

## CLINICAL SCIENCE

# Radioguided occult lesion localization versus wire-guided localization for non-palpable breast lesions: randomized controlled trial

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**AIM:** This prospective randomized clinical study was conducted to compare radioguided occult lesion localization (ROLL) with wire-guided localization to evaluate optimum localization techniques for non-palpable breast lesions.

**METHODS:** A total of 108 patients who were undergoing an excisional biopsy for non-palpable breast lesions requiring pathologic diagnosis were randomly assigned to the ROLL group (n=56) and wire-guided localization group (n=52). In the study, patients' characteristics, radiological abnormalities, radiological technique of localization, localization time, operation time, weight of the excised specimen, clearance margins, pathological diagnosis and perioperative complications were assessed.

**RESULTS:** There were no differences between the two groups in terms of age, radiological abnormalities and localization technique ( $p = \text{non-significant for all}$ ). ROLL techniques resulted in 100% retrieval of the lesions; for the wire-guided localization technique, 98%. Both localization time and operation time were significantly reduced with the ROLL technique ( $p = \text{significant for all}$ ). The weight of the specimen was significantly lower in the ROLL group than in the wire-guided localization group ( $p = \text{significant}$ ). The overall complication rate and pathological diagnosis were similar for both groups ( $p = \text{non-significant for all}$ ). Clear margins were achieved in 91% of ROLL patients and in 53% of wire-guided localization patients, and the difference was significant.

**CONCLUSIONS:** The present study indicated that the ROLL technique is as effective as wire-guided localization for the excision of non-palpable breast lesions. In addition, ROLL improved the outcomes by reducing localization and operation time, preventing healthy tissue excision and achieving clearer margins.

**KEYWORDS:** Non-palpable breast lesions; ROLL technique; Wire-guided localization; Radioguided surgery.

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## INTRODUCTION

Suspicious clinically occult breast lesions are found frequently as a result of widespread mammographic screening programs of asymptomatic women.<sup>1-3</sup> Some 15-20% of these lesions are malignant, and their removal should be preceded by a radiographically guided localization procedure to assure an accurate and low tissue volume biopsy.<sup>4,5</sup> Several techniques have been developed as a diagnostic and therapeutic tool. Wire-guided localization (WGL) is presently the most commonly used localization method for non-palpable breast lesions.<sup>6-8</sup> However, the ideal technique should involve precise localization, avoid the excessive surgical resection of healthy breast tissue,

improve the rate of free margin, not discomfort the patient and decrease operative time. Although WGL has been shown to accurately localize the lesions, the technique has some disadvantages. The placement of the wire is difficult in dense breast tissue.<sup>9</sup> The wire may be displaced during surgery. For surgical excision with free margins, the surgeon must follow the wire through healthy tissue until the lesion is found, and this causes the extensive removal of healthy breast tissue. Furthermore, migration or rupture of the wire leads to a small risk of pneumothorax, and the discomfort of the patient and injuries for both the surgical team and the pathologist are other restrictions of the procedure.<sup>10-12</sup>

Radioguided occult lesion localization (ROLL) is a new method for the localization and resection of non-palpable breast lesions.<sup>13-15</sup> The approach involves the intratumoral injection of a small amount of nuclear radiotracer under guidance by ultrasonography or stereotactic mammography. Radioactivity allows for the radiolabeling of the lesion and subsequent surgical excision guided by a handheld

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gamma ray detection probe. During the last decade, ROLL has gained popularity on account of several advantages associated with a reduced excision volume, more accurate centricity of a lesion within the surgical specimen, better cosmetic results and a higher percentage of tumor-free margins.<sup>16-19</sup> In addition, in recent studies investigating the feasibility of ROLL for lesion localization, the method was shown to be a simple, fast and accurate technique. However, although ROLL has been used for more than 10 years, there are a small number of reports in the literature investigating the superiority between ROLL and WGL.<sup>20-22</sup> Because most of these studies are non-randomized and included a limited patient number, we present a prospective randomized study comparing ROLL with WGL for non-palpable breast lesions. We aimed to compare ROLL with WGL for non-palpable breast lesions in terms of the clearance of excision margins, weight of the excised specimen, duration of the procedure, operative time and perioperative complication rate.

## MATERIALS AND METHODS

Between June 2007 and May 2009, a total of 115 consecutive patients who were undergoing excisional biopsy for non-palpable breast lesions detected by mammogram or ultrasonograph, and who required a pathologic diagnosis of these lesions, were enrolled in this study. The study was approved by the local ethics committee at the University Hospital, Mersin, Turkey. Informed consent was obtained from all patients.

A total of 7 patients, including 2 patients with diffuse microcalcifications, 2 patients with multicentric lesions, 1 patient whose wire dislodged during patient transfer and 2 patients who refused to participate were excluded from the study. The remaining 108 patients were assigned randomly to ROLL patients whose non-palpable breast lesions were localized by ROLL and followed by surgical resection (ROLL group,  $n = 56$ ) or WGL patients whose non-palpable breast lesions were localized with a wire hook and followed by surgical resection (WGL group,  $n = 52$ ). Randomization was performed according to a computer-generated list before lesion localization by an independent computer consultant.

Tumor localization was conducted by two breast radiologists and one nuclear medicine physician, and surgical procedures were performed by two breast surgeons.

For cases randomized to the ROLL technique, <sup>99m</sup>Tc-labeled colloidal human serum albumin was injected directly into the breast lesion, or around the lesion, with a 15-20 gauge needle under ultrasound (US) or stereotactic guidance 4-24 hours before surgery. Colloidal kites were prepared using MBq <sup>99m</sup>Tc pertechnetate in 3-4 cc saline solution (human albumin nanocolloid; Sentiscint, Medi-Radiopharma Ltd, Hungary). Four patients underwent surgery in 4 hours, using 7.4 MBq; and 10.5 MBq of radiopharmaceuticals was used in those awaiting surgery for 24 hours. The site of isotope injection was confirmed by direct visualization under US or by the presence of the tip of the needle within the target area under stereotactic control. The location of the lesion was identified and marked on the skin to facilitate intraoperative identification by the surgeon. In the preoperative room before anesthesia, all patients were controlled with a gamma probe for dedicated radioactivity. All patients underwent a standard general anesthetic

protocol and surgical preparation. A gamma-detecting probe (Europrobe/Eurorad/Euromedical/French) measuring the radioactivity in counts per second was used; the hotspot area with maximum radioactivity corresponded to the site of the lesion. The probe was placed in a laparoscopic camera sleeve. An incision was made in the skin projection over the hotspot area on a cosmetic basis. The probe was used repeatedly to confirm the location of the hotspot during the excision and check the position of the lesion. The limit of excision was determined by guidance of the frequency and intensity of the radioactivity. Following excision of the lesion, the cavity was checked for any residual areas of activity. Further surgical exploration was performed if the count in the cavity remained high. The excised specimen was sent to the radiology department for radiographic confirmation of the presence of the lesion. When no residual activity was shown in the cavity, hemoclips were placed on the four corners of the biopsy area. After hemostasis, a wound closure was performed.

For patients randomized to WGL, a single hooked wire was used under mammographic or US guidance. With Kopan's hook system, non-palpable breast lesions were localized just before surgery by radiologists. All patients underwent a standard general anesthetic protocol and surgical preparation. If the entrance of the wire into the skin was near the hooked lesion, an incision was made on a cosmetic basis next to the wire entrance through the skin; otherwise, if the entrance of the wire into the skin was far away from the hooked lesion, an optimum incision was made. Complete removal of the lesions was made with the guidance of the hook. After the complete removal of all surgical specimens, verified by mammographic or ultrasonographic study, hemoclips were placed on the four corners of the biopsy area and the wound was closed.

All the specimens were sent for histopathological investigation. The anterior, superior and lateral sides of the specimens were marked with sutures. Clearance margins  $\geq 1$  mm and  $\geq 5$  mm were accepted for invasive cancer and ductal carcinoma in situ (DCIS) respectively.

Patients' characteristics, radiological abnormalities, radiological localization technique, localization time, operation time, weight of the excised specimen, clearance margins, pathological diagnosis, perioperative complications and hospital stay were recorded.

Microsoft Excel and SPSS 10.0 were used to store and analyze the data. Categorical variables including radiological abnormalities, radiological localization technique, clearance margins, pathological diagnosis and perioperative complications were analyzed using the Chi-square method, and continuous variables including age, localization time, operation time, weight of the excised specimen were analyzed with the Student t-test or Mann-Whitney U-test. Significance was considered as  $p < 0.05$ .

## RESULTS

The ROLL group included 1 male and 55 female with a mean age of 45 years (range 25-61 years), whereas the WGL group consisted of 52 females with a mean age of 47 years (range 34-72 years). There was no significant difference in the age of the patients between the two groups ( $p = 0.15$ ). A total of 24 patients presented with a non-palpable image showing a mass, microcalcifications were present in 29 patients, and asymmetric density in 3 patients in the ROLL

group, compared with 22, 24 and 6 patients for the WGL groups respectively. However, there were no statistically significant differences between the two groups regarding radiological abnormalities ( $p=0.51$ ). Thirty-one ROLL patients were localized with US and 25 by stereotactic technique; this compared with 21 and 31 patients, respectively, in the WGL group, and there was no significant difference between the two groups in terms of the radiologic localization technique ( $p=0.13$ ). The localization time was significantly reduced with the ROLL group compared with 15 min and 23 min for WGL groups ( $p=0.001$ ). The localization time lasted a median of 18 min with mammography and 13 min with US in the ROLL group, compared with 30 min and 13 min for the WGL group. The localization technique significantly affected the localization time. Localization time was significantly decreased in ROLL patients when a mammography was used ( $p=0.001$ ). Localization time was not different between the two groups when US was used ( $p=0.783$ ).

The ROLL technique resulted in 100% retrieval of the lesions and the WGL technique resulted in 98% retrieval, as shown by the radiologic confirmation (mammography or US) of the breast specimen ( $p=0.503$ ). In 3 patients from the ROLL group (5.3%), the lesion was not confirmed by imaging the surgical specimen in the first excision, but performing a wider excision with a gamma probe guide resulted in the retrieval of the lesion during the same surgical procedure. A surgical field examination after lesion resection found no significant activity in all cases. In the WGL group, 4 patients needed intraoperative re-excision, and in one patient (2%) the lesion was not confirmed radiologically even though wider excision was made.

The duration of surgical excision was 31 min on average (range 15–105 min) in the ROLL group and 43 min on average (range 20–120 min) in the WGL group. The length of the surgical procedure was significantly reduced with ROLL ( $p=0.001$ ). The localization technique significantly affected the length of the surgical procedure. Lesion localization by stereotaxy increased the duration of surgery compared with lesion localization with US ( $p=0.05$ ).

The weight of the excised specimen was significantly lower in the ROLL group than in the WGL group: 14 g (2–100 g) versus 28 g (3–175 g) respectively ( $p=0.001$ ).

No difference was found in the complication rate between the two groups ( $p=0.213$ ). In the ROLL group, one patient had a hematoma and one patient in the WGL group had seroma. All these complications were treated without surgery.

In the study design, surgical excision was planned as an outpatient model. All the cases were completed 6 hours later in surgery.

Twelve (21%) patients in the ROLL group and 14 (27%) in the WGL group had a cancer diagnosis, and the difference was not significant ( $p=0.505$ ). In the ROLL group, final pathological diagnosis showed invasive ductal carcinoma for 3 patients, DCIS for 6 patients, DCIS with invasive components for 2 patients and mucinous carcinoma for 1 patient. In the WGL group, final pathological diagnosis showed invasive ductal carcinoma for 2 patients, DCIS for 7 patients, invasive lobular carcinoma for 1 patient and tubular carcinoma for 1 patient.

The number of patients with a benign pathology was similar in both groups. The most frequent benign diagnosis

was florid-type epithelial hyperplasia and fibrocystic changes.

Among cancer patients, a significantly larger number of WGL patients (6/14; 42.9%) had involved margins compared with 1/12 (8.3%) ROLL patients ( $p=0.05$ ). The patient with involved margins in the ROLL group had a mastectomy, which was her preference. Three of the six patients with involved margins in the WGL group had to be offered a mastectomy because of the extensive nature of DCIS. Two patients underwent a re-excision of the involved margins. The other patient underwent a mastectomy because of her preference. The clinical, radiological and pathological features of patients are presented in Table 1. Among cancer patients with clear margins, 1 patient in the ROLL group and 2 patients in the WGL group had a mastectomy, which was their preference.

## DISCUSSION

The main goal of the successful management of non-palpable breast lesions is accurate preoperative localization for correct surgical biopsy. A hooked wire inserted under radiographic or US guidance has been the technique used most often to localize and remove occult breast lesions. Because of several disadvantages of wire localization, new localization methods have been investigated. ROLL was developed as a new localization technique in 1997, and the technique has been shown to be highly satisfactory and reliable for the localization of occult breast lesions; it became routinely used at some institutes.<sup>14</sup> Clinically controlled

**Table 1** - Clinical, radiological and pathological features of patients.

	ROLL	WGL	<i>p</i>
Patients (n)	56	52	
Age (years)	45 (25–61)	47 (34–72)	0.15
Radiological abnormality			0.51
Mass	24	22	
Microcalcifications	29	24	
Asymmetric density	3	6	
Localization technique			0.13
US	31	21	
Stereotactic	25	31	
Localization time (min)	15	23	0.001
US	13	13	
Stereotactic	18	30	
Duration of surgery (min)	31 (15–105)	43 (20–120)	0.001
Weight of specimen (g)	14 (2–100)	28 (3–175)	0.001
Complication (n)	1	1	0.213
Pathological diagnosis			0.505
DCIS	6	7	
DCIS with invasive component	2	3	
Invasive ductal carcinoma	3	2	
Lobular carcinoma	–	1	
Mucinous carcinoma	1	–	
Tubular carcinoma	–	1	
Atypical ductal hyperplasia	2	1	
Atypical lobular hyperplasia	1	–	
Benign pathology	41	37	
Margins			0.05
Clear	11 (91%)	8 (57%)	
Involved	1 (9%)	6 (43%)	

DCIS = ductal carcinoma in situ; US = ultrasound.

trials have recommended radioguided surgery as an important tool in the removal of non-palpable breast lesions, as a simple, fast and feasible method that can be implemented in the clinical routine of patients with non-palpable breast lesions.<sup>13,17-23</sup>

Precise localization is the most important factor in the accurate surgical removal of clinically occult breast lesions. Gennari et al.,<sup>23</sup> in their study with the ROLL technique, found that a suspicious lesion was found in 99.1% of cases. De Cicco et al.<sup>16</sup> concluded that ROLL enables the surgeon to remove occult breast lesions easily and reliably. The results in our series are similar to those studies, detecting suspicious lesions in 100% of cases and finding the lesion within the surgical specimen in all cases with the ROLL technique. Some studies that compared ROLL with WGL showed that ROLL was more precise than the hook wire procedure.<sup>13,21</sup> In the present study, we did not find a difference between ROLL patients and WGL patients regarding the localization of the lesion. As mentioned below, we found ROLL as effective as WGL for the localization of occult breast lesions.

The US or stereotactic method was used for localization in both ROLL and WG patients. In agreement with the literature, in the present study, without no significant difference between the radiologic localization of the occult lesions, the localization time was significantly decreased with ROLL compared with WGL.<sup>13,21</sup> In Rampaul et al.'s<sup>21</sup> study, surgical and radiological difficulty was assessed using a Likert scale, and ROLL was shown to be an easier procedure to perform than WGL both radiologically and surgically. Similarly, in the present study, the duration of surgery was significantly reduced with the ROLL procedure. The use of a handheld probe allowed the surgeon to identify the hotspot easily in three dimensions. The probe is used as often as necessary during surgery to check the position of the lesion, and this makes the operation quicker. Moreover, the radiological guided wire placement is a technically difficult procedure, particularly in dense breast tissue. Moreover, when a hook wire is used, the surgeon must follow the path of the wire, which might not be a practical route for reaching the lesion. And the wire can be displaced making repositioning difficult.

Some 15-20% of patients who underwent a diagnostic biopsy of a non-palpable breast lesion showed malign findings. Similar to the literature, in the present study, 21% patients in the ROLL group and 27% in the WGL group had a cancer diagnosis. Surgical excision for non-palpable breast lesions requires a balance between excising a high rate of free tumor margins and a low rate of healthy tissue resection. In previous studies, surgical excision with hooked wire guidance has been reported with a high rate of 50% involved margins.<sup>24</sup> On the other hand, in comparison with hooked wire localization, the ROLL technique has shown a lower incidence of second surgery for involved margins due to better centering of the lesions and higher rates of free tissue margins.<sup>13,19,25</sup> In the study by Nadeem et al.,<sup>13</sup> a larger number of inadequate excisions were recorded with WGL, as 43% of WGL patients had <1 mm safety margins versus 17% in the ROLL group. Similarly, in the present study among cancer patients, a significantly lower number (8.3%) of ROLL patients had involved margins compared with WGL patients (42.9%). The ROLL technique associated with the intraoperative macroscopic examination of margins allows a low re-excision rate and spares normal breast tissue

for an optimal surgical technique. If the pathologist was present in the operative room, checking for immediate margin involvement by the tumor might improve these results.

Compared with the literature, the specimen weight in our study is similar and the specimen weight in patients treated with WGL is larger than in patients treated with the ROLL procedure.<sup>13,19,21</sup> Recent series have confirmed better cosmetic results associated with smaller breast volumes excised with the ROLL technique.<sup>13,21,25</sup> In our study, we did not evaluate the cosmesis, but it is suggested from other series that improved cosmesis might be associated with a smaller specimen weight volume excised. The other rationale for improved cosmetic results was that the ROLL procedure allowed an esthetic incision into the skin.

Although serious complications were described for the WGL procedure in the literature, there were no serious complications in the ROLL procedure. Only a 1-5% incorrect placement rate of the radiotracer has been described in the literature for the ROLL procedure.<sup>16,19,21</sup> On the other hand, in the present study, there were no serious complications in either group, except for seroma and hematoma.

## CONCLUSION

In the present study, the ROLL technique has proved as reliable and effective as WGL in localizing non-palpable breast lesions. The ROLL technique appears to be superior to WGL in terms of localization time and duration of surgery, and it provides a higher percentage of tumor-free margin despite a lower average specimen weight. Therefore, we suggest ROLL as an effective alternative to WGL in localizing occult breast lesions.

## REFERENCES

- Cady B, Stone MD, Schuler JG, Thakur R, Wanner MA, Lavin PT. The new era in breast cancer. Invasion, size and nodal involvement dramatically decreasing as a result of mammographic screening. *Arch Surg.* 1996;131:301-8.
- McLelland R. Screening mammography. *Cancer.* 1991; 67:1129-31, doi: 10.1002/1097-0142(19910215)67:4+<1129::AID-CNCR2820671505>3.0.CO;2-3.
- Goedde TA, Frykberg ER, Crump JM, Lay SF, Turetsky DB, Linden SS. The impact of mammography on breast biopsy. *Am Surg.* 1992;58:661-6.
- Franceschi D, Crowe J, Zollinger R, Duchesneau R, Shenk R, Stefanek G, et al. Breast biopsy for calcifications in nonpalpable breast lesions. A prospective study. *Arch Surg.* 1990;125:170-3.
- Papatestas AE, Hermann D, Hermann G, Tsevdos C, Lesnick G. Surgery for nonpalpable breast lesions. *Arch Surg.* 1990;125:399-402.
- Querci della Rovere G. Localization of impalpable breast lesions. A surgical approach. *Eur J Surg Oncol.* 1996;22:478-82.
- Silverstein MJ, Gamagami P, Rosser RJ, Gierson ED, Colburn WJ, Handel N, et al. Hooked-wire directed breast biopsy and overpenetrated mammography. *Cancer.* 1987;59:715-22, doi: 10.1002/1097-0142(19870215)59:4<715::AID-CNCR2820590409>3.0.CO;2-C.
- Besic N, Zgajnar J, Hocevar M, Gierson ED, Colburn WJ, Handel N, et al. Breast biopsy with wire localization: factors influencing complete excision of nonpalpable carcinoma. *Eur Radiol.* 2002;12:2684-9.
- Davis PS, Wechsler RJ, Feig SA. Migration of breast biopsy localization wire. *Am J Radiol.* 1983;141:929-30.
- Rahusen ED, Bremers AJ, Fabry HF, van Amerongen AH, Boom RP, Meijer S. Ultrasound-guided lumpectomy of nonpalpable breast cancer versus wire-guided resection: a randomized clinical trial. *Ann Surg Oncol.* 2002;9:994-8, doi: 10.1007/BF02574518.
- Homer MJ. Transection of the localization hooked wire during breast biopsy. *AJR Am J Roentgenol.* 1983;141:929-30.
- Tykkä H, Castren-Person M, Sjoblom M. Pneumothorax caused by hooked wire localization of an impalpable breast lesion detected by mammography. *Breast.* 1993;2:52-53, doi: 10.1016/0960-9776(93)90039-I.
- Nadeem R, Chagla LS, Harris O, Desmond S, Thind R, Titterrell C, et al. Occult breast lesions: a comparison between radioguided occult lesion

- localisation (ROLL) vs. wire-guided lumpectomy (WGL). *Breast*. 2005;14:283–9, doi: 10.1016/j.breast.2005.04.002.
14. Luini A, Zurrida S, Galimberti V, Paganelli G. Radioguided surgery of occult breast lesions. *Eur J Cancer*. 1998;34:204–5.
  15. Machado RH, Oliveira AC, Rocha AC, Landesmann MC, Martins FP, Lopes SA, et al. Radioguided occult lesion localization (ROLL) and excision of breast lesions using Technetium-99m-macroaggregate albumin and air injection control. *J Exp Clin Cancer Res*. 2007;26:515–19.
  16. De Cicco C, Pizzamiglio M, Trifiro G, Luini A, Ferrari M, Prisco G. Radioguided occult lesion localisation (ROLL) and surgical biopsy in breast cancer. Technical aspects. *Q J Nucl Med*. 2002;46:145–51.
  17. Paganelli G, Luini A, Veronesi U. Radioguided occult lesion localization (ROLL) in breast cancer: maximizing efficacy, minimizing mutilation. *Ann Oncol*. 2002;13:1839–40, doi: 10.1093/annonc/mdf343.
  18. Bitencourt AG, Lima EN, Pinto PN, Martins EB, Chojniak R. New applications of radioguided surgery in oncology. *Clinics*. 2009;64:397–402.
  19. Luini A, Zurrida S, Paganelli G, Galimberti V, Sacchini V, Monti S, et al. Comparison of radioguided excision with wire localization of occult breast lesions. *Br J Surg*. 1999;86:522–5.
  20. Moreno M, Wiltgen JE, Bodanese B, Schmitt RL, Gutfilen B, Fonseca LM. Breast surgery for occult lesion localization – correlation between two methods. *J Exp Clin Cancer Res*. 2008;27:29, doi: 10.1186/1756-9966-27-29.
  21. Rampaul RS, Bagnall M, Burrell H, Pinder SE, Evans AJ, Macmillan RD. Randomized clinical trial comparing radioisotope occult lesion localization and wire-guided excision for biopsy of occult breast lesions. *Br J Surg* 2004;91:1575–7, doi: 10.1002/bjs.4801.
  22. Medina-Franco H, Abarca-Pérez L, García-Alvarez MN, Ulloa-Gómez JL, Romero-Trejo C, Sepúlveda-Méndez J. Radioguided occult lesion localization (ROLL) versus wire-guided lumpectomy for non-palpable breast lesions: a randomized prospective evaluation. *J Surg Oncol*. 2008;97:108–11, doi: 10.1002/jso.20880.
  23. Gennari R, Galimberti V, De Cicco C, Zurrida S, Zerwes F, Pigatto F, et al. Use of technetium-99m-labeled colloid albumin for preoperative and intraoperative localization of nonpalpable breast lesions. *J Am Coll Surg*. 2000;190:692–8, doi: 10.1016/S1072-7515(00)00272-6.
  24. Chadwick DR, Shorthouse AJ. Wire-directed localization biopsy of the breast: an audit of results and analysis of factors influencing therapeutic value in the treatment of breast cancer. *Eur J Surg Oncol*. 1997;23:128–33.
  25. Thind CR, Desmond S, Harris O, Nadeem R, Chagla LS, Audisio RA. Radio-guided localization of clinically occult breast lesions (ROLL): a DGH experience. *Clin Radiol*. 2005;60:681–6, doi: 10.1016/j.crad.2004.12.004.