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REVIEW

Omitting Sentinel Lymph Node Biopsy in Early-Stage Breast Cancer Patients

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Abstract

Purpose of Review To describe current research regarding omission of sentinel lymph node biopsy (SLNB) in breast cancer patients.

Recent Findings Results from a recent clinical trial, the SOUND trial, with results pending from trials such as NAUTILUS, INSEMA and BOOG 2013–08, suggest that the omission of SLNB in patients with T1-2 N0 invasive breast cancer is oncologically safe and has noninferior 5-year distant disease-free survival compared to those who underwent SLNB ± ALND. Best practice guidelines do recommend omitting SLNB for older patients with estrogen receptor invasive breast cancers and for most patients undergoing surgery for ductal carcinoma in situ.

Summary Axillary surgery continues to evolve over time to less surgery in the axilla for patients with both invasive and non-invasive disease. Changes in adjuvant therapy, increased use of genomic testing and axillary US have all impacted this trend.

Keywords Breast cancer · Sentinel lymph node biopsy · Axillary lymph node biopsy · Omission · De-escalation

Introduction

Sentinel lymph node biopsy (SLNB) has revolutionized the management of breast cancer by providing accurate staging information while minimizing morbidity associated with axillary lymph node dissection (ALND) [1]. Recent research has challenged the necessity of SLNB in certain patient populations, sparking debate and investigation into the practice of omitting SLNB altogether [2]. The trend towards omitting SLNB has been influenced by several factors, including the recognition of overtreatment and the desire to minimize treatment-related morbidity [3, 4]. Early studies investigating the feasibility of omitting SLNB in select patient populations demonstrated that certain clinical and pathologic factors, such as tumor size, grade, and hormone receptor status, could reliably predict the likelihood of nodal involvement. These findings paved the way for more selective approaches to axillary staging, where SLNB is reserved for patients deemed at higher risk of nodal metastasis [5]. This review provides an in-depth analysis of the historical perspective of SLNB in breast cancer, older trials exploring the omission of ALND, key studies such as the SOUND and NAUTILUS trials exploring the omission of SLNB, the role of SLNB in ductal carcinoma in situ (DCIS), and the challenges and controversies surrounding the omission of SLNB in breast cancer management.

Historical Perspective of SLNB in Breast Cancer

Axillary surgery in breast cancer reflects an evolution of surgical techniques and diagnostic approaches aimed at understanding and managing the spread of invasive breast cancer. The axillary nodes can be involved in breast cancer metastasis, making their evaluation crucial for staging and treatment decisions [6]. Fisher et al. present findings indicating that lymph node involvement served as an indicator rather than a determinant of distant metastasis, with the primary

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tumor's characteristics primarily determining the risk of distant spread. [7] However, the techniques for assessing lymph node status were limited, often relying on gross examination during surgery. A significant advancement came in the mid twentieth century with the introduction of the radical mastectomy, which involved extensive removal of breast tissue along with the axillary lymph nodes[9]. As surgical techniques evolved, efforts were made to refine the assessment of axillary lymph nodes while minimizing surgical morbidity. In the 1990s, the concept of SLNB emerged [8]. SLNB revolutionized the management of breast cancer by providing a less invasive means of assessing lymph node status, reducing the need for extensive axillary surgery in many cases. While SLNB has become the standard approach for evaluating lymph node status in early-stage breast cancer, ongoing research continues to explore ways to further refine and personalize axillary management strategies, aiming to optimize outcomes while minimizing surgical morbidity for patients [3].

NSABP B04 Trial

The National Surgical Adjuvant Breast and Bowel Project (NSABP) B-04 was a pioneering trial that evaluated the efficacy of radical mastectomy versus total mastectomy with or without radiotherapy in the treatment of patients with operable breast cancer. Patients did not undergo axillary dissection until they presented with clinically enlarged axillary nodes. This was a prospective randomized clinical trial that included 1,665 women between 1971 and 1974. After 25 years of follow up, the results continue to show no significant differences in long term outcomes between the treatment groups, even in the group that underwent delayed ALND for clinically enlarged axillary nodes. These findings demonstrate that performing upfront axillary dissection prior to clinical involvement does not impact survival. Lymph nodes are markers of disease but removal of them does not drive survival. Lymph nodes provide important information for staging and adjuvant treatment decisions but whether a patient undergoes an axillary procedure or not may not impact survival. While not specifically focused on axillary lymph node dissection omission, this trial laid the groundwork for subsequent studies by demonstrating that less extensive surgery could be equally effective [9].

Omitting ALND in Older Women

Some older clinical trials in older women with breast cancer again demonstrate that axillary surgery itself does not determine survival. Martelli et al. present long-term follow up data from a single institution, randomized controlled trial that enrolled women presenting from January 1996 to June 2000 comparing ALND versus no axillary dissection in older patients with T1N0 breast cancer. This study provides valuable insights into the optimal management of axillary lymph nodes in this specific patient population [10].

The trial enrolled older patients aged 65 to 80 years or older with clinically node-negative, early-stage breast cancer (T1N0) of 2 cm or less in mammographic diameter. All patients underwent lumpectomy. Participants were randomly assigned to undergo ALND or to receive no axillary dissection. Those assigned to undergo ALND, had all 3 levels of axillary nodes removed. All patients underwent radiation therapy and hormonal therapy post operatively, as indicated.

The primary endpoint of the study was overall survival, with secondary endpoints including disease-free survival, locoregional recurrence rates, and treatment-related morbidity. Patients in both study arms received appropriate adjuvant therapy, including breast-conservation surgery or mastectomy and adjuvant radiation therapy and/or hormonal therapy, as indicated.

After 15 years of follow up, distant metastasis rate, overall survival and breast cancer mortality in the axillary dissection and no axillary dissection groups were the same. This study also suggests that even SLNB can be avoided in this population because the 15 year crude cumulative incidence of overt axillary metastases was very low, and the data from lymph nodes is unlikely to change post operative management [10].

The International Breast Cancer Study Group conducted a trial aimed at evaluating whether refraining from axillary dissection in elderly women would lead to enhanced quality of life while maintaining comparable disease free survival and overall survival rates [11]. The primary endpoint included quality of life, reported by the patient and physician. This trial enrolled women 60 years and older with clinically node-negative operable breast cancer who were assigned to undergo SLNB + axillary dissection or SLNB alone. All patients received adjuvant Tamoxifen for 5 years. This trial showed that avoiding axillary dissection transiently improves quality of life, with the largest quality of life effects noted from baseline to the first postoperative follow up appointment. After 6 to 12 months the differences in quality of life disappeared. At a median follow up of 6.6 years, disease free survival and overall survival were similar in the SLNB + axillary dissection group and the SLNB alone group (67% vs 66% and 75% vs 73%). Axillary recurrence was observed in 2% of all enrolled patients, with 3% recurrence in the SLNB alone group and 1% recurrence in the SLNB + axillary dissection group. The study was not powered to establish treatment equivalence [11].

Newlin et al. conducted a study regarding the omission of axillary dissection and survival. The purpose of the study was to determine if women aged 70 years and older could forgo axillary dissection with the same disease-free survival

as those that do undergo axillary dissection. This study reviewed cancer databases of two large tertiary teaching hospitals and a community breast cancer center to determine if women over 70 years old with T1 breast cancer benefit from axillary dissection in terms of disease-free survival. Those undergoing ALND had no difference in survival compared to those who did have ALND [12].

The aforementioned trials all demonstrate that more extensive axillary surgery, ie axillary dissection, did not result in improved cancer outcomes, at least in older women. The axillary dissection by itself does not drive outcomes. Additionally, those who did not undergo axillary dissection had very low axillary recurrence rates at 2–3%. After these trials, the next decade witnessed the development and validation of the SLNB to replace axillary dissection. SLNB eventually migrated into the neoadjuvant setting as well and became standard of care for many patients undergoing neoadjuvant therapy. After the SLNB was validated and proven to have equivalent outcomes to axillary dissection, many investigators started trials examining whether SLNB could be omitted all together. In the next few paragraphs, we will explain recent trials that have tested whether SLNB is needed at all for patients with invasive and noninvasive disease.

Recent Clinical Trials Investigating Omission of SLNB for Invasive Breast Cancer

SOUND Trial

As seen in Table 1, the SOUND trial represents a significant milestone in the exploration of omitting SLNB in breast cancer management. This is a prospective phase 3 randomized clinical trial conducted in Italy, Switzerland, Spain and Chile that aimed to assess the safety and efficacy of omitting SLNB in patients with clinically node-negative early-stage breast cancer. This study enrolled 1,463 women of all ages between February 6, 2012 and June 30, 2017 with breast cancer less than 2 cm and a negative preoperative axillary ultrasound who were undergoing breast conservation surgery and radiation therapy. Patients with suspicious axillary lymph nodes on ultrasound required a fine needle aspiration to rule out metastatic disease. Lymph nodes with micrometastases or macrometastases were defined as positive. Enrolled patients were randomized to undergo SLNB or to omit SLNB. Of those that underwent SLNB, 13.7% had metastases to the axillary lymph nodes, representing a favorable group of participants. Patients with positive lymph nodes underwent ALND. The primary objective of

Table 1 Recent Randomized Controlled Trials of SLNB vs No SLNB

	SOUND	INSEMA
Enrollment #	1463	5505
Enrollment Year	February 2012 – June 30, 2017	September 2015 – April 2019
Location	Italy, Spain, Switzerland, Chile	Austria, Germany
Randomization Arms	1. No SLNB group 2. SLNB group (± ALND)	Randomization 1: 1. No SLNB 2. SLNB Patients with SLNB and pN + status randomized to: 1. SLNB alone 2. SLNB + completion ALND when one to three macromets on SLNB
Age	Any	18 years or older
Tumor Size	Less than 2 cm	Less than 5 cm
ER/PR Status	Any	Any
Node Status	Clinically and radiographically negative nodes	Clinically and radiographically negative nodes
Exclusions	Distant metastasis Positive axillary lymph nodes Patients undergoing neoadjuvant therapy	Distant metastasis Positive axillary lymph nodes Patients undergoing neoadjuvant therapy
Major Differences from Other Trials	Axillary US mandatory before surgery	Axillary US mandatory before surgery 2 randomizations
Primary Outcome	Distant disease-free survival (at 5 years)	Invasive disease-free survival (at 5 years)
Secondary Outcomes	Distant recurrences, axillary recurrences, disease, free survival, overall survival, quality of life, eval of type of adjuvant therapy administered (at 5 years)	Overall survival, locoregional recurrence, axillary recurrence, determination of actual applied radiotherapy, quality of life (at 5 years)
Results	Noninferior 5-year distant disease-free survival compared to those who underwent SLNB	Increased breast and arm symptoms in the SLNB group. Survival results pending ongoing 5 year follow up

the SOUND trial was to determine whether clinical nodal assessment using ultrasound, combined with physical examination, could reliably identify patients with a low risk of nodal involvement who could safely forego SLNB.

The results of the SOUND trial demonstrated that omitting SLNB in patients with breast cancer up to 2 cm and radiographically and clinically negative axillary lymph nodes did not compromise distant disease-free survival at 5 years of follow up, despite 13.7% of the patients having positive nodes in the SLNB group. The study found no significant differences in locoregional recurrence rates, distant metastasis rates, or overall survival between patients who underwent SLNB and those managed with clinical nodal assessment alone [13••].

Several caveats about the SOUND trial exist. First, all patients underwent preoperative axillary US which may not be standard practice at many centers in the United States. Second, the tumor positive node rate in the SOUND trial was only 13.7% versus 37.5% in the ALND group and 44.8% in the SLNB group in the ACOSOG Z0011 trials, 23% in the ALND group and 26% in the SLNB group in the ALMANAC trial, 30% in the AMAROS trial, and 32.3% in the ALND group and 35.5% in the SLNB group in a single institution study by Veronesi et al. [5, 13••, 14–16]. The SOUND trial enrolled a highly select patient population with low-risk early-stage disease. Third, all patients underwent radiation therapy. A noted limitation of the trial was that all available options for radiotherapy were allowed, including partial breast radiation and whole breast radiation at conventional fractionation or hypofractionated courses and it is not clear if the axilla was radiated or not. Fourth, over 30% of the patients in the SOUND trial were over 65 years old and these patients may qualify for omission of radiation therapy. Fifth, approximately 13% of tumors in the SOUND trial were either triple negative or HER2neu positive and most surgeons are performing SLNB for these tumor phenotypes. Nonetheless, the SOUND trial highlighted the potential for de-escalation in the treatment of the axilla and it remains to be seen if surgeons will integrate these findings into practice [13••].

INSEMA Trial

As demonstrated in Table 1, the INSEMA trial, investigates the efficacy and safety of limited axillary staging in clinically and radiographically node-negative early invasive breast cancer (c/iT1-2) among patients undergoing breast conservation therapy. The primary endpoint was to assess whether avoiding SLNB in early-stage breast cancer can be done without reducing disease free survival. The secondary endpoints were overall survival, local and axillary recurrence rates and determination of actual applied radiation dose at each axillary level. Quality of life was also examined.

This trial is a prospective, randomized trial that included women aged 18 years and older with early invasive breast cancer (clinically/radiologically < 5 cm; T1-2 N0) who were undergoing breast conservation therapy and post operatively whole breast radiation. 1,001 women were enrolled and randomized twice between September 2015 and June 2016. Patients were first randomized to undergo SLNB or to omit SLNB. Patients with tumor positive sentinel lymph nodes were then randomized to completion ALND or no ALND.

The results of the INSEMA trial showed that the rate of axillary recurrence is slightly increased in the no further surgery group, but this does not affect disease free survival or overall survival [17]. In terms of quality of life, there were significant differences in breast and arm symptoms with the SLNB group experiencing increased pain, arm swelling and limited mobility compared to the omission of SLNB group [18].

Current Clinical Trials Investigating Omission of SLNB for Invasive Breast Cancer

BOOG 2013–08 Trial

The BOOG 2013–08 trial, as seen in Table 2, is aimed at investigating whether SLNB can be omitted in clinically node negative T1-2 N0 breast cancer patients treated with breast conservation therapy. This is a Dutch prospective, randomized, multicenter, noninferiority trial that took place in the Netherlands and enrolled women aged 18 years and older with pathologically confirmed clinically node negative T1-2 invasive breast cancer undergoing breast conservation therapy. The patients were randomized to undergo SLNB or to omit SLNB. In the Netherlands, axillary ultrasounds are the standard of care for preoperative nodal staging in breast cancer patients and thus all patients underwent pre operative axillary ultrasound [19].

The primary endpoints of the trial will include regional recurrence after 5 and 10 years of follow up, disease free survival, overall survival, locoregional recurrence, quality of life, morbidity and cost-effectiveness and the results are pending [19].

NAUTILUS Trial

As seen in Table 2, the NAUTILUS trial is a prospective, multicenter randomized noninferiority study investigating the role of SLNB in early-stage breast cancer patients with clinically negative axillary nodes. The NAUTILUS trial was conducted in multiple centers in South Korea and was aimed at evaluating whether omitting SLNB in clinically and radiographically node negative patients is

Table 2 Current Randomized Controlled Trials of SLNB vs No SLNB

	NAUTILUS	BOOG 2013–08
Enrollment #	1734	Est. 1644
Enrollment Year	September 1, 2020- April 2022	Ongoing
Location	South Korea	Netherlands
Randomization Arms	1. No SLNB 2. SLNB (± ALND)	1. No SLNB 2. SLNB
Age	19 years or older	18 years or older
Tumor Size	Less than 5 cm	Less than 5 cm
ER/PR Status	Any	Any
Node Status	Clinically and radiographically negative nodes	Clinically and radiographically negative nodes
Exclusions	Distant metastasis Positive axillary lymph nodes Patients undergoing neoadjuvant therapy	Distant metastasis Positive axillary nodes
Major Differences from Other Trials	Axillary US mandatory before surgery	Axillary US mandatory before surgery Patients undergoing neoadjuvant chemotherapy were included as well
Primary Outcome	Invasive disease-free survival (at 5 years)	Regional recurrence (up to 10 years)
Secondary Outcomes	Overall survival, distant metastasis free survival, ipsilateral axillary recurrence rate, locoregional recurrence rate, adverse events, quality of life (at 5 years)	Distant disease-free survival, overall survival, local recurrence, contralateral breast cancer, delayed axillary treatment, adjuvant radiation, quality of life, axillary morbidity, cost effectiveness (at 5 and 10 years)
Results	5 year follow up ongoing	5 and 10 year follow up ongoing

oncologically safe in early-stage breast cancer patients undergoing breast conservation therapy.

The trial enrolled patients 19 years and older starting in September 1, 2020 with T1-2 N0 invasive breast cancer who had negative axillary nodes clinically and on axillary ultrasound, and were undergoing breast conservation therapy [20]. Participants were randomized to undergo SLNB or to omit SLNB. All patients underwent axillary ultrasound preoperatively and all patients received ipsilateral whole breast radiation post operatively.

The primary objective of the NAUTILUS trial was 5-year disease free survival. Secondary endpoints included distant recurrence rates, locoregional recurrence rates, overall survival, and treatment related morbidity. By comparing outcomes between the SLNB and omission of SLNB treatment arms, the trial aimed to determine whether omitting SLNB is non-inferior to SLNB in the right patient population in terms of locoregional control and long-term outcomes.

The results of the NAUTILUS trial will provide critical insights into the optimal management of breast cancer patients with T1-2 N0 node negative disease, informing treatment decisions and clinical practice guidelines. The trial addresses important clinical questions and has the potential to influence standard practice in axillary staging for early breast cancer. The findings of the NAUTILUS trial are eagerly awaited and are expected to have significant implications for breast cancer management worldwide [21••].

Omitting SLNB in Ductal Carcinoma In Situ (DCIS)

Surgeons continue to de-escalate axillary surgery particularly for patients with ductal carcinoma in situ (DCIS). The low likelihood of nodal involvement in DCIS raises questions about the clinical significance of detecting micro metastases or isolated tumor cells in the sentinel lymph nodes. Studies have shown that the presence of microinvasion or occult invasive disease in DCIS is rare and may not significantly impact long-term outcomes or alter treatment recommendations [22]. Per the National Comprehensive Cancer Network (NCCN) guidelines, SLNB is not recommended for the treatment of preoperative pure DCIS, unless there is suspicion of invasion or axillary metastasis. The NCCN guidelines recommend that SLNB should be considered in mastectomy or excision in a site that would compromise SLNB in the future [23]. Unlike invasive breast cancer, DCIS does not have the potential to spread beyond the ductal system and metastasize to regional lymph nodes. As a result, the utility of SLNB in DCIS management is questioned due to the extremely low risk of nodal involvement.

While SLNB is not routinely recommended for all DCIS patients, its use may be considered in certain clinical scenarios. High-grade DCIS lesions, particularly those with extensive ductal involvement or multifocality, may raise concerns about the presence of concurrent invasive disease, however this is still up for debate [24–26]. In these cases, SLNB can serve as a tool to detect occult invasive carcinoma that may

impact treatment decisions and prognosis and spare a patient another surgery. Additionally, SLNB may be considered in patients undergoing mastectomy for DCIS, where identification of nodal involvement could influence the extent of surgical management and the need for adjuvant therapy [27].

A 10-year retrospective analysis of patients with DCIS on core needle biopsy was conducted by Podoll et al. to look at the factors associated with upgrade of DCIS to invasive cancer on final pathology and SLNB metastases to evaluate whether axillary surgery can be safely omitted in DCIS. Of 1,271 cases of DCIS, 105 cases (8%) were upgraded to invasive cancer and 19 (18%) of those upgraded had positive lymph nodes. Low grade DCIS, 10 out of 105 cases (10%), was the least likely to be upgraded to invasive cancer, suggesting that SLNB may be less appropriate in these cases compared to those with high grade DCIS [28].

The SentiNot trial, a prospective, multicenter cohort study of women with DCIS sought to assess whether the use of superparamagnetic iron oxide (SPIO) could be used to perform delayed SLNB. The study took place in hospitals in Hong Kong and Sweden between 2015 and 2019. Eligible patients included women with any DCIS undergoing mastectomy, DCIS grade 2 and > 20 mm, any DCIS grade 3 and any mass forming DCIS. During surgery, patients were injected with SPIO near the tumor site and its magnetic signal was confirmed within the axilla using a probe. If the patient's surgical pathology demonstrated invasive breast cancer, a delayed SLNB was performed using dual radiotracer. The primary endpoint of the study was the proportion of patients that avoided unnecessary SLNB, and secondary endpoints included detection rates with SPIO during delayed SLNB and its concordance with Tc^{99}. Of 254 eligible patients, 78.7% avoided upfront SLND. When delayed SLNB was performed, SPIO had a higher nodal detection rate compared to Tc^{99}, with and without blue dye. The type of breast surgery was shown to account for the poor performance of Tc^{99}. Overall, the use of SPIO and delayed SLNB may help prevent unnecessary upfront axillary surgery in DCIS patients [29••].

Omitting SLNB in Older Patients with ER Positive Tumors

Based on the aforementioned older clinical trials that omitted ALND for elderly patients with invasive disease, the concept of routinely omitting SLNB for these patients has been examined but not in a prospective fashion. The Choosing Wisely guidelines from the Society of Surgical Oncology, recommends the consideration of de-escalating surgical and systemic therapy when able and advises against the routine use of SLNB in women aged 70 and above diagnosed with T1 N0 hormone receptor positive breast cancer. Axillary staging can be considered on an individual basis, but it is not routinely recommended because there are not increased rates of locoregional recurrence or impacts on mortality when SLNB is omitted [30]. A study by Carleton et al. of 2,109 older women with early-stage, hormone receptor positive breast cancer found that rates of SLNB and radiation therapy use remain high and are increasing for SLNB (1% per year between 2010 and 2018, even after the adoption of the 2016 Choosing Wisely guidelines). Rates of recurrence were 3.5% in the SLNB group and 4.5% in the group that did not undergo SLNB. Overall, this study found that undergoing SLNB or radiation therapy was not associated with improved disease free survival or locoregional recurrence free survival in older patients with early stage clinically node negative hormone receptor positive breast cancer [31]. Calderon et al. conducted a retrospective database study that examined patients undergoing breast cancer surgery from 2002 to 2017 and found that utilization of SLNB in low risk older breast cancer patients actually has decreased over time, per current Choosing Wisely guidelines, even though rates of mammography detected breast cancer have not decreased [32].

The Cancer and Leukemia Group B (CALGB) 9343 trial is a phase 3, randomized trial that enrolled 636 patients and was conducted in 2004 with the aim of examining local recurrence and survival differences in patients over 70 with hormone receptor positive, node negative invasive breast cancer that underwent radiation therapy following breast conservation therapy and those that omitted radiation therapy following breast conservation therapy. Results from the CALGB 9343 trial showed that adjuvant radiation therapy can be safely omitted in these patients as there were no survival differences between patients that underwent radiation therapy and those that did not. An important fact with this trial was that over two thirds of patients did not have any nodes removed and the omission of axillary surgery did not seem to impact patient outcomes [33, 34].

The PRIME II trial, a phase 3, randomized trial conducted from 2003 to 2009 similarly aimed to look at the effect of omission of whole breast radiation therapy on local control in 1,326 women over age 65 with low-risk T1 or T2 breast cancers that had been treated with breast conservation therapy and axillary staging. Axillary staging included four node lower axillary sample, SLNB or ALND and patients had to be node negative to be eligible for the study. After 5 years of follow up, women that underwent whole breast radiation experienced an ipsilateral breast tumor recurrence rate of 1.3% compared to those where radiation was omitted, who experienced a recurrence rate of 4.1%. There were no differences in regional recurrence, distant metastases, contralateral breast cancers or new breast cancers between the groups [35]. Although most

patients on this trial underwent some sort of axillary staging procedure, this trial again demonstrates that radiation therapy can be safely omitted in these patients.

These trials and studies demonstrate that it is safe to omit SLNB in women over 70 years old with estrogen receptor positive breast cancers. However, trends do not show a large drop in the use of SLNB for this patient population, likely due to a combination of factors. Patients may prefer to know their nodal status particularly after reading lay patient materials that state that nodal status is one of the most important prognostic factors in breast cancer. Surgeons may prefer to know the nodal status for adjuvant radiation decisions. The CALGB 9343 and PRIME II trials both demonstrated that radiation therapy did not provide survival benefit for older women with estrogen receptor positive breast cancer but patients in these trials were all either clinically node negative or pathologically node negative. The CALGB 9343 trial may have included some node positive patients since not all patients underwent a nodal procedure. Studies have shown that approximately 10–15% of this patient population will have a tumor positive node and technically these patients would require radiation therapy [36]. Lastly, patients in the CALGB 9343 and the PRIME II trials were all placed on endocrine therapy and likely there was a higher compliance rate with five-year completion for patients on these trials then in the real world setting where up to quarter of patients will not complete their five years of endocrine therapy [37]. All of these factors underscore the complexity of omitting SLNB in elderly women and may explain why trends show fairly high utilization of SLNB in this patient population.

Conclusion

SLNB has revolutionized the management of breast cancer by providing accurate staging information while minimizing morbidity associated with ALND. This comprehensive review provides valuable insights into the historical perspective and key trials and controversies surrounding the omission of SLNB in breast cancer management. Discussions surrounding omitting SLNB for invasive cancer are ongoing and increased use of genomic studies and axillary imaging studies may determine SLNB utilization in the future. Moving forward, ongoing research efforts will need to better refine risk stratification tools and identify biomarkers that can better predict nodal involvement, further optimizing axillary staging strategies in breast cancer.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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