Original Article

Evaluation of indocyanine green combined with methylene blue staining in sentinel lymph node biopsy of breast cancer

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Background: Methylene blue as tracer used in sentinel lymph node biopsy (SLNB) have low detection rate and high false negative rate. Indocyanine green (ICG) can detect the flow of subcutaneous lymphatic vessels and the position of lymph nodes dynamically. This study sought to evaluate the efficacy of ICG combined with methylene blue staining in SLNB of breast cancer.

Methods: One hundred and fifty-six early breast cancer patients treated at our hospital from July 2020 to May 2022 were enrolled in this study. SLNB was performed by ICG combined with methylene blue staining under the guidance of the fluorescent tracer navigation system FLI-10B. Standard axillary lymph node dissection (ALND) was performed in patients with sentinel lymph node (SLN) metastasis confirmed by intraoperative frozen pathology, while low ALND was performed in patients with negative SLNs. According to the staining condition, the SLNs were divided into: (I) the combined group (SLNs with methylene blue staining and/or ICG luminescence); (II) the methylene blue group (SLNs with methylene blue staining alone); and (III) the ICG group (SLNs with ICG luminescence alone). The detection rate, accuracy, sensitivity, and false negative rate of SLNB were compared among the 3 groups.

Results: A total of 592 SLNs were detected in the combined group (average 3.8 SLNs), yielding a detection rate of 97.4%; the accuracy, sensitivity, and false negative rates were 97.4%, 92.7%, and 7.3%. In the methylene blue group, 390 SLNs were detected (average 2.5 SLNs), yielding a detection rate of 84.6%; the accuracy, sensitivity, and false negative rates were 83.3%, 89.1%, and 10.9%. A total of 483 SLNs were detected in the ICG group (average 3.1 SLNs), the detection rate was 92.9%; the accuracy, sensitivity and false negative rates were 91.7%, 90.9%, and 9.1%. The average number of detected SLNs, detection rate and accuracy rate in the combined group were higher than those in the methylene blue group ($P<0.05$), and the accuracy rate of the combined group was higher than that of the ICG group ($P<0.05$).

Conclusions: ICG combined with methylene blue staining is a promising and effective tracing strategy in the SLNB of breast cancer with high detection and accuracy rates.

Keywords: Breast cancer; sentinel lymph node biopsy (SLNB); indocyanine green (ICG); methylene blue; fluorescent image navigation

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Introduction

Breast cancer is one of the most common malignant tumors in women, and is the 1st most common female cancer, and the 2nd most common cause of cancer-related mortality in females worldwide (1). In recent years, the incidence of breast cancer has continued to increase gradually, especially in younger female patients (2,3). In China, the incidence of breast cancer has risen rapidly since the 1990s, and the prevalence of breast cancer among urban women has increased at a rate twice that of the world average (4).

Surgical resection is the preferred treatment for breast cancer. In the past, axillary lymph node dissection (ALND) was the standard operation for invasive breast cancer (5), but it can cause several complications, including edema, pain, numbness, and limited movement of the affected limb, which further reduces the quality of life of patients. It has been reported (6) that the metastatic rate of axillary lymph node (ALN) for stage I and II breast cancer is <30%, which suggests that >70% of early breast cancer patients are overtreated. It has been suggested that patients with negative sentinel lymph nodes (SLNs) should avoid ALND (7). Thus, sentinel lymph node biopsy (SLNB) has gradually replaced ALND as the standard procedure for early breast cancer, as it reduces the incidence of postoperative complications (8).

The success (or failure) of SLNB is closely related to the selection of the tracer. At present, methylene blue and 99mTc sulfur colloid or a combination of the two are most commonly used in clinical practice; however, both tracer agents have their advantages and disadvantages. Methylene blue is one of the most widely used tracers in SLNB. It is simple to operate, cheap and safe, but the detection rate is low (about 70–80%), and the false negative rate is high. A number of clinical trials have been performed to assess new tracer agents, such as indocyanine green (ICG), superparamagnetic iron oxide, indigo carmine, and carbon nanoparticles, among which ICG has been the most extensively studied.

To optimize the tracing strategy in SLNBs of breast cancer, this study sought to evaluate the application value of a dual-tracer method of ICG combined with methylene blue. We present the following article in accordance with the STARD reporting checklist (available at https://gs.amegroups.com/article/view/10.21037/gs-22-434/rc).

Methods

Patient enrollment

This is a retrospective study. A total of 156 female patients (aged 31–74 years, with a median age of 52 years) with breast cancer, who underwent surgery at our hospital from July 2020 to May 2022, were enrolled in this study. To be eligible for inclusion in this study, the patients had to meet the following inclusion criteria: (I) be female; (II) have pathologically confirmed breast cancer before the operation; (III) have clinical stage I and II breast cancer; (IV) have no suspicious positive lymph nodes (cN0) in the armpit; (V) have no evidence of distant metastasis (M0); and (VI) have provided informed consent for the SLN biopsy and clinical trials. Patients were excluded from the study if they met any of the following exclusion criteria: (I) had a history of SLNB or axillary surgery; (II) had ALN metastasis or distant metastasis; (III) had inflammatory breast cancer; (IV) were pregnant and lactating; and/or (V) were allergic to ICG. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by medical ethics committee of Changde First People's Hospital (No. 2022-074-01) and informed consent was taken from all the patients.

SLNB procedure

The SLNB was performed in all patients, except for patients with inflammatory breast cancer and patients with metastatic lymph nodes in the axilla that have been confirmed in clinical stage N2, by injecting methylene blue and ICG at the same time. Under the main procedure, routine disinfection and sheet laying were performed after anesthesia. Next, 1 mL of methylene blue (1%) was injected subcutaneously into the outer upper quadrant near the areola or around the tumor. After 10 min, 1 mL of ICG (0.5 mg/mL) was injected into the areola area of the affected side at multiple points (if the mass is located in the outer upper quadrant and is removed, the lymphatic drainage channel may be damaged. Thus, a small amount of methylene blue and ICG were injected subcutaneously above the incision).

After the ICG injection, a local massage was performed in the areola area for 30 s. The lymphatic drainage imaging

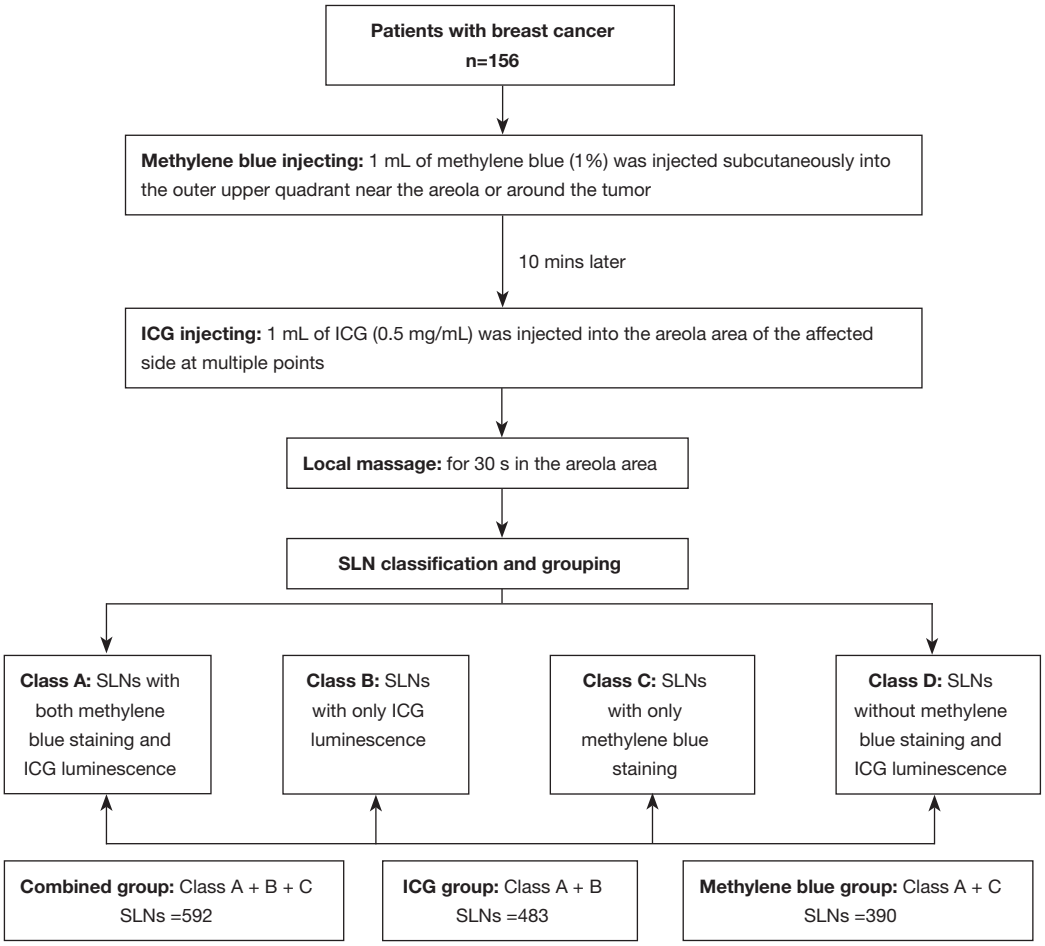

Figure 1 Procedures of the workflow. ICG, indocyanine green; SLN, sentinel lymph node.

in the outer upper quadrant of the breast on the affected side was performed with the fluorescent imaging surgical navigation system FLI-10B (Nanjing Nuoyuan Medical Devices Co., Ltd., Nanjing, China), the vanishing point of the lymphatic vessels was marked, and the skin was cut 1–2 cm from the mark to the armpit. If the lymphatic vessels were not well displayed, the conventional method was used. Under this method, the incision was made at the 2 transverse fingers under the axillary fold line at the outer edge of the pectoralis major muscle or at the tip of the axillary hair. The skin and subcutaneous tissue were cut layer by layer until the axillary fascia was exposed. The axillary region was then traced with a fluorescent probe until the "luminous" lymph nodes were traced. Finally, the lymph nodes were removed to confirm whether they are luminous. In the same way, the luminescent lymph nodes in the armpit were removed until there was no obvious fluorescence signal. At the same time, the blue-stained lymphatic vessels were traced to the blue-stained lymph nodes. If obvious swelling, fusion, or hard lymph nodes were found, they were removed together (see *Figure 1*).

SLNs with luminescence or blue staining, or neither were recorded, and were then sent for rapid frozen pathology and routine paraffin pathological examinations. Patients without SLN metastasis continued to receive low ALND (group I). Patients with SLN metastasis and double tracer failure (neither luminescence nor blue staining) immediately received standard ALND. Breast surgery including total mastectomy, breast conserving surgery, 1-stage prosthetic implantation, and latissimus dorsi breast reconstruction, was performed according to the pre-operative discussion plan.

SLN classification, grouping, and evaluation

The identified SLNs were classified as follows: Class A, SLNs with both methylene blue staining and ICG

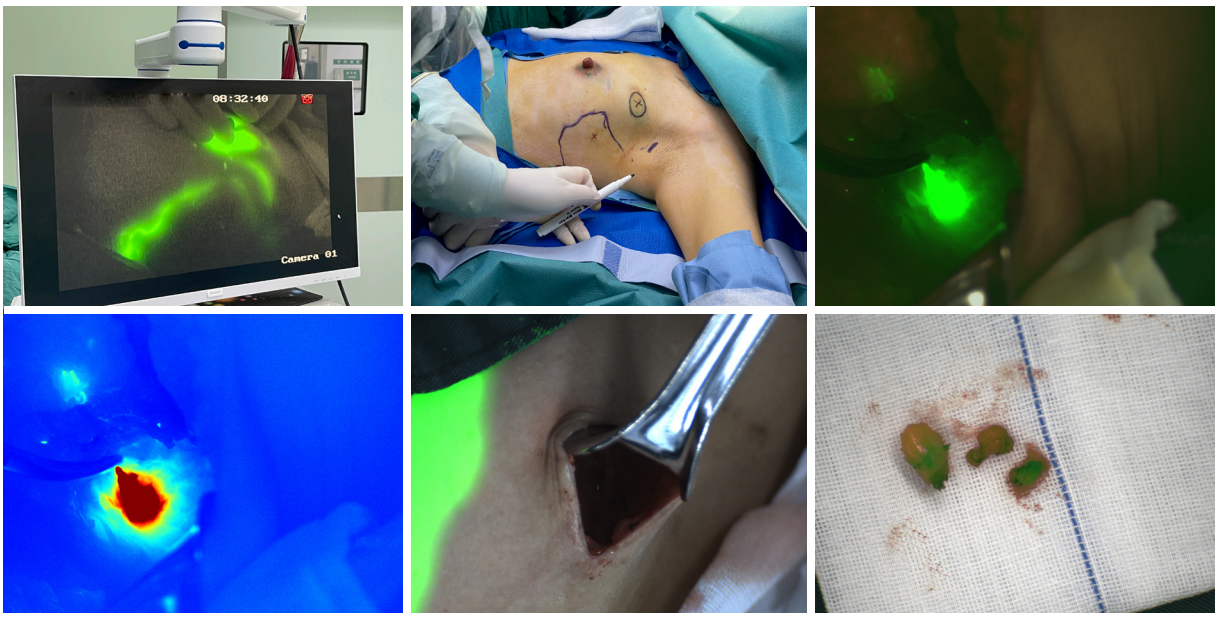

Figure 2 Lymphatic drainage imaging was used to trace lymph nodes.

luminescence; Class B, SLNs with only ICG luminescence; Class C, SLNs with only methylene blue staining; Class D, SLNs without methylene blue staining and ICG luminescence. The SLNs were divided into the following 3 groups: (I) the combined group (SLNs with methylene blue staining and/or ICG luminescence, Class A + B + C); (II) the ICG group (SLNs with ICG luminescence, Class A + B); and (III) the methylene blue group (SLNs with methylene blue staining, Class A + C).

The detection, accuracy, sensitivity, and false negative rates of the SLNs among the 3 groups were evaluated according to the SLNB evaluation criteria of Louisville University (9). The detection rate was calculated using the following formula: detection rate = the number of SLN cases/the number of biopsy cases × 100%. The accuracy rate was calculated using the following formula: accuracy = (the number of true positive cases + the number of true negative cases)/the number of total cases × 100%. The sensitivity rate was calculated using the following formula: sensitivity rate = the number of true positive cases/(the number of true positive cases + the number of false negative cases) × 100%. The false negative rate was calculated using the following formula: false negative rate = the number of false negative cases/(the number of true positive cases + the number of false negative cases) × 100%.

Statistical analysis

SPSS 16.0 software was used for the statistical analysis. The Chi-square test was used to compare differences among groups with respect to the detection, accuracy, sensitivity, and false negative rates A difference was considered statistically significant when the P value was <0.05.

Results

In this study, a total of 152 SLNBs were successfully performed in 156 patients. After ICG injection, lymphatic drainage images were developed to trace the lymph nodes in the 145 patients (see *Figure 2*). After the methylene blue injection, blue-stained lymph nodes were observed in 132 patients. ALN metastasis was found in 55 of the 156 patients, of which, there were 4 false negative patients in the combined group (false negative rate: 7.3%), 6 in the methylene blue group (false negative rate: 10.9%), and 5 in the ICG group (false negative rate: 9.1%).

In the combined group, a total of 592 SLNs were successfully detected with an average of 3.8 SLNs, and the detection rate was 97.4%, the accuracy rate was 97.4%, and the sensitivity rate was 92.7%. In the methylene blue group, a total of 390 SLNs were detected with an average of

Table 1 Efficacy of SLNBs in the combined group and the methylene blue group

Characteristic	Combined group	Methylene blue group	P
Average number of detected SLNs (total N)	3.8 (N=592)	2.5 (N=390)	0.000
Detection rate	97.4% (152/156)	84.6% (132/156)	0.000
Accurate rate	97.4% (152/156)	83.3% (130/156)	0.000
Sensitivity rate	92.7% (51/55)	89.1% (49/55)	0.507
False negative rate	7.3% (4/55)	10.9% (6/55)	0.507

SLNB, sentinel lymph node biopsy; SLN, sentinel lymph node.

Table 2 Efficacy of SLNBs in the combined group and the ICG group

Characteristic	Combined group	ICG group	P
Average number of detected SLNs (total N)	3.8 (N=592)	3.1 (N=483)	0.058
Detection rate	97.4% (152/156)	92.9% (145/156)	0.064
Accurate rate	97.4% (152/156)	91.7% (143/156)	0.025
Sensitivity rate	92.7%% (51/55)	90.9% (50/55)	0.728
False negative rate	7.3% (4/55)	9.1% (5/55)	0.728

SLNB, sentinel lymph node biopsy; ICG, indocyanine green; SLN, sentinel lymph node.

2.5 SLNs, and the detection rate was 84.6%, the accuracy rate was 83.3%, and the sensitivity rate was 89.1%. In the ICG group, a total of 483 SLNs were successfully detected with an average of 3.1 SLNs, and the detection rate was 92.9%, the accuracy rate was 91.7%, and the sensitivity rate was 90.9%. By comparison, the average number of detected SLNs, the detection rate, and the accuracy rate of the combined group were significantly higher than those of the methylene blue group ($P<0.05$). The sensitivity rate of the combined group was higher than that of the methylene blue group, and the false negative rate was lower than that of the methylene blue group, but the difference was not statistically significant ($P>0.05$). The accuracy rate of the combined group was significantly higher than that of the ICG group ($P<0.05$). The average number of detected SLNs, the detection rate, and the sensitivity rate of the combined group were higher than those of the ICG group, and the false negative rate was lower than that of the ICG group, but the differences were not statistically significant ($P>0.05$; see *Tables 1,2*).

Discussion

SLN is the 1st lymph node in a primary tumor with lymph node metastasis, and SLNB is the standard operation for the ALN staging of early breast cancer (10). The accuracy and detection rate of SLN are greatly affected by the tracer techniques (11). In the past, the most commonly used tracers in clinical SLN were blue dye and nuclide. However, the detection rate of blue dye is low, and the false negative rate is high (12). Radionuclide tracing has some practical problems, such as radiation protection, complex production, storage and application processes, and high requirements for supporting facilities (13). Thus, a convenient, safe, effective and feasible SLN tracing technique for breast cancer is urgently needed.

In recent years, fluorescence tracing technology has been developed and widely used in oncology surgery, especially in breast conserving radical mastectomy. Kitai *et al.* (14) first reported using SLNB technology with ICG-fluorescence and a near-infrared spectral imaging system and obtained a 94% SLN detection rate. Other studies (15,16) then confirmed the accuracy and safety of ICG for SLNB in breast cancer. Cumulative clinical studies have confirmed that the detection rate of ICG as a fluorescent tracer is better than that of blue dye, and does not differ to that of nuclide (17-20). Thus, ICG is expected to become a substitute for traditional tracers.

It has been reported (21) that the accuracy of SLN is improved when ICG is combined with another technology.

In several western studies, a dual-tracer strategy (which most commonly comprises methylene blue plus nuclide) has been used in SLNB for breast cancer. In the ACOSOG-Z1071 study, the false negative rate of SLNB with methylene blue plus nuclide was 10.8%, that of methylene blue alone was 22.2%, and that of nuclide alone was 20.0% (22). In the SENTINA study, the detection rate and the false negative rate of SLNB with nuclide alone were 87.8% and 16.0%, respectively, while, the detection rate and the false negative rate of SLNB with methylene blue plus nuclide were 77.4% and 8.6%, respectively (23).

The dual-tracer strategy of ICG combined with methylene blue has excellent performance in SLNB, and is superior to methylene blue alone in improving the detection rate of SLN and reducing the false negative rate (17,24-27). Few studies have been conducted to compare the SLNB efficacy between ICG combined with methylene blue and ICG alone (28,29). In this study, according to the staining condition, the SLNs were divided into the following 3 groups: (I) the combined group; (II) the methylene blue group; and (III) the ICG group. The detection, accuracy, sensitivity, and false negative rates of SLNB were analyzed and compared among the 3 groups. The results showed that the average number of detected SLNs, the detection rate, and the accuracy rate of the combined group were higher than those of the methylene blue group and the ICG group. This was largely because the combined group benefited from the advantages of the 2 tracers. ICG can clearly and real-time show the process of the drainage of the lymphatic network under the areola to the axilla, so as to help the operator to accurately locate the SLN, determine the surgical incision, and combine methylene blue staining to reduce the difficulty of SLNB. While the methylene blue group has some blindness in the process of searching sentinel lymph nodes.

Under the guidance of the fluorescent image surgical navigation system, the drainage of lymph nodes was clearly displayed. During the operation, the direction of lymphatic vessels was able to be visually observed, and the skin incision and SLN was able to be accurately located, reducing the blindness of searching for SLN. If the operation field is polluted by ICG leakage during operation, SLN can also be found along the blue-stained lymphatic vessels to improve the average number of SLNs detected and the detection rate of SLNB. Thus, there is a complementary relationship between methylene blue and ICG. However, in this study, the false negative rate of the combined group was lower than that of the methylene blue group and the ICG group, which may be related to the increase in the average number of SLN detected in the combined group.

NSABPB32 research (30,31) showed that the number of SLNs detected was inversely proportional to the false negative rate. Appropriately increasing the number of SLNs may reduce the false negative rate of SLNB, which may be one of the reasons for the low false negative rate of the combined group. The results of the current study showed that the dual-tracer strategy reduced the false negative rate. If the sample size was further expanded, positive results may be obtained. Additionally, the selected population of the combined group was exactly the same as that of the methylene blue group and the ICG group, which avoided selection bias, and yielded a highly reliable conclusion.

In this study, there were 4 patients with SLNB failure, including 1 obese patient, and 1 patient in whom the failure occurred after the resection of the external upper quadrant tumor. During the operation, ICG extravasation in lymphatic vessels occurred, polluting the operation field and leading to the formation of artifacts. SLNs could not be identified by the fluorescent image surgical navigation system, and methylene blue stained lymphatic vessels and lymph nodes were not found in the incision. The other 2 cases occurred in patients after neoadjuvant chemotherapy. No methylene blue staining or fluorescence development was found in the SLNs. It may be that chemotherapy led to the destruction of lymph node structure, fibrosis, and potential changes in lymphatic reflux pathways (32), which affected the migration and localization of the dyes, resulting in the decrease in the SLN detection rate and the increase in the false negative rate.

This study had some limitations. First, follow-up data on the patients' local recurrence rate and long-term survival benefits are missing due to the time limit. Second, the sample size is small, which may have caused a statistical bias.

In conclusion, a dual-tracer of ICG combined with methylene blue is superior to methylene blue and ICG alone in the SLNB of breast cancer, and can improve the average number of detected SLNs, the detection rate, and the accuracy rate of SLNB.

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Footnote

Reporting Checklist: The authors have completed the STARD reporting checklist. Available at https://gs.amegroups.com/article/view/10.21037/gs-22-434/rc

Data Sharing Statement: Available at https://gs.amegroups.com/article/view/10.21037/gs-22-434/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://gs.amegroups.com/article/view/10.21037/gs-22-434/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by medical ethics committee of Changde First People's Hospital (No. 2022-074-01) and informed consent was taken from all the patients.

References

1. World Cancer Report 2014. World Health Organization; 2014.
2. Bray F, Ferlay J, Soerjomataram I, et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68:394-424.
3. Chen VC, Lin KY, Tsai YH, et al. Connectome analysis of brain functional network alterations in breast cancer survivors with and without chemotherapy. PLoS One 2020;15:e0232548.
4. Chen W, Zheng R, Baade PD, et al. Cancer statistics in China, 2015. CA Cancer J Clin 2016;66:115-32.
5. Oeffinger KC, Fontham ET, Etzioni R, et al. Breast Cancer Screening for Women at Average Risk: 2015 Guideline Update From the American Cancer Society. JAMA 2015;314:1599-614.
6. Dominguez FJ, Golshan M, Black DM, et al. Sentinel node biopsy is important in mastectomy for ductal carcinoma in situ. Ann Surg Oncol 2008;15:268-73.
7. Krag DN, Anderson SJ, Julian TB, et al. Sentinel-lymph-node resection compared with conventional axillary-lymph-node dissection in clinically node-negative patients with breast cancer: overall survival findings from the NSABP B-32 randomised phase 3 trial. Lancet Oncol 2010;11:927-33.
8. Veronesi U, Viale G, Paganelli G, et al. Sentinel lymph node biopsy in breast cancer: ten-year results of a randomized controlled study. ANN SURG 2010;251:595-600.
9. Zhang B, Bai Y, Chen G. Clinical significance of sentinel lymph node biopsy in breast cancer. Zhonghua Zhong Liu Za Zhi 2000;22:395-7.
10. Moncayo VM, Aarsvold JN, Grant SF, et al. Status of sentinel lymph node for breast cancer. Semin Nucl Med 2013;43:281-93.
11. Breast Cancer Group, Oncology Branch, Chinese Medical Association. Operation guide for fluorescent tracer sentinel lymph node biopsy of breast cancer. Chinese Journal of Breast Disease (Electronic Edition) 2017;11:193-7.
12. Lyman GH, Somerfield MR, Giuliano AE. Sentinel Lymph Node Biopsy for Patients With Early-Stage Breast Cancer: 2016 American Society of Clinical Oncology Clinical Practice Guideline Update Summary. J Oncol Pract 2017;13:196-8.
13. Li J, Zhang H, Hu D. Recent Advances in the Tracer Technology Used for Sentinel Lymph Node Biopsy in Breast Cancer. Adv Breast Cancer Res 2022;11:109-19.
14. Kitai T, Inomoto T, Miwa M, et al. Fluorescence navigation with indocyanine green for detecting sentinel lymph nodes in breast cancer. Breast Cancer 2005;12:211-5.
15. Lin J, Lin LS, Chen DR, et al. Indocyanine green fluorescence method for sentinel lymph node biopsy in breast cancer. Asian J Surg 2020;43:1149-53.
16. Guo WB, Gao W, Liu JT, et al. Application of indocyanine green fluorescence navigation in sentinel lymph node biopsy for breast cancer. Chinese Journal of General Surgery 2015;24:658-62.
17. Inoue T, Nishi T, Nakano Y, et al. Axillary lymph node

recurrence after sentinel lymph node biopsy performed using a combination of indocyanine green fluorescence and the blue dye method in early breast cancer. Breast Cancer 2016;23:295-300.
18. Sugie T, Ikeda T, Kawaguchi A, et al. Sentinel lymph node biopsy using indocyanine green fluorescence in early-stage breast cancer: a meta-analysis. Int J Clin Oncol 2017;22:11-7.
19. Lu Y, Cheng G. Application value of indocyanine green fluorescence tracer in sentinel lymph node biopsy. Contemporary Medicine Forum, 2019;17:164-6.
20. Goonawardena J, Yong C, Law M. Use of indocyanine green fluorescence compared to radioisotope for sentinel lymph node biopsy in early-stage breast cancer: systematic review and meta-analysis. Am J Surg 2020;220:665-76.
21. Ahmed M, Purushotham AD, Douek M. Novel techniques for sentinel lymph node biopsy in breast cancer: a systematic review. Lancet Oncol 2014;15:e351-62.
22. Boughey JC, Suman VJ, Mittendorf EA, et al. Sentinel lymph node surgery after neoadjuvant chemotherapy in patients with node-positive breast cancer: the ACOSOG Z1071 (Alliance) clinical trial. JAMA 2013;310:1455-61.
23. Kuehn T, Bauerfeind I, Fehm T, et al. Sentinel-lymph-node biopsy in patients with breast cancer before and after neoadjuvant chemotherapy (SENTINA): a prospective, multicentre cohort study. Lancet Oncol 2013;14:609-18.
24. Cao Y, Wang S, Guo J, et al. Application of indocyanine green combined with methylene blue in sentinel lymph node biopsy of breast cancer. Chinese Journal of General Surgery 2014;29:119-22.
25. Zhang Z, Xie P, Chen J, et al. Clinical application value of indocyanine green combined with methylene blue in axillary sentinel lymph node biopsy of breast cancer. Chinese Journal of Oncology 2016;43:757-60.
26. Guo W, Zhang L, Ji J, et al. Evaluation of the benefit of using blue dye in addition to indocyanine green fluorescence for sentinel lymph node biopsy in patients with breast cancer. World J Surg Oncol 2014;12:290.
27. Jung SY, Kim SK, Kim SW, et al. Comparison of sentinel lymph node biopsy guided by the multimodal method of indocyanine green fluorescence, radioisotope, and blue dye versus the radioisotope method in breast cancer: a randomized controlled trial. Ann Surg Oncol 2014;21:1254-9.
28. Mandal P, Mishra A, Deo SVS, et al. A pilot study evaluating sentinel lymph node biopsy using dual dye technique with ICG and methylene blue for early breast carcinoma (EBC). Indian J Surg 2021:1-8.
29. Benson JR, della Rovere GQ; Axilla Management Consensus Group. Management of the axilla in women with breast cancer. Lancet Oncol 2007;8:331-48.
30. Krag D, Harlow S, Julian T. Breast cancer and the NSABP-B32 sentinel node trial. Breast Cancer 2004;11:221-4; discussion 264-6.
31. Cohen LF, Breslin TM, Kuerer HM, et al. Identification and evaluation of axillary sentinel lymph nodes in patients with breast carcinoma treated with neoadjuvant chemotherapy. Am J Surg Pathol 2000;24:1266-72.
32. Tsuyuki S, Yamaguchi A, Kawata Y, et al. Assessing the effects of neoadjuvant chemotherapy on lymphatic pathways to sentinel lymph nodes in cases of breast cancer: Usefulness of the indocyanine green-fluorescence method. Breast 2015;24:298-301.

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