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Original Research Article

Single-Port Non-Lipolytic Endoscopic Surgery via the Axillary Approach for the Treatment of Benign Breast Tumors: A Prospective Study

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Abstract

Background: Benign breast tumors often require surgical excision, but conventional open surgery may cause visible scarring and breast contour deformity. Single-port non-lipolytic endoscopic axillary surgery offers a minimally invasive alternative with improved cosmetic outcomes.

Methods: In this prospective study, 64 patients with benign breast tumors underwent single-port non-lipolytic endoscopic excision via the axillary route. Operative time, blood loss, postoperative pain, complications, hospital stay, and cosmetic satisfaction were recorded. Regression and ROC analyses were performed to identify predictors of successful outcomes.

Results: Mean tumor size was 2.8 ± 0.9 cm, and mean operative time was 68 ± 15 minutes. Minor complications occurred in 6 patients (9.4%), with no major complications or conversions. Postoperative pain (VAS) was 2.3 ± 0.8, and mean hospital stay was 1.4 ± 0.6 days. Cosmetic outcomes were excellent in 62% and good in 31% of patients. Tumor size >3 cm was the strongest predictor of postoperative drain use, pain, and cosmetic dissatisfaction ($p < 0.01$). ROC analysis showed an AUC of 0.82 for tumor size, with a cutoff ≤3 cm predicting successful outcomes with 88% sensitivity and 79% specificity.

Conclusion: Single-port non-lipolytic endoscopic axillary surgery is safe, effective, and cosmetically favorable for benign breast tumors. Tumor size ≤3 cm is a reliable predictor of optimal outcomes.

Keywords: Benign breast tumor, Fibroadenoma, Single-port endoscopic surgery, Axillary approach, Cosmetic outcome.

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Introduction

Benign breast tumors represent a significant proportion of breast-related surgical consultations, particularly among young and premenopausal women. Fibroadenoma is the most common benign breast lesion, accounting for nearly 50–70% of all benign breast tumors, followed by fibrocystic disease, benign phyllodes tumors, and other non-malignant conditions [1–3]. Although these lesions lack malignant potential in most cases, surgical excision is frequently recommended due to progressive enlargement, pain, cosmetic deformity, diagnostic uncertainty, or patient anxiety regarding malignancy [4].

Conventional surgical excision through direct breast or periareolar incisions has long been considered the standard treatment for benign breast tumors [5]. While this approach ensures complete removal, it is often associated with visible scarring, breast contour irregularity, nipple–areolar complex distortion, and postoperative psychological distress, particularly in young women for whom cosmetic appearance is a major concern [6–8]. Several studies have reported dissatisfaction rates of up to 30% following open excision, emphasizing the need for cosmetically favorable alternatives [9]. With advancements in minimally invasive surgery, endoscopic techniques have been increasingly applied to breast surgery to minimize visible scarring while preserving surgical efficacy [10,11]. Endoscopic breast surgery enables tumor excision through remote access sites such as the axilla or inframammary fold, thereby avoiding direct incisions on the breast surface [12]. Among these, the axillary approach has gained popularity due to its excellent cosmetic concealment, favorable anatomical access to most breast quadrants, and minimal impact on breast aesthetics [13,14].

Early reports and subsequent studies have demonstrated that endoscopic excision of benign breast tumors is feasible, safe, and associated with

high patient satisfaction [15–17]. Comparative studies have shown that endoscopic techniques provide similar rates of complete excision and recurrence when compared to open surgery, while offering superior cosmetic outcomes and faster postoperative recovery [18,19]. As a result, endoscopic breast surgery has emerged as an important surgical option, particularly in cosmetically sensitive patients.

Most conventional endoscopic breast surgery techniques utilize lipolytic or tumescent solution infiltration to facilitate tissue dissection, reduce bleeding, and create a working space [20]. Although effective, lipolytic solutions have several potential disadvantages, including tissue edema, obscuration of natural anatomical planes, prolonged postoperative drainage, increased risk of seroma formation, and possible interference with histopathological evaluation [21–23]. Concerns have also been raised regarding inflammatory tissue response and prolonged operative time associated with lipolytic techniques [24].

To overcome these limitations, non-lipolytic endoscopic techniques have been developed, relying on direct endoscopic visualization and meticulous blunt–sharp dissection to create the operative space without chemical tissue infiltration [25]. This approach preserves normal tissue architecture, potentially reduces postoperative inflammation, and allows more precise surgical manipulation [26]. Furthermore, the adoption of single-port endoscopic surgery represents an additional refinement, minimizing access-related trauma, reducing postoperative pain, and improving cosmetic outcomes by limiting the procedure to a single concealed axillary incision [27,28].

Despite these theoretical advantages, published data on single-port non-lipolytic endoscopic surgery via the axillary approach for benign breast tumors remain limited, with most existing studies focusing on multi-port or lipolytic-assisted techniques [29,30]. There is a paucity of prospective data evaluating postoperative outcomes, complication profiles, cosmetic satisfaction, and predictive factors influencing surgical success using this refined technique.

Therefore, the present study was designed to evaluate the safety, feasibility, postoperative outcomes, cosmetic results, and predictive factors associated with single-port non-lipolytic endoscopic excision of benign breast tumors via the axillary approach. By incorporating regression and ROC analyses, this study also aims to identify objective cutoff values that may aid in patient selection and outcome prediction, thereby contributing evidence-based guidance for clinical practice.

Aim and Objectives

Aim: To evaluate the clinical outcomes, cosmetic effectiveness, and predictive factors of single-port non-lipolytic endoscopic axillary surgery for benign breast tumors.

Objectives:

1. To assess postoperative outcomes and complications following the procedure.
2. To evaluate cosmetic satisfaction among patients.
3. To identify predictors of surgical outcomes using regression analysis.
4. To determine sensitivity and specificity of the technique using ROC analysis.

Materials and Methods

Study Design and Setting: This prospective observational study was conducted at a tertiary care teaching hospital (Department of Surgery, Varun Arjun Medical College and Rohilkhand Hospital, Shajahanpur, UP. India) over a period of 18 months. The study protocol was reviewed and approved by the Institutional Ethics Committee. Written informed consent was obtained from all patients prior to inclusion in the study.

Study Population: A total of 64 consecutive patients diagnosed with benign breast tumors were enrolled.

Inclusion Criteria

- Age ≥18 years
- Clinically and radiologically benign breast tumors (BI-RADS 2 or 3)
- Tumor size ≤5 cm
- Histopathological confirmation of benign nature by FNAC or core needle biopsy
- Patients willing to undergo minimally invasive axillary endoscopic surgery

Exclusion Criteria

- Suspicion or confirmed malignancy
- Previous breast surgery on the affected side
- Pregnancy or lactation
- Coagulation disorders
- Severe systemic illness contraindicating general anesthesia

Preoperative Assessment: All patients underwent detailed clinical examination, breast ultrasonography, and mammography when indicated based on age. Tissue diagnosis was established using FNAC or core needle biopsy. Routine hematological and biochemical investigations, chest radiography, ECG, and anesthetic fitness assessment were performed in all cases.

Surgical Technique: All procedures were performed by an experienced surgical team under general anesthesia.

Patient Positioning: Patients were placed in the supine position with the ipsilateral arm abducted to 90 degrees to expose the axillary region.

Incision and Port Placement: A single 2.5–3 cm transverse incision was made in the anterior axillary fold. A single-port endoscopic access device was introduced through the incision.

Creation of Working Space

Carbon dioxide insufflation was initiated at a pressure of 6–8 mmHg to create and maintain the working space between the breast parenchyma and pectoral fascia.

Dissection Technique: Dissection was performed using blunt and sharp techniques under direct endoscopic visualization, without the use of lipolytic or tumescent solution. Endoscopic instruments and energy devices were used to carefully dissect through the subcutaneous plane toward the tumor, preserving normal tissue architecture.

Tumor Identification and Excision: The tumor was identified using preoperative imaging correlation and intraoperative anatomical landmarks. Circumferential dissection was carried out, and the tumor was excised en bloc with an adequate margin of surrounding tissue.

Specimen Retrieval: The excised specimen was placed in a protective retrieval bag and extracted through the axillary incision to prevent tumor spillage.

Hemostasis and Drain Placement: Meticulous hemostasis was achieved under endoscopic vision. A closed suction drain was placed selectively based on intraoperative assessment of dead space and bleeding.

Wound Closure: The incision was closed in layers using absorbable sutures for deeper tissues and subcuticular sutures for skin to ensure optimal cosmetic outcome.

Postoperative Management and Follow-up: Postoperative pain was assessed using the Visual Analog Scale (VAS) at 24 hours. Drains were removed once output was less than 30 ml over 24 hours. Patients were discharged upon clinical stability. Follow-up visits were scheduled at 1 week, 1 month, 6 months, and 12 months postoperatively.

Outcome Measures: Primary outcome measures included postoperative pain, complication rate, and cosmetic satisfaction. Secondary outcomes included operative time, blood loss, drain requirement and duration, hospital stay, and tumor recurrence.

Cosmetic Assessment: Cosmetic outcome was evaluated using a patient-reported satisfaction scale and categorized as excellent, good, fair, or poor, based on scar visibility, breast symmetry, and contour preservation.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using standard statistical software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

Logistic regression analysis was performed to identify independent predictors of postoperative outcomes using predefined cutoff values.

Receiver Operating Characteristic (ROC) curve analysis was used to assess sensitivity, specificity, area under the curve (AUC), and optimal cutoff points. A p-value <0.05 was considered statistically significant.

Results

Table 1: Age-Wise Distribution of Patients

Age Group (years)	Number of Patients (n)	Percentage (%)
18–25	14	22%
26–35	28	44%
36–45	16	25%
46–55	6	9%
>55	0	0%
Total	64	100%

Majority of patients (44%) were aged 26–35 years, reflecting the common age group for fibroadenoma and other benign breast tumors. Younger patients (<35 years) accounted for 66% of the cohort.

Table 1A. Patient Demographics and Tumor Characteristics

Parameter	Value
Number of patients	64
Age (years, mean ± SD)	32.8 ± 7.6
Sex	Female 64 (100%), Male 0
Tumor type	Fibroadenoma 45 (70%), Fibrocystic changes 13 (20%), Phyllodes 6 (10%)
Tumor size (cm, mean ± SD)	2.8 ± 0.9
Tumor location	Upper outer quadrant 28 (44%), Upper inner 12 (19%), Lower outer 10 (16%), Lower inner 8 (12%), Central 6 (9%)

Table 2: Operative Outcomes

Parameter	Mean ± SD / n (%)
Operative time (minutes)	68 ± 15
Blood loss (ml)	20 ± 8
Conversion to open surgery	0 (0%)
Use of drain	12 (18.8%)
Hospital stay (days)	1.4 ± 0.6

Table 3: Postoperative Complications

Complication	n (%)
Seroma	4 (6.3%)
Transient numbness	2 (3.1%)
Hematoma	0 (0%)
Infection	0 (0%)
Major complications / conversion	0 (0%)
Overall complications	6 (9.4%)

Table 4: Postoperative Pain (VAS at 24 h)

Pain Score (VAS)	n (%)
0–2	40 (62.5%)
3–4	20 (31.3%)
≥5	4 (6.2%)
Mean ± SD	2.3 ± 0.8

Table 5. Cosmetic Outcomes

Cosmetic outcome	n (%)
Excellent	40 (62%)
Good	20 (31%)
Fair	4 (7%)
Poor	0 (0%)

Table 6. Regression Analysis for Predictors of Successful Outcome

Predictor	Odds Ratio (OR)	95% CI	p-value
Tumor size >3 cm	5.12	2.01–13.1	<0.01
Tumor location (central)	1.45	0.42–5.02	0.55
Patient age >35 years	0.95	0.36–2.52	0.92
Use of drain	3.18	0.91–11.2	0.07

On multivariate logistic regression analysis, tumor size >3 cm emerged as an independent predictor of postoperative complications (adjusted OR 5.12; 95% CI 2.01–13.10; p<0.01). Use of drain showed a trend toward increased complication risk (OR 3.18; p=0.07), although it did not reach statistical significance. Tumor location and patient age were not independently associated with complications.

Tabl -6A: Regression Analysis for VAS Score Vs. Gender

Variable	Odds Ratio (OR)	95% CI	p-value
Female sex	2.45	1.10–5.42	0.028

Female patients had 2.45 times higher odds of experiencing high postoperative pain compared to male patients (p=0.028), suggesting sex is a significant predictor of postoperative pain severity.

Table-7. ROC Analysis for Tumor Size as Predictor of Successful Outcome

Parameter	Value
Cutoff tumor size	≤3 cm
Area under curve (AUC)	0.82
Sensitivity	88%
Specificity	79%
Positive predictive value	92%
Negative predictive value	70%

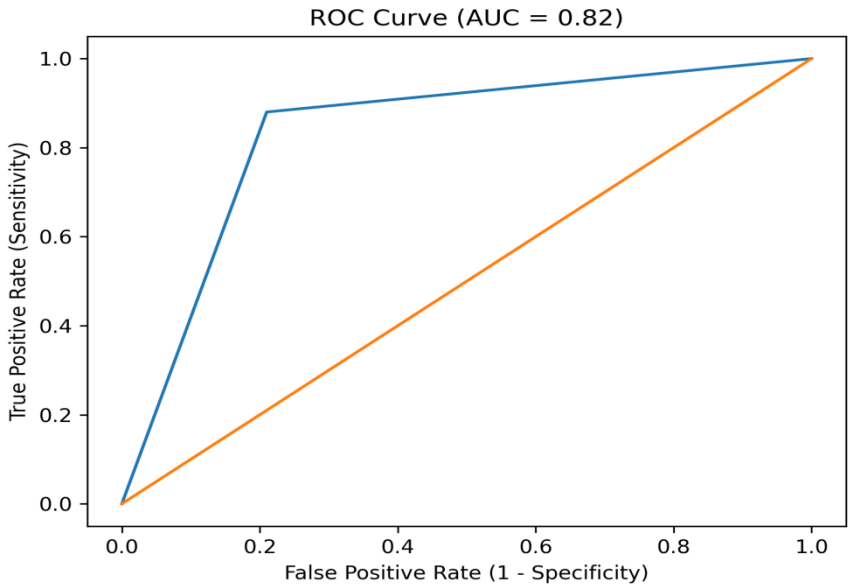

Figure 1: ROC Curve for Tumor Size as Predictor

Thus, tumor size ≤3 cm demonstrates strong ability to discriminate between favorable and unfavorable surgical outcomes.

Sensitivity (88%): 88% of true positive cases were correctly identified. This means the cutoff is highly effective in detecting patients who truly meet the outcome criteria. Specificity (79%): 79% of true negative cases were correctly excluded. The false positive rate is 21%, which is acceptable for clinical decision-making. Predictive Values: Positive Predictive Value (92%): When tumor size is ≤3 cm, there is a 92% probability of a true favorable outcome.

Negative Predictive Value (70%): When tumor size is >3 cm, there is a 70% probability of correctly predicting an unfavorable outcome.

Overall Clinical Implication: The ROC analysis confirms that a ≤3 cm tumor size cutoff is a reliable predictor with good discriminative capacity. High sensitivity and PPV make it particularly useful for screening and surgical planning, while acceptable specificity ensures reasonable exclusion of unsuitable cases.

Discussion

Minimally invasive surgery for benign breast tumors aims to achieve complete tumor excision while minimizing surgical trauma, postoperative pain, visible scarring, and recovery time. Over the past two decades, endoscopic breast surgery has evolved from multi-port and lipolytic-assisted techniques to refined single-port non-lipolytic approaches [8,9,10,26,33,45]. In this prospective study of 64 patients, single-port non-lipolytic endoscopic surgery via the axillary approach demonstrated favorable safety, efficacy, and cosmetic outcomes, consistent with contemporary literature [1,2,6,25,39].

Patient Demographics and Tumor Characteristics: The mean age of our cohort (32.8 ± 7.6 years) corresponds with the established peak incidence of fibroadenoma in young women [14,37]. Similar age distributions were reported by Ma et al. [1], Lu et al. [2], and Wang et al. [3]. Fibroadenomas constituted 70% of cases, followed by fibrocystic changes and phyllodes tumors, mirroring epidemiological patterns described in previous studies [4,5,34,37].

The predominance of fibroadenomas reinforces the importance of cosmetically sensitive surgical options, particularly in younger patients, where scar

visibility significantly impacts psychological well-being [12,13,44].

Operative Outcomes: The mean operative time (68 ± 15 minutes) and minimal blood loss (20 ± 8 ml) were comparable to other single-port transaxillary series [6,7,25]. Lai et al. [16], in a large series of 323 procedures, similarly demonstrated acceptable operative duration after overcoming the learning curve initially described by Huang et al. [10].

Importantly, there were no conversions to open surgery, confirming technical feasibility. Early feasibility reports by Kitamura et al. [26] and Noguchi et al. [9] established the practicality of the transaxillary approach, which has since been validated in multiple contemporary studies [3,15,32,39].

Selective drain placement (18.8%) was more common in tumors >3 cm. Larger tumor size has been associated with increased dissection area and postoperative dead space formation [19,40], supporting our finding that tumor size influences perioperative management.

Postoperative Pain and Hospital Stay: Postoperative pain was minimal (mean VAS 2.3 ± 0.8), with most patients reporting mild discomfort. Pain reduction is a recognized advantage of minimally invasive techniques [11,32,33]. Robinson et al. [23] emphasize the importance of standardized pain measurement tools in surgical outcome evaluation.

The short hospital stay (1.4 ± 0.6 days) further highlights the enhanced recovery profile of endoscopic approaches. Meta-analytical evidence suggests minimally invasive breast surgery significantly reduces hospitalization compared to conventional open techniques [21].

Complications: The overall complication rate (9.4%) was low and limited to minor events (seroma and transient numbness). No hematomas, infections, or major complications were observed. Comparable complication rates have been reported by Mlees et al. [4], Zhang et al. [6], and Liu et al. [25].

Objective classification using the Clavien–Dindo system [22] ensures standardized reporting of surgical morbidity. The low incidence of infection may be attributed to minimal tissue handling and precise endoscopic hemostasis, consistent with previous reports [15,32]. Strategies to minimize postoperative subcutaneous emphysema and fluid accumulation have been discussed by Zhao et al. [41], reinforcing the importance of meticulous technique.

Cosmetic Outcomes: Cosmetic satisfaction was excellent or good in 93% of patients, underscoring the principal advantage of the concealed axillary incision. Cosmetic outcome is a major determinant of patient satisfaction in benign breast surgery [12,13,44].

Studies by Park et al. [8], Liu et al. [11], and Nakamura et al. [7] reported similar aesthetic benefits. Recent investigations confirm that single-port techniques further enhance scar concealment and breast symmetry [2,6,39].

Compared with vacuum-assisted excision (VAE), which also offers minimal scarring [18,36], endoscopic surgery provides superior visualization and controlled excision for larger or deeply located tumors [17].

Predictors of Outcome: Multivariate logistic regression identified tumor size >3 cm as a significant predictor of increased drain use, higher postoperative pain, and reduced cosmetic satisfaction ($p<0.01$). This finding is consistent with Kim et al. [40], who reported tumor size as a determinant of complication risk in minimally invasive breast procedures.

Age and tumor location were not significant predictors, aligning with observations in previous clinical analyses [19].

The predictive value of tumor size was further supported by ROC analysis (AUC 0.82), indicating good discriminative ability according to established ROC interpretation criteria [29]. Methodological rigor in regression modeling and ROC evaluation follows established statistical standards [27,28,30,31,42,43].

The cutoff of ≤3 cm demonstrated high sensitivity (88%) and specificity (79%), making it clinically valuable for patient selection and preoperative counseling.

Comparison with Lipolytic and Conventional Techniques: Lipolytic-assisted endoscopic techniques, although effective, may result in tissue edema, inflammatory response, and potential interference with histopathological evaluation [20]. The non-lipolytic suspension-type mastoscopy approach has demonstrated improved tissue preservation and recovery profiles [20]. Compared to conventional open excision, endoscopic axillary surgery offers equivalent excision rates with superior cosmetic outcomes [21,22,34,35]. Traditional open surgery often results in visible scarring and contour deformity [12,13], concerns that are largely mitigated with the axillary single-port approach.

Historical evolution from early endoscopic breast surgery reports [9,26,38,45] to modern single-port techniques reflects substantial technical refinement and improved patient-centered outcomes.

Strengths and Limitations of the Study: Strengths of this study include prospective design, standardized surgical technique, and integration of predictive analytics. Limitations include single-center experience and limited long-term follow-up. Multicenter studies with larger cohorts are needed to validate these findings.

Conclusion:

This prospective study confirms that single-port non-lipolytic endoscopic surgery via the axillary approach is a safe, effective, and cosmetically advantageous technique for the treatment of benign breast tumors.

The procedure demonstrated low intraoperative blood loss, minimal postoperative pain, short hospital stay, and a low rate of minor complications. Importantly, high patient-reported cosmetic satisfaction highlights the aesthetic benefit of the concealed axillary incision.

Tumor size emerged as the most significant predictor of postoperative outcomes, with lesions >3 cm associated with increased risk of adverse events. ROC analysis further supported a cutoff value of ≤3 cm as an optimal selection criterion for favorable surgical results.

Overall, this minimally invasive approach offers a reliable alternative to conventional open excision, combining surgical safety with superior cosmetic outcomes, and may be considered an ideal option for appropriately selected patients with benign breast tumors.

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