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The diagnostic value of digital breast tomosynthesis with complementary ultrasound in comparison with magnetic resonance imaging in assessment of postoperative changes and locoregional recurrence of breast cancer

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Abstract

Background: Digital breast tomosynthesis with complementary ultrasound is a powerful imaging modality in detection of breast cancer. Magnetic resonance imaging has many limitations due to its low specificity multiple pitfalls especially signal-to-noise ratio, as well as the spatial resolution. Our purpose of the study is to evaluate the role of digital breast tomosynthesis with complementary ultrasound compared to magnetic resonance imaging in the assessment of postoperative changes and locoregional recurrence of breast cancer.

Results: Our prospective study included thirty women who underwent conservative breast surgery. Digital breast tomosynthesis with complementary ultrasound revealed greater specificity (95.2%) than Magnetic resonance imaging (90.5%) in the detection of locoregional recurrence of breast cancer. On the other hand, it revealed the same sensitivity (88.9%). Subsequently, digital breast tomosynthesis with complementary ultrasound showed higher accuracy (93.3%) and higher positive predictive value (88.9%) than magnetic resonance imaging (90%), (80%), respectively. However, both of them revealed a comparable negative predictive value (95%).

Conclusion: Digital breast tomosynthesis with complementary ultrasound is a powerful imaging modality that can be used to detect any recurrence in patients who are surgically treated for breast cancer with higher specificity, accuracy than magnetic resonance imaging. Additionally, the use of these modalities enhances the diagnosis of surgically treated breast cancer for early detection of recurrence.

Keywords: Digital mammography, Tomosynthesis, Ultrasound, Magnetic resonance imaging, Postoperative scarring, Locoregional recurrence, Breast cancer

Background

Loco-regional recurrence is defined as recurrence either in the ipsilateral breast or axillary lymph nodes. The incidence of breast cancer recurrence is estimated at about 1% per year [1]. The early diagnosis and treatment may have a good effect on the prognosis to avoid uncontrolled loco-regional recurrence [2]. Women who are treated by

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conservative breast surgery or mastectomy are at risk of disease recurrence. So, these women have to continue to follow-up with mammography, ultrasound, and MRI to evaluate postoperative scar and differentiate it from malignancy [3].

Magnetic resonance imaging shows many limitations such as its low specificity, administration of contrast media, relatively high cost, and long examination time [4].

Digital breast tomosynthesis is a new modification to mammography that provides three-dimensional imaging of the breast. The images are reconstructed from various projections and acquired from multiple angles. Reconstruction of tomographic images is done with about 1 mm slice thickness [5]. Digital breast tomosynthesis has higher sensitivity and specificity than conventical mammographic imaging especially in dense breast tissue [6]. Breast ultrasound has a powerful role to characterize lesions and is broadly used as a complementary imaging modality to mammography [7].

Aim of the work

Our study aims to evaluate the role of digital breast tomosynthesis with complementary ultrasound in comparison with magnetic resonance imaging in the assessment of postoperative changes and locoregional recurrence of cancer breast.

Patients and methods

A prospective study is approved by the ethics review of our institution. Informed consent for our examinations was provided by all the patients included in our study. The privacy of patients was guaranteed throughout the different phases of the study. Thirty female patients who were surgically treated by conservative breast surgery were included. The study was started in March 2021 till September 2021. Our study included patients with suspected recurrence by symptoms or by clinical or radiological data on follow-up. The age group was from 20 to 70 years. Several patients were excluded from our study such as patients with contraindication to mammography, e.g., pregnant women, inability to lie in prone position, severe obesity, very large breasts, renal impairment, history of allergic reaction to contrast agent, compromised renal functions (eGFR < 30 ml/min/1.73m2), patients with MRI non-compatible implantable devices, patients with cardiac pacemaker, patients with a metallic foreign body, and patients with severe claustrophobia who cannot tolerate the MRI scan.

Table 1 Demographic data regarding age, clinical finding, and time of presentation

		Total no. = 30
Age (years)	Mean ± SD	50.73 ± 8.57
	Range	35–66
Clinical finding	Palpable mass	8 (26.6%)
	Postoperative follow-up	14 (46.8%)
	Diffuse breast enlargement	8 (26.6%)
Time of presentation	1–2 years	3 (10.0%)
	2–3 years	7 (23.3%)
	3–5 years	16 (53.4%)
	More than 5 years	4 (13.3%)

Table 2 BIRADS scoring by DBT with the US compared to MRI

	Total no. = 30
BIRADS of DBT with US	
II	16 (53.4%)
III	6 (20.0%)
IV	5 (16.6%)
V	3 (10.0%)
BIRADS of MRI	
II	16 (53.4%)
III	4 (13.3%)
IV	7 (23.3%)
V	3 (10.0%)

(See figure on next page.)

Fig. 1 A 46-year-old patient underwent left conservative breast surgery 6 years ago, **a** (MLO) view DBT **b** (CC) view DBT, **c** ultrasound. Tomosynthesis revealed a lower central ill-defined spiculated lesion partially obscured by condensed glandular tissue. Complementary ultrasound revealed irregular hypoechoic solid lesion, the lesion was categorized as (BIRADS4). MRI **d** Axial T1 weighted image **e** Axial T2weighted image **f** post-contrast subtraction T1 weighted image: revealed ill-defined heterogeneously enhancing irregular spiculated lesion eliciting low signal in T1 and T2, the lesion was categorized as (BIRADS4). Histopathology revealed IDC

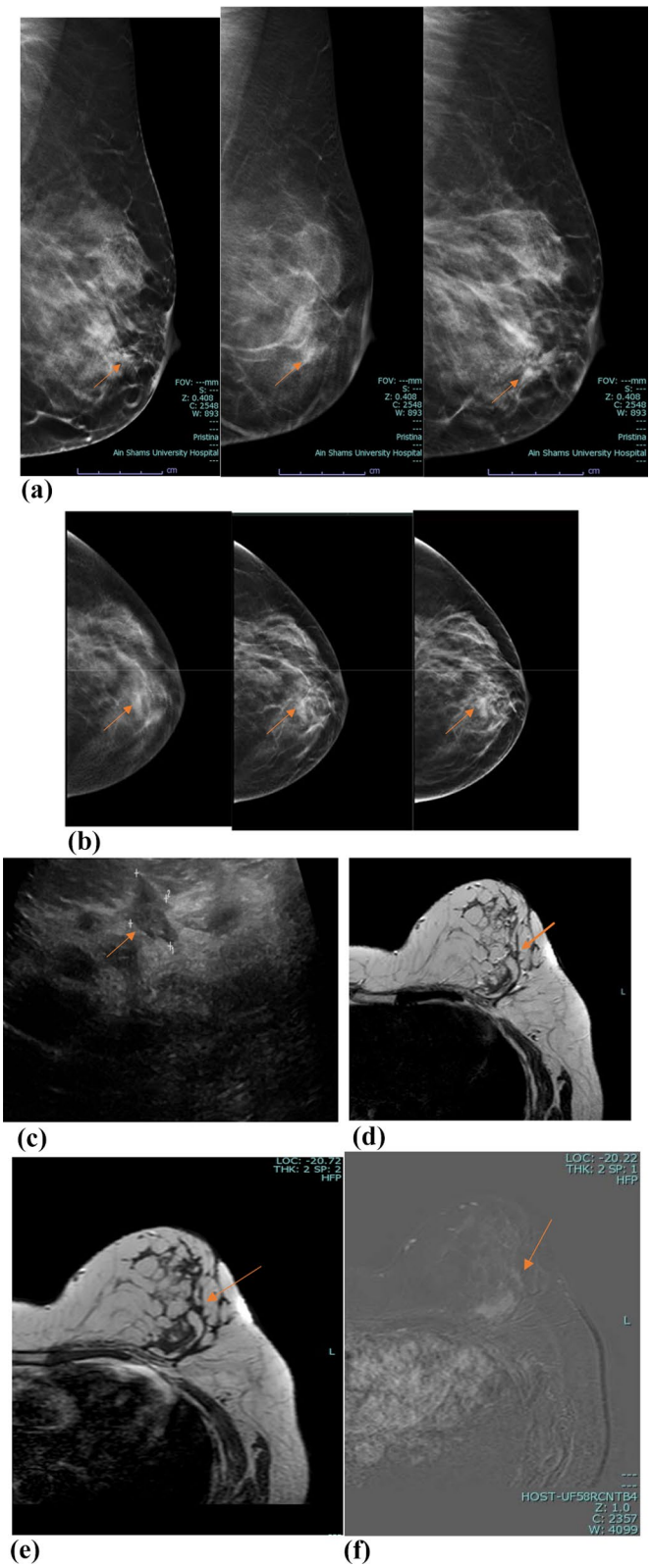


Fig. 1 (See legend on previous page.)

The clinical history and medical sheets of all the patients were adequately and precisely reviewed. Patients were assessed with DBT conducted using, FDA-approved GE Prestina Senographe Hologic's Selenia Dimensions system, USA. Examination time: 2 to 3 min. Standard views mediolateral-oblique and craniocaudal views are taken for all patients. The breast was compressed and held stationary between the compression paddle and the detector, in a procedure similar to that used at digital mammography. The X-ray tube moved in an arc overhead, executing multiple series of low-dose exposures at preset intervals, each one from a various angle. The results were a series of multiple projections. After imaging acquisition, DBT various images were reconstructed into multiple sections about 1. This process allows three-dimensional. Then, complementary ultrasound was conducting using (LOGIC P9, GE, USA). High-resolution ultrasound was performed for all participants by a 6–12 MHz linear array transducer. Then, all the participants were subjected to MR imaging examinations. MRI was conducted at our institution with the same 1.5 T MR scanner Achieva; Philips Medical Systems, Bothell, WA, USA. A phased-array coil was used and the patient was in a prone position. The examination was performed by precontract various sequences: Axial non-fat saturated TIWI was obtained with the following parameters: 495 ms and TE 10 ms. Axial non-fat-suppressed T2-weighted turbo spin-echo was obtained with the following imaging parameters: TR 4365 ms and TE 120 ms. For the aforementioned sequences slice thickness 2 mm, matrix 307-512, and FVO 300–360 mm. Axial STIR was obtained with the following parameters: 9313 ms, TE 55 ms, and inversion time (TI) is 150 ms, slice thickness 2 mm, field of view (FOV) 300–360 mm, and the matrix is 307–512. Dynamic study was obtained with the following parameters: TR/TE 8.4/4.6 ms, slice thickness 2 mm with no inter-slice gap, FOV 300–360 mm and the matrix are 307–512. Dynamic contrast-enhanced MRI was performed after the injection of a bolus of gadopentetate dimegluminein a dose of 0.2 mmol/kg using an automated injector at a rate of 3–5 ml/s through a 18–20 gauge. Intravenous cannula inserted and this was followed by a contrast bolus infusion of saline (total of 20 ml at 3–5 ml/s). Dynamic study consists of one pre-contrast and five post-contrast series. Post-processing includes subtraction which was obtained by subtracting each of the pre-contrast images from each post-contrast series image, creation of time to signal intensity curve for suspicious enhancing lesions, and maximum intensity projection (MIP) views obtained through each orthogonal plane, producing sagittal, coronal, and axial projection. Subtraction images were first examined followed by an examination of the rest of the sequences.

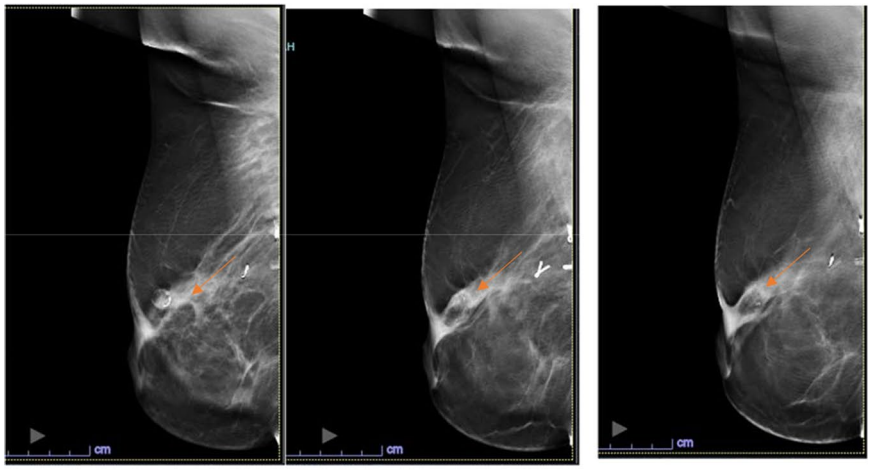
All the data by DBT with complementary ultrasound and MRI were analyzed. Characterization of lesions was done independently by two different radiologists to avoid bias. Ultrasound and DBT results were reported by an experienced radiologist with ten years' experience in women imaging. Another different experienced radiologist in breast imaging with 10 years' experience in breast imaging analyzed the MRI results independently to avoid bias. They were evaluated according to the ACR BIRADS system. BIRADS I, II, III are considered as potentially benign findings, while BIRADS IV and V are considered as probably malignant lesions. The possible pathology suggested by DBT, ultrasound, and MRI had been correlated with histopathological biopsy or at least 3 months follow-up for potentially benign findings.

Statistical analysis

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MRI were calculated to differentiate between benign postoperative changes and recurrent malignant lesions. Data were analyzed using the computer program SPSS (Statistical package for social science) version 17.0. A P value < 0.05 was considered statistically significant. P value of < 0.01 was considered highly significant in all analyses.

(See figure on next page)

Fig. 2 A 53-year-old patient with right breast cancer underwent right conservative breast surgery 5 years ago. **a** (MLO) view DBT **b** (CC) view DBT **c** Ultrasound: Tomosynthesis revealed retro areolar ill-defined area of architectural distortion related to the postoperative bed with micro-calcific foci which proved by ultrasound to be a suspicious ill-defined hypoechoic solid lesion with multiple micro calcific foci, the lesion was categorized as (BIRADS 4).MRI: **d** Axial T1weighted image **e** AxialT2 weighted image **f** STIR **g** post-contrast subtraction T1 weighted image revealed ill-defined lesion eliciting high signal in T1and low signal in STIR with no appreciable contrast enhancement suggestive of fat necrosis, the lesion was categorized as (BIRADS3). Histopathology revealed DCIS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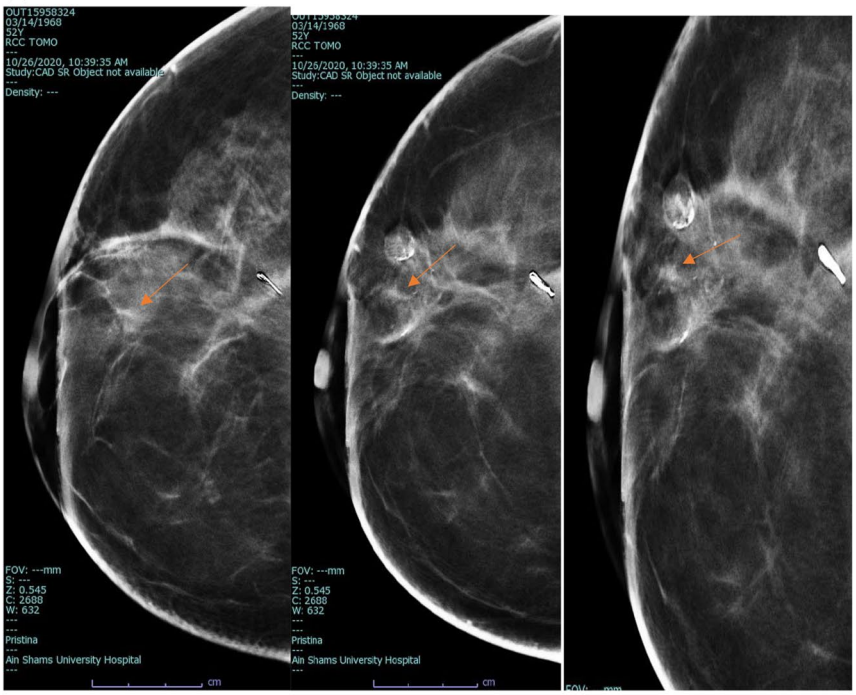
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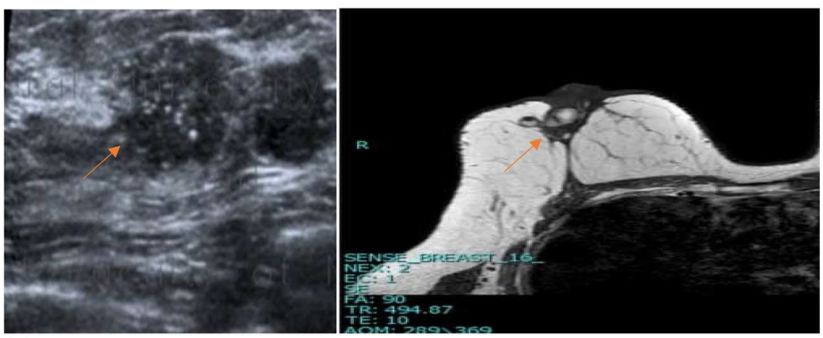
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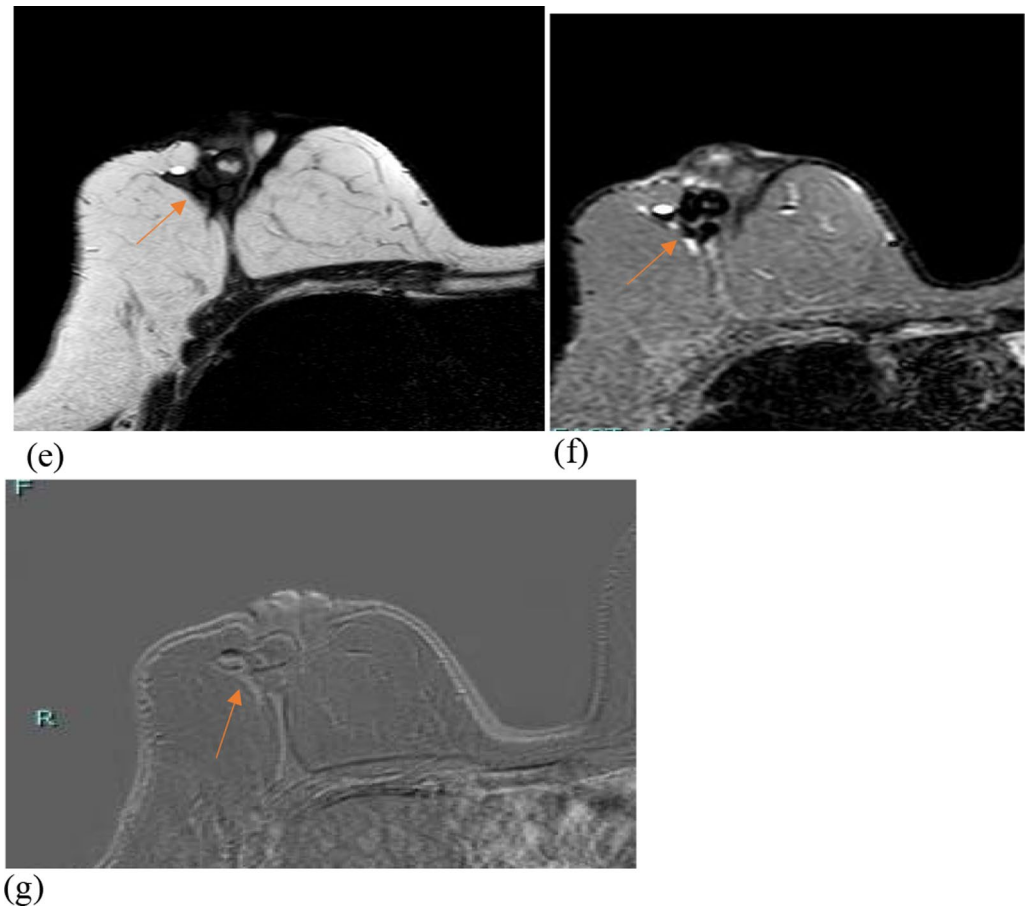

Fig. 2 continued

Results

Statistical analysis was performed for 30 postoperative breasts. The mean patient age is 50.73 ± 8.57 (range: 35–66) years. Eight cases (26.6%) were presented with a palpable mass, and eight cases (26.6%) were presented by diffuse breast enlargement, and 14 cases (46.8%) were postoperative follow-up. Three cases (10%) were presented after 1–2 years after surgery, four cases (13.3%) after more than 5 years, seven cases (23.3%) after 2–3 years, and 16 cases (53.4%) after 3–5 years. (Table 1).

Results of DBT, ultrasound and MRI were interpreted according to BIRADS scoring: DBT and ultrasound results were as the following: BIRADS II (53.4%), BIRADS III (20%), BIRADS IV (16.6%) and BIRADS V (10%). MRI results were as the following: BIRADS II (53.4%), BIRADS III (13.3%), BIRADS IV (23.3%), and BIRADSV (10%) (Table 2).

Pathology/follow-up diagnosed benign lesions as the following: (five seromas, nine postoperative scar tissue, two fat necrosis, one mastitis, one sclerosing adenosis, three fibroadenoma). On the other hand, nine lesions were diagnosed as malignant lesions by histopathology: (six invasive ductal carcinoma (Fig. 1), one invasive lobular carcinoma, one DCIS (Fig. 2), one intracystic papillary carcinoma (Fig. 3)) (Table 3).

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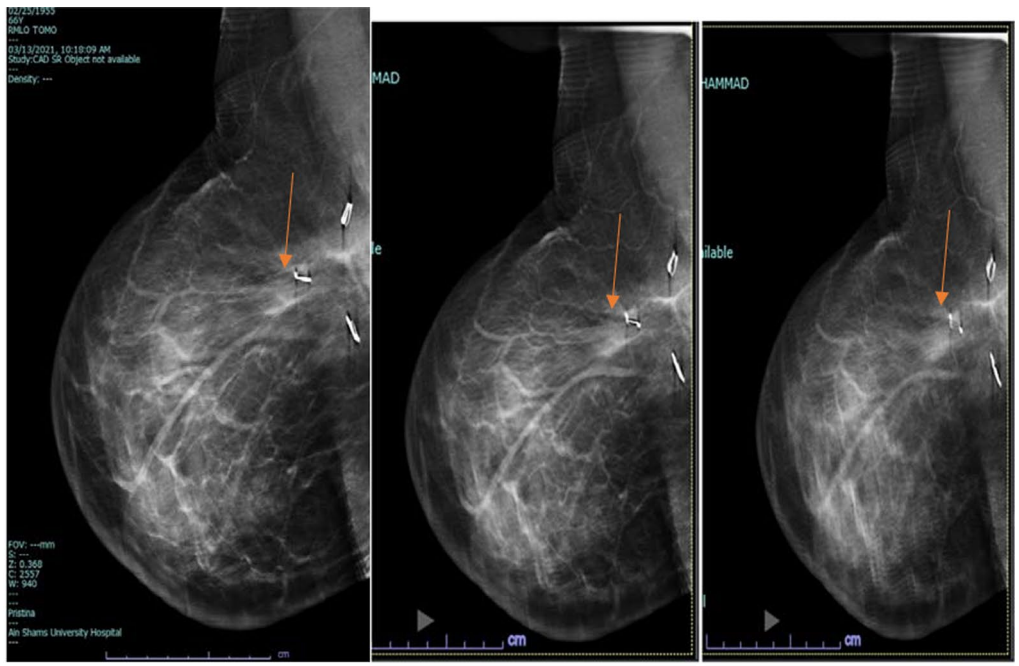
Fig. 3 A 51-year-old patient with right sided breast cancer underwent conservative breast surgery 5 years ago. **a** DBT: (MLO) **b** (CC) view DBT **c** Ultrasound. Tomosynthesis revealed well-defined partially circumscribed lesion, complementary ultrasound revealed well-defined hypoechoic partially cystic partially solid lesion, the solid competent shows internal vascularity, the lesion was categorized as (BIRADS 4). MRI: **d** Axial T1 weighted image **e** Axial T2 weighted image **f** STIR **g** post-contrast subtraction T1 weighted image proved to be well-defined cystic lesion with internal solid nodule eliciting high signal in TI and low signal in T2 and STIR and faint post-contrast enhancement, the lesion was categorized as (BIRADS 4). Histopathology revealed intracystic papillary neoplasm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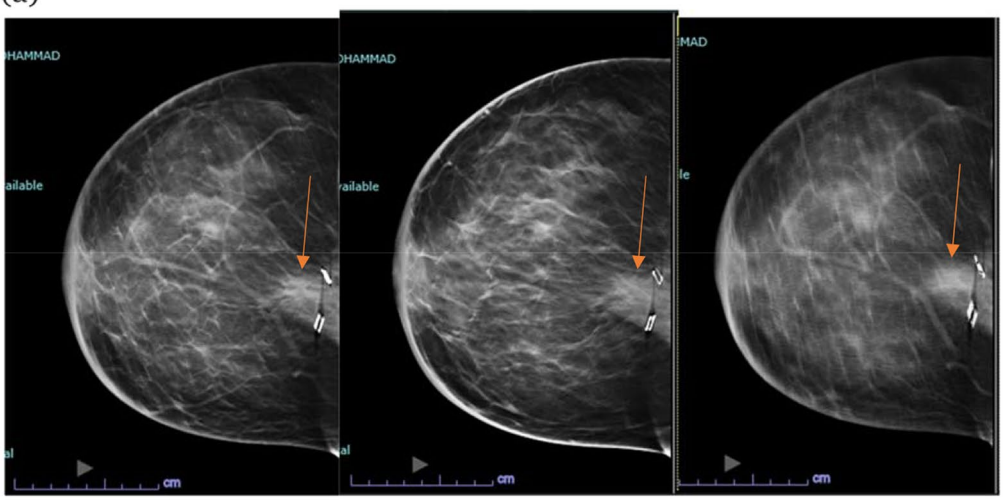
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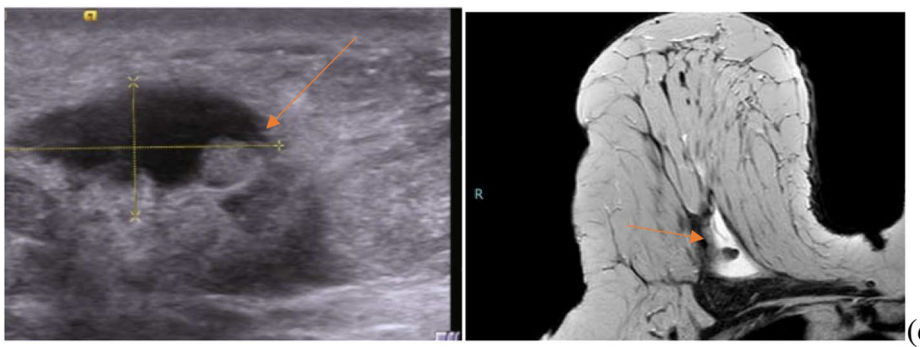

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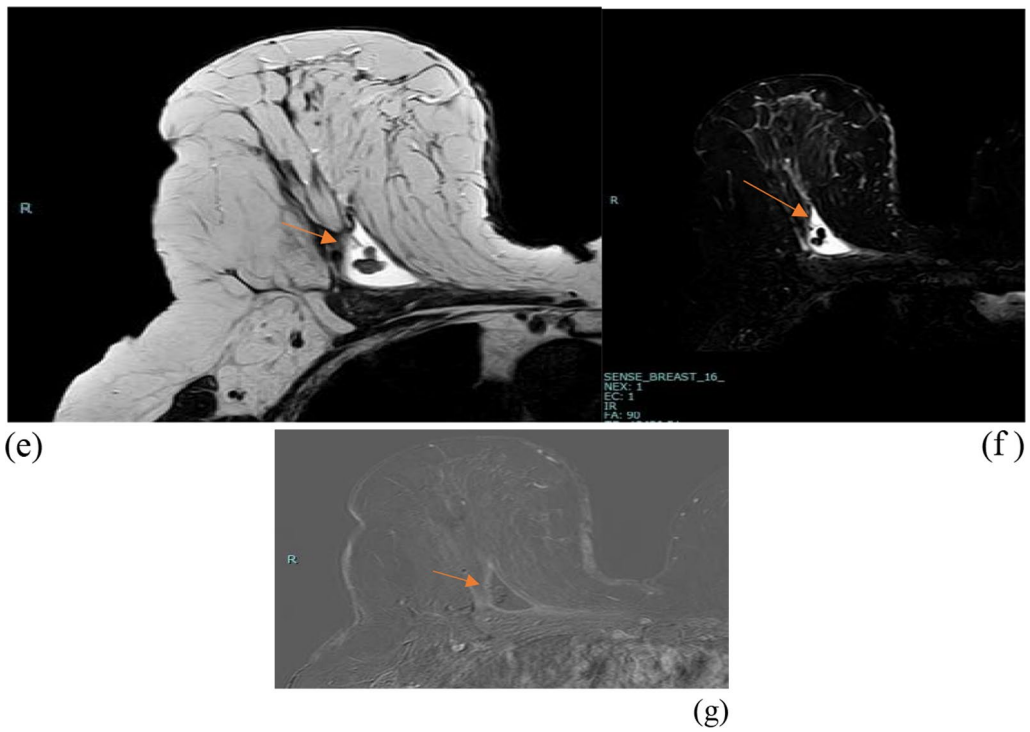


Fig. 3 continued

Table 3 Pathology /Follow-up results

Pathology/FU	No	%
Findings		
IDC	6	20%
ILC	1	3.3%
DCIS	1	3.3%
Fibroadenoma	3	10%
intracystic papillary carcinoma	1	3.3%
Sclerosing adenosis	1	3.3%
Seromas	5	16.7%
Mastitis	1	3.3%
Fibrosis/scar tissue	9	30%
Fat necrosis	2	6.8%
Results		
Benign	21	70%
Malignant	9	30%

Comparison of the result of US, DBT, and MRI results to final diagnosis revealed DBT with the US diagnosed 21 lesions as benign and nine lesions as malignant lesions, yet there was one false positive and one false negative case. While MRI diagnosed 20 lesions as benign and 10 lesions as malignant lesions, yet there were two false positives and one false negative case (Table 4).

Table 4 The results of DBT with US, and MRI compared to the final result by follow-up or pathology

		Total no. = 30
Final result by follow-up or pathology	Benign	21 (70.0%)
	Malignant	9 (30.0%)
DBT with US	Benign	21 (70%)
	Malignant	9 (30%)
MRI	Benign	20 (66.7%)
	Malignant	10 (33.3%)

In our study, DBT with complementary US showed greater specificity (95.2%) than MRI (90.5%), yet it revealed the same sensitivity (88.9%). Subsequently, DBT with complementary ultrasound shows higher accuracy (93.3%) and higher PPV (88.9%) than MRI (90%), (80%), respectively. However, both of them revealed comparable NPV: DBT with US (95%) and MRI (95%). (Table 5).

Table 5 Sensitivity, specificity, PPV, NPP, and accuracy of DBT with the US and MRI

	TP	TN	FP	FN	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
DBT with US	8	20	1	1	88.9	95.2	88.9	95.2	93.3
MRI	8	19	2	1	88.9	90.5	80.0	95.0	90.0

Discussion

After breast traditionalist treatment, the rate of repetitive breast carcinoma is almost 1% per year. Early discovery of locally repetitive breast carcinoma has been appeared to altogether move forward long-term survival [8]. DCE-MRI has been appeared to be a profitable apparatus in discovery and characterization of recurrent breast carcinoma. MRI has been appeared to be valuable in separating postoperative scar from repetitive breast carcinoma. The capacity of MRI to distinguish between re-current breast carcinoma and generous post-treatment changes depends on its capacity to survey both injury morphology and contrast uptake [8].

However, magnetic resonance imaging shows many limitations. Thus, another modality was needed to overcome these limitations [4]. Subsequently, DBT can be added to the usual examination and provide better execution than classic DM especially in dense breast [9].

In our study, we evaluated 30 female patients who were surgically treated by conservative breast surgery. The mean patient age was 50.73 (range: 35–66). DBT with the US identified eight recurrent cases compared to the histopathology and 20 cases benign findings. MRI identified eight recurrent cases compared to the histopathology and 19 cases with benign findings (Fig. 4).

DBT and US had only one false-negative case proved to be recurrent mass (IDC) by histopathology and one false positive case proved to be fat necrosis by histopathology. MRI had one false-negative case proved to be recurrent mass (DCIS) by histopathology and two false- positive cases proved to be intracanalicular fibroadenoma, and sclerosing adenosis by histopathology.

The results of DBT, US, and MRI those were interpreted according to the ACR-BIRADS scoring system with ultrasound results were as the following: BIRADS II (53.3%), BIRADS III (16.7), BIRADS IV (20%) and BIRADSV (10%). MRI results were as the following: BIRADS II (53.4%), BIRADS III (Fig. 5). (13.3%), BIRADS IV (23.3%), and BIRADSV (10%).

DBT with the US had 20 true negative cases, eight true positive cases, one false positive case, and one false-negative case. MRI had 19 true negative cases, eight true positive cases, two false-positive cases, and one false-negative case. One case which was graded by DBT and US as BIRADS 3 lesion and by MRI as BIRADS 4 lesion proved to be recurrent mass (IDC) by histopathology, a result was consistent with MRI findings. One case which was graded by DBT and US as BIRADS 4 lesion and by MRI BIRADS 3 proved to be fat necrosis by histopathology, a result was consistent with MRI finding. One case which was graded by DBT and US as BIRADS 3 and by MRI as BIRADS 4 lesion proved to be fibroadenoma by histopathology. Another case which was graded by DBT and US as BIRADS 2 and by MRI as BIRADS 4 proved to be sclerosing adenosis by histopathology. One case which was graded by DBT and US as BIRADS 4 and by MRI as BIRADS 3 proved to be (DCIS) by histopathology, a result was consistent with DBT and US findings.

In our study, DBT with complementary US showed greater specificity (95.2%) than MRI (90.5%), yet it revealed the same sensitivity (88.9%). Subsequently, DBT with complementary ultrasound shows higher accuracy (93.3%) and higher PPV (88.9%) than MRI (90%), (80%) respectively. However, both of them revealed comparable NPV: DBT with the US: (95%) and MRI: (95%).

Early reports and studies of DBT were focused on its usual screening role. They have visualized its capability to diminish the number of recall rates and also to improve the cancer detection rates. To our knowledge, we are the first study that compares DBT with the complementary US to MRI in the assessment of postoperative changes and locoregional recurrence of breast cancer.

Rossano et al. [10] conducted a study on preoperative assessment of breast cancer patients that combined DBT

(See figure on next page.)

Fig. 4 A 61-year-old patient with left-sided breast cancer underwent conservative breast surgery. DBT: **a** Mediolateral oblique (MLO) **b** (CC) view DBT **c** Ultrasound. Tomosynthesis revealed a lower inner partially circumscribed lesion which proved by ultrasound well-defined complicated cystic lesion with internal echo debris (postoperative seroma likely hemorrhagic), the lesion was categorized as (BIRADS 3).MRI **d** Axial T1 weighted image **e** Axial T2 weighted image **f** Post-contrast subtraction T1 weighted image proved to be well-defined complicated cystic lesion with internal content eliciting high signal in T1 and T2 with faint post-contrast enhancement (postoperative seroma likely hemorrhagic), the lesion was categorized as (BIRADS 3). FNAC revealed hemorrhagic fluid

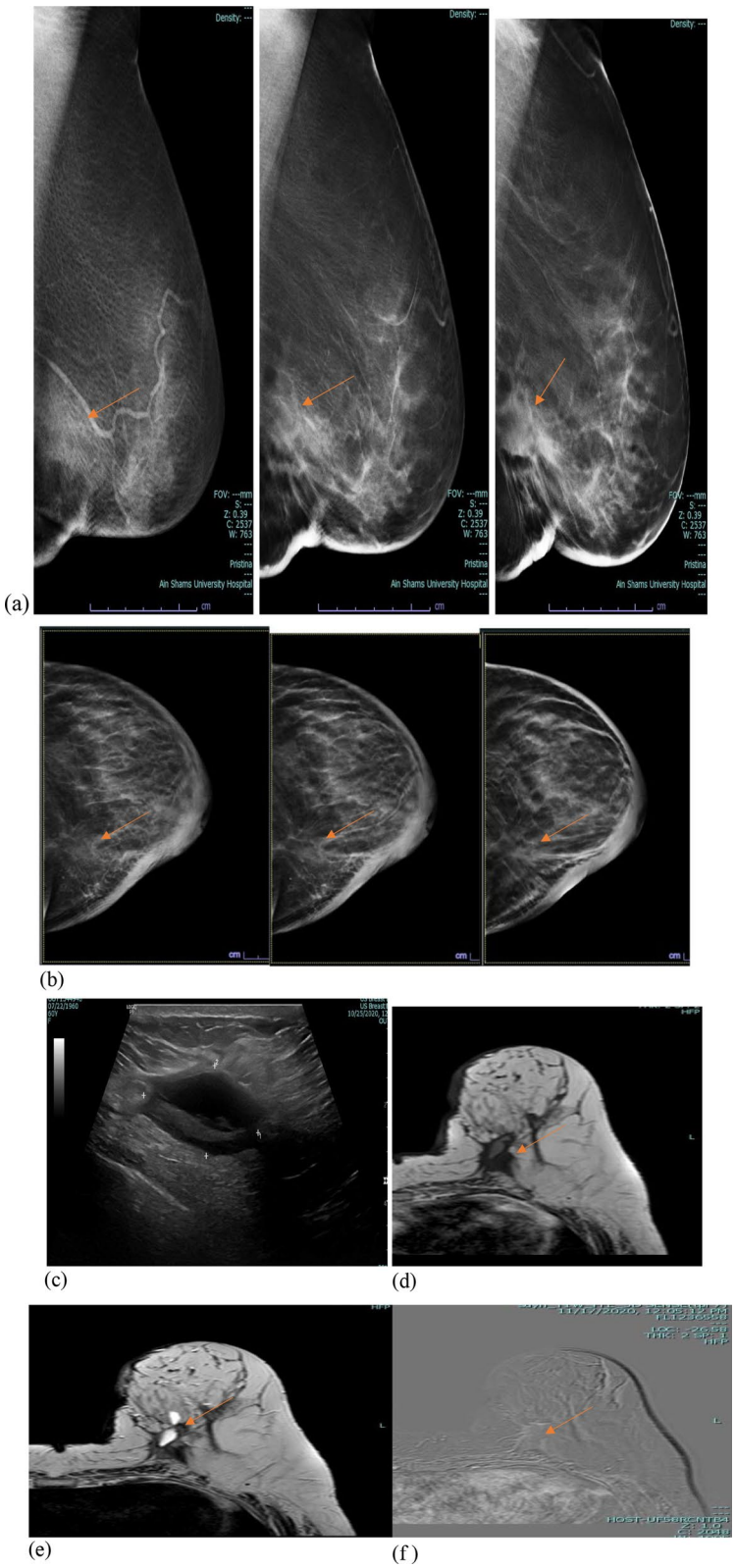


Fig. 4 (See legend on previous page.)

with automated breast US and compared it to MRI. It revealed that DBT with the US had lower sensitivity than MRI. The concluded sensitivity for DBT, US, and MRI (76.5% vs 91.7%), respectively. The study showed statistically different results from our study. However, this may be related to several factors such as the use of automated breast ultrasound, larger number of patients, and the study was done on patients preoperatively. Christopher et al. [11] conducted a study that compared DBT to MRI, which revealed that MRI had higher sensitivity and lower specificity than DBT. The concluded results of sensitivity and specificity for MRI and DBT were (95.7% vs 39.1%) (86.7% vs 97.4%) respectively. However, the study used an abbreviated MRI technique and the study aimed to detect breast cancer among women with dense breasts. Another study done by Ola et al. showed a higher sensitivity specificity, and accuracy of MRI. Yet, in contrast to us, it was conducted to evaluate the role of MRI in the early detection of recurrent breast cancer. The concluded sensitivity, specificity, and accuracy of MRI were (100%, 94%, 96%), respectively.

El-Adalany and El-Metwally [8] *conducted* a study to evaluate the role of MRI in the detection of breast cancer. The concluded sensitivity, specificity, NPV, PPV and accuracy (97.7%, 90%, 95.5%, 90%, 94.5%). The breast MRI was performed on a 1.5 T MR imagining system like our study. The results were statistically different from our study. This may be related to several factors such as a larger number of patients, the use of unenhanced MRI techniques. Osman et al. [12] conducted a study to evaluate the role of DBT in treated breast cancer. The concluded sensitivity and specificity of DBT, PPV, NPV, and accuracy were lower than our study: (84.2%, 53.1%, 86.7%, 48.9%, 64%), respectively.

Mariscotti et al. [13] showed the same results in our study as regards the higher specificity of DBT with the US than MRI. The concluded specificity of DBT, US, and MRI was (88.2% vs 74.2%), respectively. A breast MRI was performed on 1.5 T on both studies. However, the study evaluated the patients preoperatively. In concordance to our results, Roganovic et al. [14] revealed that DBT had higher sensitivity and specificity than MRI (100% vs 93.1%) vs (75% vs 60.7%), respectively. However, we have to put into consideration that the study was performed on a 3.0 T MR imaging system and our study was conducted on a 1.5 T MRI machine. Kamal et al. [9] conducted a study that compared MRI to DBT in the assessment of breast lesions and showed that DBT had lower specificity than MRI (80.7% vs 89.7), respectively.

As regards, the PPV and NPV DBT and US showed higher PPV than MRI. These results matched the studies done by Mariscotti et al. [13] Jung et al. [2], and Roganovic et al. [14]. In contrast to our study, Kamal et al. [9] MRI had higher PPV and NPV than DBT (74. 1% vs 60.53%) (97.2% vs 96. 9%), respectively.

Breast MRI was conducted on a 1.5 T MR imaging system in our study Mariscotti et al., [13], Jung et al. [2]. El-Adalany and El-Metwally, [8], and Rossano et al. [10] conducted their studies like our study on 1.5 T MRI machines. Roganovic et.al [14] use a higher 3.0 T MRI imaging system, while Kamal et al. [9] used a lower MRI operating machine than our study (1 T MR imaging system).

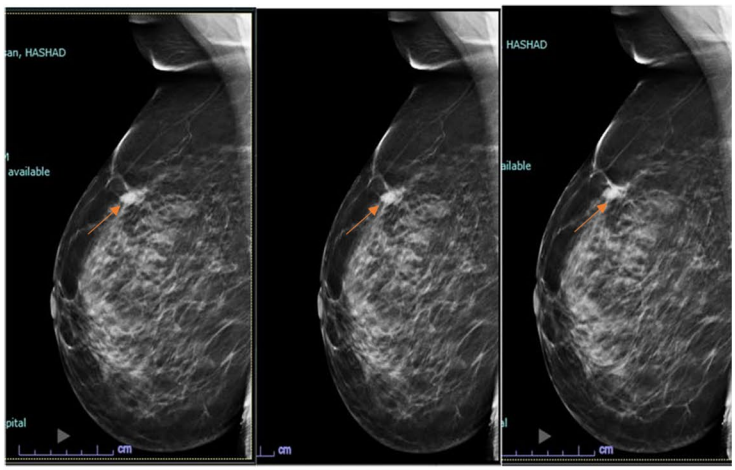
Moodie et al. [15], and Lam et al. [16]. stated that the added role of DBT in the detection of cancer breast after treated breast cancer has not been adequately and broadly examined yet. Up till now, a very low number of studies has screened the role of DBT in surgically treated breast cancer and its role in the detection of locoregional recurrence, yet it has revealed a significant reduction in recall rates.

Limitations and future recommendations

The limitation of our study included a small no of patients, the high cost of MRI and tomosynthesis. Another limitation is the use of a 1.5 T operating MRI machine and some patients refused to do the MRI examination and to receive the contrast media. To our knowledge, we are the first study that compares DBT with the complementary US to MRI in the assessment of postoperative changes and locoregional recurrence of breast cancer. So, future recommendations to compare DBT with the complementary US in comparison with MRI in the assessment of postoperative scarring and locoregional recurrence are recommended on a larger number of patients. They may be also conducted on a higher MRI operating system using 3 T machines. More advanced techniques can be added such as contrast-enhanced mammography and multiparametric MRI.

(See figure on next page.)

Fig. 5 A 58-year-old patient with right breast cancer underwent right conservative surgery 6 years ago.DBT: **a** (MLO) view DBT **b** Craniocaudal (CC) view **c** Ultrasound. Tomosynthesis revealed an upper outer partially circumscribed oval lesion related to the operative bed, complementary ultrasound revealed well-defined hypoechoic oval solid lesion the lesion was categorized as (BIRADS 3). **d** Axial T1weighted image **e** Axial T2weighted image **f** post-contrast subtraction T1 weighted image proved to be well-defined oval lesion eliciting low signal in T2 and T1 and faint post-contrast enhancement, the lesion was categorized as (BIRADS 3). Histopathology revealed fibroadenom



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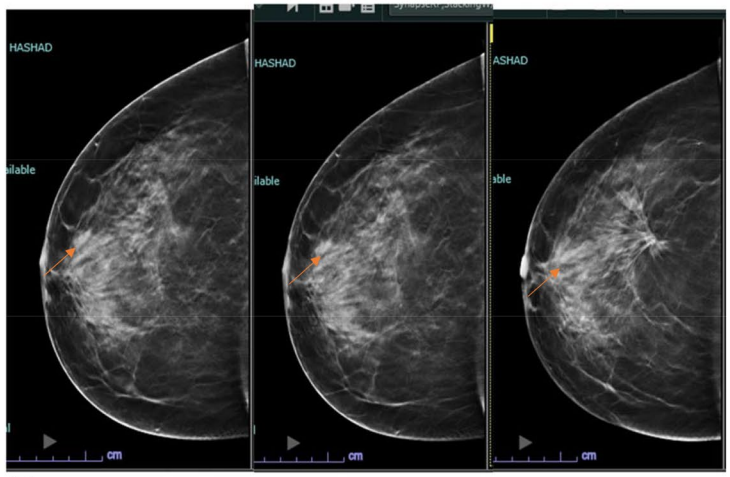

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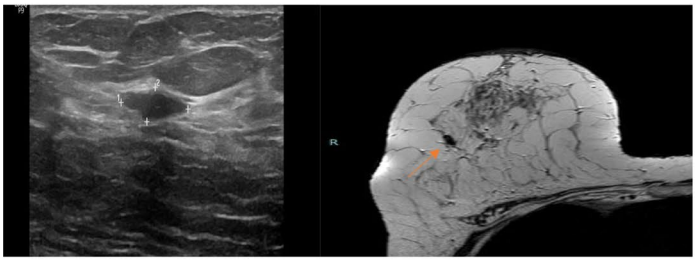
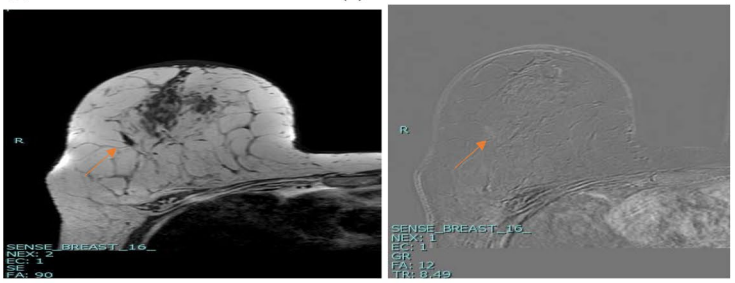


(c) (d)



(e) (f)

Fig. 5 (See legend on previous page.)

Conclusion

DBT with complementary ultrasound is a powerful imaging modality that can be used to detect any recurrence in patients who are surgically treated for breast cancer with higher specificity, accuracy and higher PPV than MRI. The use of these modalities may enhance diagnosis of surgically treated breast cancer, as well as increasing the rate of early detection of locoregional recurrence.

Abbreviations

DBT: Digital breast tomosynthesis; DM: Digital mammography; PPV: Positive predictive value; NPV: Negative predictive value; US: Ultrasound; MRI: Magnetic renounce imaging; LRR: Locoregional recurrence.

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Not applicable.

Authors' contributions

MB suggests and develops the research idea, data collection and analysis, shares in statistical analysis, shares in manuscript writing, revising and editing, prepares figures and tables. L.H contributed to reviewing literature and preparing cases. E.M contributed to data collection and analysis and prepared cases. M.A refers cases, clinical examinations, preparing of cases, shares in manuscript writing, data collection of final results, data collection and analysis and reviewing literature. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Research Ethics Committee of the Faculty of Medicine at Ain shams University in Egypt on march 2021; Reference Number of approval: no FMASU 121/2021. All patients included in this study gave informed written consent to participate in our research. If the patient was unconscious at the time of the study, written informed consent for their participation was given by their legal guardian.

Consent for publication

All patients included in this scientific research gave written informed consent to publish the all data contained within our study. If patients were unconscious when consent for publication was requested, a written informed consent for the publication of these data was given by their legal guardian.

Competing interests

The authors declare that they have no competing interests.

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