DOI: https://doi.org/10.2298/SARH161215071V
UDC: 618.19-006-073; 618.19-006-089

ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Intraoperative digital specimen radiography in the treatment of nonpalpable breast lesions

Ferenc Vicko[1,3], Zoran Radovanović[1,3], Tatjana Ivković-Kapicl[1,3], Dragana Đilas[1,3], Dejan Lukić[1,3], Milanka Tatić[1,3], Tatjana Petrović[2]

[1]University of Novi Sad, Faculty of Medicine, Novi Sad, Serbia;
[2]Institute for Pulmonary Diseases of Vojvodina, Sremska Kamenica, Serbia;
[3]Oncology Institute of Vojvodina, Sremska Kamenica, Serbia

SUMMARY

Introduction/Objective About a third of the breast lesions on mammography are clinically occult. The goals of surgical treatment are to locate, remove, and verify their presence in the removed breast tissue. Standard specimen mammography (SSM) has been an official procedure for the latter, while intraoperative digital specimen radiography (IDSR) was introduced recently.

The aim of this study was to evaluate the use of IDSR versus SSM and possible benefits regarding the duration of the procedures (operating room occupancy), availability of digital mammography for additional number of patients, surgeon productivity, and the quality of performed services.

Methods A retrospective chart review of 109 patients who underwent IDSR for nonpalpable breast lesions was performed between January 2014 and June 2016. We compared the difference in the duration of IDSR versus SSM procedure. We also observed the number of re-excisions and evaluated time-saving in the operating room workflow.

Results The average duration of surgery in the IDSR group of patients was 51 minutes, compared to 64 minutes in the SSM group. Every IDSR procedure saved 13 minutes over the standard SSM. That would allow another 28 procedures in the same time frame, with the same quality of service compared with SSM. In that way we increased productivity by 27.5%. Additional operation/surgery was needed for histologically involved surgical margins in three cases (2.75%).

Conclusion The use of new technology resulted in the rationalization of the operative room workflow and gave better productivity. More savings were obtained through the increase of digital mammography capacity for diagnostics, decrease of anesthesia duration, and better management of human resources. The number of "true" re-excisions, involving additional surgery, remained similar after introducing IDSR.

Keywords: nonpalpable breast tumors; specimen radiography; nonpalpable lesion localization

INTRODUCTION

The treatment of breast tumors has significantly advanced thanks to new technologies and new drugs, which have led to better understanding of the nature of the disease. Intraoperative digital specimen radiograph represents such a technology. It shortened the operative time, increased the productivity and decreased the work costs. A number of scientific papers report on the ways to rationalize the work of operating rooms [1, 2, 3].

Screening for breast cancer reveals an increased rate of nonpalpable changes which require the use of various techniques for their localization, followed by histological verification [4, 5]. The use of percutaneous core biopsy and vacuum-assisted biopsy solve diagnostics for a number of lesions without the need for surgery [6, 7, 8]. However, the malignancies confirmed by these biopsies, intermediary histological findings or suspicious malignancies, not suitable for core biopsies because of their localization, size, or other contraindications, should be managed by open biopsy. Localization of such lesions is often performed by a hook-wire, radiotracer (radioguided occult lesion localization), dye or metallic clips placed at the site of percutaneous biopsy, or it can be done by intraoperative ultrasound localization [9–13]. These markers help the surgeon localize and excise the lesion precisely. Because those lesions are often nonpalpable and/or invisible even in the excised tissue, it is necessary to confirm that they have been excised completely [11, 14, 15]. This can be achieved by standard specimen mammography (SSM) or intraoperative digital specimen radiography (IDSR) [16, 17].

The aim of this study was to evaluate the use of IDSR, which replaced previous SSM in December 2013. We assessed possible benefits regarding the duration of surgery and operating room occupancy, availability of digital mammography for additional number of patients, surgeon productivity, and the quality of performed services. This method allows surgeon and/or radiologist to immediately interpret the specimen in the operating room.

Received • Примљено: December 15, 2016
Revised • Ревизија: February 15, 2017
Accepted • Прихваћено: February 20, 2017
Online first: March 14, 2017

Correspondence to:
Ferenc VICKO
Faculty of Medicine
21000 Novi Sad, Serbia
ferenc.vicko@mf.uns.ac.rs

Table 1. Sequence of actions for standard specimen mammography (SSM) and intraoperative digital specimen radiography (IDSR)

SSM	Duration (min.)	IDSR	Duration (min.)
1. The surgeon excises the localized lesion and marks it for better orientation			
2. Transport of the specimen to the Center for Imaging Diagnostics	6	No action	0
3. The technician takes images of the specimen	5	The assisting scrub nurse takes an image of the specimen in the operating room; the surgeon sees it on the monitor; the radiologist can read the image simultaneously on his monitor; consultation is upon surgeon's decision	1
4. The radiologist reviews the image and communicates the results to the surgeon	3	No action	0
5. "Frozen section" analysis of excised margins			
6. Re-excision of the tumor bed			
7. Identification of the sentinel node and axillary dissection if the sentinel node is positive			
8. The end of the procedure			

METHODS

A retrospective study of patient charts and operative protocols gave us the data for 109 patients from 2014 to June 2016. Around one half of the patients underwent preoperative percutaneous biopsy, while the rest was proven by frozen section during their surgery. In case of histologically confirmed or suspicious lesions for infiltrative carcinoma visible on ultrasonography, lesion localization was performed primarily by a radiotracer, which allows sentinel node identification, or we used wire localization with para-areolar injection of the radiotracer. Otherwise, the sentinel node (SN) would have to be examined in a separate procedure. The third method is the use of ultrasound pre- and intraoperatively for lesion localization. The preoperative part is often done by a radiologist by marking the lesion over the skin; intraoperatively, ultrasound is available to surgeons. After lesion localization, all patients underwent breast conserving surgery with or without SN identification, and axillary dissection for metastases.

The durations of the procedure for the IDSR group were obtained from the operative protocols. Since the SSM procedure duration differs from IDSR only in the time needed for transportation, the radiological technicians needed to obtain a specimen mammogram, and the radiologists to interpret it, we simply calculated and added that time to the results we obtained for the IDSR group (Table 1). These measurements were taken three times by a stopwatch and the average time was six, five, and three minutes. We never considered the possibility of mammogram examination of a patient being in progress, which would prolong every procedure for up to 20 minutes.

We divided all the IDSR patients into subgroups in order to precisely evaluate the time needed for tumor excision in the following way: those who had re-excision, SN identification, or both (re-excision + SN), and those who underwent axillary dissection.

In addition, we estimated the total number of re-excisions indicated by the surgeon and radiologist on the ground of IDSR, or other reasons (visual or palpatory findings in the tumor bed), or by the histopathologist (frozen section analysis of the resected margins).

Table 2. Discrepancies between histological findings on percutaneous biopsy and open surgery

No.	Percutaneous biopsy	Surgical biopsy
1.	fibrosclerosis	Ductal CIS, G2, 3,5 mm
2.	papillary tumor	Papillary CIS, G1, 10 mm
3.	papillary tumor	CIS, G?, 8 mm
4.	DCIS, G3	Ductal microinvasive, G3, 3 mm
5.	CDI, G2, DCIS, G2	DCIS, G2
6.	CDI, G2, DCIS, G2, 4 mm	ADH
7.	DCIS, G2, 11 mm	No tumor
8, 9.	CDI, G2, > 40 mm	No tumor after neoadjuvant treatment

CIS – carcinoma in situ; G – grade of the tumor; CDI – carcinoma ductale invasivum; ADH – atypical ductal hyperplasia

We also estimated the total number of additional surgeries for the group. The productivity was assessed in relation to the predicted time-saving with the use of IDSR.

RESULTS

The localization procedures were pre- and intraoperative ultrasound in 66 (60.5%) cases, "hook-wire" in 29 (26.6%), and radioguided occult lesion localization in 14 (12.8%) cases. Out of 109 lesion localizations, 52 (47.7%) patients underwent preoperative percutaneous biopsy; the remaining 57 (52.3%) lesions were proven by frozen section analysis intraoperatively. Twenty-nine (26.6%) patients were verified to have benign lesions, while 30 (27.5%) had infiltrating carcinoma, 28 (25.7%) in situ, and 22 (20.2%) the combination of the two.

There were discrepancies between the histological findings on "core" biopsy and open surgery in nine (8.25%) cases (Table 2).

The average diameter of the invasive tumor was 12.8 mm (range of 4–30 mm), 13 mm (range of 0.2–35 mm) for in situ tumors, and 12.5 mm for the combination of the two (range of 1.5–30 mm).

The average duration of surgery in the IDSR group of patients was 51 minutes, compared to 64 minutes in the SSM group. The average 51 minutes would be prolonged

Table 3. Number of additional surgeries indicated by involved surgical margins

No.	Primary "frozen section" procedure	Additional (second) surgery	Three or more procedures
1.	Free margin (2 mm) on the frozen section	CDI, G2 on the margin	-
2.	No tumor on the margin	CLI, LCIS on the margin	LCIS on the margin solved by mastectomy
3.	No tumor on the margin	DCIS, G2 on the margin	-

CDI – carcinoma ductale invasivum; CLI – carcinoma lobulare invasivum; LCIS – carcinoma lobulare in situ; DCIS – carcinoma ductale in situ

another 11 minutes if re-excision was needed. In case of SN identification, the average time is 66 minutes, a combination of the two would give 83 minutes, and up to 97 minutes for axillary dissection.

The number of re-excisions during the procedure was 33 (30.3%). Additional surgery was needed for histologically involved surgical margins in three cases (2.75%). In one case after the second surgery and lobular carcinoma in situ on the margin, mastectomy was performed (Table 3).

DISCUSSION

It must be said that in SSM procedure potential errors regarding the identification, orientation, and transportation of the excised specimen are possible; this can lead to misinterpretation of resected margins by the histopathologist. Compression of the specimen during mammography imaging can cause overlapping of the margins, which can result in false positive or negative excised margins. The use of IDSR allows for an immediate evaluation of the specimen, confirmation of the complete removal of targeted tissue, and the assessment of excised margins. Our study confirmed that the procedure was shorter by 13 minutes with IDSR compared to SSM. Similar findings were reported in a study by Kaufman et al. [18]. Other studies do not state similar results [19]. Our results showed that preoperative percutaneous biopsy and histological verification of an occult lesion did not shorten the duration of the procedure significantly. It can be explained by the practice of frozen section analysis of surgical margins in all patients in addition to IDSR.

Every IDSR procedure saved 13 minutes over the standard SSM. That would allow another 28 procedures in the same time frame, with the same quality of service compared with SSM. In that way we increased productivity by 27.5%.

We expect more benefits in the future knowing the impact to the learning curve and engagement of all surgeons in the IDSR procedure.

Different studies report positive resection margins in up to 40% of the patients treated with breast conserving surgery [20, 21]. This leads to additional surgery, adverse effects on cosmetics, psychological distress, and higher costs.

According to other authors, the percentage of re-excisions performed in the course of operation is comparable to ours (30%) [17, 22], or lower [18, 23]. IDSR optimizes the surgical procedure because the surgeon, radiologist, and histopathologist have a real-time information about the positive resection margins [22]. It is now possible to exchange opinions directly with no additional time consumption. We had tree re-operations (2.75%) in our study; McCormick et al. [23] found this percentage to be 12%, and after two-view specimen mammography they reduced this rate to 5% [23]. The future goal is to avoid additional operations and increase productivity as much as possible.

CONCLUSION

The use of new technology resulted in the rationalization of the operative room workflow and gave better productivity. More savings were obtained through the increase of digital mammography capacity for diagnostics, decrease of anesthesia duration, and better management of human resources. The use of this method slightly increased the number of re-excisions during the primary operation. The number of "true" re-excisions, involving additional surgery, remained similar after introducing IDSR.

The use of IDSR in everyday practical work has made possible rapid creation and interpretation of specimen radiograms and making immediate surgical decisions based on these images.

REFERENCES

1. Friedman DM, Sokal SM, Chang Y, Berger DL. Increasing Operating Room Efficiency through Parallel Processing. Ann Surg. 2006; 243(1):10–4.
2. Stahl J, Sandberg W, Daily B, Wiklund R, Egan M, Goldman J, et al. Reorganizing patient care and workflow in the operating room: a cost-effectiveness study. Surgery. 2006; 139(6):717–28.
3. Sokal SM. Maximizing Operating Room and Recovery Room Capacity in an Era of Constrained Resources. Arch Surg. 2006; 141(4):389–93.
4. White RR, Halperin TJ, Olson JA, Soo MS, Bentley RC, Seigler AHF. Impact of Core-Needle Breast Biopsy on the Surgical Management of Mammographic Abnormalities. Ann Surg. 2001; 233(6):769–77.
5. Holloway CM, Easson A, Escallon J, Leong WL, Quan ML, Reedjik M, et al. Technology as a force for improved diagnosis and treatment of breast disease. Can J Surg. 2010; 53(4):268–77.
6. Brenner RJ, Bassett LW, Fajardo LL, Dershaw DD, Evans WP, Hunt R, et al. Stereotactic Core-Needle Breast Biopsy: A Multi-institutional Prospective Trial. Radiology. 2001; 218(3):866–72.
7. Image-Detected Breast Cancer: State of the Art Diagnosis and Treatment. J Am Coll Surg. 2001; 193(3):297–302.
8. Jackman RJ, Burbank F, Parker SH, Evans WP, Lechner MC, Richardson TR, et al. Atypical ductal hyperplasia diagnosed at stereotactic breast biopsy: improved reliability with 14-gauge, directional, vacuum-assisted biopsy. Radiology. 1997; 204(2):485–8.

9. Silverstein MJ, Gamagami P, Rosser RJ, Gierson ED, Colburn WJ, Handel N, et al. Hooked-wire-directed breast biopsy and overpenetrated mammography. Cancer. 1987; 59(4):715–22.
10. Medina-Franco H, Abarca-Pérez L, García-Alvarez MN, Ulloa-Gómez JL, Romero-Trejo C, Sepúlveda-Méndez J. Radioguided occult lesion localization (ROLL) versus wire-guided lumpectomy for non-palpable breast lesions: A randomized prospective evaluation. J Surg Oncol. 2008; 97(2):108–11.
11. Lovrics P, Cornacchi S, Vora R, Goldsmith C, Kahnamoui K. Systematic review of radioguided surgery for non-palpable breast cancer. Eur J Surg Oncol. 2011; 37(5):388–97.
12. James TA, Harlow S, Sheehey-Jones J, Hart M, Gaspari C, Stanley M, et al. Intraoperative Ultrasound versus Mammographic Needle Localization for Ductal Carcinoma in Situ. Ann Surg Oncol. 2009; 16(5):1164–9.
13. Karanlik H, Ozgur I, Sahin D, Fayda M, Onder S, Yavuz E. Intraoperative ultrasound reduces the need for re-excision in breast-conserving surgery. World J Surg Oncol. 2015; 13:321.
14. Dua SM, Gray RJ, Keshtgar M. Strategies for localisation of impalpable breast lesions. Breast. 2011; 20(3):246–53.
15. Birdwell R. MRI-directed, wire-localized breast excisions: incidence of malignancy and recommendations for pathologic evaluation. Hum Pathol. 2008; 2008:58–9.
16. Muttalib M, Tisdall M, Scawn R, Shousha S, Cummins R, Sinnett H. Intra-operative specimen analysis using faxitron microradiography for excision of mammographically suspicious, non-palpable breast lesions. Breast. 2004; 13(4):307–15.
17. Bathla L, Harris A, Davey M, Sharma P, Silva E. High resolution intra-operative two-dimensional specimen mammography and its impact on second operation for re-excision of positive margins at final pathology after breast conservation surgery. Am J Surg. 2011; 202(4):387–94.
18. Kaufman CS, Jacobson L, Bachman BA, Kaufman LB, Mahon C, Gambrell LJ, et al. Intraoperative Digital Specimen Mammography: Rapid, Accurate Results Expedite Surgery. Ann Surg Oncol. 2007; 14(4):1478–85.
19. Kim SHH, Cornacchi SD, Heller B, Farrokhyar F, Babra M, Lovrics PJ. An evaluation of intraoperative digital specimen mammography versus conventional specimen radiography for the excision of nonpalpable breast lesions. Am J Surg. 2013; 205(6):703–10.
20. Liberman L, Kaplan J, Zee KJV, Morris EA, Latrenta LR, Abramson AF, et al. Bracketing Wires for Preoperative Breast Needle Localization. Am J Roentgenol 2001; 177(3):565–72.
21. Zavagno G, Goldin E, Mencarelli R, Capitanio G, Bianco PD, Marconato R, et al. Role of resection margins in patients treated with breast conservation surgery. Cancer. 2008; 112(9):1923–31.
22. Cabioglu N, Hunt KK, Sahin AA, Kuerer HM, Babiera GV, Singletary SE, et al. Role for Intraoperative Margin Assessment in Patients Undergoing Breast-Conserving Surgery. Ann Surg Oncol. 2007; 14(4):1458–71.
23. Mccormick JT, Keleher AJ, Tikhomirov VB, Budway RJ, Caushaj PF. Analysis of the use of specimen mammography in breast conservation therapy. Am J Surg. 2004; 188(4):433–6.

Интраоперативна дигитална радиографија узорка у третману непалпабилних промена дојки

Ференц Вицко[1,3], Зоран Радовановић[1,3], Татјана Ивковић Капицл[1,3], Драгана Ђилас[1,3], Дејан Лукић[1,3], Миланка Татић[1,3], Татјана Петровић[2]

[1]Универзитет у Новом Саду, Медицински факултет, Нови Сад, Србија;
[2]Институт за плућне болести Војводине, Сремска Каменица, Србија;
[3]Институт за онкологију Војводине, Сремска Каменица, Србија

САЖЕТАК

Увод/Циљ Трећина мамографским прегледом нађених промена у дојци је непалпабилна. Циљ хируршког лечења је да локализује, уклони и потврди промене у одстрањеном ткиву. Мамографија узорка је била стандардна метода за потврду, а интраоперативна дигитална мамографија је уведена недавно.

Циљ рада је био да се одреди евентуална предност интароперативне дигиталне радиографије узорка (ИДРУ) у односу на стандардну мамографију узорка (СМУ), у трајању операције (заузетости операционе сале), ослобађања капацитета дигиталног мамографа за додатни број прегледа, у продуктивности и квалитету пружене услуге.

Методе Ретроспективно је анализирано 109 картона болесника са ИДРУ од јануара 2014. до јуна 2016. Време трајања операције са ИДРУ је упоређивано са временом трајања операције код СМУ. Посматран је број реексцизија и процењена је уштеда у времену рада операционе сале.

Резултати Просечно време трајања операције је 51 минут у групи ИДРУ у односу на 64 минута код СМУ. Свака процедура ИДРУ је донела уштеду у времену од 13 минута у односу на СМУ. Таква уштеда би дозволила извођење још 28 додатних процедура у односу на СМУ у истом временском оквиру, са истим квалитетом услуге. То значи повећање продуктивности за 27,5%. Друга хируршка интервенција је због позитивних ресекционих ивица била потребна у три случаја (2,75%).

Закључак Увођењем нове технологије постигнута је рационализација у раду операционе сале и повећана је продуктивност. Неоспорна је и уштеда због ослобађања капацитета дигиталног мамографа за дијагностичке потребе. Скраћење времена трајања анестезије доноси материјалне уштеде и рационализацију у управљању. Број реексцизија у другом акту је практично непромењен након увођења ИДРУ.

Кључне речи: тумори дојке; непалпабилни; локализација; радиографија узорка