

Nerve Preservation and Allografting for Sensory Innervation Following Immediate Implant Breast Reconstruction

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Summary: While newer breast reconstruction approaches utilizing nipple-sparing mastectomy (NSM) techniques and immediate reconstruction can provide excellent aesthetic outcomes, absent postoperative sensation remains a major limitation. Here, we present a novel technique for implant reconstruction combining the latest advances in breast oncologic, reconstructive, and peripheral nerve surgery to improve sensory outcomes. Sixteen women (31 breasts) underwent NSM and prepectoral, direct-to-implant reconstruction. During NSM, careful dissection was performed along the lateral aspect of the breast to preserve any visible intercostal nerves. When nerves could be preserved without compromising oncologic safety, they were left intact within the subcutaneous tissue of the lateral mastectomy skin flap. Nipple/areolar complex (NAC) neurotization was also performed utilizing allograft coapted from transected T₄ or T₅ lateral intercostal nerves to subareolar nerves identified at the completion of the mastectomy. Of the 12 women (23 breasts) with at least 3 months' follow-up, NAC 2-point discrimination was preserved in 20 breasts (87%), was worse in 2 breasts (9%), and had actually improved in 1 breast (4%). All patients had intact sensation to light touch throughout the majority of, if not their entire, reconstructed breasts. None of the women developed dysesthesias or neuromas. Nerve grafting in conjunction with careful nerve preservation at the time of NSM and implant-based breast reconstruction is safe and effective with a 90% rate of preserved sensation. With longer follow-up, continued return of sensation or possibly improved sensation from baseline can be reasonably anticipated. (*Plast Reconstr Surg Glob Open* 2019;7:e2332; doi: 10.1097/GOX.0000000000002332; Published online 24 July 2019.)

INTRODUCTION

Breast reconstruction techniques have evolved steadily over the past several decades transitioning from the Halstead radical mastectomy to the nipple-sparing mastectomy (NSM) techniques used today.^{1,2} With these advances have come improved aesthetics and less invasive reconstructive approaches. However, one of the remaining challenges has been the loss of breast sensation following

mastectomy and reconstruction, with many authors reporting suboptimal patient-reported outcomes following these procedures.^{3,4} Sensory recovery following NSM remains poorly understood, with authors reporting postoperative rates of skin flap or nipple sensation ranging from 0% to 47%.^{2,5,6} Concomitantly, there have been tremendous advancements in nerve reconstruction, specifically techniques employing nerve allografts to bridge large nerve gaps, with success rates approaching those of autograft.^{7,8} As a proof of concept/pilot study, we present a consecutive series of patients who underwent nerve preservation and cadaveric nerve grafting at the time of NSM and implant-based reconstruction, a novel procedure combining the latest advances in oncologic, breast reconstruction, and peripheral nerve surgery.

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Fig. 1. Right breast incision and pocket following NSM with internal view demonstrating a preserved T₄ intercostal heading laterally into the subcutaneous space to innervate the lateral skin flap.

MATERIALS AND METHODS

Sixteen women (31 breasts) underwent NSM followed by immediate, direct-to-implant, prepectoral implant reconstruction. During the same procedure, we also performed neurotization of the nipple/areolar complex (NAC) utilizing nerve allograft. NSM and reconstruction were performed by a single plastic surgeon also formally trained in breast surgical oncology (A.W.P.), while nerve dissection and grafting were performed by a single plastic surgeon also formally trained in peripheral nerve surgery (Z.M.P.). Static 2-point discrimination was measured preoperatively in all 4 areolar quadrants and the nipple using a Diskriminator (Sensory Management Services, LLC, Baltimore, Md.).

During NSM, lateral dissection was carefully performed to identify and preserve the fourth and/or fifth intercostal nerves whenever possible at the thoracic cage (Fig. 1). The largest of these nerves was dissected into the breast parenchyma until it branched. Gentle traction was then applied to the nerve within the parenchyma and the resulting area of puckering seen on the external areola was marked. The intercostal nerve was then sharply transected at maximal length (SDCI; see figure, **Supplemental Digital Content 1**, which displays the left breast incision and pocket following NSM, external view (A), and demonstrating a transected T₅ intercostal nerve with good preserved nerve length (B) and a dissected subareolar nerve (C) to which coaptation will be performed, <http://links.lww.com/PRSGO/B142>).

Standard NSM with removal of all visible breast and ductal tissue was then completed, with care to dissect under the NAC sharply, without electrocautery, to minimize thermal damage to neurovascular structures. Once the mastectomy specimen was removed, the area under the NAC was carefully dissected to isolate subareolar neural structures corresponding to the previously marked site, often found adjacent to small vessels. A portion of the presumed distal neural target was excised during one of our early cases and sent for pathological evaluation using

S-100 to identify neural elements, which were confirmed histologically (Fig. 2).

Nerve reconstruction was then begun utilizing a 1–2 × 70 mm Avance nerve allograft (Axogen, Jacksonville, Fla.). Connector-assisted coaptation of the allograft to the proximal nerve end was performed using 8-0 or 9-0 epineurial sutures. Standard prepectoral reconstruction with silicone gel implants and anterior implant coverage with acellular dermal matrix (ADM; Alloderm—Allergan, Irvine, Calif.) was finalized. With the implant in place, distal nerve coaptation to the previously identified subareolar nerve was performed as previously noted, carefully laying the allograft directly over the ADM. The allograft was left at its full length of 7 cm in all but 2 patients, where it could be trimmed to 6 cm and still have a tension-free repair. Postoperatively, 2-point discrimination of the NAC was re-measured at 3 months and 6 months and sensation to light touch was assessed by physical examination throughout the entire reconstructed breast. In addition, patient satisfaction with the sensation of the breast skin and nipple/areola were recorded.

RESULTS

Of the 16 women included in the study, 12 (23 breasts) have had at least 3 months of follow-up, 6 of whom have had over 6 months follow-up. In the patients with at least 3 months follow-up, NAC 2-point discrimination was found to be preserved compared with preoperative values in 20 breasts (87%), was worse in 2 breasts (9%), and had actually improved in 1 breast (4%). All patients reported intact sensation to gross, light touch throughout the majority of, if not their entire, reconstructed breasts. All patients reported good satisfaction with their sensory outcomes, with 8 patients (67%) reporting similar overall preoperative and postoperative breast and NAC sensation. No women developed dysesthesia or other symptoms concerning for neuromas.

DISCUSSION

Providing women with reliable sensation following mastectomy remains a final hurdle for breast reconstruction and one that has is important for overall satisfaction with reconstruction outcomes.^{9–13} Although aesthetic advances made possible with NSM and prepectoral, direct-to-implant breast reconstruction are beneficial, addressing postoperative sensation is essential to truly allow women to feel like themselves postoperatively (Fig. 3). In this study, we demonstrate the feasibility, efficacy, and consistency of a mastectomy/reconstructive approach that allows for both breast and NAC sensory preservation and restoration. Although some studies report NAC sensation in up to 47% of patients undergoing NSM without nerve reconstruction,² the metrics used to define sensation in these studies were not consistent and a combination of implant-based and varied autologous reconstructive techniques are described.¹⁴ Other analyses of implant-only reconstructions have been hampered by heterogeneity in the type of mastectomy performed and outcomes measures used.¹⁵ Although a

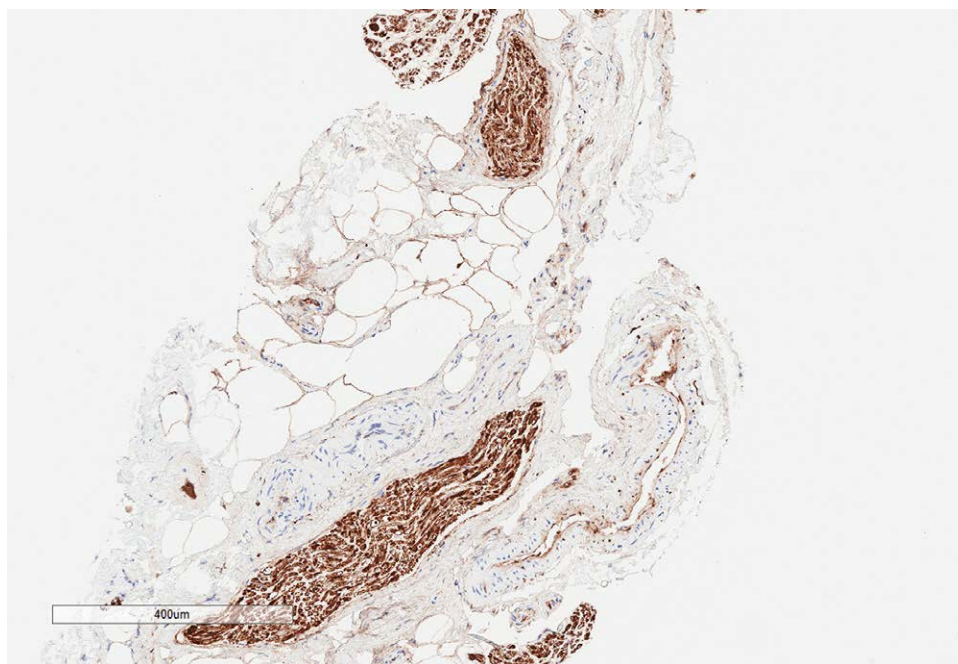


Fig. 2. S-100 staining of the distal neural target in patient #3. The presence of neural elements is clearly evident thus demonstrating a defined, distal target for sensory restoration.

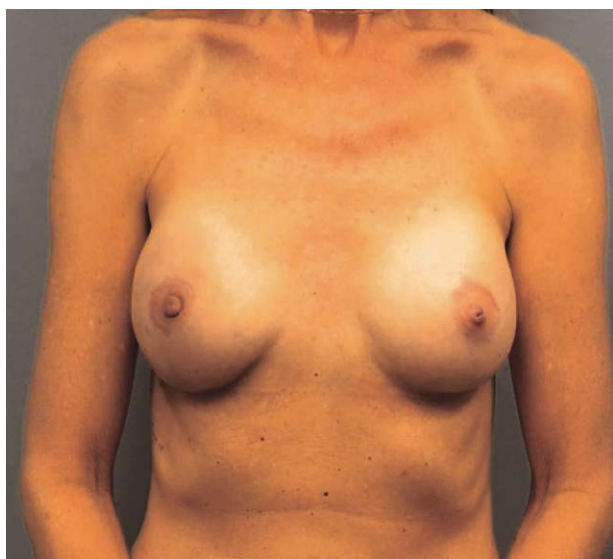


Fig. 3. A 55-year-old woman following sensation-preserving right NSM and implant reconstruction in addition to contralateral augmentation.

direct comparison between studies is not possible given the different metrics and patient populations, a much larger percentage (over 90%) of the patients in our study reported good sensation in both their breast skin envelope and NAC.

As a proof of concept/pilot study, this study is limited by the small sample size, lack of a control group, and the relatively short-term follow-up in some patients. Moreover, patient satisfaction data were recorded retrospectively only and not evaluated with a validated patient-reported

outcomes tool. As we move forward incorporating this procedure more widely into our breast reconstruction practice, we have already begun a more formal evaluation addressing these deficiencies. For sensation, we will measure NAC and skin sensation pre- and postoperatively with the AcroVal, a more quantitative assessment tool. More frequent measurements of both skin and NAC sensation in the early postoperative period will also help differentiate the contribution of nerve preservation versus nerve grafting.¹⁶ Finally, we will assess patient-reported sensation and satisfaction outcomes using relevant sections of the BREAST-Q.¹⁷

SUMMARY

This study introduces the concept of nerve preservation and grafting for sensory innervation following immediate implant breast reconstruction as a viable option for patients. We believe that with time and further technical refinements, it could become the gold standard in implant-based breast reconstruction surgery.

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