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Endoscopic and Robotic Minimally Invasive Breast Surgery (MIBS) for Benign Breast Lesions: Our Experience of 80 Cases and Descriptive Comparison

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ABSTRACT

Objective: Minimally invasive breast surgery (MIBS) via an extramammary approach offers an alternative to conventional open lumpectomy, eliminating breast scarring and improving psychological outcomes in patients with benign breast lesions. While endoscopic MIBS (EMIBS) has been described, data on robotic MIBS (RMIBS) are sparse. We analyzed the clinical and cosmetic outcomes of EMIBS and RMIBS.

Materials and Methods: Eighty patients undergoing MIBS for benign breast lumps were divided into endoscopic (n = 40) and robotic (n = 40) groups. Primary endpoints included cosmetic outcomes [evaluated via Patient and Observer Scar Assessment Scale (POSAS) and BREAST-Q], total operative and docking times, and complications, which were statistically analysed (IBM SPSS Statistics version 30).

Results: Groups were comparable in age (p = 0.325), lesion size (median 2.0 *vs.* 2.75 cm; p = 0.247), and number of lumps (median 1 in both groups; p = 0.165). Operative time analysis showed that operative time was significantly longer in the robotic group (median 150 *vs.* 95 minutes; p<0.001). Complications were minor, self-resolving, and comparable across both groups (Fisher's exact p = 0.647). Cosmetic outcomes (at 1 month) were comparable between the two groups: median POSAS score 2 and median BREAST-Q score 88 (breast-conserving therapy module, satisfaction with breasts subscale). A subjective reduction in physical strain on the surgeon was noted in the robotic group; no objective ergonomic measurements were performed.

Conclusion: We demonstrate the feasibility and safety of both approaches for benign breast lesions, with comparable and favorable cosmetic outcomes, and with the robotic platform offering subjective improvement in ergonomic strain, especially in difficult-to-access medial quadrants. These findings are hypothesis-generating and require validation using instruments such as NASA-TLX or the Borg CR-10 scale in larger studies.

Keywords: Benign breast lumps; breast surgery; endoscopic breast surgery; minimally invasive breast surgery; robotic breast surgery

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KEY POINTS

- Our series of 80 patients provides insight into minimally invasive breast surgery (MIBS) and compares the two modalities—endoscopic and robotic—in the context of benign breast lesions.
- Both modalities offer comparable aesthetic outcomes and have similar complication profiles.
- Robotic MIBS is safe and feasible; despite having longer operating times, it offers relative subjective reductions in ergonomic strain.
- Robotic surgery provides wristed articulation, enabling dissection of difficult-to-access medial-quadrant lesions with relative ease.

Introduction

Benign breast lumps, including fibroadenomas, epithelial proliferation, and fibrocystic changes, are the most common breast pathologies in young women, with incidence peaking between the ages of 25 and 40. In India, 82% of premenopausal and 38% of postmenopausal women with breast lumps have benign breast disease (1). The 2025 American Society of Breast Surgeons (ASBrS) guidelines recommend excision for lesions exhibiting discordant imaging, substantive growth, a size >4−6 cm, or suspicion of phyllodes tumor (PT), and for symptomatic relief or patient preference.

Historically, open lumpectomy has been the standard of care, involving anterior access via periareolar, radial, or circular incisions and division of the breast parenchyma; although effective, this approach causes visible scarring, prolongs recovery, and results in patient dissatisfaction with cosmetic outcomes. A small subset will also have resultant breast asymmetry, especially when lumps are >5 cm (2, 3). Poorer aesthetic outcomes following traditional surgery for benign breast disease often lead to a desire for subsequent reconstructive surgery (3-5). Minimally invasive breast surgery (MIBS) employing endoscopic and robotic techniques has emerged as a potential alternative for addressing these limitations. MIBS was first described in 1995 (6), and developed in East Asia for the removal of benign and malignant tumors (7-10). Studies have reported excellent cosmetic outcomes and quality of life on subsequent follow-up, with minimal complications.

Despite the excellent cosmesis offered by MIBS, working within the confined retromammary space is technically challenging, because standard endoscopic instruments lack articulation, and 2D visualization limits depth perception, leading to suboptimal ergonomics and increased physical strain for the operator. The advent of robotic surgery offers potential solutions to these limitations via 3D high-definition visualization, tremor filtration, and instruments with seven degrees of freedom.

Studies comparing endoscopic and robotic approaches have predominantly discussed nipple-sparing mastectomy (NSM) (11, 12). Limited data exist on robotic breast lumpectomy for benign disease, and comparisons between endoscopic MIBS (EMIBS) and robotic MIBS (RMIBS) are sparse. This study aims to evaluate patients undergoing EMIBS and RMIBS, analyze cosmetic efficacy, perioperative safety, and operative times, and detail our experience with surgeon ergonomics across the 2 modalities.

Materials and Methods

A comparative study analyzed 80 female patients who underwent MIBS for benign breast lesions. The cohort was divided into two groups: endoscopic ($n = 40$) and robotic ($n = 40$). Allocation was done temporarily: we performed EMIBS exclusively until the acquisition of a surgical robot; thereafter, we performed only RMIBS. Group assignment was not determined by randomization, patient preference, surgeon case selection, or lesion size. The study was approved by the Institutional Ethics Committee of St John's Medical College Hospital (IEC no: IEC/1/1246/2025; IEC study ref no: 175/2025; date: 10 September 2025) and written informed consent was obtained from the patients.

Patients aged 18 years and above who underwent MIBS in the department of surgical oncology at our institute for benign breast lumps (confirmed by ultrasound and fine-needle aspiration cytology) were included in the study. Patients undergoing MIBS for malignant etiologies, including robotic NSM, and patients under 18 years were excluded, as were cases of minimally invasive Hadfield's procedure. Inclusion criteria were aligned with 2025 ASBrS guidelines for benign fibroepithelial lesion (FEL) excision (13).

All procedures were performed under general anesthesia by a single surgeon (R.S.R.). Our technique involved a 4-cm axillary incision parallel to the midaxillary line and the creation of working space after identification of the lateral borders of the latissimus dorsi and the pectoralis major, which serve as major landmarks for appropriate placement of the access port to ensure ergonomic placement (Figure 1b). The GelPoint Advanced Access Platform (Applied Medical, Inc., Rancho Santa Margarita, CA, USA) was inserted to facilitate single-incision endoscopic surgery. Lumpectomy was performed after development of the prepectoral plane, either endoscopically or robotically. We used the Stryker 1588 platform (Stryker Corp., Kalamazoo, MI, USA) for EMIBS, along with a 30-degree, 10-mm camera, a laparoscopic monopolar spatula, and a grasper. RMIBS was performed using the DaVinci X platform (Intuitive Surgical, Sunnyvale, CA, USA), and we used monopolar hot shears, fenestrated bipolar, and a 0-degree endoscope (Figures 1c, 1d). Indocyanine green (ICG)

was administered, and the FireFly mode on the DaVinci platform was used to visualize the lesion boundaries. Specimen extraction was followed by hemostasis, lavage, and layered wound closure (Figure 1e). A sterile pressure dressing was applied and was changed on postoperative day 2.

Primary endpoints included cosmetic outcomes at 1 month, operative time, blood loss, and complications. Operative time was measured in minutes from skin incision to closure. For RMIBS, total operative time was subdivided into the docking time and console time. Cosmetic outcomes were evaluated at 1 month postoperatively using the Patient and Observer Scar Assessment Scale (POSAS) for scar quality and the BREAST-Q questionnaire (breast conservation therapy module, satisfaction with breast subscale) for breast satisfaction. Observer POSAS scoring was not blinded with respect to surgical modality, as blinding was not feasible in this single-surgeon, single-centre retrospective setting. Only the satisfaction with breast subscale was administered, because it most directly captured our aesthetic endpoint of interest, satisfaction with breasts after MIBS. Follow-up was recorded for 6 months postoperatively; patients who had not yet reached the 6-month follow-up were treated as censored observations. Subjective assessment of physical strain on the surgeon and ergonomic difficulty were recorded.

Statistical Analysis

Data were entered into an Microsoft Excel file and statistically analyzed using IBM SPSS Statistics version 30 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Kolmogorov-Smirnov test and described in terms of range; mean ± standard deviation, median (interquartile range), frequencies (number of cases) and relative frequencies (percentages) as appropriate. Quantitative variables were compared using the Student's t-test for independent samples for parametric data and the Mann-Whitney U test for independent samples for non-parametric data, respectively, along with 95% confidence intervals (CIs) (Hodges-Lehman estimator for non-parametric and Welch correction for parametric comparisons). Categorical variables (complications) were compared with Fisher's exact test. Operative time was compared only between unilateral procedures (n = 38 endoscopic, n = 36 robotic) because bilateral cases involve two separate lesion excisions and are not directly comparable. Bilateral cases (n = 6; 2 endoscopic, 4 robotic) were retained in the overall cohort and reported descriptively. To address potential confounding by lesion size and to mitigate the possibility of bias (especially since the surgeon gains considerable experience with endoscopic technique before beginning the robotic cases), multivariable linear regression was performed for unilateral cases, with a 1:1 nearest-neighbour propensity-score-matched analysis for confirmation. Because allocation was strictly temporal, surgeon experience was structurally collinear with modality and could not be entered as an independent covariate; matching and regression therefore addressed confounding by lesion size rather than temporal drift and were interpreted as sensitivity analyses. Follow-up was analysed using Kaplan-Meier estimation and the log-rank test, accounting for ongoing follow-up in the more recently operated robotic cohort. A two-tailed $p<0.05$ was considered statistically significant.

Results

Eigthy patients were included (n = 40 endoscopic; n = 40 robotic). Age (mean 36.00±9.47 *vs.* 38.28±11.03 years; p = 0.325; 95% CI −6.85 to +2.30), lesion size (median 2.0 *vs.* 2.75 cm; p = 0.247), and number of lumps (median 1 in both groups; p = 0.165) were comparable across both groups. A total of 6 bilateral procedures were performed (2 endoscopic, 4 robotic) and excluded from the operative-time comparison. Among unilateral cases (n = 38 endoscopic, n = 36 robotic), operative times were significantly longer in the robotic group (median 150 *vs.* 95 minutes; $p<0.001$, 95% CI −65 to −35 min). After adjusting for lesion size, RMIBS remained independently associated with longer operative time (+42.8 min; 95% CI, 26.1–59.5; $p<0.001$); lesion size was not significant (p = 0.379). A propensity-matched analysis was concordant, showing a mean difference of +43.9 min (95% CI 25.9–62.0; $p<0.001$). In the robotic group, mean docking time was 11.60±4.18 minutes (n = 40, range 5–20). Systematic recording of console time commenced from the 14th case and was captured in 21 of the subsequent 27 procedures; the recorded values therefore derive disproportionately from later cases and averaged 80.29±42.96 minutes (range 23–170) (Table 1). Comparison of operative times between the first and last 19 unilateral endoscopic cases and the first and last 18 robotic unilateral consecutive cases showed no significant difference (endoscopic median 95 *vs.* 95 min; p = 0.735; robotic median 152 *vs.* 150 minutes; p = 0.27). Estimated blood loss was less than 30 mL in all cases, and no conversions to open surgery occurred.

Cosmetic outcomes at 1 month were comparable between groups: POSAS observer score median 2 in both groups (mean 1.80±0.69 *vs.* 1.70±0.61; p = 0.548); BREAST-Q satisfaction with breast score median 88 in both groups (mean 88.50±6.29 *vs.* 90.50±5.97; p = 0.100) (Table 1, Figures 1a, 1f- 3).

Overall, 42.5% of patients in the endoscopic group (n = 17) and 35% of patients in the robotic group (n = 14) experienced at least one complication (Fisher's exact p = 0.647) (Table 2). Minor complications included transient peri-incisional numbness (endoscopic n = 3, 7.5%; robotic n = 4, 10%), mild bruising (endoscopic n = 5, 12.5%; robotic n = 5, 12.5%), and subcutaneous emphysema (endoscopic n = 7, 17.5%; robotic n = 6, 15%), all resolving spontaneously (Clavien-Dindo I). In the endoscopic subgroup, One patient each developed a skin burn of the breast,

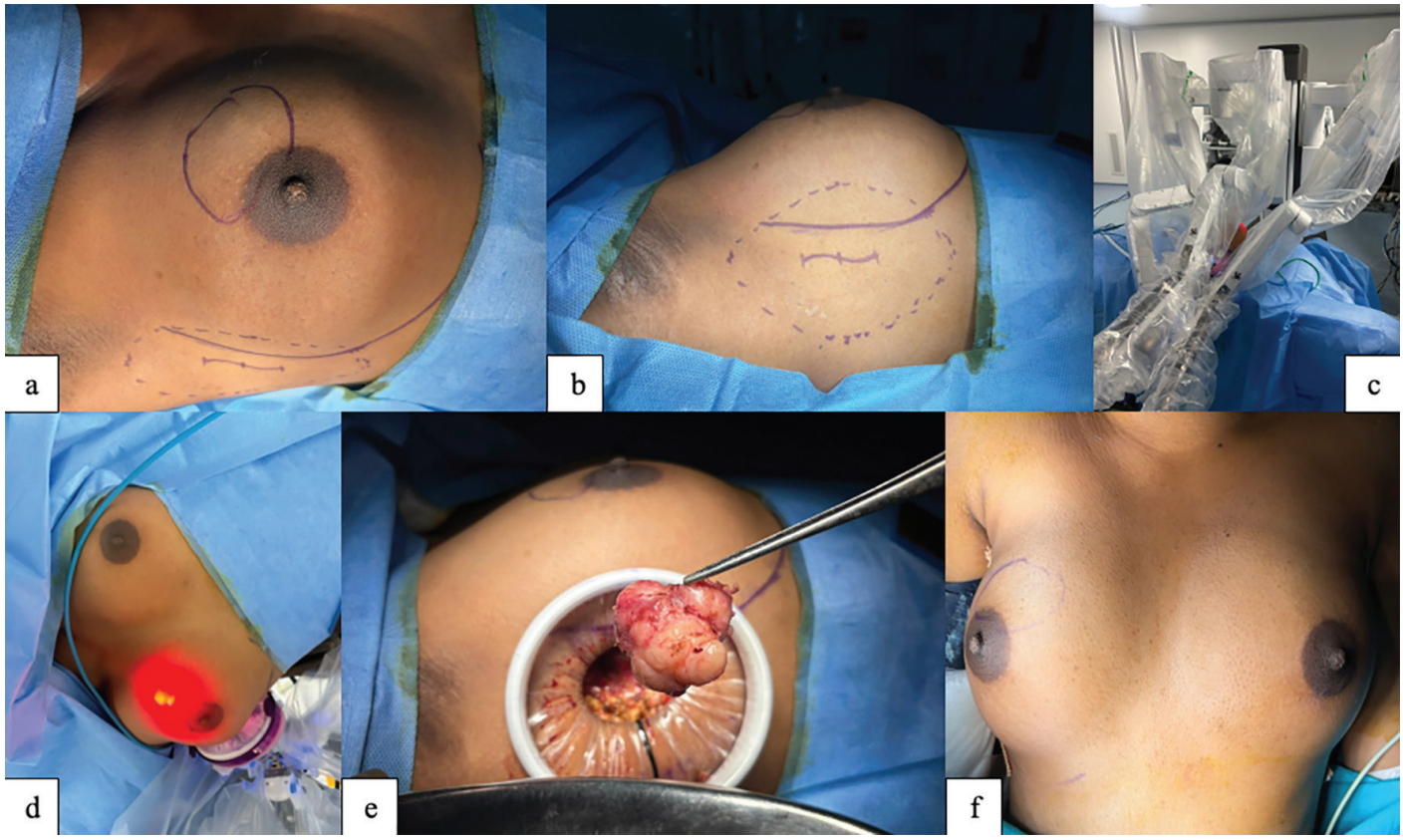

Figure 1. a) Preoperative photograph before RMIBS. b) Incision and markings for RMIBS. c) Robotic docking setup for RMIBS. d) Intraoperative photograph of dissection via GelPoint Access port in RMIBS. e) Lumpectomy with specimen retrieval via GelPoint Access port during RMIBS. f) Immediate postoperative outcome after RMIBS

RMIBS: Robotic minimally invasive breast surgery

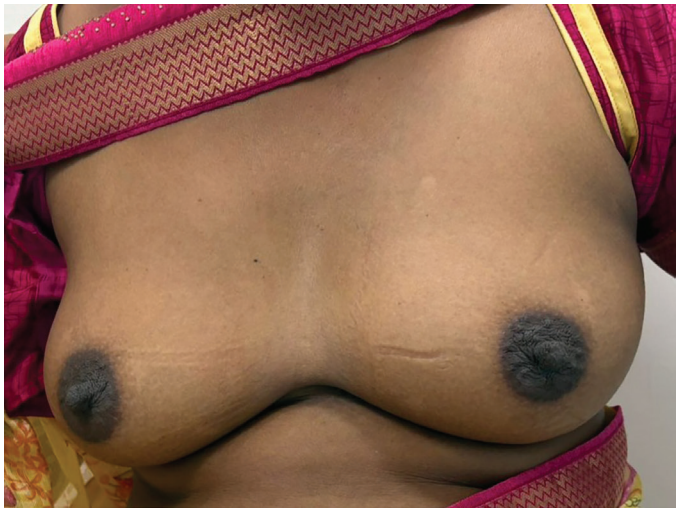

Figure 2. One month postoperative appearance after RMIBS

RMIBS: Robotic minimally invasive breast surgery

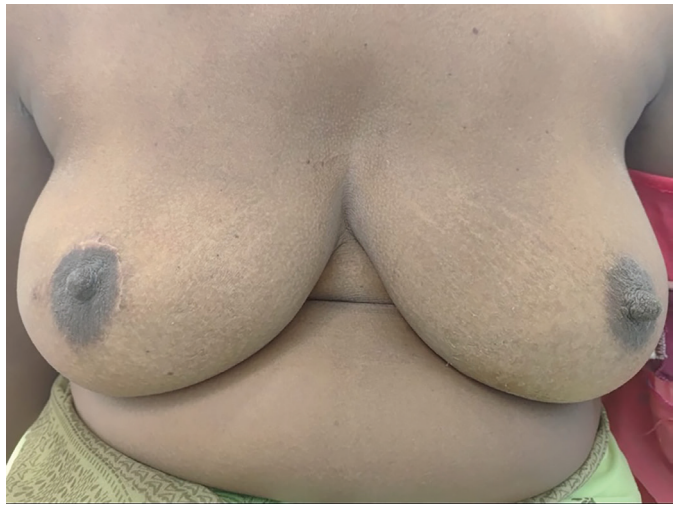

Figure 3. Six month postoperative appearance after EMIBS

EMIBS: Endoscopic minimally invasive breast surgery

Table 1. Patient, lesion characteristics, operative time and cosmetic outcomes data

Variable	Endoscopic (*n* = 40)	Robotic (*n* = 40)	*p*	Effect size (95% CI)
Age (years), mean ± SD	36.00±9.47	38.28±11.03	0.325	Mean diff −2.28 (−6.85 to +2.30)
Lesion size (cm), median (IQR)	2.0 (2.0–3.0)	2.75 (2.0–3.5)	0.247	—
Number of lumps, median (range)	1 (1–3)	1 (1–3)	0.165	—
Laterality, *n* (%)			0.457	
Right	22 (55.0)	17 (42.5)		
Left	16 (40.0)	19 (47.5)		
Bilateral	2 (5.0)	4 (10.0)		
Operative time (min) in unilateral cases[a]	*n* = 38 Mean: 103.42±35.55 Median: 95 (IQR 80–115)	*n* = 36 Mean: 147.78±34.59 Median: 150 (IQR 130–169)	<0.001	(−65 to −35 min)
Operative time (min), adjusted for lesion size	—	—	<0.001	+42.8 min (26.1 to 59.5)
Operative time (min), full cohort[b]	*n* = 40 109.25±45.96	*n* = 40 157.88±46.49	—	—
Docking time (min), mean ± SD	—	*n* = 40 11.60±4.18 range 5–20	—	—
Console time (min), mean ± SD[c]	—	*n* = 21 80.29±42.96 range 23–170	—	—
POSAS observer score	Mean: 1.80±0.69 Median: 2 (IQR 1–2)	Mean: 1.70±0.61 Median: 2 (IQR 1–2)	0.548	−0.19 to +0.39
BREAST-Q score	Mean: 88.50±6.29 Median: 88 (IQR 88–88)	Mean: 90.50±5.97 Median: 88 (IQR 88–97)	0.100	−4.72 to 0.72

SD: Standard deviation; IQR: Interquartile range; CI: Confidence interval; POSAS: Patient and Observer Scar Assessment Scale. Groups were comparable with respect to all baseline patient and lesion characteristics. Bilateral cases excluded from operative-time comparison (*n* = 2 endoscopic, *n* = 4 robotic). [a]: The adjusted difference from a multivariable linear regression (operative time modelled on modality and lesion size) in unilateral cases (*n* = 74) showed that lesion size was not a significant predictor (*p* = 0.379). A 1:1 nearest-neighbour propensity-score-matched analysis yielded concordant results (+43.9 min; 95% CI 25.9 to 62.0; *p<0.001);* [b]: Descriptive only; no statistical comparison performed on the full cohort given the inclusion of bilateral cases; [c]: Console time was systematically recorded for 21 of 40 robotic cases

Table 2. Complications (Clavien-Dindo Grade I)

Complication	Endoscopic *n* (%)	Robotic *n* (%)	Fisher's exact *p*
Peri-incisional numbness	3 (7.5)	4 (10.0)	1.00
Bruising	5 (12.5)	5 (12.5)	1.00
Subcutaneous emphysema	7 (17.5)	6 (15.0)	1.00
Seroma	1 (2.5)	0 (0.0)	1.00
Skin Burn	1 (2.5)	0 (0.0)	1.00
Neuropraxia	1 (2.5)	0 (0.0)	1.00
Hematoma	0 (0.0)	0 (0.0)	—
Infection	0 (0.0)	0 (0.0)	—
Any complication, per patient	17 (42.5)	14 (35.0)	0.647

a seroma after 3 months, and immediate neuropraxia of the ipsilateral upper limb. There were no significant differences between groups for any individual complication type ($p \geq 1.00$, all types). No infections or hematomas occurred.

Kaplan-Meier estimate of follow-up duration showed a mean follow-up of 6.00 months (95% CI, 6.00–6.00) in the endoscopic group and 5.70 months (95% CI, 5.36–6.04) in the robotic group, with the difference reflecting censored observations among recently operated robotic patients. (log-rank comparison $p = 0.397$).

The final histopathologic analysis showed benign pathology in all patients, with comparable profiles across both groups (Fisher-Freeman-Halton $p = 0.985$). Fibroadenoma (simple or with associated fibrocystic changes) was the most common histopathologic diagnosis (endoscopic group: 77.5%, $n = 31$; robotic group: 72.5%, $n = 29$). Benign phyllodes tumour was present in 5 patients (endoscopic group-5%, $n = 2$; robotic group-7.5%, $n = 3$) (Table 3).

Table 3. Histopathology distribution

Histopathology	Endoscopic *n* (%)	Robotic *n* (%)	Total *n* (%)
Fibroadenoma	26 (65.0)	24 (60.0)	50 (62.5)
Fibroadenoma with fibrocystic changes/ adenosis	5 (12.5)	5 (12.5)	10 (12.5)
Fibrocystic disease	5 (12.5)	5 (12.5)	10 (12.5)
Other benign[1]	2 (5.0)	3 (7.5)	5 (6.3)
Phyllodes tumour (benign/ borderline)	2 (5.0)	3 (7.5)	5 (6.3)
Total	40 (100)	40 (100)	80 (100)

[1]: Other benign lesions include pleomorphic adenoma, intraductal papilloma (with fibrocystic change), granulation/inflammation, fibrosis with calcification, and fibroadenoma with foci of usual ductal hyperplasia. All 80 patients had benign disease on final histopathology

Discussion and Conclusion

The 2025 ASBrS and the Society of Breast Imaging guidelines for management of benign FELs (13) include the following indications for fibroadenoma excision: 1) discordant imaging, 2) patient preference or symptoms, 3) concern for a PT, 4) size >4 to 6-cm, and 5) substantive growth over time. Lesions called FEL on core biopsy, with histologic or clinical suspicion for PT, should be excised without transection but do not require a negative surgical margin. They suggest that surgical planning for all breast lesions should consider aesthetics, future breastfeeding, sensory implications, and the consequences of potential final pathology. Conventional open lumpectomy techniques cause scarring over the breast, leading to cosmetic deformities, asymmetry, and even a desire for subsequent reconstruction.

The evolution of breast surgery is increasingly defined by the dual imperatives of oncologic safety and aesthetic preservation; moving the incision to extramammary sites changes the patient's psychological paradigm (8, 14). Eaves first reported endoscopic breast augmentation with excellent cosmesis (6). Kitamura et al. (8, 15) reported the first endoscopic surgery for benign breast lumps using 3 small mid-axillary line incisions, balloon dissection, CO_2 insufflation and tumor extirpation. Similar approaches for breast cancer and benign breast tumors have been reported, with good cosmetic results and concealed scars in the axilla (9, 14). Cheng et al. (10) described a periareolar endoscopic approach for giant juvenile fibroadenomas (5–10 cm) that involved a single incision, dissection of the tumor from the parenchyma, specimen retrieval in a bag (intact or morcellated) tumor removal. Oncoplastic techniques have been applied to juvenile giant fibroadenoma to limit contour deformity after excision of large lesions (16), underscoring that aesthetic consequences of open excision recur across lesion size. The extramammary approach addresses the same concerns by a different route. In the Indian context, Bipte et al. (17) recently established feasibility and safety in 5 cases (6 breasts) for endoscopic and robotic NSM, citing the need for further larger studies with a longer duration.

Although the study lacked a comparative open lumpectomy group, the rationale for MIBS compared with conventional lumpectomy is discussed in the literature. Open lumpectomy is effective but produces a visible scar on the breast, carries a risk of contour deformity and asymmetry, especially for lesions >5 cm, and is associated with measurable dissatisfaction with the cosmetic outcome, sometimes prompting reconstruction (2-5). Extramammary approaches place incisions in the axilla, and series using endoscopic techniques have reported favorable cosmesis and quality-of-life outcomes (6-10). Shorter operative times for open lumpectomies (44.1 min–70.28 mins) (18-20) should be weighed against the cosmetic and psychological benefits of avoiding a scar on the breast itself, which is the main rationale for adoption of either modality of MIBS. This value increased as we transitioned to EMIBS (95 mins) and RMIBS (150 mins). RMIBS in our study is characterized by extended operative time owing to additional time for docking, instrument changes, and camera cleaning caused by fogging from inadequate smoke evacuation. The actual console operating time (dissection and enucleation) was efficient, though it was not sufficiently fast to offset the initial docking duration. Temporal allocation raised the possibility of bias, especially since the surgeon had already gained experience with the endoscopic technique; regression analyses and propensity score matching were performed. Despite this transferred experience, The higher robotic times reflect the statistical significance of the operative time finding. However, a contribution of prior experience to other outcomes cannot be excluded. In high-volume surgical practices, time is a critical resource, and the addition of 15–20 minutes for setup and docking cannot be ignored. Longer operative time has practical implications, including increased turnover time due to docking, undocking, and moving the robot away, and it affects operating room efficiency and scheduling, potentially reducing the number of cases per list. Breast-specific differs from docking for abdominal or pelvic surgeries. However, docking times decrease as the surgeon, assistants, and staff gain experience and familiarity with the procedure. Our mean console time was 80.29±42.96 minutes. Lian et al. (21) and Hung et al. (22) have reported a learning curve of 17 cases for endoscopic transaxillary approach, and significant reduction in operative time as surgical experience increases. In our statistical analysis, a learning-curve effect was not observed in either the endoscopic or the robotic series. Yet, larger volumes may reveal one over a longer timeframe. In our experience, EMIBS was associated with greater subjective physical strain, instrument damage, and gas leaks due to frequent manipulation; these complications were absent in robotic series, which benefited from the relative ease

of dissection in medial quadrants with wristed instrumentation and ergonomic seating of the surgeon, as well as from reduced access port damage owing to diminished manipulation and instrument torque.

In our experience in EMIBS, the benefit of tactile feedback from palpation was negated by reduced working space, gas leaks, reduced visualization due to inadequate smoke evacuation, and reduced skin-to-cautery distance. In RMIBS dissection, ICG guidance facilitated the dissection and reduced palpation, preserving the working space. Learning to operate without palpatory guidance, relying solely on 3D visualization, formed the principal part of our robotic learning curve. Once it was overcome, medial quadrant dissection was performed with relative ease.

While both techniques safely achieved complete lesion removal, in our experience the robotic platform facilitated meticulous dissection through magnified 3D-visualization and wristed articulation in the narrow, dome-like retromammary space which restricts rigid, straight endoscopic instruments, as shown by Branco et al. (23) The robotic cohort demonstrated the feasibility of performing larger lumpectomies with relative ease, as lesion size was not significant in the regression analysis; increased operating time is intrinsic to the platform and the workflow, not a function of lesion size. Endoscopic breast surgery is ergonomically difficult, forcing the surgeon to operate with elevated arms and rotated wrists in non-neutral positions, particularly in medial quadrant lesions; these positions may contribute to strain and fatigue. The robotic console enabled the surgeon to operate in a seated, optimized posture, with tremor filtration and motion scaling, which were perceived to reduce the effort of fine dissection in a constrained space. Thus, reduced musculoskeletal fatigue and subjective physical strain were reported by the surgeon. However, this observation reflects the experience of a single surgeon and requires formal validation using the NASA-TLX or the Borg CR-10 scale before firm conclusions about ergonomic benefits can be drawn.

Minor complications were similar across both modalities. The modality does not affect complications; thus, any potential benefits of RMIBS do not come at the expense of patient outcomes. Our experience mirrors the trial by Toesca et al. (24) where comlications (nipple-areolar complex or skin perfusion problems, tactile impairment, seroma, hematoma, reoperations, and infections) were comparable between robotic and conventional NSM.

Our cohort demonstrated good cosmetic outcomes at 1 month in both groups (POSAS observer score median 2; BREAST-Q score median 88, range 78–100; $p = 0.100$), primarily due to the complete absence of scars on the breast mound. The axillary incision healed well in all patients and remained completely concealed when the arm was at rest. Breast symmetry and nipple-areolar complex orientation were preserved uniformly across the 80 cases. These findings corroborate recent literature validating the cosmetically favorable results of extramammary approaches. Good cosmesis with an extramammary approach using the ABNSW grading method [breast asymmetry (A), breast shape (B), nipple shape (N), skin condition (S), and wound scars (W)] has been reported (9). Our experience confirms that the robotic platform does not require larger or more obtrusive access points than its endoscopic counterpart. At the same time, endoscopic surgery can be adopted in resource-constrained settings without access to a robot. Cosmetic satisfaction is achieved regardless of the technology used.

As in any healthcare innovation, barriers to adoption of RMIBS are influenced by resource allocation and cost (25). The use of robotic technology for benign pathologies warrants discussion of costs and requires justification. Robotic surgery entails substantial acquisition, maintenance, and consumable costs, as well as longer operative time, which should be weighed against potential benefits to surgeon ergonomics and patient-related outcomes. In resource-constrained settings, EMIBS, which achieves comparable outcomes without a surgical robot, may be a more pragmatic option. Robotic procedures in this series were performed on weekends in a dedicated operating room, reflecting local scheduling practice rather than a strategy evaluated for efficiency. Operating room throughput, turnover, case-per-list capacity, and therefore no conclusions regarding operating room efficiency or cost-effectiveness can be drawn from these data. Formal economic and workflow analyses are required before the additional operative time associated with RMIBS can be weighed against any proposed benefit.

Study Limitations

The study has several limitations: it is a retrospective, single-surgeon, single-center series, and the findings may not be generalizable. We lacked a concurrent open-surgery cohort, and the cosmetic advantage was inferred from the literature rather than directly demonstrated; we did not explicitly analyze the statistical superiority of MIBS over open surgery. Group allocation was strictly sequential; thus, surgeon experience is, by design, inseparable from modality. Regression and matching adjust for lesion characteristics but cannot account for temporal drift in operator proficiency, and therefore surgeon experience could not be modelled as a covariate. The operative-time difference is interpretable in one direction only: as the robotic group followed accumulated endoscopic experience, the longer robotic times are unlikely to reflect inexperience. For all other outcomes, a contribution from accumulated experience cannot be excluded. Bilateral cases ($n = 6$) were excluded from the

operative time comparison. Console time was not recorded for the first 13 robotic procedures; therefore, the reported values derive from later cases and the missingness is non-random, so console time should not be read as representative of the whole series. The ergonomic assessment was subjective and should be regarded as a preliminary observation; future studies using objective ergonomic assessment tools, such as NASA-TLX or similar instruments, are required. Formal analysis is also needed to ascertain the superiority of RMIBS in difficult-to-access medial-quadrant lesions. Relatively short follow-up periods (6 months) necessitate further studies to evaluate long-term cosmetic outcomes and patient-reported outcomes. Further studies are required to obtain a more comprehensive analysis of aesthetic outcomes, as only scar and breast satisfaction were analyzed, and the instruments used did not assess symmetry, contour, and volume. Cosmetic assessment was not blinded: observer POSAS scores were assigned by the authors, who were aware of the operative modality, and observer bias in favour of the newer technique cannot be excluded. The two groups did not differ on either cosmetic measure, which limits the practical consequences of this bias. Blinded or independent photographic assessments are warranted in future studies. Neither procedural cost nor operating room efficiency were formally measured in this study, both of which are required to justify RMIBS in the context of benign lumps. These limitations mean the study should be interpreted as exploratory and hypothesis-generating, rather than establishing superiority of either modality

Our study, which is among the larger series on the minimally invasive approach to benign breast lumpectomy, demonstrates the safety and feasibility of EMIBS and RMIBS for benign breast lumps in the Indian context. A descriptive comparison reveals comparable and satisfactory cosmetic results. EMIBS was associated with significantly shorter operative times than RMIBS. The robotic platform reduced subjective strain during assessment, especially in difficult-to-access medial quadrants, highlighting the need for further large-scale, prospective, multicenter studies comparing the two modalities to confirm the ergonomic advantages of robotic surgery using NASA-TLX or similar instruments and to include a cost-effectiveness analysis.

Ethics

Ethics Committee Approval: The study was approved by the Institutional Ethics Committee of St John's Medical College Hospital (IEC no: IEC/1/1246/2025; IEC study ref no: 175/2025; date: 10 September 2025).

Informed Consent: Written informed consent was obtained from the patients.

Footnotes

Authorship Contributions

Surgical and Medical Practices: R.S.R., N.D., G.S., M.S., V.L.V.V., S.A., N.K.; Concept: R.S.R., N.D.; Design: R.S.R., N.D.; Data Collection and/or Processing: R.S.R., N.D., G.S., S.A., N.K.; Analysis and/or Interpretation: R.S.R., N.D., G.S.; Literature Search: R.S.R., N.D., G.S.; Writing: R.S.R., N.D., G.S., M.S., V.L.V.V.

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