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CASE REPORT
Breast

Intraoperative Fluorescence Imaging to Identify and Preserve the Fifth Anterior Intercostal Sensory Nerves during Inferior Pedicle Reduction Mammoplasty

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Summary: Postoperative sensitivity of the nipple–areola complex (NAC) is an important concern for women after reduction mammoplasty. Previous studies have demonstrated that sensory branches of the fifth anterior intercostal nerve are important for innervating the NAC and that using an inferior pedicle technique is associated with improved sensory retention. The significance of this case report is that it demonstrates the importance of the fifth anterior intercostal sensory nerve branches using a prototype fluorescent imaging camera. The benefit of this device is that it can detect intraoperative auto-fluorescence of nerves and facilitate their identification and preservation, potentially facilitating the retention of sensation in the NAC and surrounding skin. The goals of this article are, therefore, to demonstrate the importance of this neurovascular pedicle when the inferior pedicle technique is used for breast reduction; and to provide demonstrative evidence of the nerve's presence within the fifth anterior intercostal artery perforator pedicle. The case involved a woman with mammary hypertrophy who underwent bilateral reduction mammoplasty using the inferior pedicle technique. Full NAC sensation was demonstrated on postoperative day 3 with complete sensory recovery at 1- and 3-month follow-up confirmed. To our knowledge, this is the first reported instance of the fifth intercostal nerve being visualized during aesthetic breast surgery, demonstrating the importance of this neurovascular bundle for sensory preservation when an inferior pedicle reduction mammaplasty technique is used. *(Plast Reconstr Surg Glob Open 2024; 12:e5699; doi: 10.1097/GOX.0000000000005699; Published online 28 March 2024.)*

Reduction mammoplasty is one of the most commonly performed plastic surgery procedures. Many operative techniques have been described to reduce breast size and relieve breast hypertrophy symptoms. Traditionally, breast shape, scar length, and complication rates have been the focus of surgeons. A more recent surgical objective has been preserving sensation of the nipple–areola complex (NAC). After reduction mammaplasty, sensation loss may be due to anatomical variations, pedicle selection, and intraoperative injury to sensory nerves.

Recent anatomical and clinical studies have demonstrated the importance of the fifth anterior intercostal (AIC) artery and nerve in preserving NAC viability and sensation.[1,2] We describe a patient who underwent bilateral reduction mammaplasty using the inferior pedicle technique in whom the fifth AIC sensory branches were clearly visualized using a prototype fluorescence imaging camera.

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CASE PRESENTATION

A 52-year-old woman with breast hypertrophy underwent bilateral reduction mammaplasty using the inferior pedicle technique and an inverted T skin incision pattern (Fig. 1). We decided to use the inferior pedicle technique, given the extent of breast hypertrophy and the need to elevate the NAC more than 6 cm. Preoperative tactile and thermal sensory testing was performed to assess baseline sensation. The inferior pedicle was dissected using surgical scissors rather than via electrocautery to minimize the risk of iatrogenic nerve injury (Fig. 2). Nerve dissection

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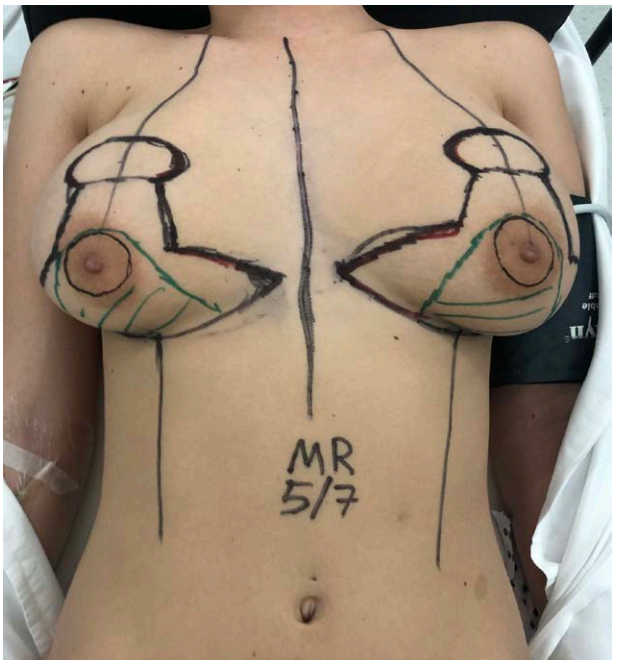

Fig. 1. Preoperative marking using a Wise pattern.

Fig. 2. Resection of the breast with preservation of the inferior pedicle.

of the artery and nerve is demonstrated in Video 1. [**See Video 1 (online),** which displays surgical dissection of the fifth intercostal artery and nerve is demonstrated under standard operating room light. Note that though the fifth intercostal artery is visible in white light, the fifth intercostal nerve is not.]

Note that, in routine operating room light, the artery, but not the nerve, was visible. However, when the fluorescence imaging camera (Dendrite; Axon Imaging Technologies, Germany) was used, sensory branches of the fifth AIC nerve clearly fluoresced throughout their length. [**See Video 2 (online),** which displays surgical dissection of the AIC artery perforator neurovascular pedicle. The fifth AIC nerve branch is visualized both under standard operating room light (top panel) and using the near-ultraviolet (NUV) fluorescence camera (bottom panel). Note that, as in Video 1, the nerve branch is not visible in standard operating room light, but clearly visible in NUV light. The nerve's fluorescence was due to auto-fluorescence, as no dye was used.]

Postoperatively, the patient experienced no complications. At 72-hour follow-up, she reported full sensation throughout both breasts. Formal sensory testing at both 1- and 3-month follow-up revealed full cutaneous and nipple areolar sensation, including two-point, fine-touch, and thermal discrimination.

DISCUSSION

Reduction mammaplasty remains the most effective treatment for breast hypertrophy. However, sensory loss of the NAC remains problematic. Recent cadaveric studies have demonstrated that NAC innervation is more complex than previously described.[1,3,4] Several authors have demonstrated that reduction mammaplasty performed using an inferior pedicle technique enhanced retention of NAC sensation over superior-pedicle techniques.[5–7] This can be explained based on the known neural pathways responsible for innervating the female breast and NAC. The intercostal nerves emanating from the second to sixth interspaces account for primary innervation of the breast.[3] Innervation of the NAC is derived from the third to fifth intercostal nerves, the principal nerve arising from the anterior and lateral divisions of the fourth intercostal nerve. Anatomical studies have further demonstrated that the anterior division of the fourth intercostal nerve traverses superficially toward the medial border of the NAC; meanwhile, the lateral division of the fourth intercostal nerve traverses within the pectoral fascia and gland before innervating the NAC.[3] The third and fourth intercostal nerves are typically injured with glandular excision. However, though usually injured with superior, superomedial, and central mound techniques, the fifth AIC nerve is usually preserved with the inferior-pedicle technique.[3] Terminal branches of these nerves can also be injured when the size of the areola is reduced, which is a likely explanation for the decreased postoperative sensitivity of the medial and superior portions of the NAC.

Clinical studies of women undergoing reduction mammaplasty using various pedicle techniques have focused on postoperative sensitivity of the NAC. Schlenz et al[5] prospectively compared five reduction mammaplasty

techniques: the inferior pole resected in two and preserved in three. They found that, with reduction mammoplasty techniques that preserved the inferior pole of the breast, more women retained NAC sensation. Their recommendations were to avoid excising breast tissue inferiorly and medially to avoid injuring NAC innervation. This phenomenon was also reported by Schreiber et al, who compared sensory outcomes after reduction mammoplasty with a medial versus inferior pedicle.[7] Although NAC sensation was preserved using either of these pedicle techniques, the sensory thresholds for the nipple were lower following the inferior- (1.47–4.47) versus medial-pedicle approach (5.36–13.34), confirming higher innervation density within inferiorly-based pedicles. Areolar sensation also was preserved using either pedicle; however, the sensory thresholds again were lower for the inferior technique (4.87–14.79 versus 8.29–22.99). From an anatomical perspective, this can be indirectly attributed to preserving the fifth AIC nerve with the inferior approach.

Iatrogenic nerve injury is always a risk during reduction mammaplasty. One obstacle to preventing iatrogenic injury to sensory nerves is that they are generally smaller than motor nerves; hence, they are more difficult to visualize and avoid.[8] Furthermore, iatrogenic nerve injury may occur not just by sectioning a nerve, but by stretching, crushing, tying off, or thermally damaging it, and such damage can lead not only to lost or altered sensation, but to potentially chronic and severe neurogenic pain.[9]

Intraoperative fluorescence imaging is increasingly being used during different surgical procedures to identify anatomical structures.[2] The camera we used has an excitation filter and dichroic mirror that directs light within the NUV spectrum, with wavelengths from 385 to 500 nm to excite tissues within the surgical field. Simultaneously, an optical/emission filter filters light emitted from excited tissues with wavelengths of approximately 490 nm and directs this emitted light onto a readily-visible display screen, where images of nerve tissue seem bluish-green and can be captured using ImageJ software (ImageJ.net, USA). In this patient, this prototype camera was used specifically to help identify the fifth AIC sensory nerve. Although it was used in a patient undergoing surgery involving an inferiorly-based pedicle, it can also be used during breast surgery involving any pedicle orientation.

During the procedure, the specific wavelength emitted by the imaging system caused nerves in the surgical field to auto-fluoresce.[10] This auto-fluorescence can help surgeons visualize and differentiate targeted nerves from surrounding tissues, aiding in their preservation.[2,10] By identifying and avoiding injury to the fifth AIC sensory nerve, this might specifically contribute to improved patient-reported outcomes following aesthetic breast surgery.

CONCLUSION

In this article, we have demonstrated that preserving NAC sensitivity after reduction mammaplasty is possible, and introduced the potential of a novel neural imaging system to delineate neural anatomy during breast surgery.

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DISCLOSURES

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