



# The yield of axillary clearance in breast cancer in Khartoum locality -Sudan: a cross-sectional study.

Nagla Mustafa Ibnouf Mohamed, MBBS, MRCS<sup>a,\*</sup>, Aya Mohmedelhassan Elhag Yousif, MBBS, MRCS<sup>b</sup>

**Objectives:** Axillary clearance is an established part of the management of breast cancer. The aim of this study was to determine the number of retrieved lymph nodes (LNs) after axillary clearance surgery.

**Methods:** Over a 2-year period (January 2020–December 2022), data from 96 patients, who underwent axillary clearance surgery in Khartoum locality, were collected. Multivariate analysis was used to assess the yield of axillary clearance.

**Results:** The mean of total number of retrieved LNs was 12.8, the mean of positive LNs was 2.6. There was statistical correlation between the total number of retrieved LNs and total number of positive LNs ( $P = 0.000$ ). 53.1% of patients had stage II breast cancer, with 91% of them having invasive ductal carcinoma. Neoadjuvant chemotherapy decreased the total number of retrieved LNs ( $P = 0.001$ ). No statistically significant correlation was found between previous axillary surgery and the number of the retrieved LNs ( $P > 0.05$ ).

**Conclusions:** There were enough axillary LNs for histological studies; the total number of positive LNs increased with the increase in total number of retrieved LNs. Neoadjuvant chemotherapy reduced the yield of axillary clearance.

**Keywords:** axillary clearance, axillary surgery, breast cancer, breast reconstruction, breast surgery, oncoplastic surgery

## Introduction

The breast is an organ characterized by the complexity of its anatomy, development, functions, and aesthetic aspects. Breast cancers are classified according to histology into: ductal carcinoma *in situ*, lobular carcinoma *in situ*, invasive ductal carcinoma, invasive lobular carcinoma, medullary carcinoma, mucinous (colloid) carcinoma, tubular carcinoma, papillary carcinoma, metastatic breast cancer, phyllodes tumors, mammary Paget disease, and inflammatory breast cancer, with invasive ductal carcinoma being the most common type<sup>[1]</sup>.

Several treatments are used to manage breast cancer, including surgery, radiation therapy, chemotherapy, hormonal therapy, and axillary clearance; sometimes, a combination of treatments may be employed. Types of breast surgery vary from breast-conserving surgery to mastectomy, with reconstruction performed at the same time or later<sup>[2]</sup>.

Complete axillary dissection, as part of radical mastectomy, was the standard of care in the past. Long-term follow-up of patients showed substantial cure rates for those with positive nodes, indicating the therapeutic value of nodal dissection. Control of the axilla

## HIGHLIGHTS

- An adequate number of axillary lymph nodes were collected for histological analysis in all patients.
- A positive relationship was identified between the total lymph nodes retrieved and the number of positive nodes.
- Neoadjuvant chemotherapy notably decreased the number of lymph nodes retrieved.
- Stage II breast cancer was the most common diagnosis in the study population.
- The majority of cases had invasive ductal carcinoma, the leading histological subtype.
- Clinical implications: These results indicate that axillary clearance surgery provided sufficient lymph node specimens for reliable staging and prognosis. Neoadjuvant chemotherapy may influence lymph node harvest, which may impact further treatment decisions. Additional research is necessary to modify surgical methods and adjuvant treatments to enhance lymph node retrieval and improve patient outcomes.
- There was no significant correlation between a history of non-clearance axillary surgery and the total number of retrieved lymph nodes. Usually any surgical intervention in the axilla could impact the number of lymph nodes retrieved due to potential adhesions, scars, and anatomical disruptions of the axilla. However, this research did not support this hypothesis, and the findings were consistent even when compared to international studies.

<sup>a</sup>Al Neelain University, Khartoum, Sudan and <sup>b</sup>Khartoum University, Khartoum, Sudan

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

\*Corresponding author. Address:: Senior Resident of Plastic Surgery, MRCSed Holder, Al Neelain University, Khartoum, Sudan.

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was achieved in the past after the removal of positive nodes, and the recurrence rate was low. Even today, in patients with positive nodes, complete axillary clearance with modified radical mastectomy or a breast conservation approach with lumpectomy achieves control of the axilla and complete axillary staging, allowing the

oncology team to plan systemic treatment based on the total number of nodes involved<sup>[3]</sup>.

Axillary dissection is now less frequently performed, as it has often been replaced by sentinel lymph node biopsy (SLNB). However, it remains a mandatory procedure in many situations, such as clinically positive axillary lymph nodes, multiple positive sentinel nodes, or unsuccessful sentinel node mapping<sup>[4]</sup>.

### **Problem statement**

Breast cancer ranks among the most prevalent cancers in women, highlighting the necessity for effective management strategies. Adequate locoregional surgery is a cornerstone of breast cancer treatment. Consequently, it is imperative to assess the total number of lymph nodes harvested from the axilla to ensure that histological evaluations can facilitate accurate diagnoses and confirm sufficient local disease control. Currently, there is a lack of local and national data on this matter. Therefore, national and regional strategies of management may benefit from this study<sup>[5]</sup>.

### **Justification**

Axillary clearance plays a crucial role in the management of breast cancer. It is essential to evaluate the number and status of lymph nodes removed during surgery, as this information is vital for developing an appropriate treatment plan for patients. Accurately assessing the yield from axillary clearance is particularly important for effective disease management, especially regions where sentinel lymph node biopsy is not readily available.

### **Literature review**

Axillary dissection was described in the 18th century by Lorenz Heister, as a treatment for invasive breast cancer. The impact and advantages of axillary dissection have been shaped by the finding National Surgical Adjuvant Breast Project B-04 trial, which determined that axillary dissection does not impact. However, subsequent research has shown compelling evidence that axillary dissection effectively controls disease in the axilla, resulting in a local recurrence rate of 2% or lower, potentially improving overall survival rate.

The minimum number of lymph nodes as 10 is based on data published in the early 1990s, which suggests a survival benefit for patients undergoing axillary node dissection when more than 10 lymph nodes were removed<sup>[6]</sup>.

### **Anatomic boundaries**

The axilla is a quadrangular space bordered by the following: superiorly by the lower border of the axillary vein, medially by the chest wall, laterally by the axillary skin, anteriorly by the pectoralis major and minor, and posteriorly by the latissimus dorsi, teres major, and subscapularis<sup>[5]</sup>.

### **Blood supply of axillary lymph nodes**

There are between 20 and 30 lymph nodes in the axilla, with variation in number among individuals. Generally, lymph nodes are found in close association with blood vessels. The axillary

lymph nodes receive their blood supply from the axillary artery, and venous drainage occurs via branches of the axillary vein. Interestingly, it has been shown that stage II breast cancer and above are associated with a significant increase in the number of blood vessels in axillary lymph nodes<sup>[7]</sup>.

### **Nerve supply of lymphatics**

Lymph nodes do not have an intrinsic nerve supply, but they are often located near various nerves. The axillary lymph nodes are in close relation to the brachial plexus, which provides the main innervation for the muscles of the upper limb. The divisions of the brachial plexus become cords at the mid-clavicle, while the branches originate at the level of the pectoralis minor muscle. The long thoracic nerve, which arises from the C5–C7 nerve roots, is also located in the axilla. It is crucial to be aware of these structures, as they are at risk of injury during axillary lymph node surgery<sup>[8]</sup>.

### **Function**

Axillary lymph nodes are part of the immune system, defending against microorganisms and facilitating the drainage of excess interstitial fluid into the systemic circulation. The axillary lymph nodes are classified into five groups:

1. **Anterior (Pectoral) Lymph Nodes:** These nodes receive lymph from the breast, skin, and muscles of the supraumbilical and anterolateral body wall. They drain into the central and apical nodes.
2. **Posterior (Subscapular) Lymph Nodes:** These nodes receive lymph from the scapular region and the posterior thoracic wall. They drain into the central and apical nodes.
3. **Lateral (Humeral) Lymph Nodes:** These nodes receive lymph from the arm and drain into the central, apical, and deep cervical nodes.
4. **Central Lymph Nodes:** These nodes receive lymph from the anterior, posterior, and lateral groups, draining into the apical lymph nodes.
5. **Apical (Terminal) Lymph Nodes:** These nodes receive lymph from all groups as well as from the upper breast. On the left side, lymph drains directly into the thoracic duct, while on the right, it drains into the subclavian trunk<sup>[7]</sup>.

### **Clinical significance**

It is crucial to consider the number of lymph nodes involved, as the prognosis worsens when four or more axillary lymph nodes are affected. Axillary metastasis is an indicator of the aggressive nature of the disease and a marker for relapse. Three key predictors of axillary lymph node metastatic grading are tumor size, younger age, and poor histology.

Several imaging modalities are utilized to assess the axillary lymph nodes, including computed tomography (CT) scans and magnetic resonance imaging (MRI). Ultrasound is predominantly employed to identify morphological abnormalities such as hilar infiltration, cortical thickening, peripheral vascularization, and disruption of the kidney-shaped appearance. Optimal outcomes are achieved with the implementation of fine-needle aspiration biopsy (FNAB)<sup>[7]</sup>.

## Indication

Axillary dissection has primarily been replaced by sentinel lymph node (SLN) biopsy for patients with cN0 breast cancer but remains necessary for a considerable number of breast cancer patients. The current indications for axillary dissection are include:

- The clinically node-positive axilla, confirmed by fine needle aspiration or core biopsy, in a patient for whom neoadjuvant chemotherapy is not planned.
- Occult breast cancer presenting as axillary node metastasis.
- SLN positive patients who fall outside the Z0011 selection criteria (i.e. >2 SLN positive, matted nodes, mastectomy, or breast conservation without whole-breast RT)
- Inflammatory, clinical stage T4, or high-risk T3 breast cancer.
- Failed SLN mapping.
- Inadequate prior axillary dissection with residual clinically suspicious nodes.
- Sentinel or axillary nodes that remain positive after neoadjuvant chemotherapy.
- Axillary recurrence following previous breast cancer treatment<sup>[4]</sup>.

Briefly, patients in ACOSOG Z0011 were considered as eligible for the trial, if they had histologically confirmed breast cancer <5 cm in size, were clinically node negative, underwent lumpectomy with planned whole breast radiation, and had 1–2 SLNs with metastases identified (without matting or gross extra-nodal extension)<sup>[9]</sup>.

## Surgical considerations

There are three levels of axillary clearance in relation to the pectoralis minor muscle:

- Level I: Located below the lower edge of the pectoralis minor muscle.
- Level II: Situated underneath the pectoralis minor muscle.
- Level III: Positioned above the pectoralis minor muscle<sup>[7]</sup>.

## Contraindication

There are no absolute contraindications for axillary dissection; however, patients must be medically fit for general anesthesia. The decision to perform axillary dissection in the presence of distant metastases is controversial, but it may play a role in obtaining locoregional control when necessary.

If a patient has advanced disease in the axilla or palpable axillary nodes, cytological or histological confirmation of nodal involvement is not required before planning axillary surgery, thereby avoiding the need for sentinel node biopsy. Conversely, if a patient shows no evidence of axillary disease preoperatively, SLNB is mandatory, followed by axillary dissection if the sentinel node is positive.

A complete axillary dissection is typically performed in most node-positive cases. It is important to note that a clinico-radiologically node-negative axilla still has a 30% to 40% possibility of metastatic disease<sup>[5]</sup>.

Several alternative approaches to axillary surgery may be considered:

Axillary clearance involves the removal of all nodal tissue in the axilla by dissection up to the level of the axillary vein. It was the standard practice in many surgical units, but it carries high risks compared to breast surgery alone. Complications such as arm lymphoedema, seroma, infection, breast oedema, and risk of injury to the long thoracic nerve, along with shoulder stiffness are associated with the procedure.

- Axillary node sampling** involves the removal of four or five axillary nodes from the lower axilla, leaving axillary fat and most nodes and lymphatics intact. Fewer complications have been reported with this method. If the sampling contains a positive lymph node, subsequent axillary clearance or radiotherapy may be warranted.
- SLNB** is a technique that tracks the lymphatic pathway from the site of breast cancer using a radioisotope or blue lymphatic dye, enabling the biopsy of the first lymph node or nodes (the sentinel node) that drain the tumor.

Some surgeons may omit axillary surgery to avoid additional morbidity in patients who are not candidates for adjuvant therapies<sup>[8]</sup>.

## Periprocedural care: patient education & informed consent

Patients should be educated on a comprehensive set of shoulder exercises preoperatively, and their shoulder mobility should be evaluated prior to the procedure<sup>[5]</sup>.

## Surgical procedure

Axillary dissection can be performed through the incision made for a mastectomy. However, patients undergoing lumpectomy typically require a separate incision in the axilla. The preferred approach is often a skin crease incision just below the axillary hairline, extending from the posterior edge of the pectoral fold to the posterior axillary line. Flaps are raised off the skin and subcutaneous tissue<sup>[5]</sup>.

## Approach considerations

Protect the long thoracic nerve as the dissection proceeds to the apex of the axilla. Utilize the interpectoral space, if there is extensive nodal involvement, and ensure preservation of the lateral pectoral nerve. Division of the clavipectoral fascia facilitates access to the axillary fat and the enclosed nodes.

Identify the axillary vein. Separating the axillary contents from the lateral thoracic wall, exposes the long thoracic nerve, increasing the risk of injury. Identify and protect the branches of the intercostobrachial nerve (ICBN) if possible. Ligation and division of the smaller tributaries of the axillary vein allow for improved visualization and hemostasis.

Identify the subscapular vessels and the thoracodorsal nerve, which supply the subscapular and latissimus dorsi muscles. The axillary fat between the long thoracic nerve and the subscapular vascular bundle should be dissected carefully. Dissection should extend the apex to include the nodes medial to the pectoralis minor (Berg level III). A suction drain should be placed and the surgical site must be closed in layers<sup>[5]</sup>.

### Postoperative care

Encourage and ensure full mobility of the shoulder joint. Advise the patient to avoid heavy lifting with the arm on the side of the cancer, as well as any trauma or interventions on that arm to reduce the risk of infection.

### Complications of axillary surgery

- Pain at the surgical site, which is typically managed with mild analgesics.
- Hematoma.
- Swelling and bruising over the breast or axilla.
- Seroma, which may require needle drainage.
- Shoulder stiffness, a temporary complication that can be managed with physiotherapy.
- Lymphedema of the arm, a significant long-term complication.
- Numbness in the upper arm due to injury to the ICBN<sup>[5]</sup>.

There are two distinct lymphatic drainage pathways in the axillary region: one medial to the breast and one more lateral to the arm. These pathways can be preoperatively marked by intradermal injections of a radioisotope or vital dye into the breast and arm. Axillary reverse mapping is a procedure developed to identify the lymphatic drainage path of the arm to protect these lymph nodes during dissection<sup>[5]</sup>.

Proper training and technique are crucial to minimize complications, such as lymphedema. Emerging methods like axillary reverse mapping and lympho-venous anastomosis are being investigated to mitigate these risks<sup>[4]</sup>.

Two research groups have introduced new classifications:

#### Clough's classification

Clough *et al* (2010) introduced a new anatomical classification of the lower axilla focusing on the second ICBN and the lateral thoracic vein (LTV). This classification aids in identifying the precise location of the axillary SLN and its consistent positioning. This research revealed that in around 98% of cases, the axillary SLN was situated medially to the LTV, potentially reducing the need for unwarranted lateral axillary dissections<sup>[10]</sup>.

#### Li's classification

A Chinese research group led by Li, *et al* in 2013 classified the lymph nodes into two groups: those situated in the upper axillary space (zone A) and those in the lower axillary space (zone B), in relation to the ICBN. Their examination aimed to detect both macro- and micrometastasis within these nodes. They observed that all SLNs were positioned below the ICBNs, with a concentration of more than ten lymph nodes located in that specific region.

Additionally, the authors noted when lymph nodes displayed macrometastasis or micrometastasis above the ICBNs, metastasis-positive lymph nodes were found below the nerves. Conversely, in cases where lymph nodes in zone B did not show metastasis, the lymph nodes above the ICBNs were also non-metastatic. This indicates that the ICBN may serve as a new anatomical landmark in lymph node dissection procedures<sup>[10]</sup>.

### Histopathology considerations

According to pathologist guidelines, histopathological examination should be conducted on all received lymph nodes. The report should indicate the total number of lymph nodes and the total number of positive lymph nodes. Axillary clearance specimens must be placed in properly labeled containers with an adequate amount formalin for routine fixation<sup>[11]</sup>.

Axillary node specimens received with mastectomy or surgical excision should be examined carefully to maximize lymph node yield. This includes manual dissection of fixed axillary tissue with a meticulous examination through inspection and palpation. The use of clearing agents or Bouin's solution may help increase lymph node yield. It is important to note that axillary lymph nodes may be softer and more difficult to palpate in post-chemotherapy specimens, which can lead to lower lymph node yields<sup>[12]</sup>.

### Chemotherapy effect on the yield

In the 1970s preoperative chemotherapy was initially applied to locally advanced breast cancer with the intent to improve surgical resectability<sup>[13]</sup>. Since its inception, many studies have shown that approximately 50–80% of patients will show a partial or complete response to neoadjuvant chemotherapy<sup>[14]</sup>. Its use may effectively reduce the size of the primary tumor, and be an effective means reversing positive to negative axillary lymph nodes on microscopic evaluation. Results from the National Surgical Adjuvant Breast and Bowel Project (NSABP) B-18 trial showed that the incidence of histologically negative axillary lymph nodes was 37% greater among patients who received preoperative chemotherapy compared to those who received postoperative (adjuvant) chemotherapy, with a 27% rate of downstaging from mastectomy to breast conservation<sup>[15]</sup>. Thus, downstaging of axillary node status may be achieved before performing axillary lymph node dissection, just as downstaging of the breast mass may also be achieved by administering preoperative systemic therapy<sup>[6]</sup>.

Several studies have shown that there is a significantly lower nodal yield in patients undergoing axillary dissection after neoadjuvant chemotherapy compared to those undergoing primary surgery. Patients with pathologic stage II or III disease who underwent primary surgery had higher number of lymph nodes retrieved during axillary dissection when compared to those with stage I disease<sup>[6]</sup>.

### Breast carcinoma staging

Staging of breast carcinoma is based on axillary lymph node involvement.

The AJCC (American Joint Committee on Cancer) staging system for breast cancer classifies the disease based on tumor size, lymph node involvement, and the presence of metastasis. This is often referred to as the TNM system:

- **T (Tumor):** Size and extent of the primary tumor.
- **N (Nodes):** Involvement of regional lymph nodes.
- **M (Metastasis):** Presence of distant metastasis.

The combination of these factors helps determine the overall stage of breast cancer, which ranges from Stage 0 – carcinoma

stage	Description
<b>Noninvasive</b> Stage 0	No evidence of cancer cell or invasion of basement membrane, includes ductal carcinoma in situ
<b>Invasive</b>	
Stage IA	Tumour < or = 2cm ,no lymph nodes involvement
Stage IB	No tumour in the breast ,microscopic metastases( >0.2 mm but < or =2mm) in axillary lymph nodes OR Tumor in the breast < or = 2cm ,with lymph nodes involvement
Stage IIA	No tumour in the breast, but macroscopic cancer (> 2 mm) in 1-3 axillary lymph nodes OR •Tumour equal or< 2 cm, with spread to axillary lymph nodes OR • Tumour > 2 cm but equal < 5 cm, with no spread to axillary lymph nodes
Stage IIB	The tumor is larger than 2 cm but not larger than 50 mm and has spread to 1 to 3 axillary lymph nodes (T2, N1, M0) OR •The tumor is larger than 5 cm but has not spread to the axillary lymph nodes (T3, N0, M0).
Stage III A	The tumor of any size has spread to 4 to 9 axillary lymph nodes or to internal mammary lymph nodes. It has not spread to other parts of the body (T0, T1, T2, or T3; N2; M0) OR •Tumor larger than 5 cm that has spread to 1 to 3 axillary lymph nodes (T3, N1, M0).
Stage IIIB	The tumor has spread to the chest wall or caused swelling or ulceration of the breast, or it is diagnosed as inflammatory breast cancer.OR • May or may not have spread to up to 9 axillary or internal mammary lymph nodes. It has not spread to other parts of the body (T4; N0, N1, or N2; M0).
Stage IIIC	Tumor of any size that has spread to 10 or more axillary lymph nodes, the internal mammary lymph nodes, and/or the lymph nodes under the collarbone. It has not spread to other parts of the body (any T, N3, M0)
Stage IV (metastatic):	The tumor can be any size and has spread to other organs, such as the bones, lungs, brain, liver, distant lymph nodes, or chest wall (any T, any N, M1).

*in situ* – to Stage IV – advanced cancer with distant spread. This staging guides treatment options and prognosis<sup>[7]</sup>.

## Objective

### General objective

To study the yield of axillary clearance surgery in breast cancer among Sudanese patients from December 2020 to December 2022.

### Specific objectives

- To determine the number of lymph nodes that reach the histology labs after axillary surgery.
- To determine the number of positive lymph nodes in each yield and their relation to the total number of harvested lymph nodes.
- To identify the stage of the disease before surgery.
- To determine the difference in the yield of axillary clearance with or without neoadjuvant chemotherapy.

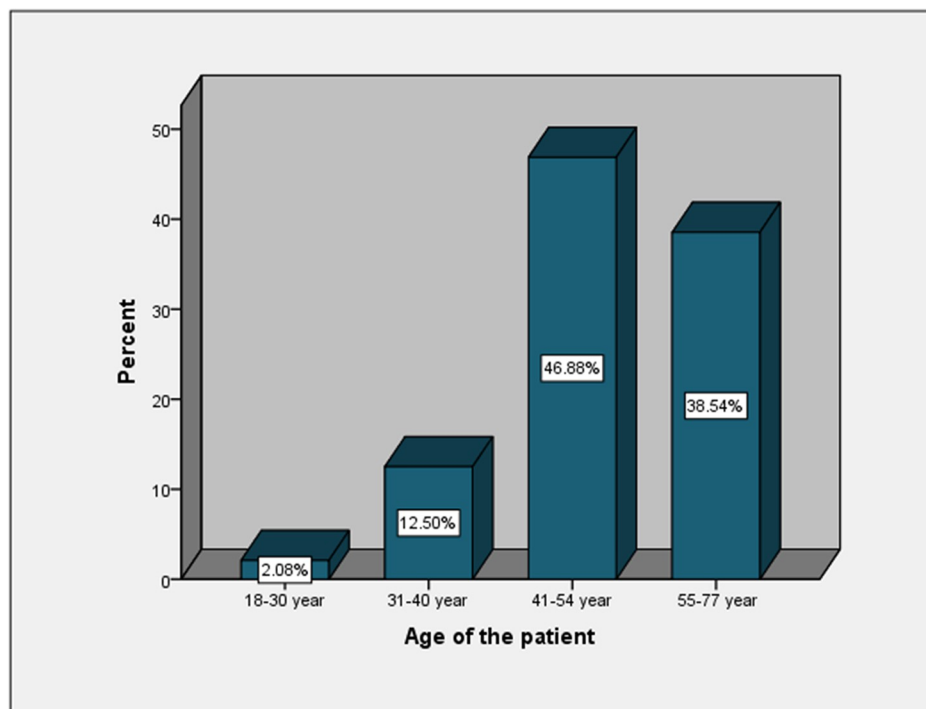


Figure 1. Age distribution of patients underwent axillary clearance surgery.

## Materials and methods

**Study Design:** Retrospective cross-sectional histopathology lab-based study.

**Study Area:** This multi-centric study includes histopathology labs in the Khartoum locality, specifically the private histopathology lab

STAC and the National Health Laboratory. Random sampling was utilized to encompass both governmental and private labs, along with the Khartoum Breast Center and the Nuclear Medicine Hospital.

**STAC National Health Laboratory:** Established in 1927/28 as a memorial to the late Sir Lee Stack, this laboratory has several

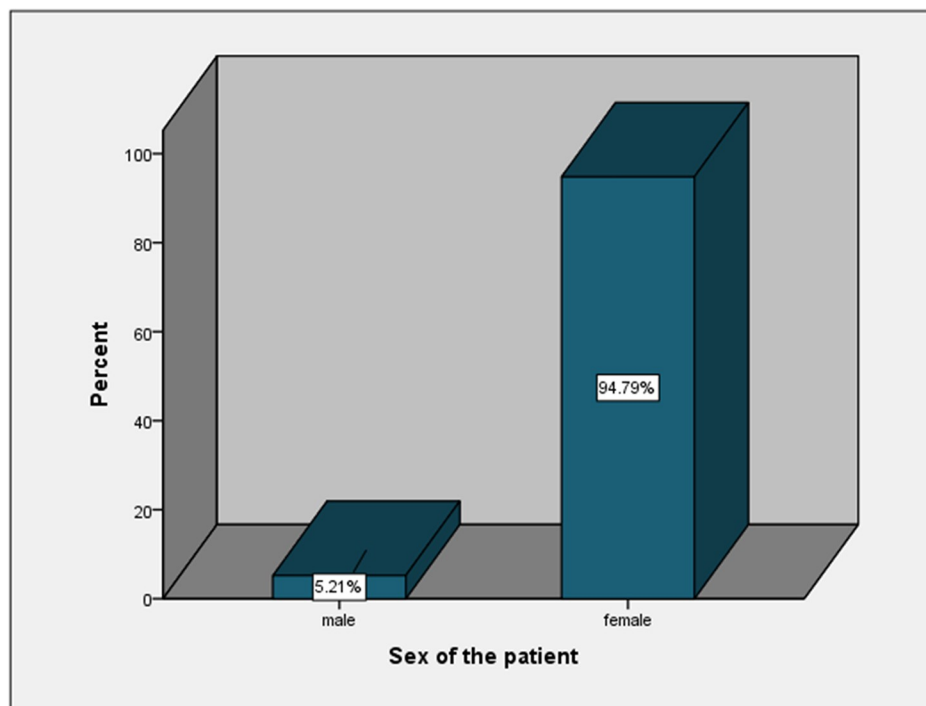
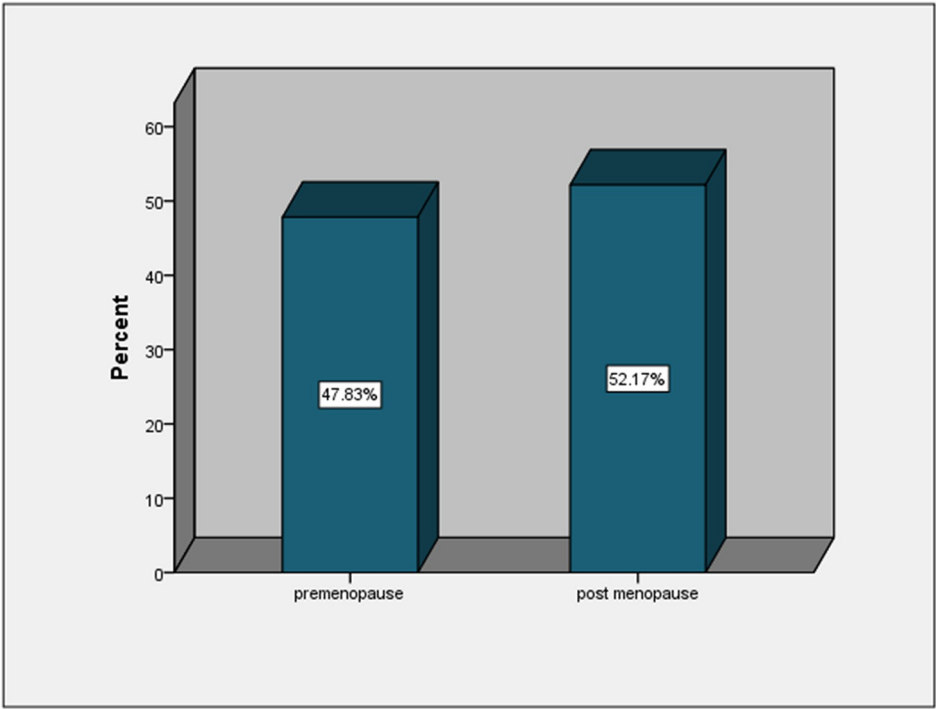


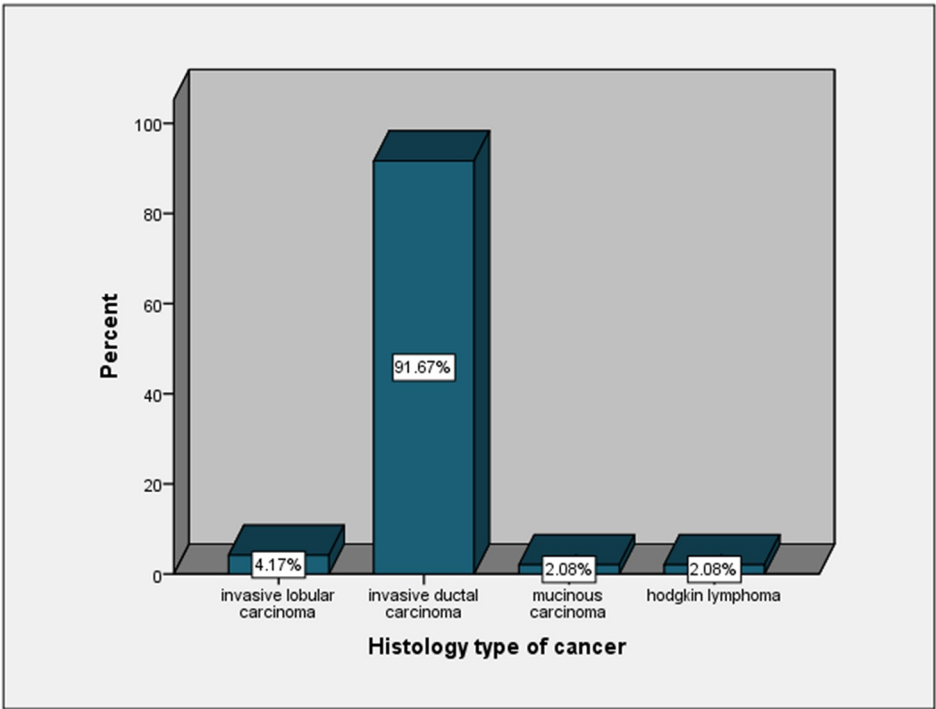
Figure 2. Sex distribution of patients underwent axillary clearance surgery.



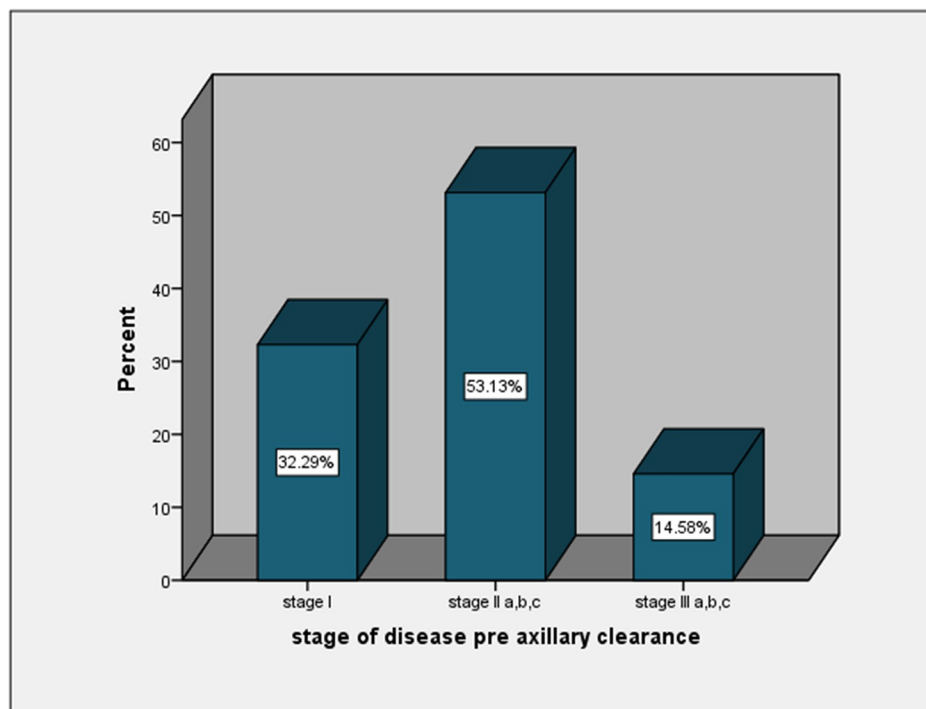
**Figure 3.** The percentage of post-menopause and pre-menopause patients who underwent axillary surgery.

departments, including the national blood bank, and is located on Algasr Street in Khartoum locality.  
**Private Labs in Khartoum** specialize in histopathology studies.

**Nuclear Medicine Hospital:** A specialized facility for the treatment of tumors in Khartoum locality.  
The facilities mentioned above play a crucial role in serving the entire country, as breast centers and nuclear facilities are



**Figure 4.** The histology type of breast cancer before the axillary clearance surgery.



**Figure 5.** The stage of breast cancer of patients before the axillary clearance surgery.

predominantly concentrated in Khartoum, the capital of Sudan.

**Study Population:** Medical records of all breast cancer patients who underwent axillary clearance surgery from December 2020 to December 2022 were reviewed.

#### Inclusion criteria

- Medical records of both male and female patients will be included.
- Histopathology records with various TNM classifications.
- Records of patients from various age groups.
- Records of patients with different types of breast cancer.
- Records of patients who underwent previous axillary clearance surgery.
- Records of patients who received chemotherapy.

#### Exclusion criteria

Patients with other malignancies.

**Sample Size:** The total coverage of all patients who underwent axillary clearance after breast surgery is approximately ten cases per month. After applying the inclusion and exclusion criteria, the estimated number of cases will be around 5 to 7. Utilizing the Taro Yamane formula, the total estimated sample size is approximately 96 cases.

$$n = N/[1 + N(e^2)],$$

( $n$  = sample size,  $N$  = total population,  $e$ , margin of error = 5% or 0.5).

**Sampling Technique:** convenience sampling technique

#### Data collection method

Secondary data were collected from medical records, histopathology reports, and patient document reviews. The researcher

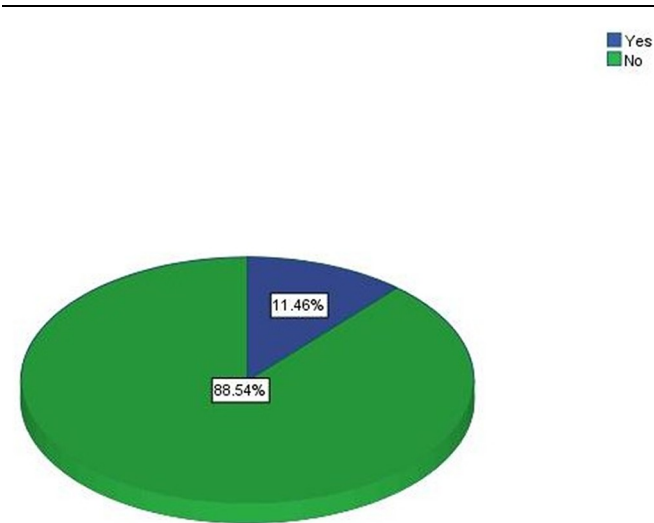
**Table 1**  
Total number of harvested LNs in axillary clearance surgery

Number of total harvested LNs	Frequency	Percent
1–5 LNs	6	6.3
6–10 LNs	27	28.1
11–15 LNs	40	41.7
16–20 LNs	18	18.8
21–25 LNs	4	4.2
26–30 LNs	0	0
31–45 LNs	1	1.0
<b>Total</b>	96	100.0

**Table 2**  
Number of positive LNs retrieved in the axillary clearance surgery

Number of positive LNs	Frequency	Percent
1–4	31	32.3
5–8	7	7.3
9–12	3	3.1
13–16	2	2.1
17–24	4	4.2
Free from tumor	49	51.0
<b>Total</b>	96	100.0



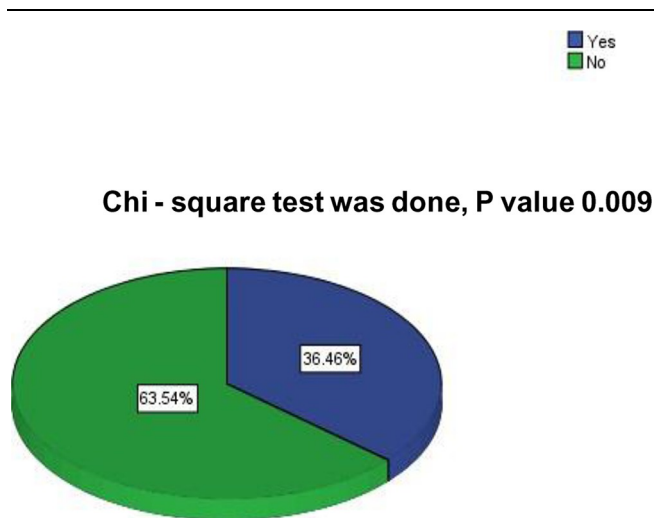


**Figure 6.** The percentage of patients with history of axillary surgery prior to axillary clearance surgery.

compiled this information using a pretested and structured data sheet, which was coded with serial numbers. Patients' names and personal information were kept confidential to maintain privacy.

**Data analysis**

Data were analyzed using the Statistical Package for Social Sciences (SPSS version 28). Association testing between variables was conducted, and the results were presented in tables and figures using Excel. In this study the most common threshold for significance is the *P*-value was typically set at 0.05. This means there is a 5% chance that the observed results could occur due to random variation alone.



**Figure 7.** The percentage of patients who received neoadjuvant chemotherapy before surgery.

**Study variables**

**Demographic Data:** Gender, age, and residence.

**Dependent Variables:** The number of lymph nodes in each yield, stage of breast cancer, histological type of breast cancer, previous nodal status, and receipt of chemotherapy.

The work has been reported in line with the STROCSS criteria.<sup>[16]</sup>

**Ethical Considerations**

Ethical approval will be obtained from the Khartoum State Ministry of Health and the Educational Development Center (EDC) of the Sudan Medical Specialization Board, and the laboratories where the research is conducted. All patients consented to data collection via the EDC and institutional study protocols. The patients medical records were reviewed in the archives office.

The names and personal information of the patients will not be revealed and remain anonymous. Serial numbers were used to increase the level of confidentiality during the completion of the data sheet.

**Result**

Ninety-six patients were included in this study with 45 (46.9%) of them in the age group 41–54 years, 37 (38.5%) patients between 55–77 years, 12 (12.5%) patients between 31–40 years, and 2 (2.1%) patients between 18–30 years. The mean age was 52 years (Fig. 1).

Ninety-one (94.8%) of the patients were females, with a female-to-male ratio of 18:1 (Fig. 2).

Forty-six (47.83%) of the female patients were premenopausal and 50 (52.17%) were postmenopausal (Fig. 3).

Invasive ductal carcinoma was found in 88 (91%) patients. Four (4.2%) patients had lobular carcinoma, two (2.1%) had mucinous carcinoma, and two (2.1%) were diagnosed Hodgkin's lymphoma (Fig. 4).

Fifty-one (53.1%) patients had stage IIa,b breast carcinoma, 31 (32.3%) of patients had stage I, and 14 (14.6%) of patients had stage IIIa,b,c (Fig. 5).

The total number of harvested lymph nodes ranged between 11–15 lymph nodes in 40 (41.7%) patients, 6–10 lymph nodes in 27 (28.1%) patients, 16–20 lymph nodes in 18 (18.8%) patients, 1–5 lymph nodes in 6 (6.3%) patients, 21–25 lymph nodes in 4 (4.2%) patients, and 31–45 lymph nodes per yield reported in 1 (1%) patient. The mean number of lymph nodes retrieved was 12.18 (Table 1).

Forty-nine (51%) patients had their lymph nodes negative for malignancy; 1–4 positive lymph nodes were found in 31 (32.3%) patients, 5–8 positive lymph nodes were found in 7 (7.3%) patients, 17–24 lymph nodes were found in 4 (4.2%) patients, 9–12 lymph nodes were found in 3 (3.1%) patients, and 13–16 lymph nodes were found in 2 (2.1%) patients. The mean number of positive lymph nodes was 2.6 (Table 2).

Eleven (11.5%) patients had undergone previous axillary surgery (Fig. 6).

Thirty-five (36.5%) patients received neoadjuvant chemotherapy (Fig. 7).

There is a significant correlation between the total number of retrieved lymph nodes and positive lymph nodes with a *P*-value less than 0.009 (Table 3).

**Table 3****Relation between the number of harvested LNs and positive one among them**

		Total number of retrieved LNs						
		1–5 LNs	6–10 LNs	11–15 LNs	16–20 LNs	21–25 LNs	26–30 LNs	31–45 LNs
Number of positive LNs	1–4 LNs	6	9	11	5	0	0	0
	5–8 LNs	0	3	4	0	0	0	0
	9–12 LNs	0	0	1	2	0	0	0
	13–16 LNs	0	1	0	1	0	0	0
	17–24 LNs	0	0	0	1	2	0	1
	Free from tumor	0	14	24	9	2	0	0

Chi-square test was done,  $P$ -value = 0.009

The mean number of total lymph nodes retrieved during axillary clearance in patients with stage I disease was 12 lymph nodes, in stage II it was 13 lymph nodes, and in stage III it was 10.5 lymph nodes (Table 4).

Since this  $P$ -value is much greater than 0.05, we would not reject the null hypothesis, indicating no significant association between previous axillary surgery and the number of lymph nodes yielded with a  $P$ -value 0.7 (Table 5).

There was a significant correlation between the histology type of cancer and the number of positive lymph nodes, with a  $P$ -value of 0.028 (Table 6).

There is significant correlation between the total number of harvested lymph nodes and the use of neoadjuvant chemotherapy with  $P$ -value of 0.001 (Table 7).

## Discussion

As medicine progresses toward established quality standards, the criteria for what constitutes an adequate surgical procedure are becoming increasingly important, especially in oncologic surgery, which typically involves clearly defined operative goals. The goal of this study, ultimately, was to evaluate the number of retrieved lymph node and quantifiable factors that may affect the number of lymph nodes removed at axillary node dissection.

This retrospective review showed that the age of the patients ranged between 18–77 years with a mean age of 52 years. This is similar to the results of Mohamed, *et al* where the median age was 45 years (range 25 to 85 years), and the National Cancer Data Base of the USA with mean age of 55 years<sup>[17,18]</sup>.

**Table 4****Stage of breast disease with mean lymph nodes retrieved during axillary clearance surgery**

Stage of breast cancer	Mean of retrieved LNs
Stage I	12
Stage II A,B	13
Stage III A,B,C	10.5

Fifty-two percent of female patients were postmenopausal, which is comparable with the results of Marieke, *et al*, where 59% of the female were postmenopausal<sup>[19]</sup>.

Invasive ductal carcinoma was the most common histological type of breast cancer consistent with the findings of Joshi, *et al*, where 98% of patients had infiltrating ductal carcinoma, and Marieke, *et al*, where 72% of the cases presented with this type<sup>[11,19]</sup>. This highlights the need for further studies to assess the prevalence of other histological types.

All patients included in this study exhibited no clinical or radiological indication of distant metastases (stage IV breast cancer). Among them, 53.13% were categorized as stage II, proportion comparable to the observations of Laura, *et al*, who noted 43.1% in stage II, and Junko, *et al*, who identified 42% in stage II. Marieke, *et al* similarly reported 47% of their cases falling into stage II. Conversely, Joshi, *et al*'s findings diverged, with the preponderance of patients (80.4%) being diagnosed with stage III breast cancer<sup>[11,18–20]</sup>.

**Table 5****Demonstrate the relation between the total number of L.N harvested and previous axillary surgery**

		Previous axillary surgery	
		Yes	No
Number of LNs yielded	1–5 LNs	1	5
	6–10 LNs	4	23
	11–15 LNs	6	34
	16–20 LNs	0	18
	21–25 LNs	0	4
	26–30 LNs	0	0
	31–45 LNs	0	1

**Table 6**  
**Demonstrate the relation between histopathology type and number of positive LNs**

		Histological type of cancer				Total
		Invasive lobular carcinoma	Invasive ductal carcinoma	Mucinous carcinoma	Hodgkin's lymphoma	
Number of positive LNs	1–4 LNs	0	31	0	0	31
	5–8 LNs	1	6	0	0	7
	9–12 LNs	0	3	0	0	3
	13–16 LNs	1	1	0	0	2
	17–24 LNs	0	3	0	1	4
	Tumor-free LNs	2	44	2	1	49
Total		4	88	2	2	96

The number of harvested lymph nodes ranged between 11–15 in 40 patients (41.7%), with a mean of 12.8 lymph nodes, consistent with the results of Mohamed, *et al*, where 10 or more lymph nodes were retrieved in more than 81% of cases, with a mean of 14 lymph nodes. In Boughy, *et al* study the mean number of lymph nodes resected was 20.4 from 93% of patients with at least 10 lymph nodes recovered<sup>[17,21]</sup>.

Nodal metastasis was found in 47 patients (48.9%) with a mean of 2.6 lymph nodes; this is similar to a study conducted by Laura, *et al*, where it was found in 65 patient with mean of 2 positive lymph nodes<sup>[20]</sup>.

There was a significant correlation between the number of retrieved lymph nodes and positivity with a *P*-value of 0.009, which is similar to the results of Mohamed, *et al*<sup>[19]</sup>.

Neoadjuvant or induction chemotherapy is increasingly utilized to enhance surgical resection and evaluate the tumor's response to systemic therapy. It is hypothesized that lymph nodes with clinical positivity are more easily detected both during surgery and on gross pathological examination compared to normal nodes. Based on this understanding, the decreased nodal yield following neoadjuvant chemotherapy is likely attributable to scar tissue and fibrosis resulting from the treatment's effects on axillary nodes.

Data review reveals that the number of harvested lymph nodes in patients who received neoadjuvant chemotherapy ranged between 6–11 lymph nodes, while patients who did not receive neoadjuvant chemotherapy had between 11–15 lymph nodes retrieved. This indicates that the total lymph node retrieval is lower in patients who received neoadjuvant chemotherapy, with a *P*-value of 0.001, consistent with previous studies. Ozao, *et al*

found that patients who received chemotherapy were more likely to have fewer than ten lymph nodes removed in their axillary clearance specimen compared to non- chemotherapy patients, with statistically significance at *P* < 0.001. In Belangert, *et al*'s study, the median number of lymph nodes retrieved in the neoadjuvant chemotherapy group was 10.0 (0–38) compared to 12.5 (0–30) in the control group (*P* = 0.002). There were also significantly more patients with fewer than 10 lymph nodes recovered in the neoadjuvant group (45 versus 28%, *P* = 0.007). However, Boughy, *et al* reported different results when they found a similar number of lymph nodes in both groups<sup>[18,21,22]</sup>.

Our data demonstrate that there was no statically significant pcorrelation between the history of non- clearance axillary surgery and the total number of retrieved lymph nodes with a *P*-value of 0.7. This finding is consistent with the study by Charkravorty, *et al*, where out of 1025 axillary procedures, axillary lymph node dissection (ALND) constituted 332 (32.4%). Among these, 207 (62.3%) underwent partial lymph node dissection, 43 (12.9%) had complete dissection, and 82 (24.6%) received delayed dissection. The median number of nodes retrieved was for 15.0 the partial group, 16.0 for the complete group, and 14.5 for the delayed group, with a *P*-value of 0.3 indicating no statistically significant difference among the groups<sup>[23]</sup>.

**Limitations**

A small sample size may limit the generalizability of the findings to the entire country. However, the facilities where the research took place serve the whole country, as breast centers and nuclear facilities are primarily situated in Khartoum, the capital of Sudan.

The absence of follow-up information makes it challenging to assess long-term outcomes related to lymph node counts and patient prognosis, highlighting the need for further research.

Differences in neoadjuvant chemotherapy regimens could affect outcomes but may not have been accounted for as this was not tested in this study.

The predominance of invasive ductal carcinoma (histological type) may limit the applicability of findings to other types of breast cancer.

**Table 7**  
**Relation between the total number of harvested LNs and the use of neoadjuvant chemotherapy**

Received chemotherapy	Frequency	Percent
Yes	35	36.5
NO	61	63.5
Total	96	100

Potential inaccuracies in counting lymph nodes or assessing their positivity could affect the reliability of the results.

## Recommendations

- In order to more accurately determine lymph node involvement, patients should undergo routine screening and monitoring, especially if they are in stages IIa, IIb, or IIc.
- To more accurately assess the effect of neoadjuvant chemotherapy on lymph node yield, consider standardizing the regimens.
- Teach medical professionals the best axillary sampling methods to ensure accurate lymph node retrieval and evaluation.
- Carry out additional research to investigate the impact of long-term neoadjuvant chemotherapy on lymph node retrieval and patient outcomes.
- In order to improve the applicability of findings across various demographics, it is recommended to incorporate a more diverse patient population in future studies.
- Create a reliable data gathering system to routinely monitor patient outcomes and lymph node retrieval, enabling future research and clinical decision-making.

## Conclusion

In this study, the average age of the patients was 52 years. The average number of lymph nodes retrieved from axillary clearance was 12.8, with an average of 2.6 positive lymph nodes in the yield. Invasive ductal carcinoma was the most common histological type of breast cancer observed. Out of the patient population selected, 51 (53.1%) of them were classified in stages IIa, IIb, and IIc. There was a direct correlation between the number of positive lymph nodes detected and the total number of harvested lymph nodes. Additionally, the total number of harvested lymph nodes decreased post neoadjuvant chemotherapy, while prior axillary sampling did not impact the total number of harvested lymph nodes.

## Ethical approval

This research was approved by Sudan medical specialization board committee in Sudan

## Consent

No patients were included just records

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## Authors' contributions

Conceptualization, formal analysis, methodology, project administration, resources, software and writing done by N.M. I.M.; review & editing by A.M.E.Y.

## Conflicts of interest disclosure

No conflicts of interest were reported during this study

## Guarantor

Nagla Mustafa Ibnouf Mohamed.

## Research registration unique identifying number (UIN)

No involvement of any human subject data for this study was collected from patient's database.

## Provenance and peer review

Not invited.

## Data availability statement

No data from this study was used for any article.

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