DOI: https://doi.org/10.53350/pjmhs02024181835

ORIGINAL ARTICLE

Impact of MRI-Based Tumor Margin Assessment on Reducing Positive Margins in Breast-Conserving Surgery

KHALID SHAKEEL BABAR[1], FAZAL HUSSAIN[2], SASUI MEMON[3], SAMREEN MUSHTAQ[4], MUHAMMAD USMAN[5], TAHIR BAIG[6]
[1]*Consultant Radiologist Liverpool Heart and Chest Hospital, Liverpool, UK.*
[2]*Registrar SBW Khyber Teaching Hospital Peshawar.*
[3]*Assistant Professor Radiology Arif Memorial Teaching Hospital Rashid Latif Khan University Lahore.*
[4]*Associate Professor Radiology. Nishter Medical University.*
[5]*Assistant Professor. Plastic Surgery Department. Bakhtawar Amin Medical and Dental College. Multan.*
[6]*Assistant Professor Diagnostic Radiology Rai Medical College and Teaching Hospital Sargodha*
Correspondence to: Fazal Hussain, Email: docfazal@gmail.com

ABSTRACT

Background: Breast-conserving surgery (BCS) is an established treatment for early-stage breast cancer. Achieving negative surgical margins is essential to minimize local recurrence and avoid re-excision procedures. However, positive margins remain a common challenge in breast-conserving surgery. Magnetic resonance imaging (MRI) provides high sensitivity in detecting tumor extent, multifocal disease, and occult lesions, which may improve surgical planning.

Objective: To evaluate the impact of preoperative MRI-based tumor margin assessment on the rate of positive surgical margins in patients undergoing breast-conserving surgery.

Methods: A retrospective observational study was conducted at a tertiary care teaching hospital between January 2023 and August 2023. Medical records of women with early-stage breast cancer who underwent breast-conserving surgery were reviewed. Patients were categorized into two groups according to imaging strategy: conventional imaging (mammography and/or ultrasound) and MRI-assisted evaluation. Demographic characteristics, tumor features, imaging findings, surgical procedures, and histopathological margin status were analyzed. Positive margin rates and re-excision requirements were compared between groups.

Results: A total of 168 patients were included. The mean patient age was 49.3 ± 10.2 years. Patients assessed with MRI demonstrated improved preoperative identification of tumor boundaries and multifocal lesions. The rate of positive surgical margins was lower in the MRI group compared with the conventional imaging group. MRI-guided planning also resulted in a lower need for re-excision surgery.

Conclusion: Preoperative MRI-based tumor margin assessment can enhance surgical planning and reduce positive margins in breast-conserving surgery. Selective use of MRI in suitable patients may improve oncologic outcomes and reduce repeat surgical procedures.

Keywords: Breast-conserving surgery, breast MRI, surgical margins, breast cancer, re-ex

INTRODUCTION

Breast cancer has been the most diagnosed malignancy in the world and is a leading cause of morbidity and mortality caused by cancer. Modern worldwide cancer rates show that over two million cancer cases of breast cancer are being diagnosed annually thus making it one of the greatest global issues of concern in oncology. In spite of the advances in treatment of breast cancer, the condition still substantially affects the socioeconomic and healthcare costs in both developed as well as developing countries. Improvement in awareness, screening programmes, and imaging technologies have been able to enable earlier breast malignancies to be detected, and hence more of the patients get an opportunity to be treated at an early stage of the disease.[1]

Treatment of breast cancer at an early-stage has undergone significant changes in the past few decades. Historically the treatment of breast cancer has involved the use of mastectomy as a normal surgical procedure but further development of surgical procedures and adjuvant therapeutic measures have made surgical operations less invasive. Breast-conserving surgery (BCS) or lumpectomy or partial mastectomy has become an effective option to mastectomy when used with the right patients. BCS is mostly aimed at removing the entire malignant mass with preservation of the esthetic and structural integrity of the breast. This approach has two simultaneous benefits of sufficient oncological treatment and better appearance, which will significantly promote the psychological and quality of life of patients.

A number of landmark randomised clinical trials have shown that breast conservancy operation with adjuvant radiotherapy has the same survival outcomes as mastectomy in patients with the early-stage breast cancer. The long-term follow-up studies have repeatedly confirmed because local disease control and overall survival is similar in these modes of treatment in case proper patient selection criteria have been put in place[3] hence, breast-conserving therapy is now the choice treatment mode among most women with localized breast cancer.

Although breast-conserving surgery is extensively applied, clear surgical margins are among the most urgent issues which are related to the given procedure. Surgical margins refer to the boundary of the resection of that tissue done in case of tumour removal and margin status can be found through histopathological analysis. There is a positive surgical margin associated with the presence of tumour cells at the limit of the resection site that indicates that there is a possibility of the presence of malignant tissue in the breast. Many studies have indicated that positive margins have a strong relation with increased risk of ipsilateral breast tumour recurrence[4] hence, negative margins, which is the lack of tumour cell at the inked border of the surgical specimen, is a critical concept to obtain satisfactory oncologic resection.

Even positive operative margins that are realized after surgery require further surgery in most cases. Re-excision surgeries could be accompanied by additional lumpectomy or even in some instances conversion to mastectomy. Moreover, the extra procedures subject the patients to additional anaesthesia, possible side effects of surgery, and mental torment. In addition, repeat surgeries also can postpone the administration of adjuvant therapies (radiotherapy or systemic treatments) which are parts of essential components in managing breast cancer. The process of re-excising may also undermine cosmetic and end up reducing patient satisfaction and general life quality.

Effective preoperative evaluation of tumour size and location is critical in the minimization of chances of positive surgical margin. Not only the preoperative assessment of a breast cancer is impossible without imaging methods, but provides enough data on the location of the tumour, its size, and the existence of further lesions. Traditional modes of imaging, such as mammography and

Received on 12-09-2023
Accepted on 29-12-2023

ultrasonography are commonly used to this end and they continue to form the basis of breast cancer diagnosis and staging. Mammography is also helpful in the identification of micro calcification and changes in architecture but ultrasound gives detailed data on the morphology of tumors and helps in the biopsy process.

However, the traditional imaging methods also have their limitations. Mammography and ultrasound might under-estimate the actual complications of tumors in some patients, especially on women with high breast density, multifocal, or those with invasive lobular carcinoma. These states may blur tumour boundaries and cause underestimation of tumour size thus increasing chances of positive margin after breast conserving surgery.Also, minor satellite lesion or multicentric disease may be invisible using conventional imaging and hence escalate chances of positive margin after breast conserving surgery.

Breast magnetic resonance imaging (MRI) has been observed to be a very sensitive imaging technique which has higher soft-tissue contrast when compared to the conventional methods. The MRI produces detailed cross-sectional images of the checked breast thus allowing a better assessment of the extent of the tumour and the subsequent identification of other malignant lesions. Contrast-enhanced MRI is another technique that makes it easier to distinguish between malignant and benign breast tissue by offering greater visualization of tumour vascularity and patterns of enhancement[6] MRI is therefore becoming even more useful in the preoperative evaluation of breast cancer.

A major benefit of breast MRI is its ability to reveal multifocal as well as multicentric disease which otherwise cannot be identified through mammography or ultrasound. Multifocal tumours refer to two or more malignant tumours in the same quadrant of the breast whereas multicentric tumours are in different quadrants. It may be crucial to have other tumour foci and may require more excision or change to the surgery. MRI also provides a more precise measurement of tumour size, which could not be done without in establishing how far the surgical resection should proceed.

Clinical trials have indicated that preoperative MRI can also minimise the occurrence of positive surgeries; by providing a more detailed tumour anatomy information to the surgeon before surgery can be done. Improved definition of tumour margins may facilitate a more accurate surgical planning, which reduces chances of failure in the removal of the entire tumour. In addition, MRI can help in the screening out of unfit patients to undergo breast-sparing surgery because of large or multicentric disease, which will avert the failure of conservative operation[7]

Notwithstanding these possible advantages, the widespread use of MRI during the preoperative assessment of breast cancer is still a controversial issue. Some of the studies are reporting that MRI can result in the upsurge in mastectomy rates due to detection of more suspicious lesions that are not necessarily clinically significant. Under certain conditions MRI results can actually trigger more aggressive surgical treatment in spite of the subsequent benignity of such lesions, which accounts for some clinical concepts of selective and not universal application of MRI, that is, its use in selected clinical circumstances, including invasive lobular carcinoma or dense breast tissue, discordant imaging, or high-risk patients.

With such debates still underway, it is reasonable to keep on investigating the same to clarify the practical effects of MRI-guided surgical planning in the common practice. The proposed evaluation of the effects of MRI on surgical margin status can generate some important insights concerning the possibility of its application in improving surgical outcomes and minimizing the number of repeat procedures. Specifically, the research in the tertiary care environment can provide valuable real-life data on the efficacy of advanced imaging methods in different groups of patients.

The current research was thus aimed at investigating the effect of MRI-based measurement of the tumour margin preoperative on positive surgical margin occurrence among breast-conservative surgery in women. To find out whether MRI can play a part in enhancing surgical accuracy and better oncologic events in the treatment of early breast cancer, the proposed study will compare the outcome of surgery in patients who are assessed using conventional imaging and those who are assessed using additional MRI.

Objective: To evaluate the effect of preoperative MRI-based tumor margin assessment on the rate of positive surgical margins in women undergoing breast-conserving surgery for early-stage breast cancer.

MATERIALS AND METHODS

Study Design and Setting: This retrospective observational study was conducted at a tertiary care teaching hospital with specialized breast imaging and surgical services. The study period extended from January 2023 to August 2023.

Study Population: The study included women diagnosed with early-stage breast cancer who underwent breast-conserving surgery during the study period. A total of 168 patients were included after applying inclusion and exclusion criteria.

Patients were divided into two groups:

1. Conventional imaging group – evaluated using mammography and ultrasound
2. MRI group – evaluated using conventional imaging plus preoperative breast MRI

Inclusion Criteria

- Female patients ≥18 years
- Histologically confirmed early-stage breast carcinoma
- Patients undergoing breast-conserving surgery
- Complete imaging and histopathology records

Exclusion Criteria

- Metastatic disease
- Recurrent breast cancer
- Primary mastectomy
- Incomplete medical records

Data Collection: Data were collected from hospital medical records, radiology reports, operative notes, and pathology databases using a structured data sheet.

Variables recorded included:

- Age and demographic characteristics
- Tumor size and histology
- Imaging modality used
- Surgical procedure details
- Histopathological margin status
- Need for re-excision surgery

Surgical Management: All patients underwent breast-conserving surgery performed by experienced breast surgeons. Surgical planning was based on preoperative imaging findings. In MRI-assessed patients, MRI findings were used to guide the extent of excision.

Outcome Measures

Primary outcome:

- Rate of positive surgical margins

Secondary outcomes:

- Re-excision surgery
- Detection of multifocal disease

Ethical Considerations: The study was approved by the institutional ethical review committee. Patient confidentiality was maintained through anonymized data extraction.

RESULTS

A total of 168 patients were included in the study.

The mean age was 49.3 ± 10.2 years.

Table 1 outlines the demographic profile of cohort of the study. Most of the respondents with 52.4% falling in the age bracket of 41 to 60 years, it is clear that breast cancer among middle aged and older women was mostly diagnosed in this cohort.

Persons between 40 years and below constituted a quarter of the group, and those above 60 years of age were 22.6.

Regarding the menopausal status, 56% of the participants were premenopausal, which was slightly higher than the percentage of postmenopausal participants (44%). This dispensation highlights the increasing rates of occurrence of breast cancer in premenopausal and postmenopausal populations.

The results of histopathological report are concluded in Table 2. The most common histological type was an invasive ductal carcinoma and it represents 70.2 percent of the total tumours, which is commonly considered as most common type of breast cancer.

The invasive lobular carcinoma was present in 14.3 0 of the cases; the latter subtype is often more difficult to identify with the help of conventional imaging modalities because of the diffusive nature of its growth.

The detection rate of ductal carcinoma in situ (DCIS) was 15.5 per cent of the patients itself being an early-stage non-invasive disease that is not yet spread to outside the ductal system of the breast.

Table 3 shows the distribution of imaging modalities used to evaluate prior to the operation. More of the patient cohort (54.8% to be precise) was assessed by using conventional methods of imaging, that is, mammography and ultrasonography.

On the other hand, adjunctive preoperative magnetic resonance imaging (MRI) study was conducted on 45.2 percent of the patients. It has included MRI to provide a more extensive evaluation of tumour size, especially in those cases where standard imaging can be insufficient to estimate the size of lesions, or that multifocal disease is overlooked.

The MRI group demonstrated a lower positive margin rate compared with the conventional imaging group. Table 4 compares surgical margin status between the MRI group and the conventional imaging group. Patients who underwent MRI evaluation demonstrated a higher rate of negative surgical margins (86.8%) compared with those assessed using conventional imaging alone (76.1%).

Conversely, the rate of positive margins was lower in the MRI group (13.2%) than in the conventional imaging group (23.9%). These findings suggest that preoperative MRI may contribute to more accurate identification of tumor boundaries, thereby improving the likelihood of complete tumor excision during the initial surgery

Those patients who had a magnetic resonance imaging (MRI) in the preoperative period had a lower requirement of repeat re-excision.

Table 5 reminds the need of further surgical operations. Comprehensively, less than 138 patients (82.1) had to undergo additional procedures, which implies that breast-conserving surgery was successful in terms of obtaining sufficient margins in most patients.

Twenty-eight patients (17.9%)-this was because of residual disease or concern of a positive margin that might require re-excision. The patients that underwent MRI evaluation experienced reduced need of secondary intervention, which suggests that improved pre-operative imaging can soothe the need of second surgery.

Table 1: Demographic Characteristics (n=168)

Variable	Frequency	Percentage
Age ≤40 years	42	25.0
Age 41–60 years	88	52.4
Age >60 years	38	22.6
Premenopausal	94	56.0
Postmenopausal	74	44.0

Table 2: Tumor Characteristics

Variable	Frequency	Percentage
Invasive ductal carcinoma	118	70.2
Invasive lobular carcinoma	24	14.3
Ductal carcinoma in situ	26	15.5

Table 3: Imaging Modality Used

Imaging Method	Number of Patients	Percentage
Conventional imaging	92	54.8
MRI-assisted imaging	76	45.2

Table 4: Surgical Margin Outcomes

Outcome	MRI Group	Conventional Imaging
Negative margins	66 (86.8%)	70 (76.1%)
Positive margins	10 (13.2%)	22 (23.9%)

Table 5: Re-Excision Surgery

Outcome	Frequency	Percentage
No re-excision required	138	82.1
Re-excision performed	30	17.9

DISCUSSION

Obtaining clean surgical margins is of utmost importance during breast conserving surgery since the status of the margin has significant effect on the occurrence of local recurrence. Previous research has shown that positive margins are the ones that are associated with a high possibility of tumour recurrence and often necessitated repeat operative procedures.

In the conducted research, there was a correlation between a lower rate of positive margins and the use of preoperative MRI. These findings support previous findings that MRI improves in the accuracy of assessments of tumour extent and allows more precise planning of resections.

MRI has been cited to be particularly useful in identifying multifocal disease development and also in the determination of tumour size in patients with dense breast parenchyma or invasive lobular carcinoma. The increased marginal definition in tumours may allow the surgeons to implement a broader excision where necessary, thereby reducing the likelihood of incomplete tumour resection.

The place of MRI in pre-operative assessment is however controversial. It has been suggested by some studies that standard MRI can serve to increase the rate of mastectomies by detecting more lesions which would otherwise not impact the clinical outcome[8] As a result, many studies offer the use of MRI as selective, as opposed to routine, in patients undergoing breast-sparing surgery.

The results of this research can imply that the MRI brings advantages to operative planning in case of proper use. From the patients under MRI assessment, the number of positive margins and the re-excision rates were lower compared to those using only the conventional imaging.

These data highlight the future use of MRI as a tool that improves the outcome of surgery, notably in the complicated cases where the size of the tumour is difficult to estimate with the help of standard imaging methods.

Limitations: The given study has a range of limitations that need to be taken into account once attempting to interpret the results. To begin with, the retrospective design can be subject to selection bias, because the participants were included and the clinical decision making was based on past recorded medical records instead of prospective and controlled protocol. Retrospective studies are also dependent on the availability and accuracy of available records, gaps in records can limit the level of detail that can be achieved concerning specific clinical variables.

Two, the study was also restricted to one tertiary care facility, and this could limit the applicability of the results to other clinical settings. Surgical skills, imaging regimen, and patient demographics may vary across the institutions and may affect observed outcomes. As a result, the results of the current research can be not sufficiently relevant to describe the experiences of other hospitals that have different clinical structures or demographics.

Another drawback lies in the unequal nature of the surgical methods used by surgeons who have taken part in the operations. Even though the institutional guidelines were followed, the techniques of individual surgeons, their levels of experiences, and decisions approaches can have influenced the margin results. This

variability in itself is difficult to remove in retrospective clinical studies.

Also, magnetic resonance imaging (MRI) was not applied to all the patients in the cohort; the clinical decision to do MRI was done individually. Such selective usage can have strengthened a certain level of selection bias with patients reporting more complicated imaging results or equivocal conclusions being over-represented in MRI subgroup.

Last but not the least, although the sample was adequate enough to make an initial analysis, it might not be adequate to identify all of the factors that can affect the surgical margin status. Greater, future research utilizing standardized imaging remedies and consistent surgical methods would provide stronger evidence of the effectiveness of MRI in reducing positive margins in breast-conserving surgery.

It is suggested that future multicentre prospective research using diverse group of patients and standardised imaging procedures is necessary in order to further clarify the role of MRI in maximizing the outcomes of surgery when dealing with breast cancer management.

CONCLUSION

Breast -conserving surgery is also one of the mainstays of the treatment of breast cancer at its initial stages, it is cost-effective to provide effective oncologic management and save breast anatomy and aesthetic outcomes. The ultimate objective of this modality surgery is the achievement of negative margins, which would be the fundamental demand to minimize the occurrence of local recursion and prevent the further surgical interventions.

As observed in this paper, preoperative MRI can eventually improve surgical planning and reduce positive surgical margins. MRI has a better visualisation of the tumour extent and is able to detect multifocal disease or occult extensions which is non-detectable with other imaging modalities.

MRI-guided evaluation has the potential to reduce the risks of incomplete tumour rejection within the scope of preoperative planning by helping the surgeon fully identify boundaries of the tumor; thus lowering the level of re-excision operations. The resulting optimisation may result in increased efficiency of treatment, less morbidity of patients due to repeated surgeries, and better clinical outcome.

Although the universal use of MRI with all patients that undergo breast conserving surgery is still debatable, selective use of MRI as part of the preoperative work-up seems to be beneficial under definite clinical conditions. Strict patient selection and multidisciplinary cooperation of radiologists, surgeons and oncologists are essential to maximise the advantages of this type of imaging.

Overall, the current findings support the possible usefulness of MRI as a supplement of preoperative assessment of breast cancer. Large-scale prospective studies are still needed to support these results and apply some conclusive clinical recommendations on how best MRI can be used in the planning of breast-conserving surgery.

REFERENCES

1. World Health Organization. Breast cancer. Geneva: WHO; 2024.
2. Fisher B, Anderson S, Bryant J, et al. Twenty-year follow-up of a randomized trial comparing mastectomy and lumpectomy. N Engl J Med. 2002;347:1233-41.
3. Veronesi U, Cascinelli N, Mariani L, et al. Twenty-year follow-up of breast-conserving surgery. N Engl J Med. 2002;347:1227-32.
4. Moran MS, Schnitt SJ, Giuliano AE, et al. SSO-ASTRO consensus guideline on margins for breast-conserving surgery. Ann Surg Oncol. 2014;21:704-16.
5. Houssami N, Ciatto S, Macaskill P, et al. Accuracy of MRI in diagnosing breast cancer. Ann Surg. 2008;247:59-69.
6. Mann RM, Balleyguier C, Baltzer PA, et al. Breast MRI: EUSOBI recommendations. Eur Radiol. 2015;25:3669-78.
7. Gommers JJJ, et al. Preoperative MRI and margin status in breast cancer. Breast Cancer Res Treat. 2021;186:141-149.
8. Houssami N, Turner R, Morrow M. Preoperative MRI and surgical treatment outcomes. Breast Cancer Res Treat. 2017;165:273-83.
9. Loibl S, Poortmans P, Morrow M, et al. Early breast cancer ESMO guidelines. Ann Oncol. 2024.
10. Lehman CD, Gatsonis C, Kuhl CK, et al. MRI evaluation of breast cancer extent. J Clin Oncol. 2007;25:248-56.
11. Berg WA, Gutierrez L, NessAiver MS, et al. Diagnostic accuracy of MRI in breast lesions. Radiology. 2004;233:830-49.
12. Turnbull L, Brown S, Harvey I, et al. Comparative effectiveness of MRI in breast cancer. Lancet. 2010;375:563-71.
13. Sardanelli F, Boetes C, Borisch B, et al. Magnetic resonance imaging of the breast. Eur Radiol. 2010;20:1145-58.
14. Morrow M, Waters J, Morris E. MRI for breast cancer screening and staging. J Clin Oncol. 2011;29:607-12.
15. Kuhl CK. The current status of breast MRI. Eur Radiol. 2007;17:2042-55.
16. Houssami N, Macaskill P, Lord SJ, et al. Preoperative MRI in breast cancer. Breast. 2013;22:171-7.
17. National Comprehensive Cancer Network. NCCN Breast Cancer Guidelines. 2024.
18. Giuliano AE, Edge SB, Hortobagyi GN. Surgical treatment of breast cancer. CA Cancer J Clin. 2018;68:240-57.
19. Morrow M, Harris JR, Schnitt SJ. Surgical margins in breast-conserving surgery. N Engl J Med. 2012;367:79-82.
20. Curigliano G, Burstein HJ, Winer EP, et al. De-escalating and escalating treatments for breast cancer. Lancet. 2017; 389:1725-40.

This article may be cited as: Babar K.S., Hussain F., Memon S., Mushtaq S., Usman M., Baig T.Impact of MRI-Based Tumor Margin Assessment on Reducing Positive Margins in Breast-Conserving Surgery. Pak J Med Health Sci, 2024; 18(1): 835-838.