

Original Research Article

Patient and tumor characteristics in breast cancer undergoing indocyanine green-guided sentinel lymph node biopsy

Debasmita Pal¹, Adesh Kumar^{1*}, Anuj¹, Garima Vats¹, Aashish Sangwan², Aayush³

¹Department of General Surgery, K. S. Hegde Medical Academy, Nitte Deemed to be University, Mangalore, Karnataka, India

²Department of General Surgery, Shri Guru Ram Rai Institute of Medical Sciences, Dehradun, Uttarakhand, India

³Department of General Surgery, Government Medical College, Jalaun, Uttar Pradesh, India

Received: 16 September 2026

Accepted: 17 October 2026

*Correspondence:

Dr. Adesh Kumar,

E-mail: ak30062001@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Sentinel lymph node biopsy (SLNB) is the standard procedure for axillary staging in early-stage breast cancer. Conventional methods rely on radioisotopes and blue dye, which pose limitations including radiation exposure, allergic reactions, and the need for specialized nuclear medicine infrastructure. Indocyanine green (ICG) fluorescence-guided SLNB has emerged as a safe, non-radioactive alternative. This study assesses the feasibility, sentinel node yield, and tumor characteristics in patients undergoing ICG-guided SLNB at a tertiary care center in Southern India.

Methods: A retrospective review was conducted of 60 female patients with early-stage, clinically node-negative breast cancer treated between June 2024 and December 2025. All patients underwent ICG-guided SLNB using a near-infrared fluorescence camera without the addition of blue dye or radiotracer. Data collected included patient demographics, tumor location, histological subtype, receptor status (ER, HER2), and the number of sentinel lymph nodes retrieved.

Results: The mean patient age was 53 ± 9.1 years, and 63.3% had a BMI ≥ 25 kg/m². Tumors were most frequently located in the upper outer quadrant (51.7%), and invasive ductal carcinoma was the predominant histology (90%). Estrogen receptor positivity was observed in 85% of cases, and 30% were HER2-positive. A mean of 2.5 ± 1.2 sentinel lymph nodes (range 1-6) were successfully harvested using ICG alone. No adverse events related to the technique were noted.

Conclusions: ICG-guided SLNB is a feasible, safe, and resource-efficient surgical technique, particularly valuable in low-resource settings where access to nuclear medicine is limited.

Keywords: Sentinel lymph node biopsy, Indocyanine green, Breast cancer, Fluorescence imaging, Retrospective study

INTRODUCTION

Breast cancer is the most commonly diagnosed cancer among women worldwide, affecting approximately 2.3 million women and causing 670,000 deaths in 2022.¹ Female sex is the predominant risk factor, with women accounting for 99% of cases; male breast cancer remains rare (0.5-1%).¹ The global incidence of breast cancer has risen steadily, with an annual increase of 3.1% since 1980.

Risk factors include older age, obesity, alcohol use, family history, prior ionizing radiation, early menarche, late first

childbirth, tobacco use, and postmenopausal hormone therapy.¹ However, nearly half of the cases occur in women over 40 with no identifiable risk factors apart from sex and age.¹

Common clinical presentations are a painless breast lump, changes in breast size or shape, skin dimpling, nipple inversion, discharge (sometimes bloody), and axillary lymph node involvement. Metastasis may occur in the bones, liver, lungs, and brain.²

Genetic predisposition is implicated in some cases, particularly involving BRCA1, BRCA2, and PALB2 mutations.¹ Tumor assessment routinely includes estrogen receptor (ER), progesterone receptor (PR), and HER2 status to guide management with surgery, chemotherapy, hormonal therapy, and radiation.²

For axillary staging in early-stage, node-negative breast cancer, sentinel lymph node biopsy (SLNB) is standard.² Traditionally, this involves dual-agent mapping with blue dye (e.g., methylene blue) and a radioisotope (technetium-99m), but these have limitations including allergic reactions, skin necrosis, and logistical challenges.³

Indocyanine green (ICG) fluorescence imaging has emerged as a promising alternative for SLNB, offering comparable identification rates while avoiding radiation and dye-related complications.³

Screening guidelines by the United States Preventive Services Task Force recommend biennial mammography for women aged 40-74 at average risk, with ultrasound or magnetic resonance imaging (MRI) reserved for high-risk individuals or those with dense breasts.² This study assesses the feasibility, sentinel node yield, and tumor characteristics in patients undergoing ICG-guided SLNB at a tertiary care center in Southern India.

METHODS

This was a retrospective observational study conducted at Justice K. S. Hegde Charitable Hospital, NITTE (Deemed to be University), Mangalore, India, between June 2024 and December 2025.

The study was approved by the institutional ethics committee, and patient data were anonymized before analysis. The informed consent was waived by the institutional ethics committee.

Study population

A total of 60 female patients diagnosed with early-stage breast cancer were included. All participants underwent fluorescence-assisted sentinel lymph node biopsy with indocyanine green for axillary lymph node staging.

ICG injection and fluorescence imaging

ICG was reconstituted to a concentration of 2.5 mg/ml, and a total dose of 5 mg (2 ml) was administered by periareolar intradermal injection at 4 sites after induction of anaesthesia. Gentle breast massage was performed for approximately 5 minutes to facilitate lymphatic uptake.

Sentinel lymphatic drainage was subsequently visualized using a near-infrared fluorescence imaging system (Stryker SPY-PHI), and the fluorescent lymphatic pathway was followed toward the axilla to identify the sentinel lymph node.

Inclusion criteria

Female patients aged ≥ 18 years, histologically confirmed early-stage invasive breast carcinoma tumor stage (T1-T3), node status (N0), and metastasis status (M0), clinically node-negative axilla on physical examination and imaging (ultrasound), underwent ICG-guided SLNB as part of primary surgical treatment, and patients with complete clinical and pathological data available in medical records were included.

Exclusion criteria

History of prior axillary surgery or breast cancer recurrence, clinically or radiologically node-positive disease, locally advanced (T4) or metastatic breast cancer (M1), known allergy to ICG or iodine, pregnant or lactating women, and patients with incomplete or missing data on key clinical/pathological parameters were excluded.

Data collection

Patient records were reviewed to extract relevant demographic, clinical, and tumor-specific information, including. Age, body mass index (BMI), lump palpability, tumor quadrant, histological subtype, tumor (T) stage, estrogen receptor (ER) and HER2 receptor status, and number of sentinel lymph nodes retrieved intraoperatively using ICG.

Statistical analysis

Descriptive statistics were used to summarize patient demographics and tumor characteristics. Continuous variables were reported as mean $\pm$ standard deviation (SD) with ranges. Categorical variables were expressed as counts and percentages. Data analysis was performed using Microsoft Excel 2019.

RESULTS

Table 1 summarizes the demographic and tumor characteristics of 60 early-stage breast cancer patients who underwent SLNB using ICG fluorescence.

The mean age was 53 years, with 63.3% of patients having a BMI ≥ 25 . Palpable lumps were present in 48.3%. The upper outer quadrant was the most common tumor site (51.7%), consistent with typical breast anatomy.

Histopathology revealed invasive ductal carcinoma in 90% of cases; lobular and papillary subtypes accounted for 6.7% and 3.3%, respectively. Tumor staging showed 45% T1, 50% T2, and 5% T3 lesions. Estrogen receptor (ER) positivity was 85%, while 30% of tumors were HER2-positive.

A mean of 2.52 sentinel lymph nodes (range: 1-6) were harvested using ICG, aligning with prior reports on both

ICG and dual-tracer techniques. All patients remained clinically node-negative at last follow-up. Assessment of long-term oncologic outcomes was beyond the scope of this study. No ICG related adverse events are documented in the available medical records.

Table 1: Demographic and tumor characteristics of early breast cancer patients undergoing ICG-guided SLNB (n=60).

Variable	Value
Age (years)	53±9.1 (range: 34-72)
BMI (kg/m ²)	26.2±3.7 (range: 21-35)
BMI ≥25 kg/m ²	38 (63.3%)
Palpable lumps	29 (48.3%)
Tumor location (upper outer quadrant)	31 (51.7%)
Pathology	Ductal: 54 (90%); lobular: 4 (6.7%); papillary: 2 (3.3%)
T-stage	T1: 27 (45%); T2: 30 (50%); T3: 3 (5%)
ER-positive	51 (85%)
HER2-positive	18 (30%)
Mean sentinel nodes harvested	2.52±1.2 (range: 1-6)
Sentinel node identification	60/60 (100 percent)

DISCUSSION

A 2018 study found no significant differences between ICG fluorescence and the conventional radioisotope technique in sentinel lymph node (SLN) detection rates or the number of nodes excised, supporting ICG as a standalone tracer for SLNB in breast cancer.⁴ The INFLUENCE trial further confirmed that ICG alone performs comparably to combinations with blue dye or radioisotopes.³

Prospective studies have consistently reported similar findings. Sugie et al achieved a 92.7% SLN detection rate with ICG alone, retrieving an average of 2.3 nodes.⁵ Kitai et al reported over 94% detection with 2.6 nodes harvested.⁶ Murawa et al found ICG superior to blue dye (93.9% versus 86.4%), with similar node retrieval rates.⁷ Collectively, these studies support ICG as a safe, efficient, and non-radioactive alternative for SLNB.

Our study reinforces the clinical feasibility of ICG fluorescence as a standalone lymphatic mapping tracer in early-stage breast cancer. The mean SLN yield of 2.52±1.2, ER positivity of 85%, and predominant ductal histology (90%) align with both regional and international cohorts.^{2,5,6}

SLN detection rates mirror prior ICG data. Sugie et al reported a 92.7% identification rate with a mean of 2.3 nodes retrieved, while Kitai et al demonstrated a mean

yield of 2.6, comparable to dual-tracer methods.^{5,6} Sorrentino et al similarly found no significant difference between ICG and radiotracer-guided mapping.⁴ The INFLUENCE trial corroborated these findings, validating ICG's equivalence as a single-agent tracer versus combinations with blue dye or technetium.³

Beyond efficacy, ICG offers logistical and clinical advantages: it eliminates radiation exposure, avoids reliance on nuclear medicine, and reduces risks associated with blue dyes.^{4,7} These features make it particularly suitable for broader adoption, especially in resource-constrained settings.

However, our study has limitations. The retrospective design, single-center scope, and modest sample size restrict generalizability. Short follow-up precluded long-term outcome analysis, and the lack of detailed molecular profiling limits prognostic insight for HER2-positive and triple-negative subtypes.

Despite these constraints, this study provides real-world data on ICG-guided SLN biopsy in an Indian tertiary setting. Beyond clinical efficacy, the logistical and cost advantages of ICG-guided SLNB are especially relevant in LMICs. Radioisotope-based techniques require access to nuclear medicine departments, radioactive tracers, and strict regulatory compliance-resources that are frequently limited in developing countries. In contrast, ICG is readily available, avoids radiation exposure, and can be easily implemented in standard surgical workflows, expanding equitable access to guideline-concordant breast cancer care. Our findings support ICG as a reliable, safe, and feasible option. Larger prospective studies focusing on survival outcomes and patient-centered endpoints are warranted to validate and expand upon these results.

CONCLUSION

ICG fluorescence-guided SLNB is a safe, effective, and feasible method for axillary staging in early-stage breast cancer. Our findings-highlighting a consistent sentinel node yield and high identification rates-reinforce the growing evidence supporting ICG as a reliable alternative to traditional dual-tracer techniques. Larger prospective studies are needed to validate its long-term oncologic outcomes and further define its role in surgical oncology practice.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. World Health Organization. Breast cancer. 2021. Available at: <https://www.who.int/news-room/fact-sheets/detail/breast-cancer>. Accessed on 22 August 2026.

2. Rawla P. Breast Cancer. In: StatPearls. Treasure Island, FL: StatPearls Publishing. 2024. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK583819/>. Accessed on 22 August 2025.
3. Pitsinis V, Kanitkar R, Vinci A, Choong WL, Benson J. Results of a Prospective Randomized Multicenter Study Comparing Indocyanine Green (ICG) Fluorescence Combined with a Standard Tracer Versus ICG Alone for Sentinel Lymph Node Biopsy in Early Breast Cancer: The INFLUENCE Trial. *Ann Surg Oncol.* 2024;31(13):8848-55.
4. Sorrentino L, Sartani A, Pietropaolo G, Bossi D, Mazzucchelli S, Truffi M, et al. A Novel Indocyanine Green Fluorescence-Guided Video-Assisted Technique for Sentinel Node Biopsy in Breast Cancer. *World J Surg.* 2018;42(9):2815-24.
5. Sugie T, Sawada T, Tagaya N, Kinoshita T, Yamagami K, Suwa H, et al. Comparison of the indocyanine green fluorescence and blue dye methods in detection of sentinel lymph nodes in early-stage breast cancer. *Ann Surg Oncol.* 2013;20(7):2213-8.
6. Kitai T, Inomoto T, Miwa M, Shikayama T. Fluorescence navigation with indocyanine green for detecting sentinel lymph nodes in breast cancer. *Breast Cancer.* 2005;12(3):211-5.
7. Murawa D, Hirche C, Dresel S, Hünnerbein M. Sentinel lymph node biopsy in breast cancer guided by indocyanine green fluorescence. *Br J Surg.* 2014;101(4):396-401.

Cite this article as: Pal D, Kumar A, Anuj, Vats G, Sangwan A, Aayush. Patient and tumor characteristics in breast cancer undergoing indocyanine green-guided sentinel lymph node biopsy. *Int Surg J* 2026;13:2186-9.