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Quality of Life, Breast Sensation, and Symptoms in Unilateral DIEP Free Flap Breast Reconstruction with Direct Neurotization: A Case Series

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ABSTRACT

Background: Loss of breast sensation after mastectomy can adversely affect a patient's quality of life (QoL). Neurotization has been proposed to enhance sensory recovery following autologous breast reconstruction. However, studies reporting objective sensory outcomes and patient-reported outcome measures (PROMs) remain limited. This case series aimed to assess sensory recovery and PROMs following unilateral deep inferior epigastric perforator (DIEP) free flap breast reconstruction with direct neurotization.

Case Presentation: Four patients underwent unilateral DIEP free flap breast reconstruction with direct neurotization between February 2024 and April 2025. We performed direct end-to-end coaptation between a harvested intercostal nerve graft and the lateral cutaneous branch of the fourth intercostal nerve (LCB4). The distal end of the graft was then secured to the flap dermis. Objective sensory recovery was assessed using Semmes-Weinstein monofilament (SWM) testing across 9 breast regions. Patient-reported outcome measures (PROMs) were assessed using the Indonesian BREAST-Q Sensation Module at 0 to 6 and 6 to 12 months postoperatively. All patients demonstrated gradual objective sensory improvement. However, symptoms, sensation, and QoL trajectories varied among these individuals.

Conclusion: Sensory recovery following direct neurotization in unilateral DIEP breast reconstruction improved over time. However, objective sensory improvement did not consistently translate into improved symptoms or QoL scores. Postoperative well-being is multifactorial, underscoring the importance of integrating objective sensory testing with PROMs to comprehensively assess functional recovery.

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INTRODUCTION

Breast cancer is the most common malignancy among Indonesian women and represents a major public health burden. Although oncological care and reconstructive



services have expanded in tertiary centers, their implementation remains uncommon on a national scale. Breast reconstruction after mastectomy has traditionally focused on aesthetic restoration and symmetry. Increasing attention has shifted toward functional recovery, particularly breast sensation, because of its importance in improving a patient's quality of life (QoL). Autologous reconstruction using a deep inferior epigastric perforator (DIEP) free flap is widely adopted because of its reliable vascularity and preservation of abdominal muscle function.^{1,2} However, loss of sensation in the reconstructed breast and nipple-areolar complex is common.^{3,4}

Neurotization using nerve coaptation may enhance sensory recovery. Evidence suggests improved sensation, fewer sensory symptoms, and better patient-reported outcome measures (PROMs) compared with nonneurotized flaps.^{3,5} However, studies vary in techniques and outcomes, and few have evaluated sensation, symptoms, and QoL together in unilateral reconstruction.^{6,7} Therefore, this case series aimed to evaluate the sensory outcomes and PROMs following unilateral DIEP free flap breast reconstruction with direct neurotization.

CASE PRESENTATION

We present 4 patients who underwent unilateral DIEP free flap breast reconstruction with direct neurotization between February 2024 and April 2025 at Dr Cipto Mangunkusumo Hospital and Metropolitan Medical Center Hospital, Jakarta, Indonesia. In this study, we performed direct neurotization, which included direct end-to-end coaptation between a harvested intercostal nerve graft and the lateral cutaneous branch of the fourth intercostal nerve (LCB4). The distal end of the graft was then secured to the flap dermis (Figures 1–6).

Sensory testing was performed by the same examiner in all patients using a standardized Semmes-Weinstein monofilament (SWM) protocol across 9 predefined regions of the reconstructed breast at each follow-up visit. The same regional mapping and testing procedures were applied consistently across all time points. The contralateral breast was also assessed as an internal control for comparison (Figure 7). PROMs were evaluated using an Indonesian version of the BREAST-Q Sensation Module at 0 to 6 months and 6 to 12 months postoperatively. Domain scores were converted to Rasch-transformed (RT) scores on a 0–100 scale.

Patient Characteristics

The mean (SD) age of the patients was 44.3 (8.1) years (range, 37–56 years). All patients underwent a modified radical mastectomy (MRM); 3 patients

underwent immediate reconstruction, and 1 underwent delayed reconstruction (Table 1).

Table 1. Patient and surgical characteristics (n = 4)

Variable	Summary
Age, median (range), y	44 (37–56)
Reconstruction timing	Immediate (n = 3), delayed (n = 1)
Laterality	Unilateral
Type of mastectomy	Modified radical mastectomy (n = 4)
Flap type	DIEP free flap
Nerve coaptation	Lateral cutaneous branch of fourth intercostal nerve
Preoperative chemotherapy	Yes (n = 2), no (n = 2)
Radiotherapy	None

^aData are presented as median (range) or counts, as appropriate. DIEP, deep inferior epigastric perforator.

Sensory and symptom outcomes

Case 1 (Immediate Reconstruction): At 0 to 6 months, BREAST-Q scores were 0 for sensation, 69 for symptoms, and 59 for QoL. At 6 to 12 months, sensation remained minimal, symptom scores were unchanged, and the QoL score declined to 54. Item-level QoL scores decreased in domains related to body confidence, clothing comfort, and sexual satisfaction, despite slight objective sensory improvement (Figure 8).

Case 2 (Delayed Reconstruction): At 0 to 6 months, scores for sensation, symptoms, and QoL were 46, 56, and 68, respectively. At 6 to 12 months, sensation, symptom, and QoL scores improved to 63, 77, and 100, respectively. Semmes-Weinstein monofilament testing demonstrated recovery from absent to the orange-purple range (10–2 g), consistent with protective sensation (Figure 8).

Case 3 (Immediate Reconstruction): At 0 to 6 months, scores were 0 for sensation, 74 for symptoms, and 57 for QoL. At 6 to 12 months, sensation improved to 32 and QoL to 68, whereas symptom scores declined to 67. Item-level symptom analysis indicated reduced discomfort, pressure, and tingling, despite concurrent sensory recovery (Figure 8).

Case 4 (Immediate Reconstruction): Sensation improved substantially from 4 to 65 between follow-ups. However, symptom scores decreased from 61 to 55 and QoL from 52 to 45. Item-level analysis revealed reductions in comfort, confidence, and sexual well-being, despite objective sensory gains (Figure 8).

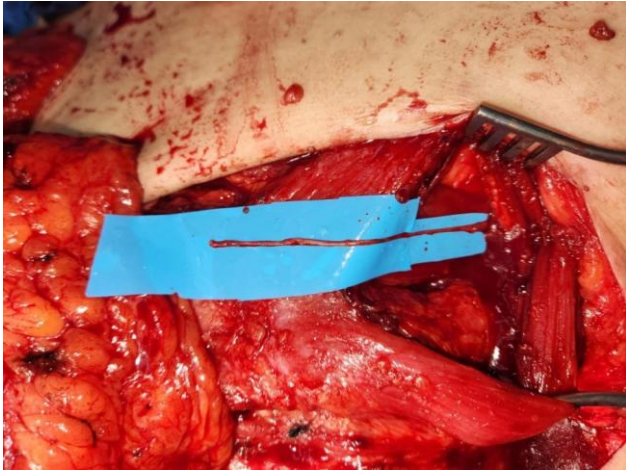


Figure 1. Identification and preservation of the lateral cutaneous branch of the fourth intercostal nerve (ICN) as a recipient nerve.



Figure 2. Intraoperative photograph showing the 19-cm length of the sensory intercostal nerve (ICN) after segmental nerve grafting

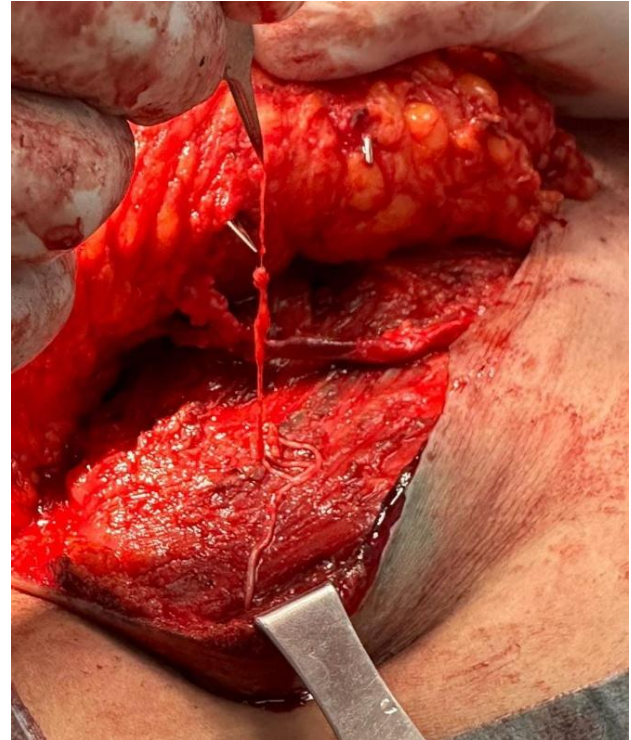


Figure 3. Nerve graft introduced to the flap skin.

Group analysis

Mean (SD) BREAST-Q sensation scores increased from 12.5 (22.4) to 40.0 (30.6) between follow-ups. Mean symptom scores increased slightly from 65 to 67, and QoL scores increased from 59 to 66.8. However, individual trajectories varied considerably. Semmes-Weinstein monofilament testing confirmed gradual sensory restoration across 7 to 9 breast regions, supporting consistent nerve regeneration over time (Figure 9). No flap losses, neuroma formation, or major complications were observed.

DISCUSSION

In this case series, a time-dependent objective sensory recovery pattern was evident, with deep pressure sensation typically returning earlier than light touch. Similar findings were reported by Shyu *et al.*^{9,10} who demonstrated improved nipple sensation, fewer denervation-related symptoms, and enhanced psychosocial and sexual well-being in innervated reconstructions. Given the small sample size, a formal correlation analysis was not performed. However, consistent with the findings of Zhang *et al.*,^{11,12} a descriptive comparison in our case series indicated a heterogeneous relationship between sensory recovery and patient-reported outcomes, with objective improvement not always corresponding to improved symptom or QoL scores.

Postoperative breast sensation is likely a multidimensional construct that cannot be fully



captured by threshold-based testing alone. While SWM testing provides quantifiable evidence of tactile recovery, it primarily measures detection thresholds and does not fully reflect how sensation is perceived or integrated into daily life. In contrast, BREAST-Q scores capture broader emotional, functional, and psychosocial dimensions. This is consistent with the psychometric framework described by Tsangaris *et al.*,¹² in which the sensation, symptoms, and QoL domains represent distinct constructs that may not change in parallel.



Figure 4. Suturing the nerve graft to the flap skin.

Another possible explanation for differing outcomes is dysesthesia occurring during nerve regeneration, manifesting as tingling, tightness, or pressure. These symptoms have been described as part of postoperative healing or nerve irritation rather than the restoration of normal light-touch sensation and may negatively influence BREAST-Q symptom scores despite improvement in objective thresholds, as observed in cases 3 and 4.¹¹ Although these phenomena are consistent with axonal regeneration and collateral sprouting, they were occasionally interpreted as discomfort rather than functional recovery. These findings suggest that early regenerative sensations may be qualitatively different from mature tactile sensations and may transiently



Figure 6. Clinical appearance at one-year follow-up after direct neurotization.

reduce patient comfort before full sensory integration occurs.



Figure 5. Immediate postoperative appearance after direct neurotization.

Beyond neurophysiological factors, psychosocial adaptation also plays a significant role.¹³ As recovery progresses, patients may become more aware of body image, bra comfort, clothing fit, and sexual well-being, all of which may influence QoL independently of sensory thresholds.⁴ Huang *et al.*¹⁰ reported that although sensory recovery contributed to well-being after DIEP free flap reconstruction, overall QoL was

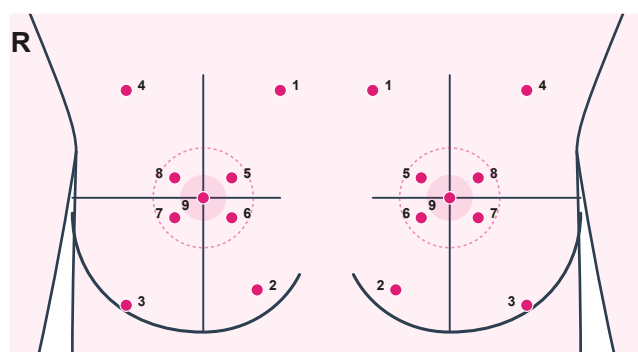


Figure 7. Nine areas assessed for sensory testing using a Semmes-Weinstein monofilament (SWM) kit.

multifactorial and could not be explained by sensation alone.

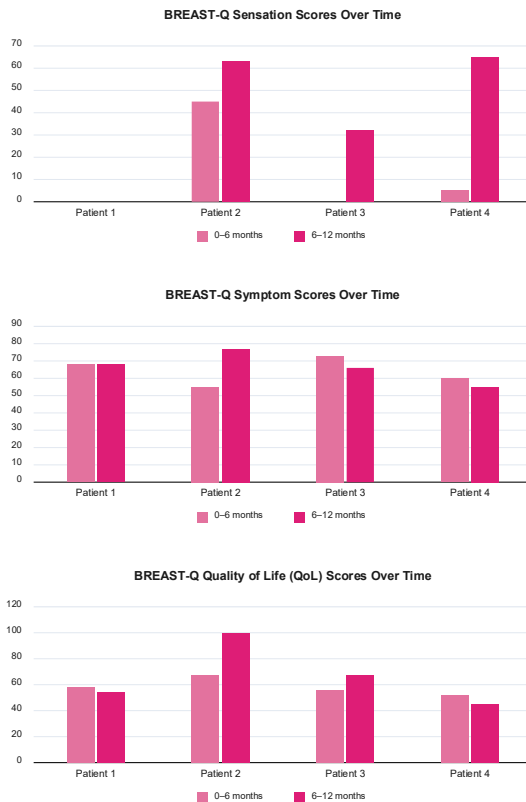
The interpretation of PROM findings may also be influenced by cultural context and instrument validity. Although the Indonesian BREAST-Q reconstruction module has undergone formal translation, back-translation, expert review, and cognitive debriefing, full psychometric validation has

not yet been completed. Ramadan *et al.*⁸ reported that a substantial proportion of BREAST-Q items required cultural adaptation, particularly those related to body image, clothing preferences, and sexual well-being. Anxiety regarding cancer recurrence, ongoing systemic therapy, fatigue, marital dynamics, and return-to-work stress may independently affect BREAST-Q scores irrespective of sensory restoration. These contextual and cultural variables, which were not formally measured in this study, may partially explain the discordance between objective testing and PROMs, thereby contributing to variability in symptom and QoL outcomes.⁸

Several limitations should be acknowledged, including a small sample size, the absence of a nonneurotized control group, a relatively short follow-up duration, and incomplete local validation of the PROM instrument. Although a 6- to 12-month follow-up period is relatively early for evaluating complete nerve graft regeneration and sensory

Case	Evaluation	Months Post-Op		Domain Sensation Change	
		0 to 6 Months	6 to 12 Months	0 to 6 Months	6 to 12 Months
1	Breast Sensation	0	0		
	Breast Symptoms	69	69		
	QoL	59	54		
2	Breast Sensation	46	63		
	Breast Symptoms	56	77		
	QoL	68	100		
3	Breast Sensation	0	32		
	Breast Symptoms	74	67		
	QoL	57	68		
4	Breast Sensation	4	65		
	Breast Symptoms	61	55		
	QoL	52	45		

Figure 8. Domain sensation changes over time following surgery in 4 cases. Sensory mapping is shown at 0 to 6 months and 6 to 12 months postoperatively. Colors indicate the minimum stimulus force required to elicit sensation: green (0.05 g, normal sensation), blue (0.2 g), purple (2 g), red (4 g), orange (10 g), and pink (300 g), with increasing force reflecting reduced sensory sensitivity.



maturation, prior evidence suggests that measurable sensory recovery after neurotization can be detected as early as 4 months postoperatively. Consistent with the findings of Djohan *et al.*,¹⁴ the present findings may therefore represent meaningful early outcomes, while recognizing that further sensory improvement may extend beyond the first postoperative year.

CONCLUSION

Direct neurotization following unilateral DIEP free flap breast reconstruction was associated with gradual objective sensory recovery over time. However, objective sensory improvements did not consistently correspond with improved patient-reported outcomes and QoL scores. These findings suggest that postoperative well-being is multifactorial and influenced not only by neurophysiological recovery but also by sensory perception, physical adaptation, and cultural factors. Combined evaluation using objective sensory measures and PROMs may therefore provide a more comprehensive assessment of recovery after breast reconstruction with direct neurotization.

REFERENCES

1. Huang A, Mackenzie EL, Cho MJ. Striving for higher levels of evidence in sensory restoration in DIEP flap

ETHICAL CONSIDERATIONS

Ethical approval for this research was obtained from the Ethics Committee of the Faculty of Medicine, Universitas Indonesia, and Metropolitan Medical Center Hospital.

DATA AVAILABILITY

Raw data were generated and stored at the Faculty of Medicine, Universitas Indonesia. The data are not publicly available to protect patient privacy.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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AI DISCLOSURE

Artificial intelligence tools were used solely for language editing and stylistic improvement

AUTHOR CONTRIBUTION

MRR: Conceptualization, Investigation, Methodology, Project administration, Validation, Writing – original draft; RD: Conceptualization, Methodology, Supervision, Validation; KB: Methodology, Resources, Supervision; FO: Resources, Supervision; NCS: Resources, Supervision; FBS: Project administration, Resources, Supervision; DAM: Project administration, Resources, Supervision; PA: Investigation, Resources; KIK: Data curation, Investigation, Project administration, Visualization, Writing – original draft, Writing – review & editing; APBS: Data curation, Formal analysis, Writing – review & editing; AJG: Data curation, Investigation, Visualization, Writing – original draft; GA: Data curation, Writing – review & editing; AAM: Data curation, Formal analysis, Visualization, Writing – review & editing; SSP: Resources, Supervision, Validation.

breast reconstruction. *Gland Surg.* 2025 Mar;14(3):268–71. doi:10.21037/gs-2024-524.



2. Djohan R, Scomacao I, Duraes EFR, Knackstedt R, Mangan R, Schwarz G. Sensory Restoration in Abdominally Based Free Flaps for Breast Reconstruction Using Nerve Allograft. *Plast Reconstr Surg*. 2023 Jan 4;151(1):25–33. doi:10.1097/PRS.0000000000009773.
3. Escandón JM, Mroueh J, Reid CM, Singh D, Sweitzer K, Ciudad P, et al. Innervated breast reconstruction: a narrative review of neurotization techniques and outcomes. *Ann Transl Med*. 2024 Aug;12(4):76–76. doi:10.21037/atm-23-504.
4. Murphy RNA, Reid AJ, Columb MO, O’Ceallaigh S, Duncan J, Holt R. Breast-Q sensory outcomes of non-neurotized, autologous, unilateral breast reconstruction with a minimum of 3-year follow-up. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. 2023 Oct;85:86–91. doi:10.1016/j.bjps.2023.06.054.
5. Shiah E, Laikhter E, Comer CD, Manstein SM, Bustos VP, Bain PA, et al. Neurotization in Innervated Breast Reconstruction: A Systematic Review of Techniques and Outcomes. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. 2022 Sep;75(9):2890–913. doi:10.1016/j.bjps.2022.06.006.
6. Beugels J, Cornelissen AJM, van Kuijk SMJ, Lataster A, Heuts EM, Piatkowski A, et al. Sensory Recovery of the Breast following Innervated and Noninnervated DIEP Flap Breast Reconstruction. *Plast Reconstr Surg*. 2019 Aug;144(2):178e–88e. doi:10.1097/PRS.0000000000005802.
7. Chang TNJ, Lu JCY, Sung CWH, Illias AM, Cheong DCF, Kao SW, et al. 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*. 2024 Jan 31;111(2). doi:10.1093/bjs/znae005.
8. Ramadan MR, Rifai DA, Atmodiwirjo P, Panigoro SS, Mukarramah DA, Sobri FB, et al. Indonesian Translation and Cultural Adaptation of the BREAST-Q Reconstruction Module. *Plast Reconstr Surg Glob Open*. 2025 Apr;13(4):e6705. doi:10.1097/GOX.0000000000006705.
9. Shyu S, Chang TNJ, Lu JCY, Chen CF, Cheong DCF, Kao SW, et al. 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*. 2025 May;111(5):3235–47. doi:10.1097/JS9.0000000000002331.
10. Huang H, Wang ML, Ellison A, Otterburn DM. Comparing Autologous to Device-Based Breast Reconstruction. *Ann Plast Surg*. 2022 May;88(3):S184–9. doi:10.1097/SAP.0000000000003073.
11. Zhang A, Huang H, Lu Wang M, Arbuiso S, Black GG, Ellison A, et al. Breast Sensation and Quality of Life. *Ann Plast Surg*. 2025 Apr;94(4S):S276–82. doi:10.1097/SAP.0000000000004258.
12. Tsangaris E, Klassen AF, Kaur MN, Voineskos S, Bordeleau L, Zhong T, et al. Development and Psychometric Validation of the BREAST-Q Sensation Module for Women Undergoing Post-Mastectomy Breast Reconstruction. *Ann Surg Oncol*. 2021 Nov 14;28(12):7842–53. doi:10.1245/s10434-021-10094-y.
13. Soares Domingues Polita B, Lapinš J, Ģilis A, Grucki M, Irmejs A, Gardovskis J, et al. Evaluation of Breast Skin/Nipple-Areolar Complex Sensation and Quality of Life after Nipple-Sparing Mastectomy Followed by Reconstruction. *Medicina (B Aires)*. 2024 Oct 9;60(10):1655. doi:10.3390/medicina60101655.
14. Djohan R, Scomacao I, Knackstedt R, Cakmakoglu C, Grobmyer SR. Neurotization of the Nipple-Areola Complex during Implant-Based Reconstruction: Evaluation of Early Sensation Recovery. *Plast Reconstr Surg*. 2020 Aug;146(2):250–4. doi:10.1097/PRS.0000000000006976.

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