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ORIGINAL ARTICLE

CME

Radar Localisation of Non-palpable Breast Lesions in a Chinese Population: a Pilot Study

SC Woo, T Wong, CM Chau, WY Fung, RLS Chan, AWT Yung, JKF Ma

Department of Radiology, Princess Margaret Hospital, Hong Kong

ABSTRACT

Introduction: *We performed a retrospective review of a radar-based breast lesion localisation system (Savi Scout; Cianna Medical, Merit Medical Systems, Inc., South Jordan [UT], United States) in a Chinese population.*

Methods: *Placement success (final target-to-reflector distance <10 mm), retrieval success, margin clearance, and re-excision rates were reviewed in the cases of 23 Chinese patients who underwent guided nonpalpable breast lesion excision from October 2019 to December 2020 using the system in a single institution.*

Results: *Twenty-three reflectors were placed under sonographic (n=13; 57%) or stereotactic (n=10; 44%) guidance to localise 23 target lesions. There was no delayed migration for the 20 reflectors placed before the day of surgery. Placement success was achieved in 21 (91%). Mean final target-to-reflector distance was 3 mm. Of the 23 lesions, two (9%) required alternative localisation owing to reflector distance ≥10 mm away from the target. Retrieval success was achieved in 22 (96%). Deactivation of a reflector was noted in one case. Of these 23 lesions, three were excised for therapeutic intent, of which one required re-excision due to close margins. There were no procedure-related complications.*

Conclusion: *This radar-based localisation system is a safe and effective device for guiding the excision of non-palpable breast lesions in a Chinese population. Its advantages, such as the fact that it causes minimal artefacts on magnetic resonance imaging, may render it a superior alternative in selected patients.*

Key Words: *Breast; Breast neoplasms; Mammography; Mastectomy, segmental; Ultrasonography*

Correspondence: *Dr SC Woo, Department of Radiology, Princess Margaret Hospital, Hong Kong*
Email: stephaniecheriwoo@gmail.com

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Ethics Approval: This study was approved by Kowloon West Cluster Research Ethics Committee of Hospital Authority (Ref: KW/EX-21-027(156-09)). The requirement for patient consent was waived.

中文摘要

華人人群不可觸及乳腺病變的雷達定位：初步研究

鄔潔欣、黃婷、周智敏、馮惠鈺、陳樂詩、翁維德、馬嘉輝

引言：我們對一種基於雷達的乳腺病變定位系統（Savi Scout）進行一項華人回顧性研究。

方法：對2019年10月至2020年12月期間在單中心接受該系統引導式不可觸乳腺病灶切除術的23名華人患者有關植入成功率（最終目標與反射器距離<10 mm）、回取成功率、邊緣清除率和再切除率進行回顧。

結果：13個反射器（57%）於超聲引導下放置，10個反射器（43%）於立體定向引導下放置，共定位23個目標病灶。手術當天之前放置的20個反射器沒有延遲移位。21例（91%）放置成功。平均最終目標與反射器的距離為3 mm。由於反射器與距離目標間≥10 mm，2個病變（9%）需要其他方式定位。22例（96%）回取成功。1例反射器失活。23個病灶中，3例因治療目的而切除，其中1例因切緣較近須重新切除。沒有手術相關的併發症。

結論：這雷達系統安全有效，能引導華人乳房不可觸及病灶的切除。其優勢克服其他定位方法的一些限制，例如減少磁共振成像偽影，對特定患者可成為良好替代方案。

INTRODUCTION

Excision of non-palpable breast lesions is traditionally performed by preoperative image-guided wire localisation. It is the most widely used method for localisation and has been the standard technique for decades.[1] However, this technique has several drawbacks including patient discomfort and possible wire transection and displacement. Furthermore, it poses limitations in scheduling flexibility, as the procedure has to be done on the same day as the surgery. It also limits the surgical approach and necessitates larger amounts of healthy breast tissue to be excised due to the presence of the wire.[2-6] Hence, newer techniques have been developed to overcome the limitations of wire localisation, including radioguided occult lesion localisation, radar reflector localisation (Savi Scout; Cianna Medical, Merit Medical Systems, Inc., Aliso Viejo [CA], US), magnetic seed localisation (Magseed; Endomagnetics, Cambridge, United Kingdom) and radiofrequency identification tag localisation (LOCalizer; Hologic, Marlborough [MA], US).[1]

At our institution, we reviewed the magnetic seed localisation technique, which gave promising preliminary results.[7] In this paper, we report on our evaluation of the radar-based localisation device. The methodology used and the outcomes analysed were similar to those of the prior study.

The radar-based surgical guidance system received 510(k) US Food and Drug Administration approval in December 2014. It was introduced in Hong Kong in late 2019. Our goal was to evaluate the safety and efficacy of radar-based localisation of non-palpable breast lesions. To the best of our knowledge, this is the first publication on radar-based localisation in a Chinese population.

METHODS

A single-institution retrospective review of 23 women who underwent radar-based localisation (Savi Scout)[8] for non-palpable breast lesions from October 2019 to December 2020 was conducted. Patients were selected in consensus by breast radiologists and breast surgeons through reviewing images on target visibility and target depth, and whether the patients had any nickel allergy or cardiac implants. Patients who had a reflector placed but underwent no surgery, and patients who underwent mastectomy instead of lumpectomy were excluded.

Localisation Procedure

The localisation procedure is largely similar to that described in the study of magnetic seed localisation by Fung et al,[7] as it is performed in the same institution and by the same group of radiologists.

Percutaneous image-guided reflector placement was performed by one of the four breast radiologists at our institution with 3 to 19 years of experience in performing image-guided breast localisation, or by a breast radiology trainee who was directly supervised by one of the breast radiologists, using a sterile single-use preloaded 16-gauge needle (7.5 or 10 cm long).

During ultrasound-guided placement, the patient was positioned supine and rolled slightly towards the contralateral side of the involved breast, with a wedge placed under the ipsilateral shoulder, with the ipsilateral arm abducted over the patient's head, to spread the breast thickness evenly. Target-to-reflector distance was evaluated in real time. During stereotactic-guided placement, patients either lay ipsilateral or contralateral decubitus or sat erect to facilitate breast compression by the stereotactic apparatus, and target-to-reflector distance was measured on post-placement mammograms in the mediolateral and craniocaudal projections.

For patients with reflectors inserted prior to the day of surgery, additional ultrasound and/or mammography was performed on the day of surgery for assessment of any delayed target migration. Significant migration was defined as a final target-to-reflector distance ≥10 mm more than on the initial images generated during reflector placement. In the case of significant migration, an alternative localisation method was employed.

Radar-based guided excision was performed with the depth of the reflector from skin first assessed by ultrasound. For the excision, the surgeon positioned the patient supine, with the ipsilateral arm abducted 90°.

The reflector was localised intraoperatively by breast surgeons with the use of the handpiece and console as described above. Specimen radiographs were acquired in all cases to confirm target lesion removal. Radial margins of the target lesion were also evaluated on specimen radiograph.

Outcome Analysis

We followed the outcome analysis described in a study of magnetic seed localisation by Fung et al.[7]

Placement success rate and retrieval success rate with 95% confidence intervals (CIs) were calculated. Placement success was defined as a final target-to-reflector distance ≤10 mm in any plane on images on the day of surgery.[9] For cases that achieved placement success, the final target-to-reflector distances were further subdivided into <2 mm, 2 to 5 mm, and 6 to 9 mm. Retrieval success was defined by localisation by the handpiece of the presence of the reflector in the first specimen radiograph. Patient demographics, preoperative pathology (if any), and surgical indications were reviewed through the electronic patient records.

The target lesions were categorised into two groups: those resected with therapeutic intent and those resected with diagnostic intent.

Among the cases with therapeutic intent, margin clearance was assessed. Margin clearance was defined as ≥2 mm disease-free margins. The re-excision rate due to inadequate margin clearance was analysed. Complications related to reflector deployment and surgeries were recorded.

RESULTS

A total of 25 patients were selected for reflector placement during the study period. Two patients were excluded (Figure 1); one patient because the surgery was not performed as she was diagnosed with concomitant Stage IV lung cancer after the reflector placement. Another patient was excluded as the breast tumour was subsequently found to have rapidly enlarged and the patient opted for mastectomy. A total of 23 female patients remained, with 23 reflectors placed (Table 1). The mean age of the patients was 55 years (range, 27-74).

In total, 23 reflectors were placed to localise 23 target lesions (Figure 2). Three of them (13%) were placed on the day of surgery, while 20 (87%) reflectors were inserted 6 to 69 days (mean 10.8 ± 13.6) before the day of surgery in an out-patient setting.

Of 23 reflectors, 13 (57%) were placed under sonographic guidance (Figure 3), and 10 (44%) were placed under stereotactic guidance (Figure 4). The most common type of target lesion was a mass (n=13; 57%). The second commonest type was biopsy markers (n=6; 26%), and the remainder were microcalcifications (n=4; 17%).

Among the 23 reflectors, 18 (78%) were within 2 mm, two (9%) were 2 to 5 mm, and one (4%) was 6 to 9 mm from the target. Two reflectors (9%) had an initial target-to-reflector distance ≥10 mm, unassociated with delayed migration, and underwent localisation by other methods. There was no delayed migration (0%) in any of the 20 reflectors placed before the day of surgery. Hence,

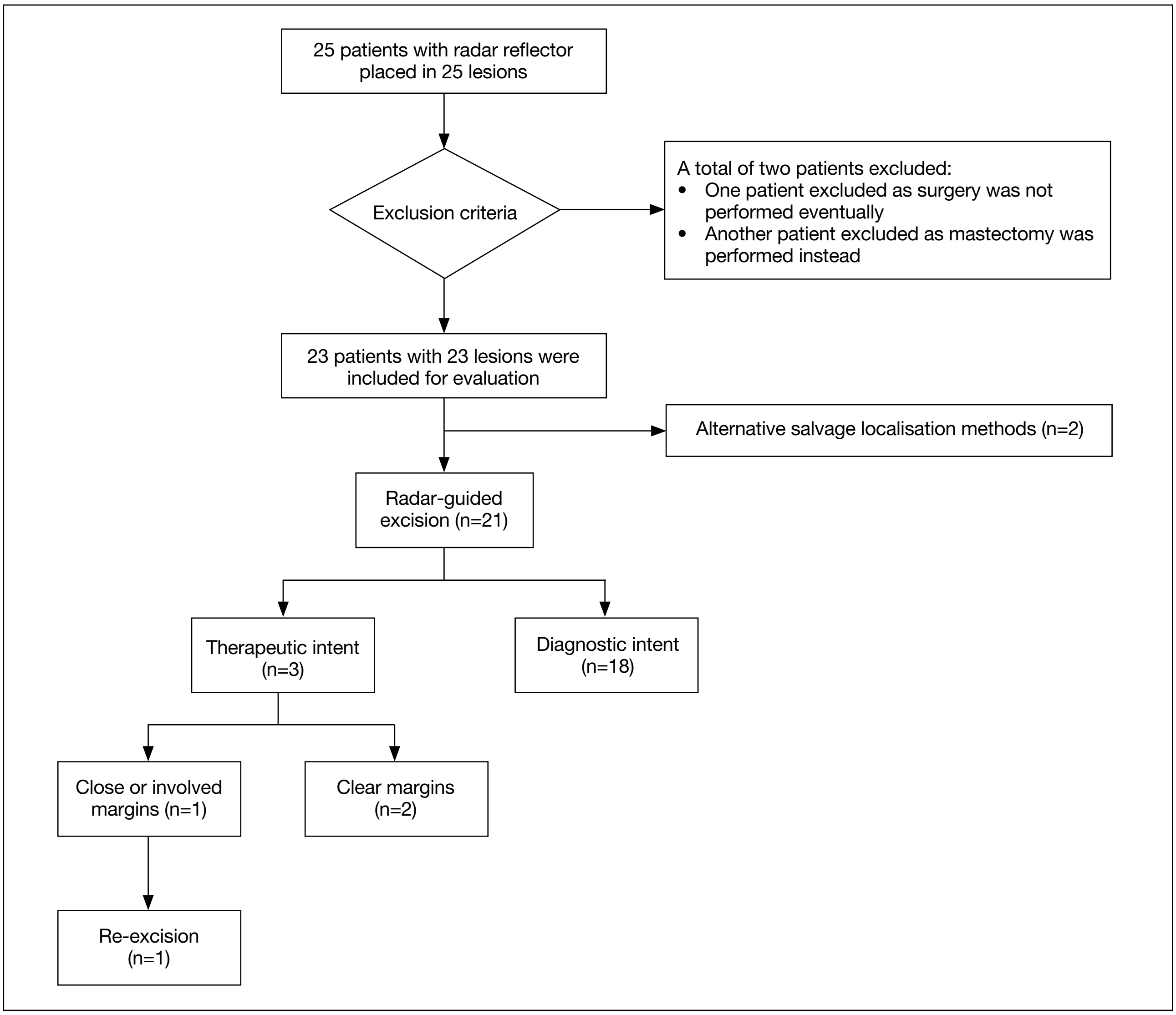

Figure 1. Flowchart showing subject recruitment and outcome.

placement success was achieved in 21 (91%) reflectors (95% CI=73.2%-97.6%). The mean final target-to-reflector distance was 3.0 ± 5 mm (Table 2). These 21 lesions had guided excision of the lesions as planned, with sonographic depth of the reflectors of 6 mm to 19 mm (mean 11 ± 3.4) from the skin surface.

Deactivation of the reflector was noted in one case. The remaining 22 (96%) reflectors were localised by the handpiece and appeared on the initial specimen radiographs (95% CI = 79.0%-99.2%).

Among the 21 lesions successfully excised, 18 (86%) were excised with diagnostic intent and three (14%) with therapeutic intent.

For the three lesions excised with therapeutic intent, one of them showed invasive ductal carcinoma on both preoperative biopsy and final surgical pathology. The second case showed atypical lobular hyperplasia with a microscopic focus of low-grade ductal carcinoma in situ (DCIS) on preoperative biopsy, and final surgical pathology revealed lobular carcinoma in situ without definite DCIS. The last case showed DCIS on preoperative biopsy, while final surgical pathology came back to be invasive ductal carcinoma with a background of extensive DCIS. This lesion had narrow margins of <1 mm and required re-excision (Figure 3). Hence the margin clearance rate was 66.7% and re-excision rate was 33.3%. No procedure-related complications were recorded.

Table 1. Characteristics of study population and target lesions (n=23).*

	No. of lesions (%)
Age, y	55 ± 11.1
Time between radar reflector placement and surgery, mean (range), d	10.8 (6-69)
Lesions with radar reflectors placed before the day of surgery	20 (87%)
Image-guidance modality for reflector insertion	
Ultrasound	13 (57%)
Stereotactic	10 (44%)
Target types	
Masses	13 (57%)
Biopsy marker	6 (26%)
Calcification	4 (17%)
Excision guidance	
Alternative salvage localisation methods	2 (9%)
Radar-reflector guided excision	21 (91%)
Diagnostic intent	18 (86%)
Therapeutic intent	3 (14%)

* Data are shown as No. (%) or mean ± standard deviation, unless otherwise specified.

DISCUSSION

Among 23 patients, placement success was achieved in 21 (91%) and retrieval success was achieved in 22 (96%). Such results are in line with prior literature, which revealed high placement success (99% to 100%)[10-15] and high retrieval success (95%-100%).[10-15] Our re-excision rate, however, was 33%, which was higher than in prior literature which ranges from 7% to 20%.[10,12]

Reflector migration has been uncommonly reported in prior literature. A prior study reports a 0% migration rate.[16] Three patients had reflectors placed on the day of surgery during our initial experience so as to ensure familiarisation of the radiologists and surgeons with the workflow of the new device. Among all of the 20 reflectors which were placed before the day of surgery, none of them showed delayed migration. This supports the fact that delayed migration is a rare occurrence, and that decoupling of surgery and radiology scheduling is feasible. The reflectors can be placed at least 30 days before the surgery. This eliminates the need to reserve

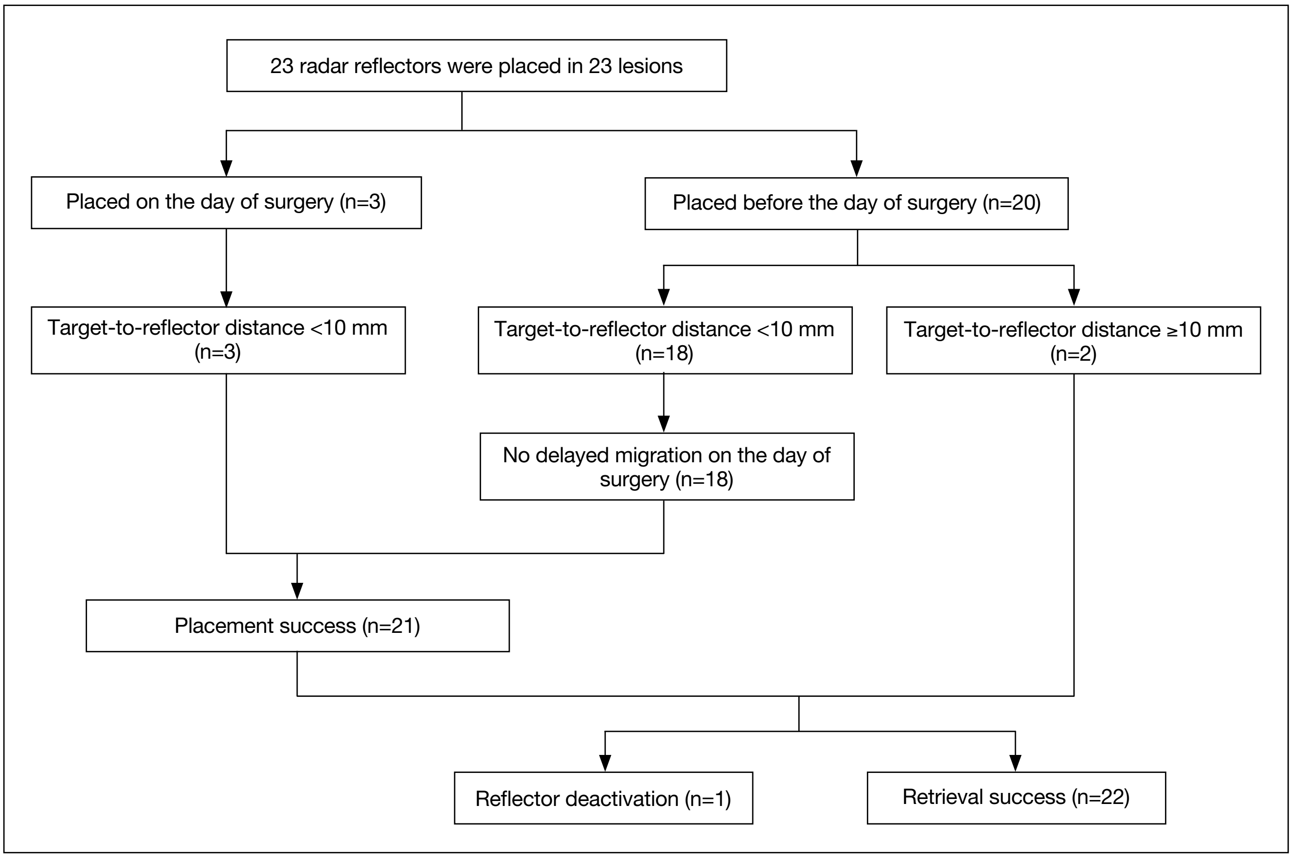

Figure 2. Outcome of the 23 radar reflectors placed in the 23 target lesions.

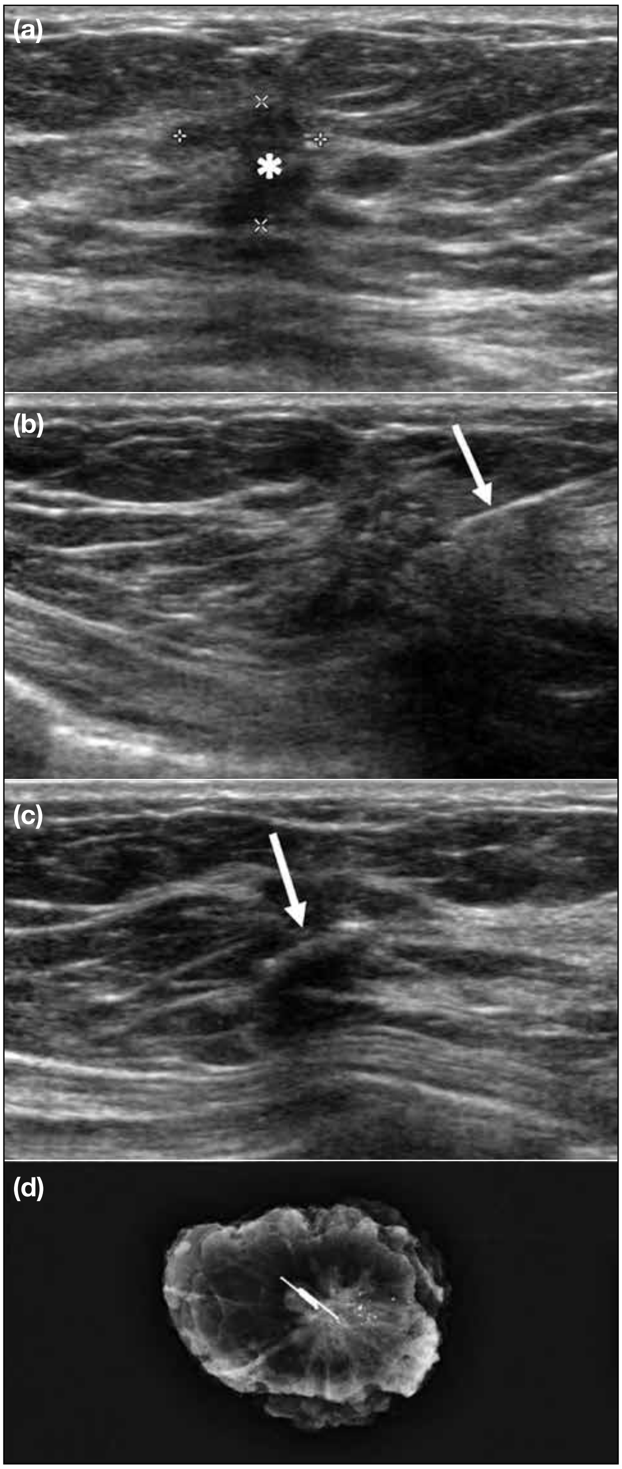

Figure 3. (a) Ultrasound of right breast of a 47-year-old woman who had biopsy-proven ductal carcinoma in situ (DCIS) at 11 o'clock (asterisk). (b) Ultrasound-guided reflector placement near the lesion was performed with the introducer needle tip (arrow) aiming at the lesion. (c) Subsequent ultrasound showing radar reflector (arrow) in the centre of the lesion. (d) Specimen radiograph showing presence of reflector, indicating successful excision. Final pathology showed invasive ductal carcinoma on a background of extensive intermediate-grade DCIS. However, the 3 o'clock margin was only 1 mm from DCIS and hence further wide local excision was performed.

Table 2. Placement success and retrieval success of 23 radar reflectors in 23 patients.*

	No. of markers (%)
Final target-to-reflector distance†	3.0 ± 5
<2 mm	18 (78%)
2-5 mm	2 (9%)
6-9 mm	1 (4%)
≥10 mm	2 (9%)
Placement success	21 (91%)
Retrieval success	22 (96%)

* Data are shown as No. (%) or mean ± standard deviation.
† The largest distance between target lesion and reflector on any plane.

radiology appointments for same-day hookwire placements, and allows placement of reflectors at the convenience of the patient as well as the of the radiology department. Patients can be put as the first case of the operation list, thus minimising presurgical fasting and risk of vasovagal syncope as compared to that if same-day localisation were needed.[6]

One of the advantages of a radar-based system over hookwire and even other novel localisation techniques such as Magseed and radiofrequency identification tag is that it is suitable for long-term implantation with minimal susceptibility artefacts on magnetic resonance imaging (MRI).[1,16,17] MRI is often needed after cases which require neoadjuvant chemotherapy to reassess the tumour for treatment response and feasibility of breast conservation surgery. The reflector does not impede the subsequent imaging assessment of the tumour due to its minimal artefacts.[17] This advantage was illustrated in one of our cases of preoperative biopsy-proven invasive ductal carcinoma. The patient underwent neoadjuvant chemotherapy for tumour shrinkage after reflector placement (Figure 5). The reflector was placed 69 days before surgery as neoadjuvant chemotherapy was needed for tumour shrinkage before surgical excision. Repeat MRI after neoadjuvant chemotherapy was performed and showed the reflector in situ, with no significant artefacts that interfered with image interpretation. No migration of the reflector was observed, and the tumour was successfully excised with adequate margins. This is one of the main advantages of the radar-based system, as other devices may cause a relatively more significant artefact. The reflector can also aid surgical detection of the tumour after satisfactory shrinkage without the need of additional localisation procedures, which can save the resources needed for another intervention, and reduce patient's anxiety and pain.

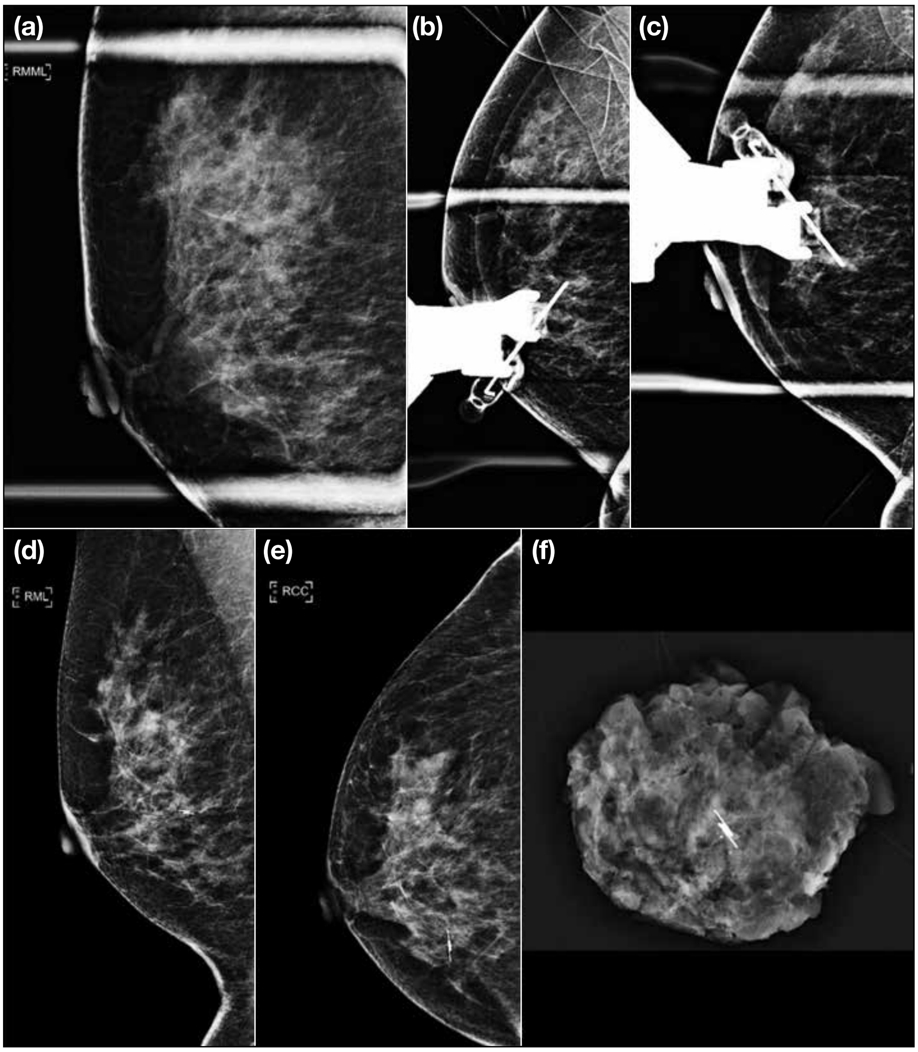

Figure 4. (a) Selected right mediolateral magnification view of the mammogram of a 55-year-old woman showing coarse heterogeneous and fine pleomorphic microcalcifications at lower inner quadrant of right breast, which showed increase in number and change in morphology when compared to prior mammograms (not shown). Stereotactic-guided core biopsy was subsequently performed showing atypical ductal hyperplasia, and hence the surgical team decided to proceed with an excisional biopsy. (b, c) The radar reflector was inserted under stereotactic guidance with diagnostic intent. (d, e) Postprocedural mammograms showing reflector in situ without migration. (f) The reflector was retrieved successfully with specimen radiograph showing presence of the reflector and microcalcifications.

Another advantage of the radar-based system is that it does not require any radioactive materials as compared to other localisation techniques such as radioguided occult lesion localisation. This technique has to be performed on the same day or a day before the surgery as the radiotracer material decays with time. Moreover, use of radiotracer material requires Nuclear Medicine unit support, and is subject to radiation safety regulations.[17] Hence comparatively, a radar-based system is more readily available, especially in smaller centres with no nuclear medicine support and does not pose any radiation exposure to the patient and personnel.[1]

There are several caveats for radar-based localisation. Although the reflector is safe to use in a strong magnetic field, the console, handpiece/cable assembly, and the delivery system are not.[8,13,18] This poses a potential limitation for use of the Scout system in lesions that are only visualised on MRI and require MRI-guided placement.

In addition, the radar-based system has a depth limit of 6 cm for detectability,[1,8] which is a potential limitation for its use. However, we do not expect signal detection to be a problem even in slightly thicker breasts as long as we push the handpiece firmly against the chest wall, as proven in a previous study that detected reflectors up to 8 cm deep.[15] When we selected patients for sonographically guided reflector placement, the sonographic depths of the lesions were <6 cm from the skin surface. For stereotactic-guided placement, we selected patients with the shortest distance of the target lesion from the skin surface <6 cm on mammogram. However, we did not encounter any patients who had

Figure 5. (a) Ultrasound of right breast of a 59-year-old woman showed an irregular hypoechoic lesion with angular margins (asterisk) at 1 o'clock, biopsy-proven to be intraductal carcinoma. (b) Ultrasound-guided radar reflector placement at the hypoechoic lesion was performed with subsequent ultrasound showing the radar reflector (arrow) in the centre of the lesion. (c, d) Mammograms done on the same day showed the reflector in situ. Magnetic resonance imaging performed after neoadjuvant chemotherapy showing shrinkage of tumour. (e) The signal void within (arrow) signified where the radar reflector is placed, which showed minimal artefacts and did not interfere with image interpretation. (f, g) Subsequent mammograms confirmed no delayed migration. Pathology of final surgical specimen showing adequate excision margins.

to be excluded due to such a depth limit. In our study, the average sonographic depth of the reflector from the skin surface was 1.1 cm ± 0.3 cm. The deepest reflector that we have placed was 1.9 cm from the skin surface. Chinese patients tend to have thinner breasts[19]; however, further studies are required to confirm whether this depth limitation poses less of a challenge in this population.

Halogen and older model operating room lights have been shown to interfere with detection of the reflector.[15] According to the experience of the surgeons in our centre, halogen operating room lights did interfere with signal detection of the reflector, and by simply directing them in another direction, we enabled detection of the transcutaneous signal. This is in line with the experience of researchers, who reported that by simply shielding, dimming, or redirecting the halogen lights slightly away from the breast while using the handpiece, accurate detection of the reflector was achieved.[15] Halogen lights are also going out of favour, with more operating rooms using LED lighting, which do not interfere with radar-based localisation.[15]

A prior study also described a case of detection signal loss after an electrocautery device came into contact with the reflector.[14] Although the reflector has since been modified with addition of an electrostatic discharge diode to minimise the risk of reflector inactivation, it does not entirely eliminate the possibility.[20] In our study, there was a case with loss of reflector signal during the operation, which was likely due to electrocautery use during skin incision, which deactivated the device at a superficial location in the subareolar region of the breast (Figure 6). After identifying the location of the reflector, the usual practice in our centre is that surgeons raise a skin flap with an electrocautery device and dissect at the edges of the reflector. In this case, loss of reflector signal was caused by inadvertent direct contact of the electrocautery with the reflector, because the reflector was close to the skin. An initial specimen radiograph did not show the presence of the reflector. However, the reflector was noted to be palpable and was removed together with the target biopsy marker as confirmed on subsequent specimen radiograph. Extra caution is suggested for the use of electrocautery device to raise the skin flap, particularly when the reflector in a superficial location, to avoid inadvertent loss of signal. However, this limitation is probably of less significance, as reflector damage by electrocautery would suggest that the surgeon has reached the lesion[21] and can visualise or at least palpate the reflector, as in our case. Apart from deactivation through direct contact with electrocautery, there is a risk of transection of the radar-based antenna during dissection,[20] albeit uncommon. We did not encounter any cases of such, but caution should be taken during operation.

Cost is another factor when considering different localisation techniques. The radar-based localisation system requires an initial capital purchase and uses several disposable items per procedure. Although it is significantly more expensive than hookwire localisation,[1] there are potential savings from more efficient operating room and radiology appointment bookings, because they do not have to be arranged on the same day. For cases which necessitate neoadjuvant chemotherapy, radar-based localisation also eliminates the need of additional localisation procedures, which is also a source of potential savings. Further cost analysis in the future will be helpful to investigate the financial aspect of different localisation techniques.

Patient selection for usage of the radar-based system must be done carefully. Patients with nickel allergy are contra-indicated to reflector insertion while extra caution is needed for patients with cardiac implants.[8] The radar reflector antennae are made of nitinol, which is an alloy of nickel and titanium, hence should not be inserted into patients with nickel allergies. For patients with cardiac implants, there is a theoretical risk that the micro-impulse radar signal may interfere with the intended function of any internal or external cardiac implants, hence the manufacturers advise to contact the cardiac implant manufacturer for instructions before using the radar-based system.[8]

There are also practical aspects which should be taken into consideration during usage of the radar-based system. It is a procedure that requires more dexterity compared to other localisation techniques. For one of the cases with target-to-reflector distance of ≥10 mm, it was performed under sonographic guidance from an inferior approach and resulted in the reflector being 1 cm superior to the centre of target lesion immediately after the placement. Sonographic guided skin marking was performed on the day of surgery. The reflector was detected and removed together with the target lesion successfully. This was performed during our initial experience, with no significant haematoma detected. This is likely related to the relative lack of experience of the operator at the initial phase, and the more technically demanding nature of the device.

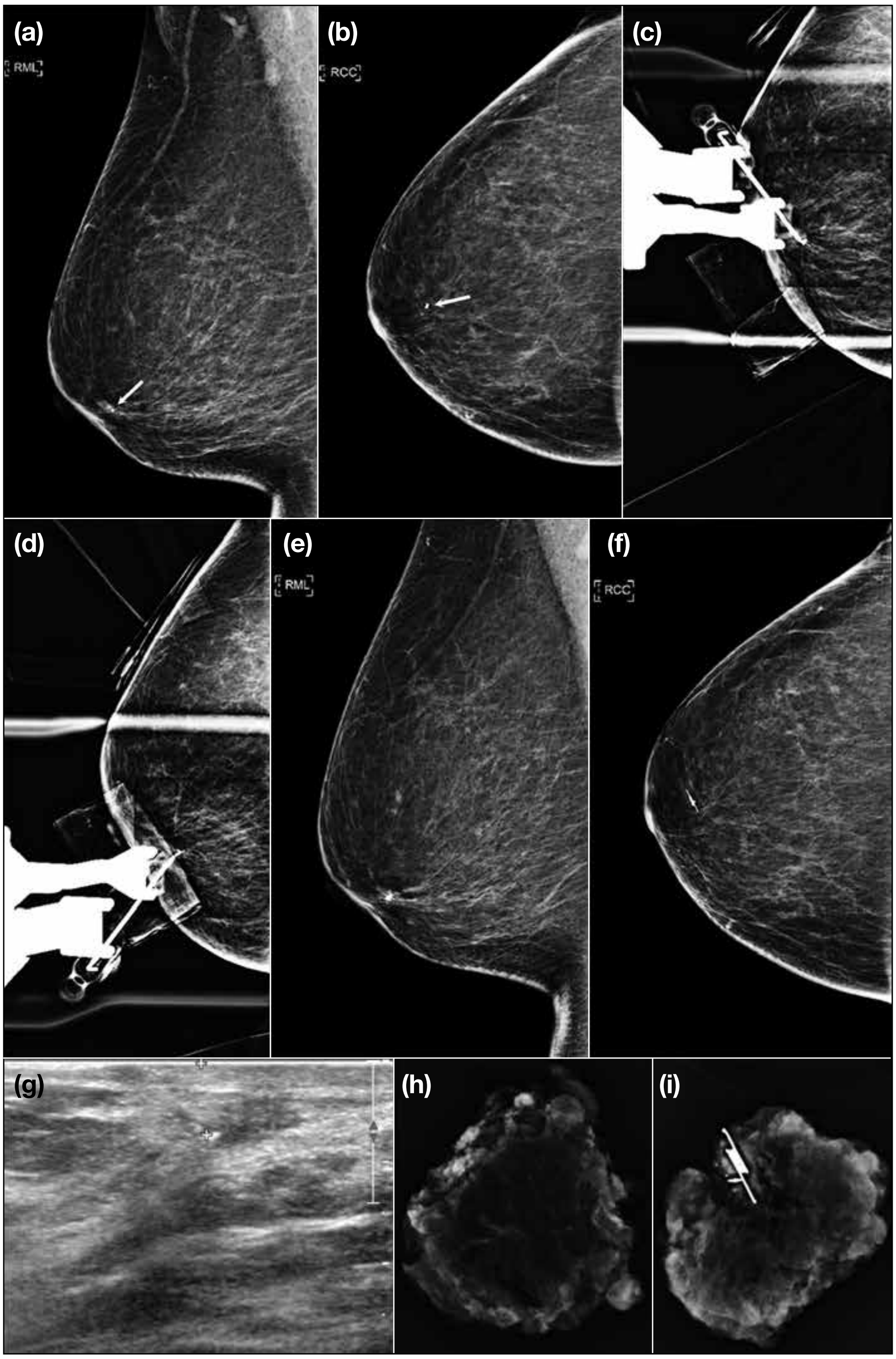

Figure 6. Right mammogram with (a) mediolateral oblique and (b) craniocaudal views of a 61-year-old woman who had prior biopsy showing papillary neoplasm with atypia in the lower outer retroareolar region of the right breast with a biopsy marker (arrows) placed during prior stereotactic-guided biopsy. (c, d) Stereotactic-guided placement of a radar reflector as performed with the tip of deployment needle targeting the biopsy marker. Postprocedural right mammogram (e) mediolateral and (f) craniocaudal views showed successful localisation of the biopsy marker. (g) Postprocedural ultrasound showing that the reflector measured 0.7 cm from skin, which is relatively superficial. Accidental deactivation of the reflector signal by electrocautery device occurred during skin incision. (h) Initial specimen radiograph did not show the presence of reflector. (i) However, the reflector was palpable and was removed together with the target biopsy marker and microcalcifications as confirmed on the subsequent specimen radiograph.

The other case with target-to-reflector distance ≥10 mm was performed under stereotactic guidance by a mediolateral approach (Figure 7). For detection of any immediate marker migration, postprocedural mediolateral and craniocaudal mammograms are routinely done in our centre to document the initial accuracy of reflector placement. The reflector was found to have migrated 2.3 cm medially from the target lesion (microcalcifications) on postprocedural orthogonal mammograms after release of breast compression. The direction of migration occurred along the direction of breast compression, with no clinically or radiologically significant haematoma detected, and hence we propose that this could be related to accordion effect (the migration of a device when compression is released, and the breast expands to its original shape and size).[20]

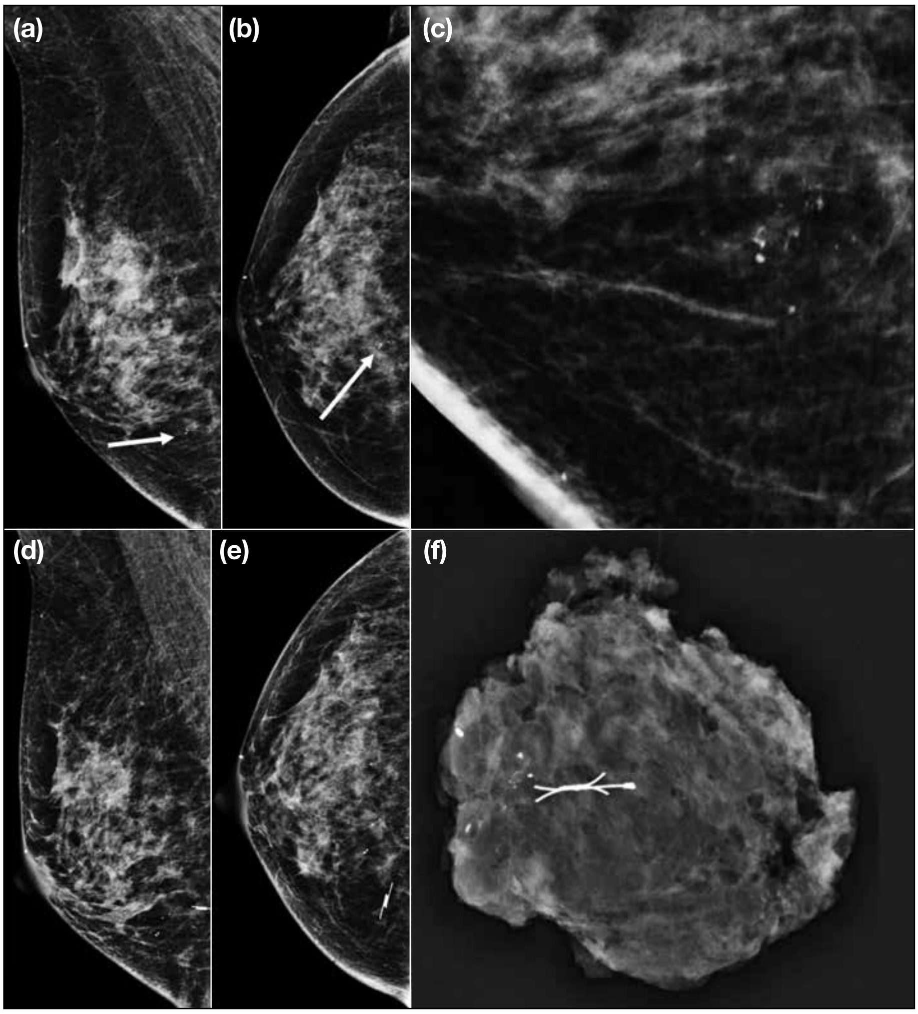

Figure 7. Right mammogram with (a) mediolateral oblique, (b) craniocaudal and (c) mediolateral magnification views of a 68-year-old woman showing a group of microcalcifications (arrows) in the lower inner quadrant of the right breast. Stereotactic-guided core biopsy was subsequently performed with pathology showing cellular atypia. The surgical team decided to proceed with an excisional biopsy. A radar reflector was inserted under stereotactic guidance with diagnostic intent. (d, e) Postprocedural mammograms showing reflector migration 2.3 cm medial to target after release of breast compression. Salvage hookwire was performed on the day of surgery. During surgery, both the index lesion and the reflector were able to be removed with (f) specimen radiograph confirming presence of microcalcifications.

A salvage hookwire procedure was performed for this patient on the day of surgery. During surgery, both the lesion and the reflector were able to be removed with a specimen radiograph confirming the presence of microcalcifications with no further calcifications at the margins, and histology confirming DCIS. Some studies advise partial release immediately prior to reflector or marker deployment to minimise the accordion effect.[19] The reflector antennae with their offset configuration serve the additional function of securing the reflector in tissue.[13] However, reflector migration still occurred in one of our cases.

Prior studies have reported dense objects between reflector and handpiece, such as calcified masses or haematomas, causing weakened signal detection.[22] None of our cases had any significant haematomas. However, from prior literature, this limitation can be overcome by placing the reflector immediately adjacent to the haematoma rather than within it and marking the skin for the surgeon if transcutaneous signal is weak, as the audible signal is usually augmented following skin incision.[13]

Our study is limited as it is a single-institution retrospective study without direct comparison to hookwire localisations or other localisation techniques in our centre. There is potential selection bias as patients were selected for radar-based localisation in a multidisciplinary meeting. Our small sample size limits our analysis for migration and margin clearance rates. We did not include any patients with more than one reflector inserted for bracketing or for multiple lesions in the same breast; hence, no information can be provided on that aspect. The manufacturer recommends at least 2.5 cm distance between reflectors, while prior literature reports placing reflectors as close as 1.7 cm apart with successful detection of distinct reflector signals.[16] Apart from the efficacy of radar-based localisation for multiple lesions, our study also did not evaluate patient satisfaction, specimen weight, cosmetic outcome, or mean duration of deployment, which are both potential advantages for radar-based localisation when compared to traditional hookwire localisation. A prospective randomised controlled trial with larger sample size and evaluation of more parameters will be needed to compare radar-based localisation with hookwire and other localisation techniques.

CONCLUSION

Results of our study suggest that the radar-based localisation system is safe and effective for guiding the excision of non-palpable breast lesions in a Chinese population. Its unique advantages, which overcome certain limitations of other localisation methods may render it a superior alternative in selected patients. Further studies should be performed to validate these findings.

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