



## Multidisciplinary international survey of post-operative radiation therapy practices after nipple-sparing or skin-sparing mastectomy

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### Abstract

**Purpose/Objective(s):** Skin sparing mastectomy (SSM) and nipple-sparing mastectomy (NSM) have entered routine surgical practice for breast cancer, though their oncologic safety has not been established in randomized controlled trials. The aim of this study was to evaluate and compare radiation oncologists' and breast surgeons' opinions concerning the indications of post-operative radiation therapy (PORT) after SSM and NSM.

**Materials/Methods:** Radiation oncologists and breast surgeons from North America, South America and Europe were invited to contribute in this study. A 22-question survey was used to evaluate their opinions.

**Results:** A total of 550 physicians (298 radiation oncologists and 252 breast surgeons) answered the survey. The majority of responders affirmed that PORT should be performed in early-stage (stages I and II) breast cancer for patients who present with risk factors for relapse after SSM and NSM. They considered age, lymph node involvement, tumor size, extracapsular extension, involved surgical margins, lymphovascular invasion, triple negative receptor status and multicentric presentation as major risk factors. Considering that after SSM and NSM, residual breast tissue can be left behind, the residual tissue considered as acceptable in the context of an oncologic surgery were 1–5 mm for breast surgeons. There is no consensus for the necessity of evaluating residual breast tissue through breast imaging.

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**Conclusion:** Although the indications of PORT after SSM and NSM vary among practitioners, standard risk factors for relapse are considered as important by radiation oncologists and breast surgeons.

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**Keywords:** Breast cancer; Skin-sparing mastectomy; Nipple-sparing mastectomy; Radiation therapy; PMRT

## Introduction

For patients diagnosed with non-metastatic breast cancer, the primary treatment approach most often involves surgery to the breast and axillary lymph nodes management (resection or sentinel lymph node biopsy). Post-operative radiation therapy (PORT) is indicated depending on tumor features as well as the type of surgery that was performed.

Patients with early-stage breast cancer can be treated with breast-conserving therapy that consists of breast-conserving surgery followed by RT. This approach has become the preferred modality of treatment since it permits organ preservation, good cosmesis, preservation of the body image and resulting in similar clinical outcomes compared to modified radical mastectomy (MRM) [1].

A modified approach to MRM has been introduced and progressively accepted to surgeons' practices, seeking to improve body image following mastectomy as well. In this context, skin sparing mastectomy (SSM) and nipple-sparing mastectomy (NSM) gained interest, though their oncologic efficacy is uncertain because no comparative studies that formally assessed this issue were performed [2].

Thus, the oncologic safety of SSM or NSM is not confirmed and it is not possible to clearly state that their results compared to MRM. Other challenges in this scenario are related to indications of PORT in breast cancer patients who received SSM or NSM, as no robust studies exist to define the RT approach to such patients. We recently published an international survey article that aimed to assess radiation oncologists' opinions about the indications of RT after SSM and NSM [3]. We recognized that the best clinical decisions involve a multidisciplinary discussion especially in situations wherein there is no consensus. Hence, the opinion of breast surgeons needs to be considered jointly with those of the radiation oncologists. The aim of this study was to evaluate their judgments concerning the indications of PORT following SSM and NSM and to compare their opinions.

## Methods

Radiation oncologists and breast surgeons from North and South America, and Europe were invited to participate in this study. Between May 2014 and September 2016, an invitation email was sent to 2120 radiation oncologists, and 2123 breast surgeons. A questionnaire containing 22 questions was prepared to evaluate their opinions with

regards to PORT indications in the context of SSM and NSM. Moreover, physicians' demographic data and practice features were also collected. The questionnaire was previously tested with eight physicians that mostly treat breast cancer before being sent to a larger population. It was administered as an online survey, and all participation in this study was absolutely voluntary without any monetary incentive for the respondents.

Frequencies and percentages were performed for describe answers according to the profession of the responders. Associations between responders and risk factors were tested using Pearson chi-square or Fisher exact test according to criteria for expected count. Significance level was set at 5% in all hypotheses tested.

## Results

### *Demographic information and practice characteristics*

A total of 550 physicians (298 radiation oncologists and 252 breast surgeons) answered the survey. Most respondents practiced in South America (41.64%), North America (29.45%) and Europe (25.82%), most often in a large city setting (69.27%).

Overall, 94.73% of respondents declared that breast cancer is one of their specialties and 72.54% of them are treating more than 60 breast cancer patients per year.

Almost 2/3 of respondents were male and the majority of them had an academic affiliation (74.9%). Seventy-six percent of participants had their primary practice involved with medical residents and fellows. Eighty-one percent had practiced for at least 5 years since finishing residency training.

Discussing newly diagnosed breast cancer patients in a multidisciplinary tumor board is performed by nearly all respondents, with only 9.82% not practicing this.

In line with current surgical practices, SSM and NSM were performed for more than 15% of newly breast cancer cases by 29.82% of the respondents.

Table 1 demonstrates the demographic and practice features of all participants.

### *Radiation therapy: clinical indications and current practice*

The majority of respondents affirmed that PORT is indicated after SSM and NSM in the presence of risk factors for

Table 1  
Demographic and practice characteristics of respondents (n = 550).

|                                                                                                                   | Respondents |      |
|-------------------------------------------------------------------------------------------------------------------|-------------|------|
|                                                                                                                   | n           | %    |
| Medical specialization                                                                                            |             |      |
| Radiation oncologist                                                                                              | 298         | 54.2 |
| Breast surgeon                                                                                                    | 252         | 45.8 |
| Gender                                                                                                            |             |      |
| Male                                                                                                              | 350         | 63.6 |
| Female                                                                                                            | 200         | 36.4 |
| Location                                                                                                          |             |      |
| Asia                                                                                                              | 15          | 2.7  |
| Australia/New Zealand                                                                                             | 2           | 0.4  |
| Europe                                                                                                            | 142         | 25.8 |
| North America                                                                                                     | 162         | 29.5 |
| South America                                                                                                     | 229         | 41.6 |
| Years since completing residency                                                                                  |             |      |
| 1–5 years                                                                                                         | 100         | 18.2 |
| 5–10 years                                                                                                        | 96          | 17.5 |
| 10–15 years                                                                                                       | 93          | 16.9 |
| > 15 years                                                                                                        | 261         | 47.5 |
| Setting of primary practice                                                                                       |             |      |
| Large city (population > 500,000)                                                                                 | 381         | 69.3 |
| Suburb or small city                                                                                              | 164         | 29.8 |
| Rural                                                                                                             | 5           | 0.9  |
| Number of new breast cancer cases seen in the last 12 months                                                      |             |      |
| 1 to 5                                                                                                            | 5           | 0.9  |
| 6 to 10                                                                                                           | 9           | 1.6  |
| 11 to 20                                                                                                          | 18          | 3.3  |
| 21 to 40                                                                                                          | 55          | 10.0 |
| 42 to 60                                                                                                          | 61          | 11.1 |
| 61 to 80                                                                                                          | 54          | 9.8  |
| 81 to 100                                                                                                         | 68          | 12.4 |
| > 100                                                                                                             | 277         | 50.4 |
| None of the above                                                                                                 | 3           | 0.5  |
| Is breast cancer one of your specializations?                                                                     |             |      |
| Yes                                                                                                               | 521         | 94.7 |
| No                                                                                                                | 29          | 5.3  |
| Percentage of newly diagnosed breast cancer patients discussed in a multidisciplinary meeting                     |             |      |
| None                                                                                                              | 54          | 9.8  |
| Up to 10%                                                                                                         | 74          | 13.5 |
| 11% – 25%                                                                                                         | 83          | 15.1 |
| 26% – 50%                                                                                                         | 68          | 12.4 |
| 51% – 90%                                                                                                         | 82          | 14.9 |
| > 90%                                                                                                             | 189         | 34.4 |
| Percentage of newly diagnosed breast cancer patients undergoing skin-sparing mastectomy/nipple-sparing mastectomy |             |      |
| Up to 5%                                                                                                          | 202         | 36.7 |
| 6% – 15%                                                                                                          | 186         | 33.8 |
| 16% – 30%                                                                                                         | 119         | 21.6 |
| 31% – 60%                                                                                                         | 31          | 5.6  |
| > 60%                                                                                                             | 14          | 2.5  |

Note: n = number of patients; % = percentage.

tumor relapse. As expected, there were statistically significant differences between radiation oncologists and surgeons, the former being more likely to recommend radiation (Table 2). The frequency at which RT is deemed not feasible due to possible technical difficulties and/or a high anticipated risk of toxicity is low, however nearly double as much for breast surgeons (Table 2).

The most significant risk factors that are considered for treating with PORT are presented in Table 3. Although all of these factors were pointed out as important or very important for all responders, there were statistically significant differences in the response patterns between radiation oncologists and breast surgeons regarding 5 of 9 assessed characteristics [lymph node involvement ( $p < 0.001$ ); lymphovascular space invasion ( $p < 0.001$ ); histological grade 3 ( $p < 0.001$ ); triple negative tumor ( $p < 0.001$ ); age ( $p < 0.001$ )].

More details regarding relapse risk factors were evaluated to better understand how these elements are used in clinical practice (Table 4). Surgeons and radiation oncologists were in agreement regarding the most appropriate cut-off tumor size, but there were statistically significant differences concerning the appropriate cut-off for number of involved lymph nodes and age (Table 4): Surgeons were more likely to consider more than 3 positive nodes as a risk factor, while radiation oncologists generally set the limit at one positive node ( $p < 0.001$ ).

#### Residual breast tissue evaluation after SSM and NSM

No consensus with regards the definition of residual breast tissue after SSM and NSM and with regards to the necessity of evaluating residual breast tissue after surgery was observed between the groups. Most responders never or rarely request breast imaging to evaluate the residual breast tissue after SSM and NSM. There is agreement that magnetic resonance imaging is considered more adequate to evaluate residual breast tissue status after SSM and NSM. Table 5 details the answers of the respondents.

## Discussion

This multidisciplinary survey of radiation oncologists and breast surgeons evaluated the post-operative indications of RT in SSM and NSM context. Our study compiled opinions of physicians that are mostly specialized in breast cancer treatment, with more than 60 patients treated per year, with an academic affiliation, and with residence in large cities in North America, South America and Europe.

SSM permits skin preservation, with the advantage of better cosmetic outcomes, as compared to MRM, after subsequent breast reconstruction [4]. SSM comprises in the removal of the all breast tissue as well as the nipple-areola complex, conserving the skin cover and inframammary fold [5,6].

Intuitively, when compared to a MRM, SSM is associated with a higher risk of leaving subcutaneous residual breast tissue that may shelter residual tumor. Thus, notwithstanding the statement that the SSM technique requests removal of as much breast tissue as achievable, the occurrence of residual breast tissue might jeopardize the oncologic safety of the procedure [7–10]. Many studies reported that the oncologic safety of the SSM is equivalent

Table 2  
Current practice of skin-sparing mastectomy and nipple-sparing mastectomy.

| Questions                                                                                                                                                                                                                          | Radiation oncologist |      | Breast surgeon |      | P value |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|----------------|------|---------|
|                                                                                                                                                                                                                                    | n                    | %    | n              | %    |         |
| Post-mastectomy radiation is indicated for early-stage (stages I and II) breast cancer patients who undergo skin-sparing mastectomy:                                                                                               |                      |      |                |      | <0.001  |
| <i>Always</i>                                                                                                                                                                                                                      | 21                   | 7.0  | 6              | 2.4  |         |
| <i>I don't know</i>                                                                                                                                                                                                                | 8                    | 2.7  | 2              | 0.8  |         |
| <i>In the presence of risk for recurrence</i>                                                                                                                                                                                      | 260                  | 87.2 | 213            | 84.5 |         |
| <i>Never</i>                                                                                                                                                                                                                       | 9                    | 3.0  | 31             | 12.3 |         |
| Post-mastectomy radiation is indicated for early-stage (stages I and II) breast cancer patients who undergo nipple-sparing mastectomy:                                                                                             |                      |      |                |      | <0.001  |
| <i>Always</i>                                                                                                                                                                                                                      | 43                   | 14.4 | 16             | 6.3  |         |
| <i>I don't know</i>                                                                                                                                                                                                                | 9                    | 3.0  | 7              | 2.8  |         |
| <i>In the presence of risk for recurrence</i>                                                                                                                                                                                      | 239                  | 80.2 | 205            | 81.3 |         |
| <i>Never</i>                                                                                                                                                                                                                       | 7                    | 2.3  | 24             | 9.5  |         |
| In your practice, how often is radiation therapy contraindicated due to possible technical difficulties and/or a high risk of toxicities related to breast reconstruction after skin-sparing mastectomy/nipple-sparing mastectomy? |                      |      |                |      | <0.001  |
| <i>Never</i>                                                                                                                                                                                                                       | 72                   | 24.2 | 68             | 27.0 |         |
| <i>Rarely</i>                                                                                                                                                                                                                      | 187                  | 62.8 | 123            | 48.8 |         |
| <i>Sometimes</i>                                                                                                                                                                                                                   | 34                   | 11.4 | 40             | 15.9 |         |
| <i>Often</i>                                                                                                                                                                                                                       | 3                    | 1.0  | 14             | 5.6  |         |
| <i>Very often</i>                                                                                                                                                                                                                  | 2                    | 0.7  | 7              | 2.8  |         |

Note: n = number of patients; % = percentage.

to the MRM, regarding loco-regional control rates [7,11–17]. Whereas local relapse rate in early-stage breast cancer patients who undergo MRM is about 10% at 20 years [18], loco-regional recurrence rates range from 0 to 7.6% after SSM, though the studies that support these results do not have appropriate long-term follow-up [19–22]. A systematic review and meta-analysis of non-

randomized studies did not show any statistically significant differences in local relapse rates between MRM and SSM [23]. Moreover, other authors demonstrated that SSM is not associated with a decrease of systemic and loco-regional control in patients with stage 0 to II breast cancer [11,24]. Although the local relapse rates seem to be low in patients with early-stage disease, it is important

Table 3  
Recurrence risk factors after skin-sparing mastectomy and nipple-sparing mastectomy.

| Characteristic                | Answer | P value       |                    |            |                |              |        |
|-------------------------------|--------|---------------|--------------------|------------|----------------|--------------|--------|
|                               |        | Not important | Somewhat important | Important  | Very important | I don't know |        |
|                               |        | n (%)         | n (%)              | n (%)      | n (%)          | n (%)        |        |
| Tumor size                    | RO     | 5 (1.5)       | 32 (10.7)          | 109 (36.6) | 151 (50.7)     | 1 (0.3)      | 0.59   |
|                               | BS     | 9 (3.6)       | 26 (10.3)          | 91 (36.1)  | 126 (50.0)     | 0 (0.0)      |        |
| Lymph node involvement        | RO     | 2 (0.7)       | 1 (0.3)            | 26 (8.7)   | 268 (89.9)     | 1 (0.3)      | <0.001 |
|                               | BS     | 5 (1.2)       | 13 (5.2)           | 59 (23.4)  | 177 (70.2)     | 0 (0.0)      |        |
| Extracapsular nodal extension | RO     | 16 (5.4)      | 51 (17.1)          | 89 (29.9)  | 137 (46.0)     | 5 (1.7)      | 0.80   |
|                               | BS     | 18 (7.1)      | 44 (17.5)          | 76 (30.2)  | 112 (44.4)     | 2 (0.8)      |        |
| Lymphovascular space invasion | RO     | 3 (1.0)       | 47 (15.8)          | 142 (47.7) | 104 (34.9)     | 2 (0.7)      | <0.001 |
|                               | BS     | 24 (9.5)      | 58 (23.0)          | 98 (38.9)  | 69 (27.4)      | 3 (1.2)      |        |
| Involved surgical margins     | RO     | 0 (0.0)       | 6 (2.0)            | 35 (11.7)  | 256 (85.9)     | 1 (0.3)      | 0.147  |
|                               | BS     | 4 (1.6)       | 8 (3.2)            | 29 (11.5)  | 211 (83.7)     | 0 (0.0)      |        |
| Histological grade 3          | RO     | 11 (3.7)      | 60 (20.1)          | 160 (53.7) | 65 (21.8)      | 2 (0.7)      | <0.001 |
|                               | BS     | 27 (10.7)     | 70 (27.8)          | 95 (37.7)  | 60 (23.8)      | 0 (0.0)      |        |
| Triple negative tumor         | RO     | 19 (6.4)      | 71 (23.8)          | 134 (45.0) | 71 (23.8)      | 3 (1.0)      | <0.001 |
|                               | BS     | 49 (19.4)     | 52 (20.6)          | 69 (27.4)  | 81 (32.1)      | 1 (0.4)      |        |
| Multicentric tumor            | RO     | 40 (13.4)     | 68 (22.8)          | 101 (33.9) | 86 (28.9)      | 3 (1.0)      | 0.16   |
|                               | BS     | 46 (18.3)     | 70 (27.8)          | 57 (22.6)  | 79 (31.3)      | 0 (0.0)      |        |
| Young age                     | RO     | 16 (5.4)      | 60 (20.1)          | 135 (45.3) | 85 (28.5)      | 2 (0.0)      | <0.001 |
|                               | BS     | 40 (15.9)     | 72 (28.6)          | 97 (38.5)  | 43 (17.1)      | 0 (0.0)      |        |

Note: RO = Radiation oncologist; BS = Breast surgeon; n = number of patients; % = percentage.

Table 4  
Appropriate cut-off for recurrence risk factors (tumor size, lymph node involvement and age).

| Questions                                                                                                                                 | Radiation oncologist |      | Breast surgeon |      | P value |
|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|----------------|------|---------|
|                                                                                                                                           | n                    | %    | n              | %    |         |
| Considering tumor size as a recurrence risk factor, which size do you consider an appropriate cut-off?                                    |                      |      |                |      | 0.244   |
| 1 cm                                                                                                                                      | 2                    | 0.7  | 0              | 0.0  |         |
| 2 cm                                                                                                                                      | 28                   | 9.4  | 20             | 7.9  |         |
| 3 cm                                                                                                                                      | 42                   | 14.1 | 46             | 18.3 |         |
| 4 cm                                                                                                                                      | 2                    | 0.7  | 6              | 2.4  |         |
| 5 cm                                                                                                                                      | 209                  | 70.1 | 172            | 68.3 |         |
| None of the above                                                                                                                         | 7                    | 2.3  | 5              | 2.0  |         |
| I don't know                                                                                                                              | 8                    | 2.7  | 3              | 1.2  |         |
| Considering lymph node involvement as a recurrence risk factor, which extent of nodal involvement do you consider an appropriate cut-off? |                      |      |                |      | <0.001  |
| 1 – 3 lymph node (s)                                                                                                                      | 193                  | 64.8 | 81             | 32.1 |         |
| > 3 lymph nodes                                                                                                                           | 91                   | 30.5 | 167            | 66.3 |         |
| None of the above                                                                                                                         | 12                   | 4.0  | 3              | 1.2  |         |
| I don't know                                                                                                                              | 2                    | 0.7  | 1              | 0.4  |         |
| Considering age as a recurrence risk factor, which age do you consider an appropriate cut-off?                                            |                      |      |                |      | <0.001  |
| 35                                                                                                                                        | 40                   | 13.4 | 40             | 15.9 |         |
| 40                                                                                                                                        | 105                  | 35.2 | 88             | 34.9 |         |
| 50                                                                                                                                        | 89                   | 29.9 | 40             | 15.9 |         |
| 60                                                                                                                                        | 13                   | 4.4  | 6              | 2.4  |         |
| 70                                                                                                                                        | 9                    | 3.0  | 8              | 3.2  |         |
| None of the above                                                                                                                         | 29                   | 9.7  | 56             | 22.2 |         |
| I don't know                                                                                                                              | 13                   | 4.4  | 14             | 5.6  |         |

Note: n = number of patients; % = percentage.

to highlight that when local recurrences occur, they are predominantly located in the subcutaneous fat or in skin [25], areas removed in the MRM.

Not surprisingly, in patients with locally advanced disease higher rates of loco-regional relapse were observed after SSM. Data from Finland showed 31% of loco-regional relapse in patients with stage III compared to 5.8% of recurrence in women with stage 0 to II [26]. The most significant characteristics that are associated with an elevated risk of local relapse in breast cancer patients who undergo SSM are nodal status, tumor size, poor tumor differentiation, and lymphovascular invasion [13,16].

The essential difference between NSM and SSM is that the nipple-areolar complex (NAC) is spared with the NSM approach [27]. There is a hypothetical risk of occult tumor infiltration of the NAC as the NAC can contain breast tissue. Hence, extra attention is needed when selecting this technique. In nearly 60% of mastectomy samples, microscopic tumor involves the NAC [28]. The main features that may be related to a higher risk of NAC involvement by tumor are: a small distance between the NAC and the tumor (<4–5 cm); positive lymph nodes status; central tumor location and multicentricity [29]. Nevertheless, loco-regional relapse rates after NSM are low in patients with early-stage breast cancer [30].

There are no prospective clinical trials that assessed the indications of RT in patients treated by SSM and NSM.

Diverse indications for RT have been indiscriminately set by groups performing those two types of surgery. These include invasion of chest wall [31], any positive lymph node or > 3 positive lymph nodes [30,31], tumor size larger than 4 cm or 5 cm [30–32]. There are publications that did not clearly define the recommendations for post-operative RT after SSM and NSM, whereas others indicated RT for all women receiving NSM [32], or recommend intraoperative RT to the NAC [33].

The present study showed that recognized clinical pathologic criteria for loco-regional recurrent risk are considered both by radiation oncologists and breast surgeons as indications for PORT. As described in Table 3, the majority of responders affirmed that PORT is recommended for patients with early-stage breast cancer in the presence of standard risk factors for recurrence: young age; positive surgical margins; triple negative tumor; lymphovascular space invasion; multicentricity; large tumor size; lymph node involvement and extracapsular extension. Although there were some statistically significant differences in the responses of radiation oncologists and breast surgeons, both groups considered all of these elements to be important in influencing the clinical decision to perform RT after SSM and NSM, with differences rather related to the threshold and/or a combination of risk factors.

Most radiation oncologist considered age younger than 40 years, involvement of one positive lymph node and

Table 5  
Breast tissue evaluating.

| Questions                                                                                                                                                                                                                                          | Radiation oncologist |      | Breast surgeon |      | P value |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------|----------------|------|---------|
|                                                                                                                                                                                                                                                    | n                    | %    | n              | %    |         |
| After skin-sparing mastectomy/nipple-sparing mastectomy, residual breast tissue can be left behind. What amount of residual tissue do you consider as acceptable in the context of an oncologic surgery?                                           |                      |      |                |      | <0,001  |
| <i>1 mm – 5 mm</i>                                                                                                                                                                                                                                 | 85                   | 28,5 | 138            | 54,8 |         |
| <i>6 mm – 10 mm</i>                                                                                                                                                                                                                                | 32                   | 10,7 | 53             | 21,0 |         |
| <i>11 mm – 20 mm</i>                                                                                                                                                                                                                               | 13                   | 4,4  | 5              | 2,0  |         |
| <i>&gt; 20 mm</i>                                                                                                                                                                                                                                  | 6                    | 2,0  | 0              | 0,0  |         |
| <i>None of the above</i>                                                                                                                                                                                                                           | 56                   | 18,8 | 51             | 20,2 |         |
| <i>I don't know</i>                                                                                                                                                                                                                                | 106                  | 35,6 | 5              | 2,0  |         |
| Do you consider it important to evaluate the residual breast tissue after skin-sparing mastectomy/nipple-sparing                                                                                                                                   |                      |      |                |      | <0,001  |
| <i>Not important</i>                                                                                                                                                                                                                               | 47                   | 15,8 | 99             | 39,3 |         |
| <i>Somewhat important</i>                                                                                                                                                                                                                          | 73                   | 24,5 | 56             | 22,2 |         |
| <i>Important</i>                                                                                                                                                                                                                                   | 70                   | 23,5 | 57             | 22,6 |         |
| <i>Very important</i>                                                                                                                                                                                                                              | 50                   | 16,8 | 30             | 11,9 |         |
| <i>I don't know</i>                                                                                                                                                                                                                                | 58                   | 19,5 | 10             | 4,0  |         |
| In your practice, how often do you request breast imaging to evaluate the residual breast tissue after skin-sparing mastectomy/nipple-sparing mastectomy (consider patients who underwent skin-sparing mastectomy/nipple-sparing mastectomy only)? |                      |      |                |      | 0,57    |
| <i>Never</i>                                                                                                                                                                                                                                       | 88                   | 29,5 | 79             | 31,3 |         |
| <i>Rarely</i>                                                                                                                                                                                                                                      | 104                  | 34,9 | 72             | 28,6 |         |
| <i>Sometimes</i>                                                                                                                                                                                                                                   | 58                   | 19,5 | 40             | 15,9 |         |
| <i>Often</i>                                                                                                                                                                                                                                       | 35                   | 11,7 | 37             | 14,7 |         |
| <i>Very often</i>                                                                                                                                                                                                                                  | 13                   | 4,4  | 24             | 9,5  |         |
| Which breast imaging modality do you consider more adequate to evaluate the residual breast tissue status after skin-sparing mastectomy/nipple-sparing mastectomy (select all that apply)? <sup>a</sup>                                            |                      |      |                |      |         |
| <i>Ultrasonography</i>                                                                                                                                                                                                                             | 82                   | 20,6 | 92             | 26,4 | 0,024   |
| <i>Mammography</i>                                                                                                                                                                                                                                 | 55                   | 13,8 | 73             | 21,0 | 0,04    |
| <i>Magnetic resonance imaging</i>                                                                                                                                                                                                                  | 206                  | 51,8 | 151            | 43,4 | 0,15    |
| <i>Computed tomography</i>                                                                                                                                                                                                                         | 19                   | 4,8  | 3              | 0,9  | <0,001  |
| <i>None of the above</i>                                                                                                                                                                                                                           | 36                   | 9,0  | 29             | 8,3  | <0,001  |

Note: n = number of patients; % = percentage.

<sup>a</sup> The statistical analysis was performed individually for each item because it was allowed to select more than one option.

tumor size greater than 5 cm as reasonable cut-offs, and most breast surgeons agreed, except for the number of nodes involved, that they put at more than 3 (Table 4).

There is high level evidence supporting radiation oncologist's opinion with regards to PORT for patients independent of the number of positive lymph nodes: The Early Breast Cancer Trialists' Collaborative Group's meta-analysis established that post-mastectomy RT decreases tumor relapse and mortality in patients with any number of positive lymph nodes who underwent modified radical mastectomy and axillary dissection [34]. Thus, these findings could correctly be applied for all breast cancer patients with positive lymph nodes who received SSM and NSM.

Although a minority of respondents routinely requests breast imaging after SSM and NSM (Table 5), we consider that imaging should be used to assess the thickness of skin flaps and to support the indication of RT in the presence of residual breast tissue. Although most radiation oncologists did not know what amount of residual tissue can be

considered oncologic acceptable after SSM and NSM, most breast surgeons pointed out 1 mm to 5 mm as the most appropriate cut-off (Table 5). A retrospective study that evaluated patients with stage 0 to IIIA breast cancer who received SSM, indicated that 59.5% of surgical specimens had residual breast tissue. The presence of breast tissue was significantly associated with to skin flaps thicker than 5 mm. Furthermore, residual tumor was present in 9.5% of samples in which skin flaps greater than 5 mm were left in place [35]. Those results support the breast surgeons' opinions.

While it is infrequently used in daily practice, all respondents (radiation oncologists and breast surgeons) consider magnetic resonance imaging as the most suitable imaging modality to assess the residual breast tissue status after SSM and NSM.

In conclusion, this survey polled the opinions of radiation oncologists and breast surgeons about the role and indications of RT after SSM and NSM. Although there are

many uncertainties about this issue, all standard relapse risk factors were pointed out as major factors guiding the decision to advice RT. As the current data with regards to the use of RT in patients with early-stage breast cancer treated by SSM and NSM are very limited, experts' opinions may be the best available evidence. Future prospective trials might be considered to evaluate the indications of RT in this context.

### Conflict of interest

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