Identifying the Surgical Cavity after Oncoplastic Breast Surgery

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Abstract

Background: Oncoplastic surgery (OPS) has improved outcomes for partial mastectomy. However, tissue rearrangement poses challenges in the post-operative management of these patients. In most cases, these patients will require post-operative radiotherapy. Accurately visualizing the surgical cavity can be particularly troublesome in patients who have oncoplastic closure of the resection cavity. Recent advances have made it feasible to perform external beam radiation using advanced methods, but these are not commonly used for breast cancer. This is due to the difficulty in identifying the exact area of the surgical site. In this series of patients, a novel method for marking the surgical site when using oncoplastic techniques was evaluated.

Methods and Materials: 65 patients had a 3-D tissue marker implanted at the time of lumpectomy. All patients were candidates for partial mastectomy and local breast reconstruction using OPS. Post-operative treatment plans for radiation and/or adjuvant chemotherapy were completed. Patients were evaluated with standard breast imaging methods for treatment planning.

Results: The marker was easily identified and clearly delineated the lumpectomy cavity. It provided 3-D characterization of the borders surrounding the cavity, and was easily distinguished from seroma and other tissue changes. Respiratory motion was easily tracked using the device making it possible to use IMRT and accelerated protocols. Use of the marker resulted in treatment volumes that were reduced by an average of 50% when compared to standard methods. In appropriate patients when the marker facilitated an accelerated protocol, total treatment time was decreased to 5-7 days. No complications were reported, and overall patient outcomes were excellent.

Conclusions: This novel 3-D marker was consistently visualized without difficulty, was readily incorporated into standard practices and had appreciable benefits when designing optimal treatment plans. Its unique features were helpful in all cases, but particularly useful when using oncoplastic techniques to reconstruct the breast with local tissue flaps.

Background

Oncoplastic surgery (OPS) combines the principles and techniques of surgical oncology (tumor removal) with those of reconstructive surgery in order to improve outcomes. These techniques have become increasingly popular since partial mastectomy creates a loss of volume in the breast, and following radiation (which is commonly delivered to the breast for local tumor control) significant deformities are quite common. Often these undesirable outcomes present patients with discomfort, disfigurement and other difficulties, which can be challenging, costly to repair and often require mastectomy and/or complex reconstructive procedures.

These breast deformities result from the combination of volume loss to the breast—following surgical removal of the tumor with surrounding tissue—combined with the effects of radiation delivered to an unnecessarily large volume of tissue. Thus, there are two clinical approaches to consider when trying to improve cosmetic outcomes in breast conservation surgery – 1) changing the surgical techniques (to incorporate OPS) and 2) limiting radiation treatment volumes to the most appropriate target volume. Since OPS techniques typically use mobilization of adjacent breast tissue to reconstruct the breast in order to minimize the effects of volume loss by tumor removal, many surgeons are unfamiliar with these methods and hence are slow to adopt OPS. In addition, mobilizing adjacent flaps into the excision cavity presents challenges...
for post-operative planning of radiation treatments, and can introduce uncertainty into the radiation therapy planning phase.

Herein we present how the 3-dimensional, bioabsorbable (BioZorb) implant has been used in 65 patients undergoing partial mastectomy for breast cancer to assist with 1) oncoplastic closure of the lumpectomy cavity, 2) identifying the tumor resection site for radiation treatment planning, and 3) long-term follow up.

Materials & Methods

Figure 1: 3-D implantable device

Following informed consent and a thorough pre-operative assessment, 65 patients were implanted with the BioZorb device during lumpectomy. The device contains 6 titanium marker clips attached to a bioabsorbable spiral.

Figure 2: Pre-Op Assessment and Special Considerations

- Complete History & Physical Exam, w/family history
- BRCA testing, if indicated
- Imaging Studies – Mammography, US, MRI
- Pathology from percutaneous biopsy
- Wire localization pre-op or intra-op to identify:
  - calcifications or other radiographic abnormalities
  - palpable abnormality
  - percutaneous marker
- Nodal evaluation (US, sentinel node, etc.)
- Pre-op and intraoperative antibiotics
- Relative contraindications – co-morbid medical issues (e.g. smoker, diabetic)

Materials & Methods – Oncoplastic Breast Reconstruction Techniques

The figures below illustrate various surgical techniques that can be used during partial mastectomy to reconstruct the breast. Proper patient selection for breast conservation and partial breast reconstruction are critical to achieving good outcomes. Oncoplastic techniques are used to optimize breast contouring and the device provides a consistent method for direct communication with the radiation oncologist.

Figure 3: Tissue Excision

Pre-op imaging and wire localization assist with the 3-dimensional assessment of tumor size and location. This information is used to determine the optimal site for the skin incision and area of tissue to remove. Surgical resection of tumor (3A) may include tunneling to tumor location, undermining adjacent tissue, flap creation, etc. Adequate margins and re-excision of close or suspicious margins should be accomplished. Once excised, the specimen is labeled by the surgeon in the operating room via color marking (3B) or sutures (3C) in order to ensure optimal communication with the pathologist.

Specimen X-rays (3D,E) provide tumor size and location within the excised tissue, which influence size and position of BioZorb device to be implanted.
Figure 4: Sizing
Selecting the appropriate size device is important as it identifies the tumor excision site for a variety of purposes, including radiotherapy and follow-up. When sized appropriately, the device should help communicate the size and location of the excised tumor, as opposed to simply filling the void created by the excision cavity. Also, when sized properly, the implant should not be palpable, and the use of a sizer set to assess the size and shape of the cavity (4A-C), is an important maneuver to help ensure selection of the appropriate size. If the sizer set is inserted and there is a paucity of overlying tissue, a smaller size should be used, or implantation should be avoided.

Figure 5: Device Placement
It is important to use meticulous sterile technique throughout the procedure. The appropriate size device is selected and removed from the packaging (5A). The device is secured to the cavity walls via bioabsorbable monofilament suture, such as PDS (5B) or Monocryl. In many cases it is advantageous to drive the suture into the tissue (e.g. pectoralis) prior to bringing the device into position within the cavity (5C). The overall stiffness and rigidity of the BioZorb structure permits the suture to be firmly secured at a variety of locations (typically 3 to 4) without risk of device deformation or suture detachment during placement. This approach eliminates the risk for significant rotation or migration of the device postoperatively.

Figure 6: Mobilization of Local Tissue Flaps
These figures illustrate a variety of ways the BioZorb device can be secured within the surrounding tumor bed margins using OPS. Important factors include the size of the breast, quality of the tissue (fatty replaced vs. glandular), skin laxity, tumor size, location and the extent of surgical dissection.

The device may be sutured posteriorly to the deep margin (e.g. pectoralis major muscle or glandular tissue). Alternatively, breast tissue can be sutured underneath the device (6A). Next, local glandular flaps can be mobilized to reside within the interior of the device (6B), over the device (6C), or the flaps may completely engulf the device (i.e. underneath, through, over and around the device - see Figure 7B). Thus, in spite of flap mobilization and cavity closure, the site of tumor resection (and the tissue at highest risk for recurrence) remains well identified for subsequent therapy and follow up, via the 3-D array of marker clips attached to the implanted device. In most cases, it is best if the long axis of the implanted device resides parallel to the chest wall.
Figure 7: Oncoplastic Partial Breast Reconstruction
The 3-dimensional bioabsorbable marker functions well as an aid for integrating OPS as a means of partial breast reconstruction. The device helps decrease the effects of tissue loss secondary to tumor removal by providing a trellis type framework for suturing local tissue flaps, while delineating the site of tumor removal. Figure 7A shows flaps being mobilized and sutured to the device, while Figure 7B shows the device after positioning of tissue underneath, through and over the device.

Figure 8: Complex Layered Closure
For most oncoplastic partial breast reconstructions, closure is performed in a complex multi-layered fashion and begins as illustrated above with suturing the deep glandular tissue flaps to the 3-dimensional device, as previously shown in Figure 7. This is followed by closure of the superficial glandular tissue over the device (8A), then closure of the subcutaneous fatty tissue deep to the skin (8B), followed by closure of the deep dermis. Finally, a running subcuticular suture is placed to approximate the skin edges (8C).
Results
In this group of 65 patients, surgical placement of the BioZorb implant provided 3-D characterization of the target surgical area, and was easily visible with clinical imaging such as CT, mammography, etc. No device related complications were reported, and overall aesthetic outcomes were excellent. During radiation treatments, respiratory motion was easily tracked using the device making it possible to use IMRT and accelerated protocols. Use of the marker resulted in reduced treatment volumes by an average of 50% when compared to standard methods. In appropriate patients when the marker facilitated an accelerated protocol, total treatment time was decreased to 5-7 days.

Figure 9: Radiation Therapy Imaging
Figures 9A & 9B illustrate the ease in visualizing the marker clips of the 3-D device on post-op CT. By clearly delineating the extent of the tumor excision site, the implant has been reported to assist with the planning, positioning and delivery of radiation therapy.\(^1\) In contrast, current methods can be ambiguous and unreliable,\(^2,3\) as can be seen above with seroma-based techniques (9C) or with the placement of a surgical clip (9D). The device has been reported to be particularly helpful for boost targeting\(^4\) when there is typically minimal or no remaining visible seroma at the time of boost.

Figure 10: Mammography
Although the spiral material of the device is not seen on mammography, the marker clips of the device clearly delineate the tumor resection site, identifying the location at greatest risk for cancer recurrence (10A,B).

Figure 11: Aesthetic Results
These results are typical of those seen in this series of 65 patients, with preservation of breast size, shape, contour and tissue consistency as seen from frontal (11A) and 3/4 (11B) views of the breast after surgery and radiation. Of note is the absence of nipple migration that may often be encountered due to scar contracture near the nipple region.
Conclusions
The 3-D marker was readily incorporated into standard and oncoplastic surgical practice, was consistently visualized without difficulty, and had appreciable benefits when designing optimal radiation treatment plans. Its unique features were helpful in all cases, but particularly useful when using oncoplastic techniques to reconstruct the breast with local tissue flaps. By employing oncoplastic maneuvers such as those described above, in conjunction with implantation of this device, excellent postoperative results can be achieved.

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Breast surgeon Gail Lebovic serves as Chief Medical Officer for Focal Therapeutics, Aliso Viejo, CA.

References

