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NAZIM BARIŞ KANAT

MURAT TUNCEL

TAMER AKSOY

AYŞEGÜL FIRAT

FİGEN DEMİRKAZIK

See next page for additional authors

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Authors

NAZIM BARIŞ KANAT, MURAT TUNCEL, TAMER AKSOY, AYŞEGÜL FIRAT, FİGEN DEMİRKAZIK, DEMİRALİ ONAT, MELTEM ÇAĞLAR TUNCALI, and BİRAY EMİNE CANER

Comparison of wire-guided localization and radio-guided occult lesion localization in preoperative localization of nonpalpable breast lesions

Nazım Barış KANAT^{1*}, Murat TUNCEL², Tamer AKSOY³, Ayşegül FIRAT⁴, Figen DEMİRKAZIK⁵, Demirali ONAT⁶, Meltem ÇAĞLAR TUNCALI², Biray Emine CANER²

¹Department of Nuclear Medicine, Mersin State Hospital, Mersin, Turkey

²Department of Nuclear Medicine, Faculty of Medicine, Hacettepe University, Ankara, Turkey

³Department of Nuclear Medicine, Faculty of Medicine, Acibadem University, İstanbul, Turkey

⁴Department of Anatomy, Faculty of Medicine, Hacettepe University, Ankara, Turkey

⁵Department of Radiology, Faculty of Medicine, Hacettepe University, Ankara, Turkey

⁶Department of General Surgery, Faculty of Medicine, Hacettepe University, Ankara, Turkey

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Background/aim: Breast lesions that are not palpable on physical examination but considered suspicious for malignancy on mammography or ultrasonography should be marked before surgery. Wire-guided localization (WGL) is the most frequently used method for preoperative marking of nonpalpable breast lesions (NPBLs). An alternative is marking by a radioactive agent (radio-guided occult lesion localization; ROLL). The present study aimed to compare WGL and ROLL for preoperative marking.

Materials and methods: The study included 25 patients marked by ROLL and 11 patients marked by WGL. The groups were compared in terms of patient and lesion characteristics, method-related characteristics, hospital stay duration, complications, cosmetic outcomes, and rate of correct marking.

Results: Suspicious lesions were marked with a success rate of 95.6% by ROLL and 100% by WGL. Complications and pain sensation rates were found significantly lower in the ROLL group compared to WGL. Although ROLL was considered more advantageous in terms of hospital stay duration, positive surgical margins, cosmetic outcomes, and excision duration, the differences between the groups were not statistically significant.

Conclusion: ROLL, which is a simple, comfortable, and reliable method, could be used as an alternative to the WGL in preoperative marking of NPBLs.

Key words: Nonpalpable breast lesion, radio-guided occult lesion localization, wire-guided localization, SPECT-CT

1. Introduction

Breast cancer is the leading malignancy among women and the second leading cause of cancer-related deaths following lung cancer. The life-time risk of breast cancer is 12.3% in women and one in each 8 women has the risk of developing breast cancer. The life-time risk for death due to breast cancer is 3.6% and it is the leading cause of cancer deaths among women aged between 40 and 55 years (1). Despite remarkable advances in the treatment of breast cancer in the recent years, early diagnosis remains important for obtaining successful therapeutic outcomes.

Breast scanning aims to detect breast cancer as early as possible. The most common methods used in routine practice to visualize breast diseases include mammography, ultrasonography (US), and magnetic resonance imaging

(2). Lesions that cannot be detected by physical examination but display asymmetry, microcalcification, and distortion on scanning methods such as mammography and US are defined as nonpalpable breast lesions (NPBLs) (3). Along with widespread implementation of breast screening programs, prevalence of detecting NPBLs has been increased in the recent years and it has been demonstrated that early diagnosis substantially reduces breast cancer-related mortality and morbidity (4).

Increase in the rate of detecting NPBLs has raised the need for percutaneous methods for the diagnosis and treatment of these lesions. Interventional methods used for the diagnosis of NPBLs include needle biopsy (mammography or US), preoperative marking, and excisional biopsy (4,5). Preoperative precise localization

* Correspondence: nbkanat@gmail.com

of NPBLs is important. In the excisional biopsy of NPBLs detected by various imaging methods, marking under imaging guidance is mandatory for the surgeon to expose the lesion and to minimize the loss of normal tissue. In general, suspicious areas where the marking would be performed include solid and complex cysts detected on US, suspicious microcalcifications, and parenchymal distortions detected by mammography (i.e. usually BIRADS-4 and BIRADS-5 lesions) (6).

Today, wire-guided localization (WGL) is the most frequently used marking method (7). In this method, a wire with a curly end is placed into the suspected lesion under mammographic and US guidance. Radio-guided occult lesion localization (ROLL) is another method alternative to WGL for the marking of NPBLs (8). ROLL depends on the principle of injecting a radioactive agent into the microcalcification or suspicious solid lesion detected by imaging methods under US or mammography guidance and then excision of the lesion in the surgery room by gamma probe. Although mostly Tc-99m-MAA (macroaggregated albumin) is used in the ROLL method, there are studies reporting the use of compounds such as Tc-99m-nanocolloid or I-125 titanium as well (9). For all lesions detected on mammography and marked before surgery, radiographies of the specimen should be performed to determine whether the lesion is completely removed or not. In routine practice, these radiographies are evaluated by the images obtained by a single projection of the specimen (10).

The aim of the present study was to compare WGL and ROLL for preoperative marking of NPBLs in terms of patient and lesion characteristics, features related to marking method, hospital stay duration, complications, cosmetic outcomes, and rate of successful marking, as well as to investigate the contribution of the use of single-photon emission computed tomography combined with computed tomography (SPECT-CT) with surgery for the localization of lesions in the ROLL group.

2. Materials and methods

The study included 36 female patients (between 24 and 78 years of age) who had NPBLs (<2 cm) and suspicious findings for malignancy on mammography and breast US (BIRADS-3, -4, or -5). Pregnant and breastfeeding women were excluded from the study. Approval of the Hacettepe University Faculty of Medicine Ethical Committee (LUT 10/69-20) and written informed consent of the patients were obtained. Patients were randomized into the ROLL and WGL groups.

In the ROLL group (n = 25), on the morning of surgery day, intratumoral 0.5 mCi Tc-99m-MAA was injected into the suspected lesion previously detected by mammography or US. The method (mammography or US) that was used

to detect suspicious lesion was assigned by radiologists. Microcalcification, parenchymal distortion, and focal asymmetric breast density were marked by mammography, whereas solid and complex cystic lesions with irregular margin extending up to spicule were marked by US.

In the WGL group (n=11), on the morning of surgery day, the previously detected suspicious lesion was marked by WGL under mammographic or US guidance. Marking was done prior to the surgery by a radiologist using a stereotaxic marking apparatus (Seno DS, GE Medical Systems, Chicago, IL, USA) fixed on the mammography device or using an US device (Aplio XG, Toshiba Medical System Corporation, Otawara, Japan). The wire was pushed through the lesion under imaging guidance.

All the patients marked by ROLL method underwent planar scanning by gamma camera in the nuclear medicine department and success of injection and whether there was contamination or not were checked. In addition to planar scanning, 12 patients underwent SPECT-CT in the nuclear medicine department after marking to make a contribution to the physician. SPECT-CT could be performed for only 12 patients due to technical difficulties. SPECT-CT was performed with a hybrid device composed of a double-headed gamma camera and integrated 4-section CT (Hawkeye, GE Medical Systems). CT images were recorded on a 512 × 512 matrix using 2.5 mA parameters and at 140 keV energy peak. SPECT images were recorded on a 128 × 128 matrix with 140 keV energy peak, 10% interfenestration, and 360°, obtaining a 20 s count in each pause. Fusion images (axial, coronal, and sagittal) of the lesions in which radioactive agent uptake was detected were recorded and printed on films. These films were used to inform the surgeon in more detail about the localization of the lesion.

The surgically removed specimen after marking was put into a container including 10% formaldehyde and sent to the pathology department. Specimen margins were stained with India ink in different colors and sliced into thin sections. The tumor was evaluated macroscopically for the size of the specimen (width, length, height) and microscopically for pathological diagnosis of the lesion, tumor diameter, closeness to the surgical margin, and estrogen-progesterone receptor status.

The WGL and ROLL groups were compared in terms of age, body mass index (BMI), radiological findings, pain during procedure, duration of excision of the lesion, weight of specimen, positivity of surgical margin, duration of hospital stay, complications, cosmetic outcomes, and rate of successful marking. The contribution of SPECT-CT to the surgery was evaluated for the patients who underwent SPECT-CT. Pain during the marking procedure was assessed by visual analog scale (VAS). Excision duration was recorded as the time between the start of incision and

the time when the lesion was removed completely. Weight of the specimen excised under surgery room conditions was weighed by precision kitchen scale and recorded in grams. Cosmetic outcomes were obtained by phone call at the postoperative 1st and 6th months and scored between 1 and 10 (1 = very bad, 10 = excellent). However, patients with malignant pathology who underwent a second surgery (5 patients in the ROLL group and 3 patients in the WGL group) in the early period (before 1 month) were excluded from the evaluation. Contribution of SPECT-CT to the surgeon was evaluated by conferring with the surgeon prior to the surgery based on the films printed on axial, coronal, and sagittal planes.

Success of correct marking of the suspicious lesion in the ROLL group was evaluated in 3 steps. The first step included the control during the injection of radioactive agent, in which observing the contrast agent close to the suspicious lesion following radioactive marking under mammographic guidance and detecting an increase in echogenicity during injection of the radioactive agent into the lesion under US guidance were considered as the criteria for success. The second step included scintigraphic control of the patient after the injection of the radioactive agent, in which the place of injection on planar scintigraphy taken in the nuclear medicine department and the presence of contamination were controlled. The last step included scintigraphic and radiologic control of the specimen, in which specimens were scanned by scintigraphy and specimen graph (only those marked under mammographic guidance) and the marked lesion was controlled for whether it was correctly removed or not during the surgery. Scintigraphic control was performed for all lesions marked under US guidance; however, control by direct graph was not performed since the lesion had no sign on direct graph.

In the WGL group, marking success was evaluated in two steps. The first step included the control during marking by wire, which was verified by the tip of the wire being close (<1 cm) to the suspicious lesion for the lesions marked under mammographic guidance, and by observing wire echogenicity in the suspicious lesion for the lesions marked under US guidance. The second step included radiological control of the specimen, in which demonstrating the suspicious lesion on a direct graph of specimens of the patients marked under mammography was considered as the criterion for success. No radiological examination was performed for the specimens of the patients marked under US guidance.

2.1. Statistical analysis

Data were analyzed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Numerical variables were expressed as mean \pm standard deviation or median (minimum–maximum), whereas categorical variables

were presented as number and percentage. For the intergroup comparisons, a t-test was used for independent groups and the Mann–Whitney U test was used for numerical variables that did not provide parametric test assumptions. Fischer's exact chi-square test was used for categorical variables in the intergroup comparisons. $P < 0.05$ was considered significant.

3. Results

The present study evaluated 36 NPBL patients with 25 patients (28 lesions) in the ROLL group and 11 patients in the WGL group. No significant differences were found between the groups in terms of age, BMI, scanning method, and the distribution of BIRADS categories (Table 1).

Radiological findings before marking were evaluated in both groups. Of the 28 lesions in the ROLL group marked under mammographic or US guidance, 14 were microcalcification, 10 were solid nodules, 3 were parenchymal distortions, and one was a cystic lesion. Of the 11 suspicious lesions marked in the WGL group, 4 were microcalcifications, 2 were solid nodules, 3 were cystic lesions, one was parenchymal distortion, and one was hypoechoic mass. In the ROLL group, pathological results of 66.6% ($n = 8$) of the lesions that were interpreted as BIRADS-5 and 25% ($n = 1$) of the lesions that were interpreted as BIRADS-3 were malignant. In the WGL group, pathological results of 66.6% ($n = 2$) of BIRADS-5 lesions and 62.5% ($n = 5$) of BIRADS-4 lesions were malignant. No malignant pathology was detected in BIRADS-4 lesions in the ROLL group or in BIRADS-3 lesions in the WGL group. Suspicious lesions observed on mammography and US were mostly located in the upper-inner quadrant ($n = 5$) and upper-outer quadrant ($n = 5$) of the right breast in the ROLL group, whereas they were mostly located in the upper-outer quadrant ($n = 5$) of the left breast in the WGL group. Histopathological evaluation revealed a malignant lesion in 9 (36%) and a benign lesion in 16 (64%) of the patients in the ROLL group. Histopathological results were reported as malignant in 7 (63.6%) and benign in 4 (36.4%) of the patients in the WGL group.

Features related to marking procedure and lesions are summarized in Table 2. No significant difference was found between the groups except for VAS score and complication rates. Pain during the procedure and the rate of complications were higher in the WGL group compared to the ROLL group. Complications in the ROLL group included hematoma in one patient and inadequate radioactivity injection in one patient. Complications in the WGL group included postoperative hematoma, surgical wound infection, arterial bleeding, displaced wire, and broken wire in one patient each.

Table 1. General characteristics of the study groups.

	ROLL group (n= 25)	WGL group (n= 11)	P
Age	47.56 ± 10.61	53.27 ± 10.29	0.143
BMI	36.00 ± 5.54	28.96 ± 5.36	0.683
Scanning method			
Mammography	12 (48.0)	5 (45.5)	1.000
Ultrasonography	13 (52.0)	6 (54.5)	
BIRADS category	28 lesions	11 lesions	
3	4 (14.3)	-	0.818
4	12 (42.9)	8 (72.7)	
5	12 (42.9)	3 (27.3)	

Data are expressed as mean ± standard deviation or number (%), where appropriate.

ROLL, Radio-guided occult lesion localization; WGL, wire-guided localization; BMI, body mass index.

Table 2. Features related to marking procedure and lesions in the study groups.

	ROLL group	WGL group	P
Pain during marking procedure (VAS score)	2.0 ± 0.81	2.61 ± 0.67	0.037
Excision duration of lesion, min	12.61 ± 4.57	13.90 ± 4.72	0.433
Weight of specimen, g	49.78 ± 38.32	39.63 ± 17.03	0.260
Surgical margin of malignant lesions			
Positive	3 (33.3)	3 (42.9)	0.343
Negative	6 (66.7)	4 (57.1)	
Diameter of malignant lesion, cm	2.23 ± 1.79	1.77 ± 1.69	0.758
Duration of hospital stay, min	290 ± 374	640 ± 1267	0.611
Complication rate	2 (8.0)	5 (45.5)	0.018
Score of cosmetic outcome			
Postoperative 1st month	7.71 ± 1.7	5.75 ± 3	0.890
Postoperative 6th month	8.21 ± 1.2	7 ± 1	0.620

Data are expressed as mean ± standard deviation or number (%), where appropriate.

ROLL, Radio-guided occult lesion localization; WGL, wire-guided localization; VAS, visual analog scale.

Considering the criteria for success of correct marking mentioned in Section 2, the ROLL method was found successful in 24 (96%) of 25 patients and in 27 (96.4%) of 28 suspicious lesions. In the remaining one patient, increase in echogenicity during injection was found suspicious and marking was considered unsuccessful in this patient. Correct injection of the radioactive agent into the lesion

area was verified with planar scintigraphy in 24 (96%) of 25 patients and in 27 (96.4%) of 28 suspicious lesions. Remarkable uptake, other than minimal radioactivity uptake, was not observed at the injection site in the remaining one patient. None of the patients had signs of contamination. Specimens of two patients were failed to be transferred to the nuclear medicine department.

Specimen scintigraphy revealed radioactivity in 22 (95.6%) of 23 patients and in 25 (96.1%) of 26 suspicious lesions. Radioactivity was not detected in the remaining one patient. Consequently, the suspicious lesion could be successfully excised in 96.1% of the lesions. It was found that the radioactive agent was left in the injector in the patient whose scintigraphy revealed no radioactivity. In all patients in the WGL group, the tip of the wire was observed close to the relevant lesion during marking and the success rate of marking was considered to be 100%. A suspicious lesion was detected on the specimen graph of 4 of 5 patients that underwent marking under mammographic guidance. The specimen of one patient was excluded from evaluation since it could not be transferred to the radiology department. As a consequence, the rate of correct marking was found high in both the WGL and ROLL groups.

It was determined that SPECT-CT made a contribution to the surgeon for the localization of lesion in 4 (33%) of 12 patients. One of these 4 patients had 2 suspicious lesions close to each other in the left breast and each lesion had undergone radioactive agent injection separately. The remaining 3 patients had lesions with deep localization. Surgeons were more oriented by getting informed about the deepness of the lesions via SPECT-CT and the lesions were excised.

4. Discussion

Along with the use of screening programs (mammography and US) all over the world, the prevalence of incidental NPBLs has gradually increased. Early detection of signs suggestive of malignancy such as focal asymmetry and mass on mammography substantially reduces the morbidity and mortality of breast cancer (11). The aim of marking NPBLs before excisional biopsy is to provide correct localization of the lesion before surgery, to obtain a clear surgical margin, and to provide the best cosmetic outcome with minimum tissue loss (12–14). Since the risk for malignancy is particularly high for BIRADS-4 and -5 lesions detected on mammography and US, this group of patients is recommended to undergo excisional biopsy following localization. For this purpose, preoperative detection of NPBLs includes various methods such as intraoperative US, localization of the corresponding skin projection, intralesional localization, and marking by wire and carbon particles (15,16). Today, WGL is the most commonly used method for preoperative marking of NPBLs (12,13,15,17). The ROLL method, an alternative method that has begun to be used for the marking of NPBLs in recent years, has been defined as a simple, rapid, reliable, and comfortable method (12,18–20).

Hybrid methods such as SPECT-CT enable both metabolic and anatomic scanning. Thus, it is possible to identify anatomic localization of the lesion by CT, which

has been detected scintigraphically. There are studies in the literature showing that SPECT-CT is superior to planar scintigraphy in detecting the sentinel lymph node in breast cancer patients (21). In the present study, which compared the WGL method with ROLL and investigated the additional contribution of SPECT-CT to localization of the lesion, patients in both groups were similar in terms of age, BMI, scanning method, and distribution of BIRADS category. Similarity of both groups in terms of general patient characteristics and radiological findings indicated that the groups were comparable.

It is recommended that suspicious lesions detected by scanning methods should be marked under mammographic guidance if they are microcalcification and under US guidance if they are solid lesions or complex cysts (19). Marking under mammographic or US guidance should be preferred based on the type of the method previously used in the diagnosis of the suspicious lesion (15). In the present study, marking methods were selected by the radiologists in line with these principles.

In the present study, pathology of one (25%) of 4 lesions in the BIRADS-3 category in the ROLL group was malignant. The positive predictive value (PPV) for malignancy in the lesions in the BIRADS-3 category has been reported between 5% and 14% (22). Higher levels in the present study might have resulted from a lower number of patients ($n = 4$) in the BIRADS-3 category. Pathology of none of BIRADS-4 lesions in the ROLL group was malignant. Likelihood of malignancy in this group, which is more heterogeneous as compared to other groups, shows a substantially wide range. Therefore, it was divided into 4a, 4b, and 4c subgroups by the American College of Radiology. PPV for malignancy in these subgroups is 6%, 15%, and 53%, respectively (23). However, subgroups of the lesions reported as BIRADS-4 in our center were not defined. Thus, the subgroup of malignancy [low (4a) or high (4c)] of the patients in the BIRADS-4 category was not known. Absence of malignant cases in BIRADS-4 lesions of the ROLL group suggested that these lesions were probably in the low group (not mentioned in the pathology report). In the present study, rates of malignancy (66.6%) detected in BIRADS-5 lesions in both groups were consistent with the literature. PPV for the malignancy in this category has been reported as 44%–68% (22).

The present study found that pain during the marking procedure, which was assessed by VAS, was less in the ROLL group compared to that in the WGL group (2.0 ± 0.81 vs. 2.61 ± 0.67 , $P = 0.037$). Similarly, in the studies by Moreno et al. (20) and Rampaul et al. (24), pain sense, which was evaluated by VAS, was reported to be less in the ROLL group as compared to that in the wire group. This can be explained by the marking duration being longer in the wire group compared to the ROLL group and difficult

proceeding of the wire in breast parenchyma in those with dense breast tissue.

In the present study, the mean excision duration of the lesion was 12.61 ± 4.57 min in the ROLL group and 13.90 ± 4.72 in the WGL group. However, there was no significant difference between the groups ($P = 0.433$). Similarly, studies in the literature have reported shorter excision duration in the ROLL group than the wire group and no significant difference between the groups (16,18–20,24,25). Following the wire in the parenchyma between the place where the wire is inserted into the skin and the suspicious lesion takes time. However, the ROLL technique enables a shorter excision duration with the assistance of the gamma probe. It is expected that excision duration would be much shorter along with the surgeons in our center becoming accustomed to using the ROLL technique and performing the technique for higher numbers of patients.

The mean weight of the specimens was 49.7 g (range: 6–153 g) in the ROLL group and 39.6 g (range: 5–67 g) in the WGL group, with no significant difference between the groups ($P = 0.260$). There are many studies in the literature reporting that specimen weight is less in the WGL method than the ROLL method. Weight of specimens in these studies has ranged between 14 g and 48 g in ROLL groups and 28 g and 53 g in wire groups (12,13,16,25–30). Mariscal Martínez et al. (18) reported that the mean specimen weight was minimally higher in the ROLL group (68.1 g) as compared to that in the wire group (67.3 g). Likewise, Rampaul et al. (24) reported the mean specimen weight as 34 g in the ROLL group and 31 g in the wire group. In the present study, wider tissue excision in the ROLL group was attributed to the surgeons keeping the safety margin wider due to the ROLL method's being used for the first time in our center. Surgeons in our center perform a wide excision approximately 3 cm in diameter including the intact tissue up to the fascia of the pectoral muscle in such a way that the area with maximum gamma probe count should be in the center. There are different opinions in the literature about excision margins. The common application reported the excision margin to be the area where the gamma probe count shows a sharp decrease (19,20,31,32). However, there are studies reporting that the lesions should be excised including 1 cm or 2 cm of intact tissue around the point with the maximum count (12,24,33).

The present study found the rate of positive surgical margin to be 33.3% in the ROLL group and 42.8% in the WGL group. Although the rate of positive surgical margin was lower in the ROLL group, there was no significant difference between the groups ($P = 0.343$). Consistent with the present results, studies in the literature have reported lower rates of positive surgical margins with the ROLL method. Studies have found the prevalence of involvement of surgical margin between 11% and 40% in ROLL groups

and 32% and 50% in wire groups (13,15,16,19,20,25,27,28). There are studies reporting that positive surgical margin was associated with tumor size and tumor histology. A positive surgical margin is more common in large tumors with the histology of ductal carcinoma in situ (DCIS) or lobular carcinoma in situ (LCIS) (29,34). Consistent with the literature, in both groups of the present study, surgical margins were positive in the patients with larger tumors and with DCIS and LCIS pathology.

Although the mean diameter of malignant lesions was higher in the ROLL group compared to the WGL group (2.23 ± 1.79 cm vs. 1.77 ± 1.69) in the present study, no significant difference was found between the groups ($P > 0.758$). Studies comparing tumor sizes have reported mean tumor diameter to be between 1.2 cm and 1.5 cm in ROLL groups and 0.9 cm and 2.5 cm in wire groups (27,32,35).

In the present study, the duration of hospital stay was remarkably lower in the ROLL group than in the WGL group, though the difference was not significant (290 ± 374 vs. 640 ± 1267 , $P = 0.611$). This was due to the fact that higher complication rates in the WGL group prolonged the duration of hospital stay in this group. Likewise, it was reported in the literature that duration of hospital stay is shorter in ROLL group patients as compared to wire group patients. This can be explained by general anesthesia given to the patients in the wire group and high complication rates in this group (19,20,30).

In the present study, 8% of patients in the ROLL group and 45% of patients in the WGL group developed complications. Complications such as vasovagal syncope, broken wire, displaced wire, pain, pneumothorax, and bleeding (19,36,37) and unsuccessful rate reaching up to 17.9% have been reported in wire groups (38). Disadvantages of the ROLL method include radioactivity passage into the duct, injection of radioactivity into the wrong place, skin contamination, and problems due to multidisciplinary work (17). If the radioactive agent passes into the duct, the image of the subsequent injected contrast agent's dispersing into the ductal tree draws attention (39). Sajid et al. (28) compared the ROLL and wire methods in their metaanalysis consisting of 4 studies and reported that neither of the groups had major complication; although the complication rate was higher in the wire group, no significant difference was found between the groups. In the present study, the complication rate was significantly higher in the WGL group as compared to the ROLL group (8% vs. 45.5%, $P = 0.018$).

Although cosmetic outcomes at the postoperative 1st and 6th months were better in the ROLL group, no significant difference was found between the groups. This might have resulted from the fact that some patients in the WGL group underwent a second surgery due to high complication rates. Similar with the present study, studies

in the literature have revealed better cosmetic outcomes in ROLL groups because of wider excision (removal of larger intact tissue) in wire groups and availability of esthetic skin incision in ROLL groups (16,19,27,29,30).

Evaluation using the criteria during the marking procedure revealed that suspicious lesions were successfully marked at a rate of 95.6% in the ROLL group and 100% in the WGL group. The rate of correct marking on planar scintigraphy of the patients in the ROLL group taken after injection was 96% (24/25). Moreover, the rate of radioactivity on specimen graphs of the lesions was 95.6% (22/23). No activity was observed on the specimen scintigraphy of a patient for whom the radioactive agent was left in the injector. Presence of a suspicious lesion was verified by specimen graphs in 100% (12/12) of the ROLL group patients that underwent mammography-guided marking and in 100% (4/4) of the WGL group patients. These findings supported the hypothesis that suspicious lesions could be successfully observed by the ROLL method. Despite the presence of different verification methods used in the literature to assess the success rate, success rate changes between 89% and 100% for both methods (19,24,25,32).

In the present study, SPECT-CT was able to be performed in only 12 patients due to technical reasons. SPECT-CT imaging provided additional information about the localization of the lesions in a patient with suspicious lesions close to each other in the same breast (left) and about the deepness of the lesion in 3 patients with deeply localized lesions. Thus, SPECT-CT imaging made a contribution to the excision of the lesion in 4 (33.3%) patients. To the best of our knowledge, no study was found in the literature about the contribution of SPECT-CT to the ROLL method in cases of suspicious breast lesions. We suggest that SPECT-CT scans may contribute to excision of lesion in selected cases, particularly in those having more

than one suspicious and deeply localized lesion (primary lesion or lymph node).

Clinical trials are usually performed to show the efficacy of a new method or an existing method. In such studies the main restriction is usually the number of patients accepted to be involved in the new trial. Such prospective studies including diseases of a specific group like one sex has to be performed over a long time period for a desirable number of patients, like in our study. We are of the opinion that studies conducted on larger numbers of patients are needed to obtain more detailed and reliable information about the contributions of SPECT-CT. In the present study we followed 25 patients in the ROLL group and 11 patients in WGL group. Both techniques have their own limitations, e.g., SPECT-CT imaging is required for the ROLL group, there is a learning curve for both the radiologist and surgeon in the WGL group, and there is no consensus for the safety margins during excision of the lesion in both techniques. During the trials we excluded 8 educational patients for whom we performed both methods. We think that the number of patients should be increased to reach desirable results for the representativeness of the trial, as well as to reach significant results when comparing the two methods.

In conclusion, the present study revealed that the ROLL method was superior to the WGL method in terms of complication rates, patient comfort (less pain), cosmetic outcomes, duration of excision, positive surgical margin, and duration of hospital stay. These results corroborate the hypothesis that ROLL is a method that can be safely preferred for marking.

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