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ORIGINAL ARTICLE
Gender-Affirming Surgery

Targeted Nipple Areola Complex Reinnervation in Gender-affirming Double Incision Mastectomy with Free Nipple Grafting

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Background: Restoration of breast sensation has become an important goal in autologous and implant-based breast reconstruction after cancer-related mastectomy. Although gender-affirming mastectomy with free nipple grafting (FNG) results in similar sensory deficits, chest reinnervation concepts have not been applied to this procedure.
Methods: This article describes a novel technique to reinnervate the FNG in patients undergoing double incision gender mastectomy.
Results: Our technique differs from previously described reinnervation techniques in several aspects: (1) the donor axon count is maximized by preserving the third to fifth lateral cutaneous nerves for coaptation to the nipple areola complex, (2) the reinnervation approach varies and is based on patient anatomy, (3) the distal graft or donor nerve is split into fascicles to increase the reinnervation zone, and (4) the split fascicles are coapted to the dermatosensory peripheral nerve elements of the dermis.
Conclusion: Chest reinnervation is technically feasible in patients undergoing double incision gender mastectomy with FNG (please also see the video abstract).
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INTRODUCTION

According to the U.S. Transgender Survey Report, masculinizing chest reconstruction is the most commonly performed procedure in patients transitioning from a woman to man.[1] The vast majority of respondents (97%) had either undergone (36%) or wanted to undergo (61%) gender-affirming chest surgery. Only 3% of respondents were not interested in surgery of the chest. Given the importance of chest recontouring in the transgender population, plastic surgeons should continue to critically evaluate and advance current techniques to improve surgical outcomes. During the standard mastectomy approach, the intercostal nerves supplying the nipple areola complex (NAC) and breast skin are removed, resulting in loss of sensation and risk of neuropathic pain.[2,3] Multiple studies have shown that the loss of sensation after cancer-related mastectomy results in significant morbidity for female and male patients.[4–6] Therefore, restoration of breast sensation has become an important goal in autologous and implant-based breast reconstruction.[7] With the advent of advanced peripheral nerve reconstruction techniques including nerve transfer and nerve grafting with allograft, it has become possible to reinnervate the NAC and breast skin after mastectomy. Several authors have described surgical techniques for autologous and implant reconstruction after cancer mastectomy with promising results.[8–10]

The concept of breast reinnervation has also been introduced in transgender patients undergoing nipple-sparing mastectomy.[11,12] Rochlin et al described nerve preservation with direct coaptation to the NAC with encouraging results.[11] Treated patients experienced significant improvement of sensation in the nipple, areola, and peripheral chest skin when compared with control ($P < 0.01$). Preoperative and postoperative sensation was comparable in treated patients.

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Although this technique is a good option in patients with small breasts, nipple preservation may not be possible in transgender patients with larger breasts. For these individuals, double incision mastectomy with free nipple grafting (FNG) is the most common procedure for chest masculinization. In fact, this technique has been reported to be the most common gender-affirming mastectomy technique overall (40%–53%).[13,14] Therefore, we feel that there is a need to provide options for chest reinnervation to patients undergoing mastectomy with FNG. This article describes a novel technique to reinnervate the FNG in patients undergoing gender-affirming double incision mastectomy with FNG.

Takeaways

Question: Double incision mastectomy with free nipple grafting (FNG) is the most common procedure for chest masculinization. Although restoration of breast sensation has been an important goal in cancer reconstruction, the same concepts have not been applied to this procedure.

Findings: This article describes the feasibility of a novel technique to reinnervate the NAC in patients undergoing gender-affirming double incision mastectomy with FNG.

Meaning: This technique maximizes axon count at the target site and increases the reinnervation zone.

SURGICAL TECHNIQUE

An incision is made around 1 cm above the inferior mammary fold crease and carried down to the pectoralis fascia. The breast tissue is lifted off the pectoralis muscle fascia from medial to lateral until the lateral pectoral border is evident. At the lateral border of the pectoralis muscle, careful dissection is performed under loupe magnification to identify the lateral cutaneous branches of the third to fifth intercostal nerves.[15] In our experience, every patient has at least two, more often three or more lateral intercostal cutaneous branches with good diameter that can be preserved prior to resection of the lateral breast tissue (Fig. 1A, B). The lateral cutaneous branches are dissected as far distal as possible to gain length. Sometimes, the nerve branches can be followed up to the skin level (Fig. 1C). Lateral superficial branches that travel to the skin should be preserved if possible, without compromising removal of breast tissue. The lateral cutaneous nerve branches are transected distally. Importantly, the blood supply to the nerves is preserved, and the vessels are not stripped of the nerves.

The final chest reinnervation technique used should be chosen based on the patient anatomy and will differ from one patient to the next. Depending on the number and length of nerve branches, different approaches can be taken to reinnervate the FNG:

1. In some cases, at least one donor nerve reaches the NAC. If donor nerve can reach the NAC under no tension, no nerve allograft is required. In most cases, the FNG is placed in a masculine position near the lateral border of pectoralis major muscle, reducing the required donor nerve length when compared with a female NAC position (Fig. 2). If there are multiple donor nerves available and only one can reach the NAC, the others can be combined into an allograft.
2. The most common scenario is that the donor nerves do not reach the NAC and a short allograft is needed. Depending on the length of donor nerves, different approaches can be taken to reach the NAC:
   a. When there are two to three lateral cutaneous nerve branches that are similar in length, all branches can be combined distally and coapted to the allograft in an end-to-end fashion (Fig. 3A).
   b. If there is a length discrepancy between donor nerves and the nerves are in close proximity to each other, the allograft can be split into fascicles proximally and each nerve can be coapted in an end-to-end fashion (Fig. 3B, C).
   c. Further, if there is discrepancy in length between the donor nerve branches, and the distance between nerves is too great to make an end-to-end coaptation to a nerve allograft work, an end-to-side coaptation between the donor nerves can be performed (Fig. 3D).

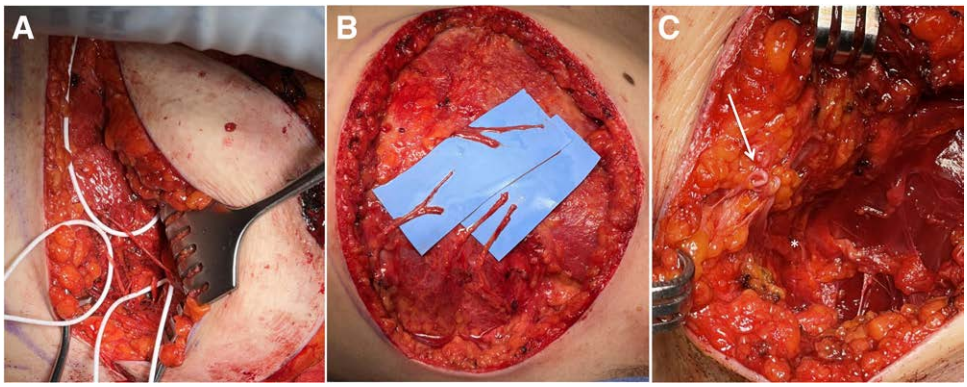

Fig. 1. Lateral cutaneous nerve dissection. The lateral cutaneous branches of the intercostal nerves are identified at the lateral border of the pectoralis major muscle (A) and transected distally (B). Sometimes, the nerve branches can be followed up to the skin level (white arrow) (C). Lateral superficial branches that travel to the skin should be preserved if possible, without compromising removal of breast tissue.

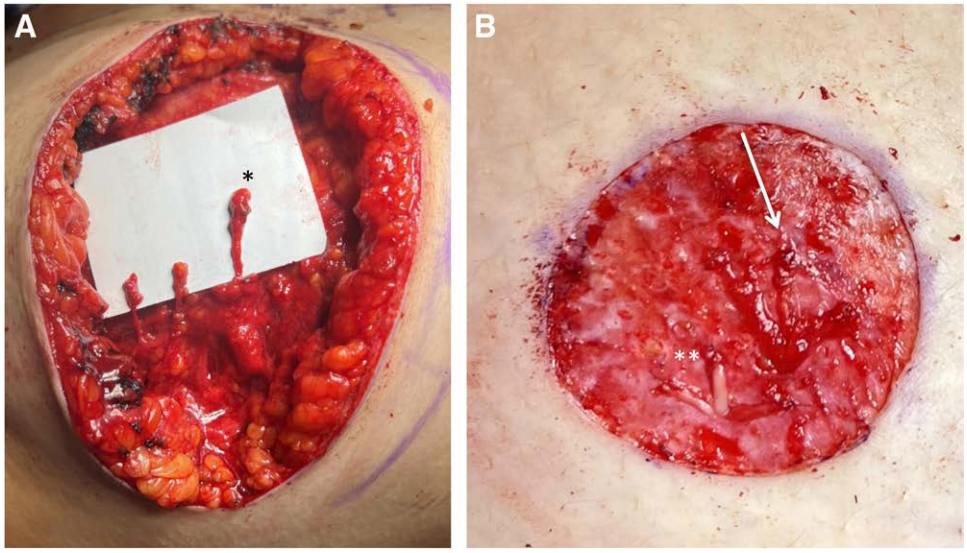

Fig. 2. Direct coaptation of the donor nerve to the NAC. The fifth intercostal nerve marked with "*" was able to reach the NAC under no tension. The donor nerve was split into its fascicles and laid onto the dermis. The other nerves were coapted to a short allograft (1.5 cm), which was passed through the NAC (marked with "**").

In most cases, a short (around 2.5 cm) allograft is necessary to reach the FNG through the superior skin flap under no tension. The superior skin flap adds 0.5–1 cm of nerve length required, depending on the amount of subcutaneous fat present. In our experience, the best allograft diameter is 2–3 mm, as this graft will yield a sufficient number of fascicles and will provide a good size match at the lateral cutaneous nerve coaptation. If only two branches are present and/or the nerve branches are small, a 1–2 mm graft may be required. The disadvantage of a smaller graft is that less fascicles are available to fan out distally. We do not recommend a 3–4 mm graft, as the size match seems suboptimal at the anastomotic site even if the lateral cutaneous nerves appear large in diameter. The lateral cutaneous nerves are flatter than the allograft; so even larger diameter nerves cannot adequately match a 3–4 mm graft surface area. If a nerve graft is required, a standard epineurial nerve repair is performed between the lateral intercostal nerves and the proximal end of the nerve graft using 9.0 Nylon suture under loupe magnification. A nerve wrap can be used to take tension off the repair site and prevent axonal escape.

Distally, the nerve graft is divided into its fascicles to increase the innervation zone (Fig. 4A). The distal end of the nerve graft is passed through the de-epithelialized area where the FNG will be placed (Fig. 4B). The distal nerve endings are spread out and coapted to the dermatosensory peripheral nerve elements of the dermis (Fig. 4C, D).[9] The nipple graft is applied over the nerve graft and sutured in place.

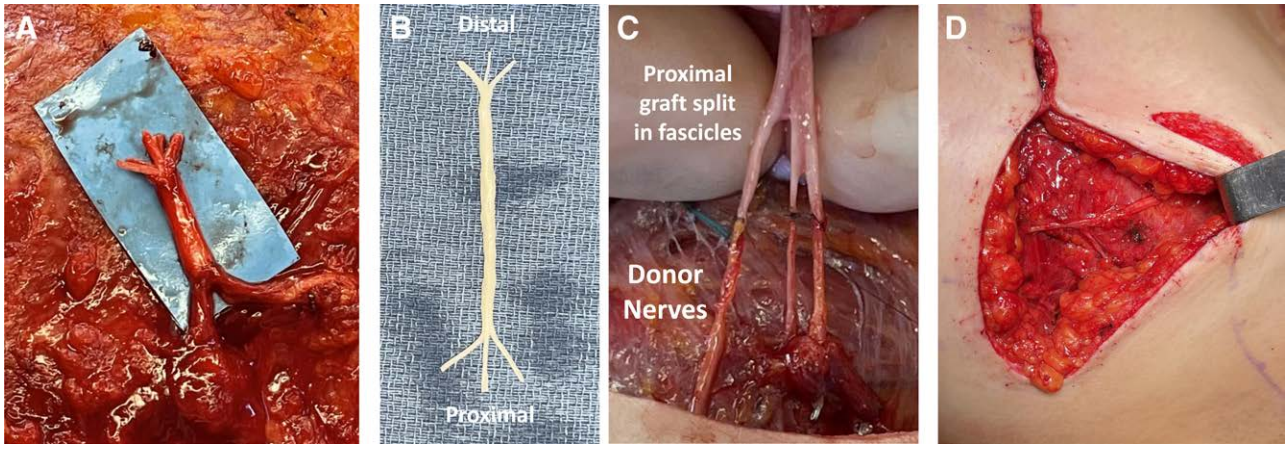

Fig. 3. Variations of nerve reconstruction with allograft. A, If there is no length discrepancy between the donor nerves, they are placed next to each other and coapted to the allograft in an end-to-end fashion. B, C, If there is a mild length discrepancy, the allograft is split into fascicles proximally and the donor nerves are anastomosed individually to the fascicles in an end-to-end fashion. D, If there is a significant length discrepancy, the shorter donor nerve is connected to a longer nerve in an end-to-side fashion, with the longest graft coapted to the allograft.

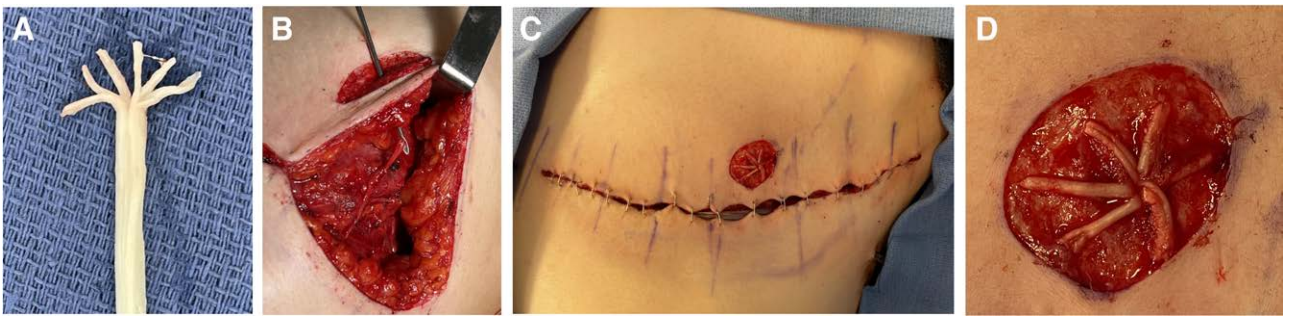

Fig. 4. Allograft distribution. The distal allograft is divided into its fascicles to increase the reinnervation zone (A). The allograft is passed through the de-epithelialized area in which the free nipple graft will be placed (B). After careful division of the fascicles, the nerve graft is distributed throughout the recipient bed of the free nipple graft to increase the reinnervation zone (C, D).

DISCUSSION

Gender-affirming double incision mastectomy with FNG is the most common procedure performed for chest masculinization in the transgender population.[1] Chest reinnervation to restore sensation of the FNG has not been described for this procedure. Our study provides a description of technique for nerve preservation and nerve transfer with or without nerve graft to connect the lateral cutaneous intercostal nerves to the FNG to preserve sensation. The goal of this study was to show feasibility of chest reinnervation in this population. Outcomes will be presented after the appropriate follow-up period. At three months, most patients regain sensation including erogenous sensation in some patients.

Our technique differs from previously described chest reinnervation techniques in several aspects. First, we elect to preserve and transfer multiple lateral cutaneous nerves, rather than preserving a single nerve. We know from the peripheral nerve literature that donor axon count correlates with restoration of function and sensation after nerve transfer.[16,17] There is a high likelihood that this principle is also true for donor nerves in the context of chest reinnervation. Therefore, by increasing the axon count, we believe that the likelihood of meaningful sensory return is enhanced. Further, by addressing the proximal nerve stump of nerves that are routinely transected during mastectomy, the likelihood of chronic pain is decreased. Chronic pain has been reported in 20%–68% of post-cancer mastectomy patients.[18] Given the technical similarities between cancer and gender-affirming mastectomy, chronic pain is also relevant in the transgender mastectomy population. Although further research is required, one retrospective study discussed that 27.4% of patients report persistent pain after gender mastectomy.[19]

Further, the distal nerve graft end is split into fascicles, rather than being placed on the dermis as one unit. When grafts are placed as a single unit, all axons converge in one small area, which may result in focal hypersensitivity. Spreading out fascicles may increase the reinnervation zone and prevent hypersensitivity of the target skin. With a large number of fascicles entering the nerve graft, a sufficient number of axons should reach each fascicle and the final target.

In addition, depending on the nerve anatomy, different approaches are taken to reinnervate the NAC. We are firm believers that there is no approach that fits all patients as anatomy differs significantly.

Lastly, the distal nerve graft end is coapted to the dermatosensory peripheral nerve elements of the dermis.[21] A recent study demonstrated that transected nerve ends innervate the dermis without coaptation to a distal nerve stump.[20] Therefore, the human lateral cutaneous donor nerve axons should innervate the dermis of the FNG.

In summary, the techniques outlined in this study follows general principles of nerve reconstruction that may expand the reinnervation zone and improve sensation in patients undergoing double incision mastectomy with FNG. (**See Video [online]**, which displays the publication *Increasing the Reinnervation Zone in Gender Affirming Double Incision Mastectomy with Free Nipple Grafting*.)

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