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Value of an intraoperative real time tissue perfusion assessment system following a nipple-sparing radical mastectomy for advanced breast cancer☆

Brenten Popiel [a], Digant Gupta [a], Subhasis Misra [b,*]

[a] Cancer Treatment Centers of America® (CTCA) at Midwestern Regional Medical Center, 2520 Elisha Avenue, Zion, IL 60099, USA
[b] Texas Tech University Health Sciences Center School of Medicine at Amarillo, 1400 S. Coulter, Amarillo, TX 79106, USA

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ABSTRACT

INTRODUCTION: Standard surgical approach for advanced breast cancer is a modified radical mastectomy with a periareolar elliptical incision. Here a unique surgical approach is presented utilizing intraoperative real time tissue perfusion technology.
PRESENTATION OF CASE: A 65-year old African American female was diagnosed with grade 3 papillary carcinoma on biopsy of a palpable 3.7 cm left breast mass at 12 o'clock position. Pathology showed a T2N0M0 invasive ductal carcinoma, triple negative disease, with clear margins. Patient opted for naturopathic treatment. Six months later, cancer recurred at the local site; the patient persisted with natural remedies. Nine months later, the mass had progressed to 14.5 cm with smaller adjacent nodules and nodular thickening of breast with no metastatic disease. Patient received neoadjuvant chemoradiation. Ten months later, patient underwent a nipple-sparing radical mastectomy given the persistent pectoral muscle involvement of this mass.
DISCUSSION: An elliptical incision was made in the superior aspect of the breast wall at least 6 cm above the areola. After tumor removal, the skin edges were approximated. It was decided preoperatively to use the SPY *Elite*™ system to assess perfusion of the flap edges. Angiography with indocyanine green showed poor perfusion of the inferior flap and an additional 2 cm of skin was resected. Final pathology showed that all margins were clear of disease and patient recovered well from surgery.
CONCLUSION: This case study shows that an individualized approach resulted in an optimal outcome for the patient. The infrequent procedure of a nipple-sparing radical mastectomy was done in coordination with SPY *Elite*™ to achieve good wound healing.

1. Introduction

The standard surgical approach for advanced breast cancer is a modified radical mastectomy.[1,2] A modified radical mastectomy is a procedure in which the entire breast is removed; including the skin, areola, nipple, and level I and level II axillary lymph nodes, but the pectoralis major muscle is spared.[3] In breast cancer cases with pectoral muscle involvement a radical mastectomy may need to be done if there is persistence of disease despite neoadjuvant chemoradiation.

In a radical mastectomy all of the breast tissue along with the nipple, lymph nodes in the axilla, and chest wall muscles, under the breast are removed.[4] Due to the invasive nature of the procedure higher incidence of post-operative complications are likely. The cause of these early complications is often attributed to inadequate tissue perfusion.[5] Surgeons have relied on vision and clinical judgment to evaluate tissue perfusion.[6] While experienced surgeons are often comfortable making this assessment, it remains subjective and can be difficult in certain situation.[7]

The SPY *Elite*™ intraoperative perfusion assessment system as shown in Fig. 1 is an imaging system used as an adjunctive method for the evaluation of tissue perfusion in surgical procedures where additional perfusion information is needed.[8] The SPY *Elite*™ system provides objective, intraoperative assessment of blood flow to tissues, allowing for immediate surgical changes that can lead to improved wound healing and reduce the risk for postoperative conditions. The system utilizes the fluorescent agent indocyanine green (ICG). ICG is a sterile, water soluble tricarbocyanine dye with a peak spectral absorption at 800–810 nm. ICG binds tightly to plasma proteins and has a short half-life of 2.5–3 min allowing for repeat evaluations during the surgical procedures.[8]

The SPY *Elite*™ intraoperative perfusion assessment system is available in the United States and Canada. It is distributed by

* Corresponding author. Tel.: +1 806 354 5563; fax: +1 806 354 5561.
E-mail addresses: Brenten.popiel@ctca-hope.com (B. Popiel), Digant.gupta@ctca-hope.com (D. Gupta), Subhasis.misra@ttuhsc.edu (S. Misra).

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Fig. 1. Image of the SPY *Elite*™ system.

LifeCell and manufactured by Novadaq. The system is cost effective because most hospitals view the complications that can arise when not using the device to far exceed the cost of the device.[9]

This study illustrates the use of the SPY *Elite*™ system to assess flap viability following a nipple-sparing radical mastectomy with an unusual incision site.

2. Presentation of case

A 65-year old African American female was diagnosed with grade 3 papillary carcinoma on biopsy of a palpable 3.7 cm left breast mass at 12 o'clock position in April 2009. In June 2009 she underwent a left partial mastectomy with sentinel node biopsy. Pathology showed stage T2N0MX ductal carcinoma that was ER/PR and HER-2/neu negative with clear margins. The patient was advised chemotherapy by her initial treating oncologist but refused conventional treatment and opted for naturopathic treatment engaging in vitamin and dietary supplements. In December 2010 the patient felt a new lump in left breast. A mammogram showed a 6 cm mass at the 1 o'clock position. A biopsy showed invasive high grade ductal carcinoma with papillary features, ER/PR and HER-2/neu negative. The patient was advised neoadjuvant chemotherapy followed by a mastectomy. The patient again refused treatment and continued with her naturopathic treatment. The mass continued to grow occupying almost the entire left breast

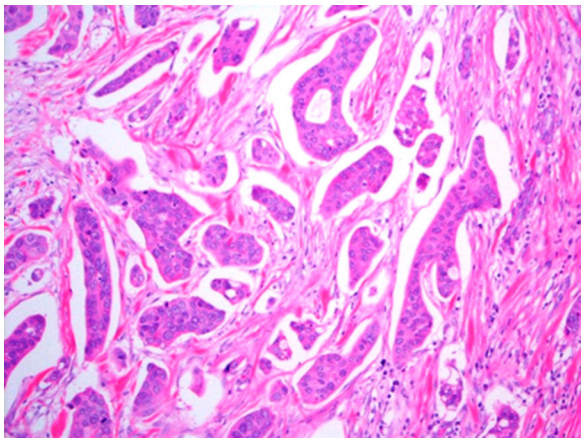

Fig. 2. Pathology showing a T2N0M0 invasive ductal carcinoma, triple negative disease, with clear margins extraction.

with increasing pressure and pain. In September 2011 the patient presented to our facility.

A CT scan revealed a 14.5 cm × 9.5 cm mass in the left breast extending toward the axillary with smaller adjacent nodules and slight nodular thickening of the skin with no metastatic disease. Multiple dilated vessels were seen in the left breast. Pathology confirmed a stage T2N0MX ductal carcinoma that was ER/PR and HER-2/neu negative with clear margins as shown in Fig. 2. Although this was a triple negative disease, the patient was advised neoadjuvant chemotherapy followed by a mastectomy to potentially avoid resecting the pectoralis muscle during the mastectomy. The patient received six cycles of 365 mg of Carboplatin and 100 mg of Taxotere from September 2011 to March 2012. During this time the patient had a break in chemotherapy due to neutropenia and for going on vacation. The patient also received radiation therapy to the left breast. From April 2012 to May 2012 the patient got 5000 cGy to the left breast in 25 fractions. In July 2012, given the mass still involved the pectoral muscle despite some response to neoadjuvant chemo and radiation therapy, a left nipple-sparing radical mastectomy with axillary dissection was performed in coordination with the SPY *Elite*™ system for assessing flap perfusion by injection of ICG under general anesthesia.

The patient was prepped and draped in the standard fashion. An elliptical incision was made, above the nipple areola from the lateral edge of the sternal border and pointing toward the axilla in its lateral aspect as shown in Fig. 3. Superior and inferior skin flaps were raised. There were dense adhesions of the skin to the upper flap area and given the concern that there could be tumor

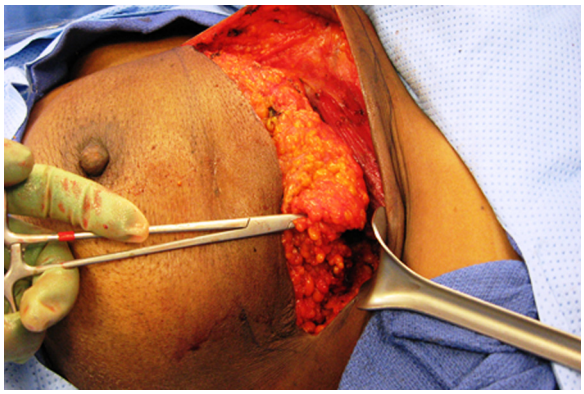

Fig. 3. Intra-operative image of the nipple-sparing radical mastectomy and specimen extraction.

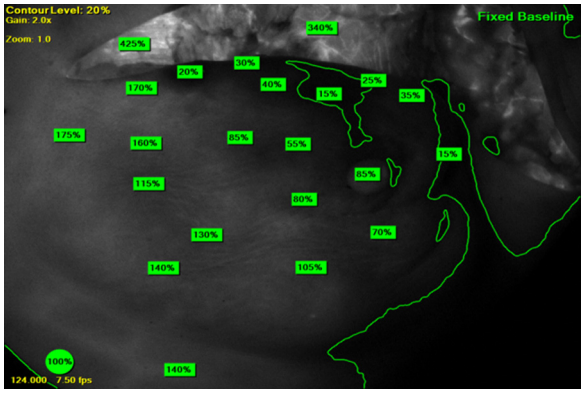

Fig. 4. Lower pole of breast imaged with the SPY *Elite*™ system to assess tissue perfusion.

Fig. 5. Postoperative image after nipple-sparing radical mastectomy.

involvement, multiple frozen sections were done and all were negative for malignancy.

The tumor was high up in the chest wall approximately 4 cm below the level of clavicle and was involving the pectoral muscle. The superior portion of the chest wall was dissected down to the level of the chest wall by going through the pectoralis muscle. The pectoralis major muscle was resected and the breast tissue was taken off the serratus anterior muscle inferiorly. The inferior envelope of the breast skin and nipple were spared and this helped in the closure of the wound later. Frozen section of the breast tissue from just under the nipple was also negative for malignancy. A 14.5 cm × 9.5 cm specimen was removed with a thin portion of skin. Axillary dissection was done. Two number fifteen Blake drains were placed, one in the axilla, and the other in the left anterior chest.

Although clinically the margins appeared well-perfused, it was decided preoperatively to use the SPY *Elite*™ imaging system to capture and view fluorescence images for the visual assessment of blood flow as an adjunctive method for the evaluation of tissue perfusion.[8] The imaging head of the SPY *Elite*™ machine as shown in Fig. 1 was positioned at the correct distance from the patient to achieve optimal imaging. Using a three way stopcock attached to an injection port on the infusion line the prepared 2.5 mg/ml ICG solution was injected as a tight bolus. The access on the stopcock was then switched to the syringe containing saline to briskly flush the ICG bolus through the line with 10 ml of sterile saline to achieve optimal image quality. The lower pole of the breast was then imaged as shown in Fig. 4. The 100 percent mark was placed in an area of undamaged skin where there was good perfusion. The numbers reflect the percentage of perfusion relative to the 100 percent marker. Angiography with indocyanine green showed poor perfusion of the inferior flap quantified by the 15 and 25 percent marks as shown in Fig. 4. As a result, an additional 2 cm of skin of the inferior flap was resected and then approximated with the superior flap. After resection this border was rechecked for perfusion. The SPY *Elite*™ imaging system showing marked improvement in the vascularity of the flap.

The dermis was closed with multiple interrupted 3-0 Vicryl sutures, and the skin was approximated with running continuous 4-0 Monocryl in a subcuticular fashion. Dermabond was applied on top of the incision.

There were no complications during the procedure, and the patient recovered well from surgery. The patient was discharged home at day one following surgery. At the last follow-up in August 2013, thirteen months after surgery, CT and PET scan images showed no evidence of recurrent disease. The patient did not receive post-operative radiotherapy or chemotherapy as there was no recurrent disease.

3. Discussion

This case study shows that an individualized approach resulted in an optimal outcome for the patient. The infrequent procedure of a nipple-sparing radical mastectomy was done, with an unusual elliptical incision made in the superior aspect of the breast wall at least 6 cm above the areola as shown in Fig. 3. The SPY *Elite*™ intraoperative tissue perfusion assessment system to assess flap viability was used successfully to find a viable flap edge to promote optimal wound healing although clinical judgment erroneously suggested that the initial flap edges were well perfused.

Fluorescence angiography with ICG is a sensitive diagnostic tool for detecting compromised tissue perfusion in trauma surgery and microsurgery.[10] The SPY *Elite*™ system allowed the surgeon to compare areas of good tissue perfusion in undamaged skin to areas of poor perfusion. In this case the SPY *Elite*™ system showed poor perfusion in the inferior flap of the breast leading to an additional 2 cm being resected resulting in improved perioperative management and better clinical results.

Final pathology showed that all margins were clear of disease and there was no lymph node involvement. The patient recovered well from surgery with satisfactory wound healing and a good cosmetic result with minimal scarring as shown in Fig. 5. With intraoperative imaging, the surgeon is provided with an on-table assessment of breast skin perfusion that facilitates identification and removal of poorly perfused tissue that results in decreases complication rates.[5]

4. Conclusion

In this case study we illustrate the use of a tissue perfusion assessment system to assess flap viability in a patient undergoing a nipple-sparing radical mastectomy with an unusual incision site. This study shows that uncommon surgical practices can be performed successfully when technology is used to complement good clinical judgment in assessing tissue perfusion.

Conflict of interest statement

None.

Funding

None.

Ethical approval

Written informed consent was obtained from the patient for publication of this Case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

Author contributions

BP participated in data collection and writing. DG participated in writing and critical revision. SM participated in concept, data collection and writing. All authors read and approved the final manuscript.

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