BREAST SENSITIZATION TECHNIQUES IN MASTECTOMIES WITH AN IMPLANT-BASED RECONSTRUCTION: A SYSTEMATIC REVIEW

J. EL-TARABOULSI, D. LEFF, P. THIRUCHELVAM

Imperial College Healthcare NHS Trust

INTRODUCTION

- **Implant-based breast reconstructions** are the **most common** oncoplastic breast reconstruction globally.
- Patients undergoing nipple-sparing mastectomies (NSM) or skin-sparing mastectomies (SSM) frequently experience **significant**, or **total loss** of breast and nipple-areolar complex (NAC) **sensation** and breast pain.
- These are predictors of **poor post-operative psychosocial and sexual wellbeing.**
- Novel surgical techniques to preserve sensation or neurotize the breast have been proposed, however their ease of implementation, reproducibility and efficacy remains investigated.

OBJECTIVES

- To **systematically review** the current literature on surgical techniques for sensation preservation or neurotization in mastectomies with implant-based reconstructions.
- To guide **clinical implementation** of neurotization techniques.
- To identify **areas of future research** in this field.

METHODOLOGY

- A **systematic review** was completed using PRISMA guidance across **PubMed, the Cochrane Library and Google Scholar**, utilizing a keyword-based advanced search, external search articles were included as well.
- Eligibility criteria: Open-access, English-language literature published between January 2000 and June 2025 on implant-based reconstructions offering a sensation preservation or neurotization technique conducted on human subjects, where the primary aim of surgery is to prevent/excise breast cancer.
- Articles were screened for eligibility using their titles and abstracts by a single reviewer.

RESULTS

- 139 articles were screened, **6** articles included.
- **174** female patients included across studies, of which **85** underwent a mastecomy with an implant-based reconstruction and a sensation preservation/neurotization technique.
- Mean age: **44.5 years**
- Mean BMI: **23.5**
- **Sensitization techniques identified:**
  1. Intercostal nerve preservation + nerve autografting.
  2. Intercostal nerve preservation + nerve allografting.
  3. Muscle reinnervation.

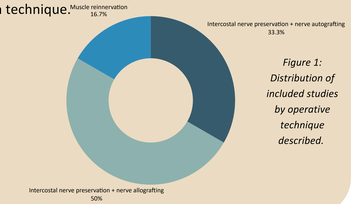


Figure 1: Distribution of included studies by operative technique described.

INTERCOSTAL NERVE PRESERVATION + NERVE AUTOGRAFTING

Operative Technique:

- Identify the lateral cutaneous branches of the intercostal nerve and dissect proximal to the inferior aspect of the rib, until bifurcation of main intercostal nerve is located.[1]
- Dissect the pectoralis major to explore the medial part of the intercostal nerve.[1]
- Use a main intercostal nerve (typically 4th intercostal nerve) as an autograft, to elongate the proximal lateral cutaneous stump, aiming to achieve 20 to 25cm of length from the proximal nerve's tip → distal graft's tip.[1, 2]
- Place the graft in an antegrade manner, with its branches sporuting and reinnervating the NAC and mastecomy flap.[1]

Outcomes:

- Chang et al., 2024: Neurotized breast has significant superior sensory results than the non-neurotized control. [1]
- Shyu et al., 2025: The inervated group scored higher than the non-innervated group in both subjective measures of patient satisfaction, and objective measures of sensation. [2]

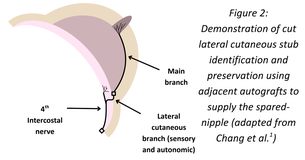


Figure 2: Demonstration of cut lateral cutaneous stub identification and preservation using adjacent autografts to supply the spared-nipple (adapted from Chang et al.[1])

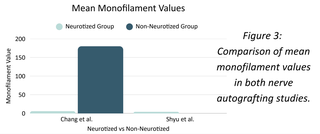


Figure 3: Comparison of mean monofilament values in both nerve autografting studies.

INTERCOSTAL NERVE PRESERVATION + NERVE ALLOGRAFTING

Operative Technique:

- Identify and dissect the dominant lateral intercostal nerve as distally as possible.[3]
- Use a nerve allograft (such as Avance) to join the intercostal nerve to the sub-areolar nerve of the NAC.[3]

Outcomes:

- Djohan et al., 2020: Utilized the antero-lateral intercostal nerve for NAC neurotization. Sensory recovery noted in both nerve-grafted and non-nerve grafted breasts 11-months post-operatively, however sensory recovery was improved in the nerve-grafted groups.[4]
  - 62.5% complication rate. 10 minutes added to total operating time.[4]
- Peled et al., 2023: No control group, however significant improvement in sensation most notable between 6 weeks and 6 months post-operatively. None of the patients reported post-mastectomy pain (incidence usually 20-50%).[3]
  - 2.5% complication rate.
- Peled et al., 2020: High rate of preserved sensation reported (87% preserved 2-point discrimination).[5]

MUSCLE REINNERVATION

Operative Technique:

- Identify and transect the intercostal nerve branches and dissect the nerve proximally.[6]
- Utilise a nerve stimulator to identify any redundant motor nerve branches that are supplying adjacent muscles (most commonly serratus anterior or adjacent intercostal muscles) then transect these branches.[6]
- Perform an end-to-end neurorrhaphy, then proceed with the intended reconstruction.[4]

Outcomes:

- O'Brien et al., 2020: Demonstrated a significant reduction in post-mastectomy pain as compared to patient's who underwent a simple mastectomy.[6]

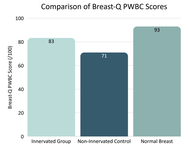


Figure 4: Comparison of Breast-Q PWBC scores following muscle reinnervation (outliers excluded), non-innervated control breasts, and patient's without a history of breast pathology.

DISCUSSION

- Demonstrated an improvement to breast and NAC sensation over time as compared to controls (when available), or literature values.
- Quality of review limited by small sample size → only 6 studies included in review, of which, 85 patients undertaking implant-based reconstructions with a reinnervation technique.
- Mixed methods of measuring sensation and different types of sensation measured across various studies. Standardizing these methods would enable direct comparison of techniques.

RECOMMENDATIONS FOR FUTURE RESEARCH

- Subgroup analysis exporing the amount of native nerve length preserved in intercostal nerve dissections, the ideal length of autograft/allograft required, optimal number of nerve coaptations, and optimal placement.
- Expansion of BREAST-Q to include nerve/sensation-related questions.
- Investigate the effects of autograft nerve neurotization on autologous free-flaps.
- Impact of chemotherapy, radiation therapy and graft length on the return of breast sensation.
- Effect of tissue expanders vs immediate implant placement on return of sensation following neurotization.

CONCLUSION

- All techniques offer promising advances in improving post-operative sensation, and reducing post-mastectomy breast pain, nonetheless, they are technically challenging, and prone to inter-operator variability.
- Small sample sizes, with younger patients, and normal BMIs, unclear whether results can be generalised to higher-risk, older patients, or patients with increased BMI.
- Techniques proposed not only improved sensation, but also associated with a significant reduction in incidence of post-mastecomy pain.[3]

REFERENCES

1. Chang, T. N. J., Lu, J. C. Y., Sung, C. W. H., Illias, A. M., Cheong, D. C. F., Kao, S. W., Kuo, W. L., Pindur, L., Chen, L. W. Y., Lin, J. A. J., Chuang, D. C. C., & Huang, J. J. (2024). Elongation of intercostal nerve cutaneous branches for breast and nipple neurotization during breast reconstruction after mastectomy for breast cancer: Case–control study. British Journal of Surgery, 111(2), Article znae005. https://academic.oup.com/bjs/article/111/2/znae005/7595494?login=false
2. Shyu, S., Chang, T. N.-J., Lu, J. C.-Y., Chen, C.-F., Cheong, D. C.-F., Kao, S.-W., Kuo, W.-L., & Huang, J.-J. (2025, May 1). Breast neurotization along with breast reconstruction after nipple-sparing mastectomy enhances quality of life and reduces denervation symptoms in patient-reported outcome: A prospective cohort study. International Journal of Surgery, 111(5), 3235-3247. https://doi.org/10.1097/JS9.0000000000002331 https://pubmed.ncbi.nlm.nih.gov/38074501/
3. Peled, A. W., von Eyben, R., & Peled, Z. M. (2023). Sensory outcomes after neurotization in nipple-sparing mastectomy and implant-based breast reconstruction. Plastic and Reconstructive Surgery – Global Open, 11(12), e5437. https://doi.org/10.1097/GOX.0000000000005437
4. Djohan, R., Scomacao, I., Knackstedt, R., Cakmakoglu, C., & Grobmyer, S. R. (2020, August). Neurotization of the nipple-areola complex during implant-based reconstruction: Evaluation of early sensation recovery. Plastic and Reconstructive Surgery, 146(2), 250-254. https://doi.org/10.1097/PRS.0000000000006976 https://pmc.ncbi.nlm.nih.gov/articles/PMC6952160/
5. Peled, Z. M., & Peled, A. W. (2019). Nerve preservation and allografting for sensory innervation following immediate implant breast reconstruction. Plastic and Reconstructive Surgery Global Open, 7(7), e2332. https://doi.org/10.1097/GOX.0000000000002332
6. O'Brien, A. L., et al. (2020). Targeted muscle reinnervation following breast surgery. Plastic and Reconstructive Surgery Global Open, 8(4), e2778. https://doi.org/10.1097/GOX.0000000000002778