopsy for a diagnosis of atypia or an indeterminate lesion on core biopsy. Additional preoperative diagnoses included 92 patients with an abnormal mammogram (27%), 56 patients with ductal carcinoma in situ (DCIS; 16%), and 15 patients with invasive carcinoma (4%). With respect to postoperative diagnoses, the majority of patients (176 or 51%) had a benign finding, 62 patients (18%) were found to have atypia, 73 patients (21%) were found to have DCIS, and 33 patients (10%) were found to have invasive carcinoma on final pathology. There was a slight increase in both DCIS (16% to 21%) and invasive cancer (4% to 10%) from the preoperative diagnoses to the final pathologic diagnoses. In both the SSM and IDSM groups, all target lesions were successfully removed.

Age and distribution of preoperative diagnoses were similar between the 2 groups, as demonstrated in Table 1. The mean age of the SSM group was 51 and the median age of the IDSM group was 52 ($P = .18$). Twenty-two percent of the patients in the SSM group and 17% of the patients in the IDSM group underwent breast cancer or DCIS; 78% of the patients in the SSM group and 83% of the patients in the IDSM group

### Table 1  Comparison of patients undergoing SSM vs IDSM

<table>
<thead>
<tr>
<th>Factors</th>
<th>SSM (n = 230)</th>
<th>IDSM (n = 114)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (median)</td>
<td>51 (range 22–88)</td>
<td>52 (range 26–85)</td>
<td>.18</td>
</tr>
<tr>
<td>Preoperative Diagnosis</td>
<td></td>
<td></td>
<td>.21</td>
</tr>
<tr>
<td>Cancer (invasive/DCIS)</td>
<td>50 (22%)</td>
<td>19 (17%)</td>
<td></td>
</tr>
<tr>
<td>Indeterminate/benign</td>
<td>180 (78%)</td>
<td>95 (83%)</td>
<td></td>
</tr>
<tr>
<td>Operative time (mean, in minutes)</td>
<td>77.51</td>
<td>68.15</td>
<td>$&lt;.0001$</td>
</tr>
</tbody>
</table>

DCIS = ductal carcinoma in situ; IDSM = intraoperative digital specimen mammography; SSM = standard specimen mammography.
had a preoperative diagnosis of indeterminate or benign ($P = .21$).

There was a significant decrease in the mean operative time from 77.51 minutes in the SSM group to 68.15 minutes in the IDSM group ($P < .0001$). The number of wire-localized excisions performed by a single breast surgeon increased by 20% in the first 2 years following implementation of IDSM. In the 5 years preceding the use of Bioptics, the average number of total cases per year was 193 and the average number of wire-localized excisions was 46 (24%). In the 2 years following implementation of Bioptics, the average total number of cases per year and average number of wire-localized excisions were 251 and 72, respectively. To adjust for overall increased case volume, we assumed that if there had been a constant proportion of wire-localized excisions, we would have expected 60 wire-localized cases (24% of 251) following implementation of Bioptics. Seventy-two wire localized excisions was 12 more cases than expected, corresponding to a 20% increase.

**Comments**

The recommendation for screening mammography and the improvement in the quality of this technique has resulted in the detection of nonpalpable lesions and increased the rate of diagnosis of early stage breast cancer. This has resulted in the increased use of localization procedures to guide resection of target lesions. The implementation of image-guided biopsies has vastly reduced the number of women undergoing open surgical biopsies, resulting in decreased costs and improvement in the care of women diagnosed with breast cancer.

Currently, the focus has shifted to improving operative efficiency and decreasing costs for women who still require surgical biopsies or lumpectomies. The standard process of obtaining SSM to confirm target lesion excision extends the time the patient is under anesthesia as well as the OR time used for each case. Additional personnel in the form of a technician to transport the specimen, a radiology technician to process the specimen, and a radiologist to review the specimen are required for evaluation with SSM. This process allows for potential errors related to specimen delivery, identification, orientation, and final pathologic margin interpretation.

The use of IDSM allows for immediate evaluation of surgical specimens and confirmation of resection of target lesions. In this study, we found a statistically significant decrease in operative time with the use of IDSM as compared with SSM. This is in agreement with the findings previously reported by Kaufman et al., who found that the use of IDSM saved an average of 19 minutes of operative time compared with the use of SSM. Moreover, we found that the decrease in operative time correlated with an increase in surgeon productivity. A 20% increase in the number of wire-localized excisions performed by a single breast surgeon was observed, possibly attributable to an additional case fitting into the allotted OR time on certain operative days. IDSM is currently used by all breast surgeons at our institution, suggesting an even more substantial impact on surgeon productivity.

It is important to note that the accuracy of IDSM and SSM has been shown to be equivalent in previous studies. In our institution, the quality of the specimen image obtained with IDSM is comparable to SSM unless compression is required. Therefore, the decrease in operative time we observed with the use of IDSM does not come at the expense of sacrificing quality of care.

Although we did find a statistically significant difference in the length of operative time with IDSM and an increase in productivity, our study does have several limitations. First, this study is a retrospective chart review and therefore incurs the bias inherent to relying on the accuracy of information recorded in the electronic medical record. Second, this study is only applicable to patients who undergo wire-localized biopsy or lumpectomy without nodal evaluation. The proportion of patients with invasive carcinoma who do not have nodal evaluation is small, and the patients in this study may not be representative of all patients with invasive carcinoma. Third, specimen evaluation with IDSM began in November 2008, so operative time may have decreased and productivity may have increased with increasing surgeon experience. It is also possible that the 20% increase in wire-localized excisions we observed after the implementation of Bioptics is attributable to a changing case mix of patients and diagnoses over the course of the study. We tried to account for this by averaging case numbers over several years. There are many factors that affect productivity that we were unable to account for, however, some of which are surgeon related and others which are systems and process related. Lastly, we did not evaluate the cost-effectiveness of IDSM. We looked at the impact on a single surgeon’s productivity relative to the length of operative time, and the increased productivity we observed suggests that the use of IDSM is cost-effective. There are many costs, however, that could be affected (either increased or decreased) by IDSM, and these need to be evaluated in a systematic way. Despite these limitations, the significant decrease in operative time with the use of IDSM is compelling.

**Conclusions**

The downstream effects of using IDSM include decreased anesthetic time, reduced operating room costs, and increased OR efficiency. Further studies are needed to evaluate the overall effect of IDSM on cost and productivity.

**References**


