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Research Article

Preservation of the Intercostobrachial Nerve during Axillary Surgery: Anatomical Considerations and Clinical Outcomes

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ABSTRACT

Background: Injury to the intercostobrachial nerve during axillary lymph-node dissection may result in numbness, paresthesia and persistent neuropathic pain. Evidence regarding nerve preservation in resource-constrained healthcare systems remains limited.

Objective: This study evaluated the anatomical patterns, feasibility and clinical outcomes of intercostobrachial nerve preservation during axillary surgery.

Methods: This prospective multicenter comparative cohort study included 132 women undergoing level I-II axillary lymph-node dissection at three tertiary-care hospitals in Pakistan. The nerve was preserved whenever technically and oncologically feasible. The primary outcomes were medial upper-arm sensory deficit and neuropathic pain at six months. Secondary outcomes included operative time, lymph-node yield, surgical complications and shoulder function. Multivariable logistic regression was performed to identify factors independently associated with sensory deficit and neuropathic pain.

Results: The nerve was preserved in 91 (68.9%) patients and divided in 41 (31.1%). A single trunk was observed in 52.3%, two branches in 34.1%, and three or more branches in 13.6%. Preservation increased the median operative time by seven minutes without reducing lymph-node yield. At six months, sensory deficit occurred in 15.4% of the preservation group and 46.3% of the division group ($p<0.001$). Neuropathic pain occurred in 9.9% and 29.3%, respectively ($p=0.004$). Preservation independently reduced sensory deficit and neuropathic pain. Complication rates were comparable.

Conclusion: Intercostobrachial nerve preservation was feasible and improved postoperative sensory outcomes without compromising axillary clearance.

Keywords: Intercostobrachial Nerve, Axillary Lymph-Node Dissection, Breast Cancer, Sensory Deficit.

INTRODUCTION

Breast cancer is the most commonly diagnosed malignancy among women worldwide and represents a major cause of cancer-related morbidity and mortality[1] .Advances in diagnosis and treatment have improved survival, making long-term functional outcomes and quality of life increasingly important.[2] Although sentinel lymph-node biopsy has reduced the need for axillary lymph-node dissection, formal dissection remains necessary in selected patients with clinically positive nodes or residual nodal disease following neoadjuvant chemotherapy.[3] Contemporary breast-cancer guidelines recommend individualized axillary management while maintaining adequate regional disease control.[4]

Axillary lymph-node dissection may be followed by pain, numbness, paresthesia, restricted shoulder movement, weakness and upper-limb lymphedema.[5] These complications may interfere with daily activities, employment, sleep and emotional well-being.[6] Upper-limb morbidity is considerably more frequent after axillary lymph-node dissection than after sentinel lymph-node biopsy.[7,8] Therefore, surgical techniques that reduce morbidity without affecting oncological clearance are clinically important.

The intercostobrachial nerve is predominantly a sensory nerve that usually arises from the lateral cutaneous branch of the second intercostal nerve.[9] It passes through the second intercostal space and crosses the axilla toward the medial and posteromedial aspects of the upper arm.[10] Its superficial location and variable course make it vulnerable during dissection of the axillary fat and lymphatic tissue.[11] Injury may result from transection, traction, compression, electrocautery or postoperative scar formation.[12]

The nerve may consist of a single trunk or divide into two or more branches within the axilla. Contributions from the first or third intercostal nerves and communications with the medial brachial cutaneous nerve may also occur.[13] These variations can make intraoperative identification and preservation difficult.[14] Division of the nerve may cause hypoesthesia, anesthesia, dysesthesia, paresthesia or burning pain involving the axilla and medial upper arm.

Recent studies have suggested that preservation reduces postoperative sensory disturbance without adversely affecting lymph-node retrieval or surgical complications.[12] However, differences in anatomical definitions, sensory assessment methods and duration of follow-up have produced variable findings. Evidence from South Asian and resource-limited healthcare systems remains particularly scarce.[14]Anatomical preservation requires careful dissection but does not require an operative microscope, nerve monitor or expensive disposable equipment.

This study evaluated the anatomical variations and feasibility of intercostobrachial nerve preservation during level I–II axillary lymph-node dissection. It also compared postoperative sensory deficit, neuropathic pain, operative outcomes and complications between patients with preserved and divided nerves.

MATERIALS AND METHODS

This prospective multicenter comparative cohort study was conducted in the breast and thoracic surgery units of three tertiary-care teaching hospitals in Pakistan, from January 2023 to December 2025. Women aged 18 years or older with histologically confirmed breast carcinoma who required unilateral level I–II axillary lymph-node dissection were enrolled through consecutive sampling.

Patients undergoing axillary clearance with either mastectomy or breast-conserving surgery were included. Patients with previous ipsilateral axillary surgery, recurrent breast cancer, pre-existing upper-limb neuropathy, brachial plexus disease, direct tumor involvement preventing safe nerve separation or inability to complete follow-up were excluded.

The sample size was calculated to detect an approximately 25% difference in six-month sensory deficit between patients with preserved and divided nerves. A power of 80%, a 5% significance level and an allowance for loss to follow-up were used. The final sample consisted of 132 patients.

Approval was obtained from the institutional ethics committees of the participating hospitals before commencement of the study. Written informed consent was obtained from every participant. Patient identities remained confidential, and study identification numbers were used during data entry and analysis.

Operations were performed by consultant surgeons or senior surgical trainees under direct consultant supervision. After elevation of the axillary flap, the lateral border of the pectoralis major, axillary vein, thoracodorsal neurovascular bundle and long thoracic nerve were identified. The intercostobrachial nerve was sought where it emerged from the second intercostal space and crossed the axillary tissue toward the medial upper arm.

Sharp dissection and low-energy bipolar cautery were used near the nerve. Preservation was defined as visible continuity of the main trunk and all technically preservable branches at completion of the operation. The nerve was divided when it was encased by tumor, densely adherent to suspicious nodes, accidentally injured or too extensively branched to preserve without compromising axillary clearance. Complete removal of suspicious nodal tissue was given priority over nerve preservation. The surgeon documented the visible nerve origin, number of branches, relationship with the axillary vein, communication with the medial brachial cutaneous nerve and final preservation status. A single-trunk pattern was recorded when the nerve remained undivided throughout the operative field. Two-branch and multiple-branch patterns were recorded according to the greatest number of separate branches crossing the axilla.

Operative time was measured from skin incision to wound closure. The time required for nerve identification and dissection was recorded separately. Estimated blood loss, number of lymph nodes retrieved, number of positive nodes and duration of hospital stay were documented. The study variables, outcome measures and their operational definitions are presented in Table 1.

Table 1. Study variables and operational definitions

Domain	Variable	Operational definition
Exposure	Nerve preservation	Visible continuity of the main trunk and preservable branches at wound closure
Primary outcome	Sensory deficit	Reduced or absent light-touch sensation in at least one mapped nerve area
Primary outcome	Neuropathic pain	DN4 score of 4 or more in the nerve distribution
Surgical adequacy	Lymph-node yield	Total lymph nodes reported on final histopathology
Functional outcome	Shoulder restriction	Active shoulder abduction below 120° at six months
Complication	Lymphedema	Inter-arm difference of at least 2 cm or a treated clinical diagnosis

A baseline sensory examination was performed before surgery. Postoperative assessments were conducted at one week, one month, three months and six months. Light-touch sensation was examined with cotton wool over standardized points in the axilla, medial upper arm and posterior upper arm. The corresponding areas on the opposite limb were used for comparison.

Sensory deficit was defined as patient-reported and examination-confirmed reduction or absence of sensation in at least one mapped area. Neuropathic pain was assessed using the Douleur Neuropathique 4 questionnaire. A score of 4 or more was considered consistent with neuropathic pain. Pain severity was recorded on an 11-point numerical rating scale.

Shoulder abduction was measured with a goniometer. Active abduction below 120° at six months was considered clinically important restriction. Postoperative complications included seroma requiring aspiration, surgical-site infection, and hematoma requiring intervention, arm lymphedema and axillary recurrence. Lymphedema was defined as an inter-arm circumference difference of at least 2 cm at a standardized point 10 cm above the medial epicondyle or a clinical diagnosis requiring treatment. No operative microscope, nerve stimulator or specialized nerve-identification equipment was used.

Data were analyzed using SPSS version 26.0. Continuous and categorical variables were summarized appropriately and compared using parametric or non-parametric tests. Multivariable logistic regression identified factors associated with six-month sensory deficit and neuropathic pain. Adjusted odds ratios with 95% confidence intervals were reported, with $p<0.05$ considered significant.

RESULTS

A total of 141 eligible women were approached, of whom 137 consented to participate. Five patients did not complete the six-month assessment, leaving 132 patients for final analysis. The intercostobrachial nerve was preserved in 91 (68.9%) patients and divided in 41 (31.1%).

The baseline demographic and treatment characteristics of the groups were comparable. Clinically positive nodal disease and neoadjuvant chemotherapy were slightly more frequent in the division group, but the differences were not statistically significant (Table 2).

Table 2. Baseline Clinical and Treatment Characteristics

Characteristic	Preserved (n=91)	Divided (n=41)	p-value
Age, years, mean ± SD	49.0 ± 10.6	50.7 ± 11.4	0.405
BMI, kg/m², mean ± SD	26.9 ± 4.4	27.5 ± 4.9	0.481
Diabetes mellitus, n (%)	16 (17.6)	9 (22.0)	0.549

Neoadjuvant chemotherapy, n (%)	47 (51.6)	25 (61.0)	0.318
Clinically node-positive disease, n (%)	56 (61.5)	30 (73.2)	0.194
Mastectomy, n (%)	71 (78.0)	34 (82.9)	0.521
Postoperative radiotherapy, n (%)	64 (70.3)	31 (75.6)	0.531

A single nerve trunk was the most frequent anatomical pattern. Two branches were identified in approximately one-third of patients, while three or more branches were observed in 13.6%. Preservation was most successful with a single trunk and least successful when three or more branches were present (Table 3).

The nerve was divided because of gross nodal adherence or encasement in 20 patients, complex multiple branching in 10, accidental traction or thermal injury in six and inadequate visualization in five.

Table 3. Intraoperative Anatomical Patterns and Preservation

Anatomical feature	Total, n (%)	Preserved, n/N (%)	Divided, n/N (%)
Single trunk	69 (52.3)	58/69 (84.1)	11/69 (15.9)
Two branches	45 (34.1)	27/45 (60.0)	18/45 (40.0)
Three or more branches	18 (13.6)	6/18 (33.3)	12/18 (66.7)
Communication with medial brachial cutaneous nerve	39 (29.5)	25/39 (64.1)	14/39 (35.9)
Course within 2 cm of axillary vein	83 (62.9)	60/83 (72.3)	23/83 (27.7)

Median operative time was seven minutes longer in the preservation group. The time required specifically for nerve identification and dissection was also greater. Blood loss, lymph-node yield, number of positive nodes and hospital stay were comparable between the groups and are presented in Table 4.

Table 4. Operative and Pathological Outcomes

Outcome	Preserved (n=91)	Divided (n=41)	p-value
Operative time, minutes, median (IQR)	112 (98–128)	105 (92–121)	0.018
Nerve dissection time, minutes, median (IQR)	9 (6–12)	3 (2–5)	<0.001
Blood loss, mL, median (IQR)	120 (80–180)	130 (90–190)	0.284
Lymph nodes retrieved, mean ± SD	16.8 ± 5.2	17.3 ± 5.5	0.501
Positive lymph nodes, median (IQR)	3 (1–6)	4 (1–7)	0.220
Hospital stay, days, median (IQR)	3 (2–4)	3 (2–4)	0.731

Sensory deficit was common during the early postoperative period but decreased in both groups during follow-up. The preservation group consistently experienced fewer sensory disturbances. At six months, sensory deficit, paresthesia and neuropathic pain were significantly less frequent among patients with preserved nerves (Table 5).

The absolute reduction in six-month sensory deficit was 30.9 percentage points. Approximately four nerves therefore needed to be preserved to prevent one additional persistent sensory deficit.

Table 5. Sensory, Pain and Functional Outcomes

Outcome	Preserved (n=91)	Divided (n=41)	p-value
Sensory deficit at one week, n (%)	38 (41.8)	32 (78.0)	<0.001
Sensory deficit at three months, n (%)	21 (23.1)	22 (53.7)	<0.001
Sensory deficit at six months, n (%)	14 (15.4)	19 (46.3)	<0.001
Neuropathic pain at six months, n (%)	9 (9.9)	12 (29.3)	0.004
Pain score at six months, median (IQR)	1 (0–2)	2 (0–4)	0.002
Paresthesia at six months, n (%)	11 (12.1)	15 (36.6)	0.001
Shoulder abduction below 120°, n (%)	7 (7.7)	7 (17.1)	0.108

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Seroma requiring aspiration occurred in 16 (17.6%) patients in the preservation group and eight (19.5%) in the division group (p=0.787). Surgical-site infection occurred in five (5.5%) and three (7.3%) patients, respectively (p=0.696). Six-month lymphedema was identified in seven (7.7%) patients after preservation and five (12.2%) after division (p=0.505). No patient required repeat surgery because of inadequate axillary clearance.

After adjustment for potential confounding factors, nerve preservation remained independently associated with lower odds of sensory deficit and neuropathic pain. The presence of three or more nerve branches was independently associated with sensory deficit (Table 6).

Table 6. Multivariable Analysis of Six-Month Outcomes

Predictor	Sensory deficit aOR (95% CI)	p-value	Neuropathic pain aOR (95% CI)	p-value
Nerve preservation	0.23 (0.10–0.52)	<0.001	0.29 (0.11–0.73)	0.009
Age, per 10-year increase	1.08 (0.82–1.43)	0.574	1.12 (0.80–1.57)	0.508
Diabetes mellitus	1.56 (0.76–3.21)	0.227	1.91 (0.85–4.29)	0.117
Neoadjuvant chemotherapy	1.19 (0.65–2.17)	0.571	1.28 (0.63–2.59)	0.494
Three or more nerve branches	2.41 (1.08–5.38)	0.032	1.82 (0.73–4.54)	0.200
Postoperative radiotherapy	1.44 (0.72–2.88)	0.305	1.66 (0.73–3.77)	0.228

DISCUSSION

The present study demonstrated that intercostobrachial nerve preservation during level I–II axillary lymph-node dissection was feasible in more than two-thirds of patients and was associated with substantially better sensory outcomes. Patients with preserved nerves experienced lower frequencies of numbness, paresthesia and neuropathic pain throughout the six-month follow-up period.[15] These findings were consistent with previous clinical evidence showing that nerve preservation reduced sensory disturbance after breast-cancer surgery.[16]The difference was most evident during the early postoperative period but remained statistically and clinically important at six months. Preservation was associated with an approximately 77% reduction in the adjusted odds of sensory deficit and a 71% reduction in neuropathic pain.

Preservation increased the median operative time by only seven minutes and did not reduce the number of lymph nodes retrieved. This additional time appeared acceptable when considered against the potential long-term burden of numbness and neuropathic pain. The technique required careful anatomical dissection but did not require specialized nerve-monitoring equipment, making it suitable for resource-constrained surgical units.[17]

Anatomical variation had an important effect on preservation success. A single trunk was observed in slightly more than half of the patients, while the remaining patients had two or more branches. Preservation was achieved in 84.1% of single-trunk cases but in only 33.3% of patients with three or more branches. These findings emphasized that surgeons should anticipate more than one anatomical arrangement rather than relying on a single textbook description.[18]

The nerve was commonly located close to the axillary vein and occasionally communicated with the medial brachial cutaneous nerve. Identification near the second intercostal space followed by careful lateral tracing provided a practical approach to preservation. Nevertheless, the nerve was divided when it was encased by tumor or densely adherent to suspicious nodes because adequate oncological clearance remained the primary objective.[19]

The reduction in neuropathic pain following preservation was anatomically and physiologically plausible. Transection, traction and thermal injury can produce axonal damage, neuroma formation and abnormal sensory discharge. [20] These processes may cause burning pain, tingling, electric-shock sensations and allodynia in the axilla and medial upper arm. Persistent pain following breast surgery is multifactorial and cannot be attributed exclusively to intercostobrachial nerve injury. Younger age, higher body mass index, diabetes, preoperative pain, psychological distress, radiotherapy, extensive surgery and severe acute postoperative pain may also contribute.[21] Nerve preservation should therefore form part of a broader strategy that includes careful tissue handling, appropriate analgesia, early rehabilitation and follow-up for persistent neuropathic symptoms.

The comparable lymph-node yield suggested that nerve preservation did not interfere with adequate axillary clearance. Current breast-cancer guidelines increasingly restrict axillary dissection to patients most likely to benefit, but meticulous morbidity-reducing techniques remain important when formal dissection is required. [22] Longer follow-up is required before conclusions can be made regarding regional recurrence or long-term oncological safety.

Seroma, wound infection and lymphedema rates were comparable between the groups. Therefore, nerve preservation did not appear to increase early surgical complications. The lower frequency of pain and sensory disturbance may facilitate arm movement and participation in postoperative rehabilitation, although the difference in shoulder restriction did not reach statistical significance.[23]

The multicenter design, consecutive enrolment and inclusion of routine surgical practice strengthened the applicability of the findings to Pakistani tertiary-care hospitals. The technique was inexpensive and could be performed without additional technology, which increased its relevance to low-resource healthcare systems.

CONCLUSION

Preservation of the intercostobrachial nerve during axillary lymph-node dissection was feasible in most patients and was associated with lower frequencies of sensory deficit, paresthesia and neuropathic pain at six months. It added only a few minutes to the operation and did not reduce lymph-node yield or increase postoperative complications. Surgeons should identify the nerve systematically, recognize its branching variations and preserve it whenever technically and oncologically safe.

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