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# Localisation using multiple magnetic seeds in unilateral breast surgery

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**Abstract**

*Introduction*

Magnetic seeds (Magseeds) are becoming increasingly used as a method of localising non-palpable breast lesions preoperatively. The outcomes of single magseed guided wide local excisions have been reported in the literature, however, there's a paucity of data on results when using multiple magseeds in one breast. In this study, we assess the feasibility and safety of inserting multiple magseeds in the same breast.

*Methods*

A retrospective analysis of all magseed guided excisions performed at the symptomatic breast health and screening breast check departments in MMUH between January 2020 and December 2022 was performed. Patients with more than one magseed inserted unilaterally were included. Primary outcome was successful retrieval of the magnetic seed. Secondary outcomes included accurate excision of the lesion and margin status

*Results*

In total 1,598 magnetic seeds were inserted between January 2020 and December 2022 at MMUH. Forty-three cases had multiple magseeds inserted unilaterally. Twenty four (55.8%) underwent wide local excision for cancerous lesions, while ten patients (23.2%) underwent excision of a borderline (B3) lesion. The remaining nine patients (20.9%) underwent both procedures simultaneously. The mean distance between both seeds was 53.84 mm (range 10-150 mm) craniocaudally and 47.42 mm (range 14-130 mm). Eight out of the 43 patients had one final pathology specimen containing both magnetic seeds. However, the remaining 35 cases (81.3%) had two separate specimens containing one magnetic seed each. All magseeds were successfully localised intra-operatively using Sentimag probe, and all magseeds and clips were retrieved within the final specimen and margins. Lesion excision was achieved in all cases and the rate of positive margins was 13.9%.

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*Discussion*
Multiple magseed localisation is a feasible, safe and effective method when bracketing a unifocal lesion or excising separate lesion in unilateral breast surgery.

**Introduction**

Breast cancer is the most commonly diagnosed malignancy amongst women, with up to 1 in 8 women will be diagnosed with breast cancer in their lifetime. More than 3500 cases diagnosed annually in the Republic of Ireland.[1,2] Screen-detected breast cancer accounts for approximately 30% of all diagnosed breast cancer cases.[2] The increase in the number of screen-detected non-palpable lesions has impacted breast-conserving surgery and led to development in the methods of preoperative localisation.

For many years wire-guided localisation has been the standard of care for localising non-palpable lesions in breast surgery. However, several shortfalls have been reported over time. Wire migration has been reported to be as high as 4% in wire-guided lumpectomy cases.[3] Moreover, theatre scheduling conflicts and patient distress are frequently encountered with wire localisation. [3,4] Alternative localisation methods have been studied as an alternative to wire localisation. Magnetic seeds have been utilised over the last number of years and have comparable perioperative and pathological results to wire-guided localisation.[5] Magnetic seeds have been shown to have higher satisfaction rates amongst patients with more efficient theatre scheduling and comparable pathological results to wire-guided localisation.[4-6] . A previously published review of our first 100 patients showed magseeds are reliable in localising breast lesions with low re-excision rates and no increase in patient morbidity or mortality.[4] Furthermore, magnetic seed localisation improved patient satisfaction rate and reduced theatre scheduling conflicts. The role of magnetic seed localisation of non-palpable breast lesions is still evolving, such as bracketing lesions or localising multiple lesions in a single breast. There remains a paucity of literature concerning utilising multiple magnetic seeds in a single breast.

This study aims to evaluate the outcomes of using multiple magnetic seeds simultaneously at an Irish tertiary breast cancer centre. We aim to report on the radiological, operative and pathological outcomes of using numerous magnetic seeds in unilateral breast surgery.

**Methods**

Following ethical board approval at Mater Misericordiae University Hospital (MMUH), we conducted a retrospective review of all magnetic seed insertion cases between January 2020 to December 2022. We identified 1,598 cases by examining radiological procedures and operation theatre databases. From this data, fifty-seven cases with multiple magnetic seeds inserted

unilaterally or bilaterally were identified . Following further analysis, only patients with multiple, unilaterally inserted magnetic seeds (in breast, axilla or both) were included in the final analysis. Therefore, fourteen cases with bilateral magnetic seeds were excluded from our patient cohort, leaving 43 eligible patients for inclusion. For this study, we created a database with patients' demographics and radiological, perioperative and pathological outcomes. Information was retrieved through the hospital's electronic files and paper charts. Patient demographics included age, gender, ASA score and source of referral. Perioperative, radiological and pathological outcomes were reported and analysed for each case.

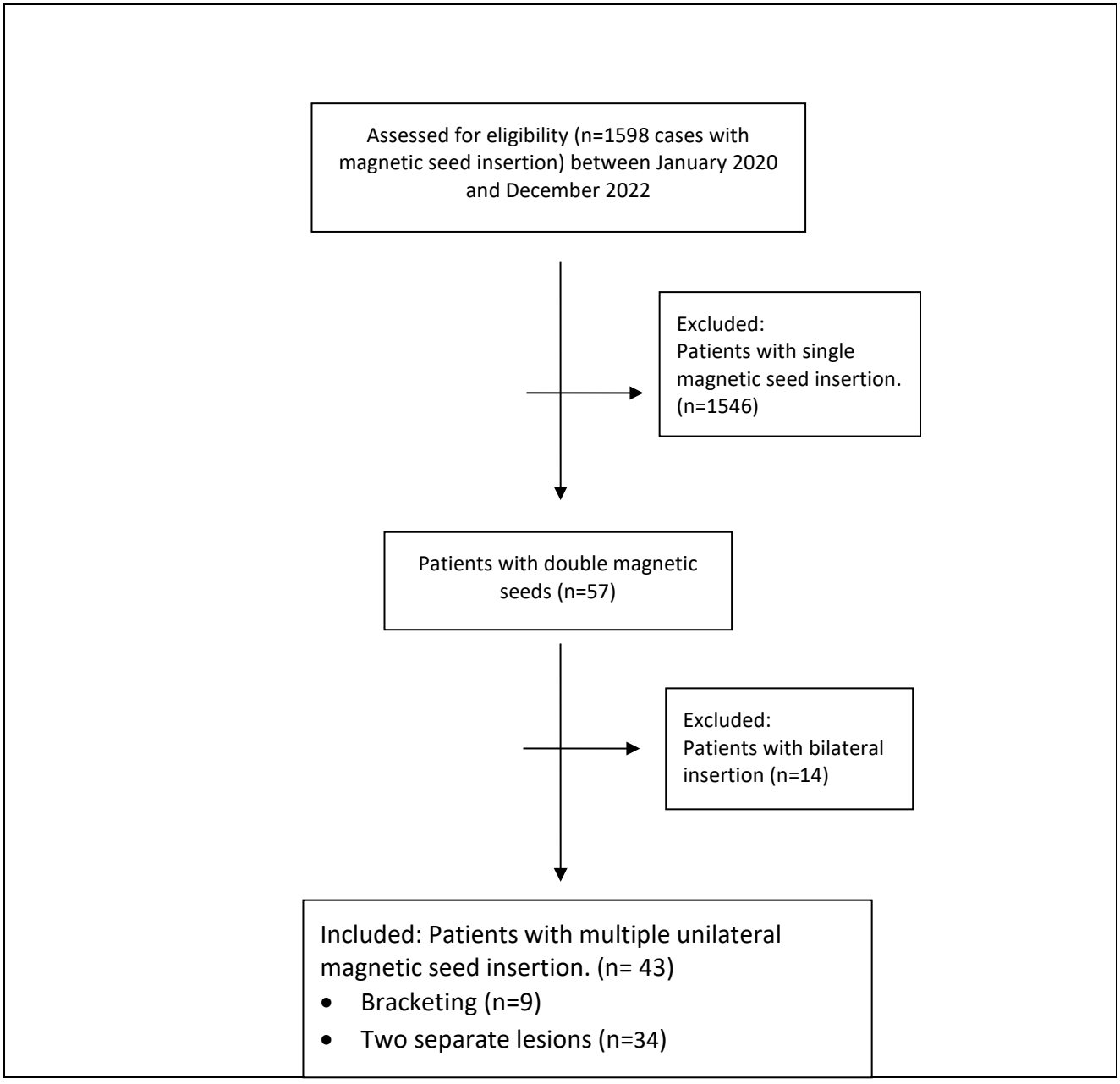


*Figure 1: patient enrolment diagram into the study*

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Following successful implementation, our centre has adopted Magnetic seed localisation as the standard localisation technique since 2018. The magnetic seeds are inserted under local anaesthetic in the radiology outpatient department under stereotactic or ultrasound guidance by a consultant breast radiologist. Post-insertion images are reviewed and annotated for the accuracy of seed deposition within the lesion. The magnetic seed system used in our hospital is the *Endomagnetics* Ltd system.

The surgical procedures performed were wide local excision, diagnostic excision or both. Five consultant breast surgeons at the Mater Misericordiae University Hospital breast surgery department performed the procedures. Intraoperatively, the magnetic seed is localised using the *Sentimag* probe governed by the signal displayed on the *Sentimag* device (0-9999). Before the excision of the final specimen, the signal is confirmed via the *Sentimag* probe and the specimen is annotated using clips (one medial, two anterior and three superiorly). We performed a specimen X-ray immediately following excision to confirm retrieval of magnetic seed, biopsy clip and complete lesion excision (Fig. 2).

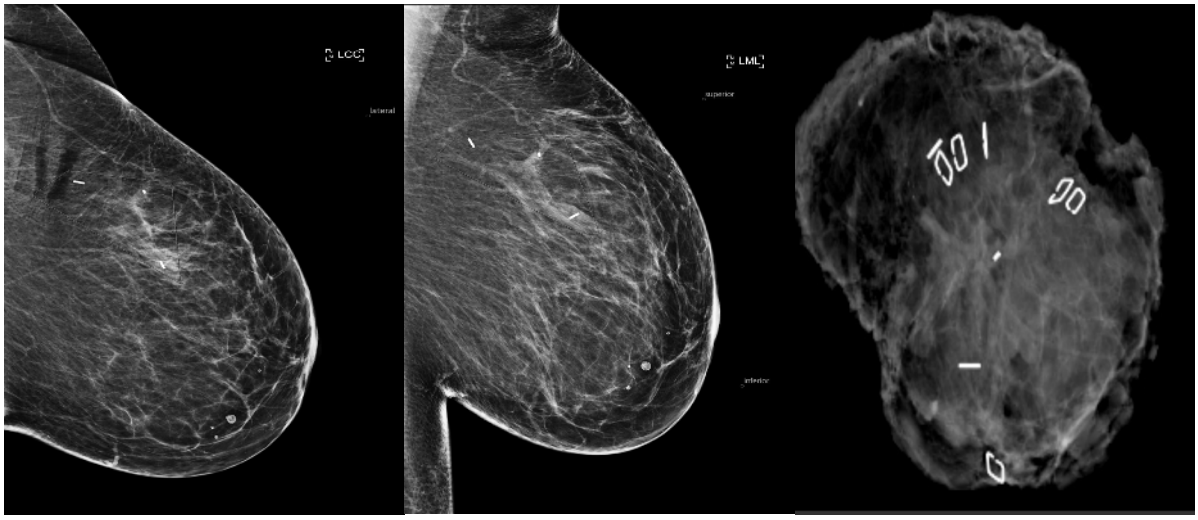


*Figure 2:* 2-axis Craniocaudal and Mediolateral mammographic views of the left breast demonstrating bracketing of a B5 mass lesion with calcifications spanning 58 mm (DCIS) in the upper outer quadrant. The clips are oblique to each other and lie 52 mm (CC) and 51 mm (ML) apart. The specimen is oriented using clips (one medial, two anterior and three superior).

The Perioperative outcomes included preoperative indication, operative time, perioperative complications and reoperation rate. Pathological outcomes included specimen size, lesion, final diagnosis, and margin status. Radiological outcomes included a magnetic seed insertion method, orientation and distance between seeds and migration on the post-insertion mammogram. Radiological outcomes were reported by a breast radiology fellow (I.W.) and confirmed by the consultant breast radiologist (E.S.). The need for further surgery was based on the SSO/ASTRO guidelines, and the decision was made following the multi-disciplinary meeting. Negative margins

were defined as "no tumour at ink" for invasive cancer and a 2 mm margin for Ductal Carcinoma In Situ (DCIS).

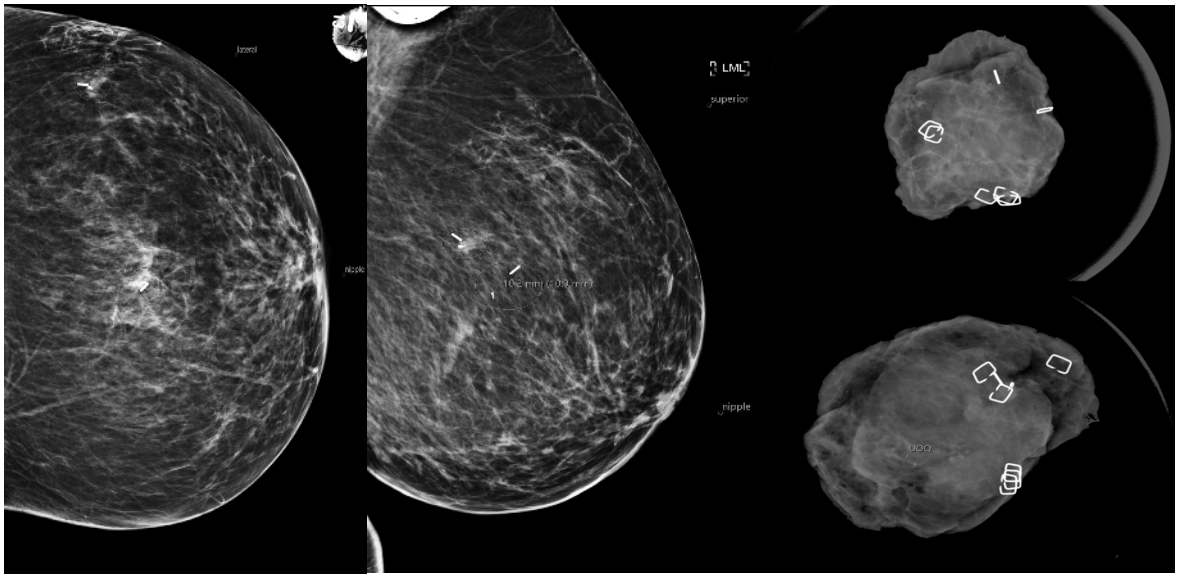


*Figure 3:* 2-axis Craniocaudal and Mediolateral mammographic views of the left breast demonstrating magseed localisation for two separate B3 lesions at 3 o'clock and centrally. Both lesions measure 10 mm on mammogram. The clips lie 86 mm (CC) and 23 mm (ML) apart. The centrally positioned magseed is within 10 mm of the original marker clip. The picture to the right demonstrates two separate orientated specimen radiographs. The specimen for the lateral lesion shows the magseed and marker clip. The central specimen only shows the magseed. A postoperative mammogram did not reveal the original marker clip, which likely fell out of the specimen prior to being imaged in the immediate postoperative period.

**Results**

In total, 43 patients were included in the study. From these, 24 (55.8%) were screening-detected cancers. The mean age of our patient cohort was 58 years old, and they were all females. The most common preoperative indication was invasive ductal carcinoma representing 51.3% of all diagnoses, followed by borderline pathology.

| Patients with multiple magnetic seeds (n=43) | |
|---|---|
| Sex<br>Female | <br>43 (100%) |
| Age (Mean) | 58.65 years |
| **ASA Score:**<br>I-II<br>III-IV | <br>33 (76.7%)<br>10 (23.2%) |

| | |
|---|---|
| **Referral source:** | |
| Symptomatic breast clinic | 19 (44.1%) |
| Screening clinic | 24 (55.8%) |
| **Type of operation** | |
| Wide local excision | 24 |
| Diagnostic excision | 10 |
| Both | 9 |
| History of neoadjuvant therapy | 2 (4.6%) |

*Table 1: Patient demographics and preoperative diagnosis*

The most common modality of magseed insertion was ultrasound (US) guided insertion (n=40). In 17.5% of the cases, mammogram and US guided insertion modalities were utilised in lesions that could not be localised by the US alone. In 18.6% of the cases; we used magseeds for bracketing a lesion for excision. In contrast, in the remaining cases, the seeds were inserted in two discrete lesions for excision. The radiologists annotated the distance between magnetic seeds on the post-insertion mammogram films. Three cases had magseeds inserted in an axillary lymph node, and 3 had magseeds inserted in the intra-mammary lymph node. The mean distance between both seeds was 53.84 mm (range 10-150 mm) craniocaudally and 47.42 mm (range 14-130 mm) mediolaterally, keeping with the suggested 30 mm between seeds to avoid signal interference. The mean radiological size of the lesions was 16.33 mm with a range of 3-58 mm. There was no reported migration of the seeds on the post-insertion mammograms. Eight out of the 43 patients had one final pathology specimen containing both magnetic seeds. However, the remaining 35 cases (81.3%) had two separate specimens containing one magnetic seed each. Radiological results can be found in Table 2.

| Unilateral Multiple magnetic seeds (n=86) | |
|---|---|
| **Magseed insertion method:** | |
| US guided insertion | 40 |
| Stereotactic guided insertion | 30 |
| US and stereotactic insertion | 16 |
| **Indication:** | |
| Bracketing | 8 (18.6%) |
| Two separate lesions | 35 (81.3%) |
| **Site of insertion:** | |
| Unilateral breast | 76 (88.3%) |
| Breast and lymph node | 10 (11.6%) |
| **Magseed orientation:** | |
| Anteroposterior | 16 (18.6%) |
| Craniocaudal | 10 (11.6%) |

| | |
|---|---|
| Oblique | 54 (62.7%) |
| Unable to assess | 6 (6.9%) |
| **Mean distance between two seeds:** | |
| Craniocaudal | 53.84 mm (range 10-150 mm) |
| Mediolateral | 47.42 mm (range 14-130 mm) |
| **Mean duration of insertion to excision** | 11.25 days (range 0-66) |
| **Migration after insertion** | 0/86 |
| **Mean radiological size of lesion** | 16.33 mm (range 3-58 mm) |

*Table 2*: Radiological outcomes: table includes details of the method of insertion of magseeds, their orientation and distance to each other and the mean duration between insertion and excision.

The primary outcome of excision of the magseed was achieved in all cases. We successfully identified magnetic seeds in 97.5% of all post-operative specimen mammograms. In one case, the magnetic seed was not on the post-excision film, however, it was found in the excised margins.

The most commonly performed procedure, was WLE (55.8%). The mean operative time was 56.6 minutes. The mean size of the final specimen was 43.12 mm, and the mean size of the final lesion on pathology was 15. 3 mm compared to the radiological mean size of 16. 33 mm. The most common final pathology was invasive cancer, of which 66.6% of the cases had invasive ductal carcinoma. Five patients with borderline preoperative diagnosis were found to have DCIS on the post-operative pathology, while two borderline cases had a final pathology of invasive tubular cancer.
Furthermore, four cases with a preoperative diagnosis of DCIS were found to have invasive cancer on their final pathology. Five patients had a magnetic seed inserted in a lymph node and the breast unilaterally. Three of them were inserted in an intramammary lymph node and were found to have cancer in the lymph node on the final pathology while the other two magseeds were inserted in axillary lymph nodes and were found benign. There were no intra-operative complications. Positive margins were found in 6/43 patients (13.9%). Four cases proceeded to have re-excision of margins, and one patient proceeded to have a completion mastectomy. The remaining case was found to be too high risk for re-intervention. A detailed description of the perioperative outcomes can be found in table 3.

| **Unilateral Multiple magnetic seeds** | |
|---|---|
| **Full excision of lesion** | 43/43 |
| Successful identification of magseed on post operative mammogram | 42 (97.5%) |
| **Positive margins** | |
| Yes | 6 (13.9 %) |
| No | 37 (86.1%) |

| | |
|---|---|
| **Reoperation** | |
| Re-excision of margin | 4 |
| Completion mastectomy | 1 |
| **Final pathology** | |
| Invasive cancer | 34 (53.2%) |
| Carcinoma in situ | 10 (12.9%) |
| Borderline lesion | 42 (33.8%) |
| **Size** | |
| Mean size of final specimen | 43.12 mm (range 10-100) |
| Mean size of lesion on pathology report | 15. 3 mm (range 1-38 mm) |
| Mean Weight of the lesion | 24.98 g (range 1.9-120.3) |
| **Mean operative time** | 56.65 minutes (range 19-99) |
| **Perioperative outcomes** | |
| Intra operative complications | 0/43 |
| Claiden Dindo III and IV | 1/43 |
| Length of stay | |
| 0 days | 42 |
| >1 day | 1 |

Table 3 Peri-operative outcomes, rate of re-excision and retrieved magseeds and pathological outcomes.

## Discussion

The incidence of non-palpable breast cancers has increased since the establishment of breast cancer screening worldwide. Screening-detected cancer accounts for approximately 28% of all breast cancer cases.[2] Wire-guided localisation of non-palpable breast cancer was the standard of care before the introduction of magnetic seeds. However, magseeds have proven to be accurate and cost-effective, bypassing shortfalls of wire localisation like patient anxiety and theatre scheduling clashes.[11,12] The iBRA-NET localisation study was a multicentre study which compared the outcomes of wire-guided versus magnetic seed localisation of breast lesions.[10] The study results proved magnetic seeds to be cost-effective and accurate in identifying index breast lesions. It also showed comparable results of re-excision rate of margins as well as perioperative complications.[10] However, to date no study has assessed the safety of using multiple magseeds in a single breast. This study fills the gap in literature when examining the outcomes of using multiple magnetic seeds in excising breast lesions unilaterally.

The primary outcome of study was to assess the safety of using multiple magseeds in a single breast. Our institute has previously shown the perioperative and pathological outcomes were also

comparable to wire-guided localisation for single Magseeds {ref}. In this study, Magseeds were recovered in 97.5% of cases in keeping with similar reported outcomes of single magseed-guided excision studies.[4,10-13] Five of our cases had magnetic seeds inserted into breast and unilateral lymph nodes. Although these are small numbers, it shows the feasibility of using magseeds in cases of targeted axillary dissection which has already been reported by Barry et al[14].

The secondary outcomes from our study was to assess the positive margin rate for invasive cancers, and complete excision of borderline lesions. The rate of positive margins was 13.9%, which is below the acceptable standard rate of 14%[15]. Two other cases had an index procedure of diagnostic excision, which showed DCIS; thus, no extra margins were taken at the time. Therefore, our re-excision of margins rate remains comparable to single magnetic seed-guided lumpectomy outcomes. [4,13-15] For the borderline lesions, in all cases the index lesion was identified on the final pathology. There was one reported morbidity of a post-operative haematoma which we managed conservatively. Otherwise, all the cohorts were treated as day cases and discharged on the same day. There was no reported in-hospital, 30 days or 60 days mortality. Therefore, multiple magnetic seeds guided excisions have comparable perioperative, radiological and pathological outcomes compared with single seed-guided excisions. The use of a novel technique comes with a learning curve in practice. The number of cases have exponentially increased over the years since the use of multiple magnetic seeds was introduced at our centre. There was ten cases with multiple magnetic performed in 2020 which increased to 32 cases in 2022. The increase in frequency of cases and expertise utilizing the new technique contributed to better outcomes over the year.

There are certain limitations to our study. It is a single-centre study with a relatively small cohort number. There may be a selection bias when choosing the cases for double magseed insertion instead of wire-guided localisation in terms of surgeon preference and timing of surgery which has not been recorded. Despite the limitations above, our study demonstrates that using multiple magnetic seeds in the unilateral breast is still a feasible and accurate technique for identifying non-palpable breast lesions. It has also proven to be a cost-effective method when compared to other localisation methods[16].

Multiple magseed localisation is a feasible, safe and effective method when bracketing a unifocal lesion or separate lesion excisions in unilateral breast surgery.

**Declaration of Conflicts of Interest:**
None declared.

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