

# Breast Reconstruction Trends in the Setting of Postmastectomy Radiation Therapy: Analysis of Practices among Plastic Surgeons in the United States

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**Background:** Radiation is an integral part of breast cancer therapy. The ideal type and timing of breast reconstruction with relation to radiation delivery are not well established. The study aimed to identify reconstructive practices among American plastic surgeons in the setting of pre- and postmastectomy radiation.

**Methods:** A cross-sectional survey of members of the American Society of Plastic Surgery was performed. Practice/demographic information and breast reconstruction protocols were queried. Univariate descriptive statistics were calculated, and outcomes were compared across cohorts with  $\chi^2$  and Fischer exact tests.

**Results:** Overall, 477 plastic surgeons averaging 16.3 years in practice were surveyed. With respect to types of reconstruction, all options were well represented, although nearly 60% preferred autologous reconstruction with prior radiation and 55% preferred tissue expansion followed by implant/autologous reconstruction in the setting of unknown postoperative radiation. There was little consensus on the optimal timing of reconstruction in the setting of possible postoperative radiation. Most respondents wait 4–6 or 7–12 months between the end of radiation and stage 2 implant-based or autologous reconstruction. Common concerns regarding the effect of radiation on reconstructive outcomes included mastectomy flap necrosis, wound dehiscence, capsular contracture, tissue fibrosis, and donor vessel complications.

**Conclusions:** Despite considerable research, there is little consensus on the ideal type and timing of reconstruction in the setting of pre- and postoperative radiation. Understanding how the current body of knowledge is translated into clinical practice by different populations of surgeons allows us to forge a path forward toward more robust, evidence-based guidelines for patient care. (*Plast Reconstr Surg Glob Open* 2023; 11:e4800; doi: [10.1097/GOX.0000000000004800](https://doi.org/10.1097/GOX.0000000000004800); Published online 17 February 2023.)

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## INTRODUCTION

Radiation therapy to the chest wall and/or lymph nodes has become an important part of breast cancer therapy. Whether in the setting of breast conserving therapy or postmastectomy radiation therapy (PMRT), radiation improves disease-free and overall survival but is not without downsides. The affected tissues often become fibrotic with compromised skin integrity and perfusion that may negatively affect wound healing.<sup>1</sup> New techniques such as intensity-modulated radiation and volumetric modulated arc therapy promise to spare adjacent tissues and

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minimize collateral injury, but even these modern technologies do not eliminate the detrimental effects on the local tissues.<sup>2</sup>

Breast reconstruction has similarly established itself as an important pillar in the comprehensive management of breast cancer. Although not necessarily lifesaving, recapitulating the native breast with either implants or autologous tissues improves patients' psychosocial and sexual outcomes.<sup>3</sup> Unfortunately, nowhere are the side effects of radiation therapy more significantly felt than in the setting of postmastectomy breast reconstruction. Not only does the tissue fibrosis distort the shape of the breast, potentially compromising the final aesthetic result, but the scarred, hypovascular pocket creates an unfavorable milieu that is prone to infection, poor wound healing, and reconstructive failure.<sup>4-6</sup>

Understanding and navigating these radiation risks have been priorities among the research community and a topic of considerable debate over the years. Although research has suggested that autologous reconstruction is associated with fewer radiation-related complications than prosthetic reconstruction, implant-based techniques remain the most performed and an important option regardless of radiation status.<sup>7</sup> Similarly, the timing of reconstruction, either immediate, delayed, or delayed-immediate, when the need for PMRT is undetermined pre-mastectomy, has been argued in every way without a clear consensus. With such uncertainty in the literature, we surveyed plastic surgeons on their preferences and concerns with regard to breast reconstruction and radiation, aiming to shed light on how the recent discourse has shaped clinical management. We hypothesized that there would be a lack of consensus among respondents, and hope to understand what surgeon characteristics and concerns contribute to the heterogeneity as we continue to forge a path toward a consensus.

## METHODS

### Survey Development

An electronic survey was created and distributed using the web-based survey tool SurveyMonkey (Momentive Inc, San Mateo, Calif.). The survey was piloted among co-authors, and the feedback was incorporated to achieve the final 17 question form (See survey, Supplemental Digital Content 1, which shows the final distributed survey, <http://links.lww.com/PRSGO/C400>).

The survey instrument addresses three main topics: (1) respondent demographics and practice characteristics; (2) preferences regarding the type and timing of reconstruction in the setting of preoperative and unknown postoperative reconstruction; and (3) concerns with performing breast reconstruction in the setting of radiation. Participants were required to answer all questions before advancing or completing the survey.

### Survey Distribution

The cross-sectional survey was reviewed and accepted by the American Society of Plastic Surgeons (ASPS) for

## Takeaways

**Question:** What are the preferred methods and timing of breast reconstruction for patients who may undergo radiation therapy in the United States?

**Findings:** From survey responses, we found a wide variety of preferences for breast reconstruction when radiation therapy is a possibility after mastectomy.

**Meaning:** The study demonstrates a lack of consensus on the optimal breast reconstruction practices following radiation therapy and highlights the need for high quality trials that can help establish evidence-based guidelines.

distribution among its membership. The questionnaire was distributed four times via email by representatives of ASPS; survey distributions were spaced 1 week apart. The survey population consisted of board-certified attending plastic surgeons both within the United States (N = 2456) and internationally (N = 2639). All survey responses were anonymous, and survey participation was completely voluntary.

### Statistical Analyses

All statistical analyses were completed using SPSS, version 28.0 (IBM Co, Armonk, N.Y.). Descriptive, univariate statistics were calculated for each of the 16 survey questions. Participant responses were compared between cohorts of interest, using  $\chi^2$  and Fisher exact analyses. The two-tailed threshold for statistical significance was set at  $\alpha = 0.05$ .

## RESULTS

### Respondent Characteristics

Overall, 477 participants completed the survey (overall response rate: 9.4%). The response rate was similar for American (9.2%) and international (9.5%) plastic surgeons. Just under 50% of respondents were from the United States; nearly 20% were from other countries in the Americas or Caribbean; and there were roughly 10% from each of Asia, Europe, and Australia/New Zealand. On average, respondents were in practice for 16.3 years, with only 15.7% of respondents in their first 5 years (Table 1). Solo practice (33.1%) and academic or military practices (27.3%) were the most common practice types, followed by small and large practice surgery practices and multispecialty practices (Table 1).

The average responder dedicated over 60% of their practice to implant-based breast reconstruction, 30% autologous reconstruction, and about 10% combined techniques (Table 2); 40.9% of respondents performed over 80% of their reconstruction using implants, and another 40% performed over 40% with autologous tissue. Neoadjuvant radiation was rare. However, most respondents reported that 25%–50% of their patient population undergoes adjuvant radiation (Table 2). About 40% of respondents are likely to delay reconstruction for any reason in their patient population (Table 2).

**Table 1. Respondent Demographics**

Demographics	Percentage
Global region	
USA	47.40%
Americas/Caribbean	20.10%
Africa	1.30%
Asia	13.60%
Australia and New Zealand	5.70%
Europe	11.90%
USA region (N = 227)	
Northeast	18.50%
Midwest	20.30%
West	25.10%
South	36.10%
Years in practice	Mean 16.3 (9.7)*
0–5	15.70%
6–15	33.80%
16+	48.00%
Practice type	
Academic/military	27.30%
Small plastic surgery practice (2–5 surgeons)	17.40%
Large plastic surgery practice (6+ surgeons)	6.50%
Multispecialty practice	13.20%
Solo practice	33.10%

\*Years in practice reported as mean and (SD).

**Table 2. Respondent Practice Characteristics**

Characteristics	Percentage
Percentage of breast reconstruction practice dedicated to:	
Implant-based reconstruction	62.70%
Autologous reconstruction	28.80%
Combined	12.90%
Greater than 80% implant-based*	40.90%
Greater than 40% autologous tissue*	28.30%
Percentage of patients with neoadjuvant radiation?	
<25%	73.38%
25–50%	20.50%
50–75%	4.25%
>75%	1.88%
Percentage of patients with adjuvant radiation?	
<25%	35.96%
25–50%	51.00%
50–75%	9.40%
>75%	3.63%
How often do you delay reconstruction after mastectomy?	
<25%	54.82%
25–50%	4.76%
50–75%	27.28%
>75%	13.14%

\*Percentage of respondents who report a practice with greater than either 80% implant-based reconstruction or 40% autologous tissue reconstruction.

### Practice Patterns

In the setting of preoperative radiation, the preferred method for reconstruction in 60% of respondents was a direct autologous procedure. Implant-based procedures were the least preferred in that setting, followed by tissue expansion into autologous reconstruction (Table 3). When the need for postoperative radiation was unknown

at the time of mastectomy, 43% of respondents opted for immediate reconstruction, followed by 39% delayed-immediate, and 18% delayed reconstruction. The preferred intervention at the time of mastectomy was tissue expander placement for 55.5% of respondents, followed by delaying reconstruction (21.4%), immediate autologous procedure (13.4%), and direct to implant reconstruction (8.2%). In the setting of postoperative radiation, only a small percentage of respondents waited less than 3 months or more than 12 months between the end of radiation and tissue expander exchange to definitive autologous or implant reconstruction; most (41%–44%) wait 4–6 months, whereas 34%–26% wait 7–12 months (Table 4).

Compared with respondents from the United States, international surgeons were significantly more likely to prefer implant-based techniques in the setting of prior radiation. International surgeons also tended to wait longer between the completion of radiation and exchanging a tissue expander for an implant or autologous reconstruction. Surgeons in practice for longer than 5 years also preferred implant-based procedures to autologous ones in the setting of radiation. Surgeons with predominantly implant-based or autologous practices demonstrated significant preferences toward that respective technique in all situations (See table 1, Supplemental Digital Content 2, which displays variations in preferred techniques and timing across respondent characteristics, <http://links.lww.com/PRSGO/C401>) (See table 2, Supplemental Digital Content 3, which displays variations in concerns with preferences regarding the timing and technique of reconstruction in the setting of preoperative and unknown postoperative radiation, <http://links.lww.com/PRSGO/C402>).

### Concerns

The most common concerns with autologous reconstruction in the setting of recent radiation were wound dehiscence followed by flap fibrosis, poor donor vessels, and mastectomy skin loss. Poor cosmetic outcome, partial/total flap loss, infection, fat necrosis, asymmetry, and tissue edema were also commonly selected by nearly 20% of respondents (Table 5). The most common concerns in implant-based reconstruction were overwhelmingly wound dehiscence (77.1%) and severe capsular contracture (76.5%), followed by mastectomy skin loss (52.6%), infection (47.1%), and asymmetry (42.5%).

With few exceptions, concerns regarding the effects of recent radiation on implant-based and autologous reconstruction were not correlated to respondent preferences for the type or timing of reconstruction. (See Supplemental Digital Content 2, <http://links.lww.com/PRSGO/C401>; See Supplemental Digital Content 3, <http://links.lww.com/PRSGO/C401>) (Table 6).

## DISCUSSION

Both radiation and breast reconstruction are established pillars in the management of breast cancer patients,

**Table 3. Reconstructive Preferences in the Setting of Preoperative or Unknown Postoperative Radiation**

Reconstructive Modality with a History of Radiation	Mean (SD)*	Preferred Option (%)	Least Preferred Option (%)
Implant-based	3.11 (1.14)	17.30%	53.80%
Direct autologous	1.73 (1.03)	59.60%	10.50%
Tissue expander to autologous	2.64 (0.93)	11.50%	19.90%
Implant and autologous	2.52 (0.89)	11.50%	15.70%
Reconstruction Timing with Unknown Postoperative Radiation	Mean (SD)†	Preferred Option (%)	Least Preferred Option (%)
Immediate	1.89 (0.86)	43%	32%
Delayed	2.25 (0.75)	18.40%	43.80%
Delayed-immediate	1.86 (0.78)	38.60%	24.10%
Reconstructive Modality with Unknown Postoperative Radiation	Preferred Option (%)		
Immediate tissue expander placement	55.50%		
Direct to implant	8.20%		
Immediate autologous reconstruction	13.40%		
Delayed reconstruction	21.40%		
No reconstruction	0.20%		

\*Ranked from one to four, with one being their most preferred and four their least preferred.

†Ranked from one to three, with one being their most preferred and three their least preferred.

**Table 4. Time from End of Radiation to Stage 2 Reconstruction**

	Autologous Tissue	Implant-based
0–3 months	11.20%	6.25%
4–6 months	44.53%	41.15%
7–12 months	34.64%	36.20%
12+ months	9.64%	16.41%

yet no consensus exists as to how these two therapies can be optimally delivered. This survey is the first of its kind to assess how board-certified plastic surgeons translate the existing body of literature into clinical practice for their breast reconstruction patients.

**Previous Radiation**

Autologous reconstruction is often quoted to be the gold standard in a previously irradiated chest. The literature shows that the elevated rates of mastectomy flap necrosis, capsular contracture, and reconstructive failure with implant-based procedures<sup>8–10</sup> decrease significantly with combined implant/autologous reconstruction,<sup>11</sup> and even more so with autologous procedures alone.<sup>12</sup> Our respondents echo these sentiments as autologous procedures were overwhelmingly preferred, and implant-based

the least preferred, in patients with a history of prior irradiation (Table 3). This sentiment is magnified among surgeons in their first 5 years of practice, as their opinions have likely been shaped by the evolving literature during their training. With such a strong consensus among respondents and with the published literature, one- or two-stage autologous reconstruction will likely continue to increase in popularity over the coming years (Supplemental Digital Content 2, <http://links.lww.com/PRSGO/C401>; Supplemental Digital Content 3, <http://links.lww.com/PRSGO/C401>).

Nonetheless, even autologous procedures have their downsides in the setting of radiation and otherwise. Pedicled musculocutaneous options carry considerable donor site morbidity,<sup>13</sup> whereas perforator flaps are technically more challenging and require microvascular anastomoses, typically to the irradiated internal mammary vessels.<sup>14</sup> Radiation is known to cause intimal hyperplasia and adventitial fibrosis, resulting in difficult dissections and friable vessels that some have hypothesized may also be prone to vascular obstruction.<sup>15</sup> Only about one-third of respondents raised concerns over the donor vessel dissection and quality (Table 5). Perhaps lower than one might expect, these numbers are a testament to how comfortable the community has become with exposure of the internal mammary vessels and the

**Table 5. Concerns with Reconstruction in the Setting of Recent Radiation\***

Autologous Tissue Reconstruction		Implant-based Reconstruction	
Concern	Percentage	Concern	Percentage
Asymmetry	19.01%	Asymmetry	42.48%
Donor vessel quality and dissection	37.78%	Hematoma	4.22%
Fat necrosis	19.76%	Mastectomy skin loss	52.55%
Hematoma	0.99%	Severe capsular contracture	76.52%
Mastectomy skin loss	34.18%	Surgical site infection	47.08%
Poor cosmetic outcome	27.59%	Wound dehiscence	77.14%
Surgical site infection	19.51%		
Tissue edema	19.76%		
Tissue fibrosis	42.00%		
Total/partial flap loss	27.09%		
Wound dehiscence	52.32%		

\*Respondents were prompted to select their three main concerns in the setting of recent radiation to the ipsilateral chest wall.

**Table 6. Variations in Concerns with Preferred Timing of Definitive Reconstruction after Radiation**

Concerns	Preferred Timing from End of Radiation to Expander to Implant Exchange			
	0–3 mo	4–12 mo	>12 mo	<i>P</i>
Asymmetry	53.50%	40.50%	45.90%	0.244
Hematoma	4.70%	3.90%	5.40%	0.903
Mastectomy skin loss	39.50%	53.90%	56.80%	0.181
Severe capsular contracture	83.70%	74.30%	86.50%	0.129
Surgical site infection	48.80%	48.00%	37.80%	0.489
Wound dehiscence	69.80%	79.30%	67.60%	0.134
Concerns	Preferred Timing from End of Radiation to Expander Removal and Autologous Reconstruction			
	0–3 mo	4–12 mo	>12 mo	<i>P</i>
Asymmetry	33.30%	17.50%	20.60%	0.154
Donor vessel quality and dissection	29.20%	39.70%	31.70%	0.330
Fat necrosis	25.00%	17.80%	27.00%	0.205
Hematoma	4.20%	0.70%	1.60%	0.241
Mastectomy skin loss	25.00%	34.70%	34.90%	0.623
Poor cosmetic outcome	16.70%	26.60%	36.50%	0.130
Surgical site infection	12.50%	20.50%	17.50%	0.572
Tissue edema	20.80%	20.90%	14.30%	0.487
Tissue fibrosis	54.20%	42.40%	34.90%	0.249
Total/partial flap loss	41.70%	25.30%	30.20%	0.184
Wound dehiscence	37.50%	53.90%	50.80%	0.292

availability of the thoracodorsal vessels as a nonirradiated option even in patients with a history of chest wall radiation. Perhaps this relative lack of concern for the donor vessels is justified, as the flap loss rate remains low even in the radiation setting.<sup>16</sup> Interestingly, the most common concerns included mastectomy flap necrosis, wound dehiscence, and, in the setting of implant-based procedures, severe capsular contracture (Table 5). All three of these were particularly common among implant reconstruction, emphasizing the importance of the growing body of evidence for fat grafting, deferoxamine, and other HIF1 $\alpha$  pathway modulators<sup>17</sup> and mastectomy flap perfusion assessment in shaping the future of breast reconstruction.<sup>18–20</sup> Future research may shift the current trends for autologous reconstruction in favor of less-invasive implant-based procedures if implants are modified to address these common concerns.

#### Unknown PMRT

It is not uncommon for surgeons to consider PMRT a relative contraindication to immediate reconstruction due to higher complication rates.<sup>21,22</sup> In fact, the deleterious effects of PMRT are believed to be even greater than that of prereconstruction radiation. To that end, many promote delaying reconstruction until after PMRT or at most placing of a temporary tissue expander to control the skin envelope until later definitive reconstruction in a “delayed-immediate” fashion.<sup>23</sup> These both minimize the risk of delays or interferences in the delivery of radiation<sup>24</sup> and effectively convert a patient at risk for postreconstruction irradiation into one with a history of prereconstruction radiation. Nonetheless, recent evidence has pushed back against this dogma, suggesting that immediate reconstruction does not result in clinically significant delays in radiotherapy<sup>25</sup> and carries reasonable success rates, particularly in autologous procedures.<sup>26,27</sup>

Not surprisingly, there was very little consensus with regard to the preferred timing of reconstruction in the setting of unknown postoperative radiation. Half of our respondents opposed delaying reconstruction, whereas only 18% preferred it as their first line. This echoes previous findings that the proportion of patients undergoing immediate reconstruction in the setting of possible PMRT is rising,<sup>28,29</sup> contrary to the evidence suggesting increased complication rates. The reality of delayed reconstruction is that for many women, the absence of their breasts results in significant short-term distress with regard to their psychosocial and sexual well-being.<sup>26</sup> Even if it comes with an increased complication rate,<sup>30</sup> having some sort of breast reconstruction, even a tissue expander, goes a long way during an already emotionally taxing period of cancer treatment. Logistically, delayed reconstruction also often necessitates an additional operative procedure and may require a longer and more difficult period of tissue expansion, particularly for women who prefer implant-based reconstruction. With only about a third of patients requiring radiation based on regional lymph node involvement,<sup>31,32</sup> the downsides of delaying reconstruction in all patients seem to outweigh the benefits for most plastic surgeons. At some centers, a sentinel lymph node biopsy is performed 2–3 weeks prior to mastectomy to eliminate the uncertainty surrounding PMRT.<sup>33</sup> Whether this would change management in patients who indeed require PMRT is an interesting question for future research.

Nearly 90% of surgeons who preferred delaying reconstruction in the setting of unknown radiation would elect for an autologous procedure. Of those, 75% prefer a single-stage pure autologous procedure, whereas 12% would perform a combined implant-autologous procedure (eg, latissimus flap), and 13% would elect for prior tissue expansion. Only about 10% of surgeons would

opt for delayed implant-based procedures in the setting of possible PMRT, further highlighting the need for future research to improve the safety of delayed implant reconstruction.

Another 40% of respondents each preferred delayed-immediate or immediate reconstruction in the setting of unknown PMRT. When choosing the procedure for immediate reconstruction in the setting of questionable radiation, there is conflicting evidence as to whether autologous or implant-based procedures would be preferred. Several studies have evaluated the outcomes of immediate autologous and implant-based reconstruction in women who need PMRT.<sup>34–36</sup> Although fat necrosis and fibrosis rates are elevated in autologous reconstructions that are radiated,<sup>12,37</sup> a recent analysis of the Mastectomy Reconstruction Outcome Consortium registry demonstrated significantly fewer complications and improved quality of life outcomes with immediate autologous reconstruction compared with implant-based procedures in the setting of PMRT at 1-year.<sup>34</sup> In our series, 53% of respondents who preferred immediate reconstruction in the setting of unknown PMRT reported a preference for implant-based techniques. Although still the majority, this is lower than the expected rate of immediate implant-based reconstruction<sup>38</sup> and likely a testament to the potential benefit of autologous reconstruction in this setting.

Kronowitz introduced the delayed-immediate concept to achieve aesthetic outcomes similar to immediate reconstruction in those who do not require PMRT while avoiding concerns regarding radiation-delivery and final cosmetic outcomes in those who do.<sup>23</sup> The tissue expander may be exchanged for definitive reconstruction within a couple of weeks if skin flaps are adequate or they can remain until more skin is recruited. Respondents were nearly split in their preference for exchange to autologous versus implant with a delayed-immediate approach and the ultimate decision is likely to depend on the final determination regarding PMRT, the quality of the healing mastectomy skin flaps, and patient preference.

Ultimately, the lack of consensus regarding both timing and technique of reconstruction in the setting of unknown postoperative radiation reflects the disparate literature on the topic.

### Timing of Stage 2 Reconstruction

Among surgeons performing delayed-immediate reconstruction, there is a paucity of data that investigates the optimal timing between PMRT and tissue expander exchange for definitive autologous or implant-based reconstruction. Anecdotally, most reconstructive surgeons prefer to delay reconstruction many months after radiation to allow the local inflammatory process to subside and theoretically decrease the risk of complications. Particularly in the setting of microvascular reconstruction, a 12-month or greater delay is believed by some to allow the internal mammary recipient vessels to “settle,” decreasing the risk of anastomotic thrombosis and reconstructive failure.<sup>15</sup> One of the earliest studies attempting to address this question found a greater rate of major complications, including flap loss and early reoperation,

in those undergoing reconstruction 12 months or less after radiation.<sup>39,40</sup> Several studies since then, however, have failed to identify any significant differences in patient outcomes using cutoffs of 12 months or even 6 months between radiation and autologous reconstruction.<sup>41,42</sup> Due to the paucity of data, the optimal time remains uncertain. Clinical practice, however, seems to favor shorter intervals between radiation and reconstruction (Table 4).

There is a similar dearth of information to guide the optimal timing between the completion of radiation and expander to implant exchange. Unlike autologous reconstruction, the primary concerns with implant-based techniques relate to the fibrosis of the breast skin flaps with subsequent risk of poor wound healing, implant exposure, infection, and reconstructive failure. Many surgeons assess the readiness for definitive implant placement by visual inspection of the skin. However, histologic changes in inflammation, elastin organization, and vascularity of the tissues do not correlate to visual improvements in skin quality, and instead remain abnormal for longer than 12 months following radiation.<sup>40</sup> Again, in our series, most surgeons preferred to wait between 4 and 6 months (41.1%) or between 7 and 12 months (36%).

Interestingly there were no significant differences in the concerns regarding the effects of radiation on the reconstruction across any of the time groups for both autologous and implant-based reconstruction (Table 6).

## LIMITATIONS

There are several limitations to bear in mind when interpreting the results of this study. Although our response rate is low, the ASPS is a diverse group of surgeons, many of whom do not routinely perform breast reconstruction (See table 3, Supplemental Digital Content 4, which shows a nonresponder analysis performed for validation of survey data, <http://links.lww.com/PRSGO/C403>). We believe that our survey self-selected for surgeons familiar with the relevant procedures, and we therefore captured much more than 10% of this smaller subset of the ASPS membership. Although our survey includes plastic surgeons from a variety of practice backgrounds (Tables 1 and 2), it is possible that limiting ourselves to the ASPS membership excludes a population of nonacademic plastic surgeons and may overstate the preference of autologous reconstruction. The survey was also presented in English and may have limited responses to surgeons who are fluent in English. In addition, use of acellular dermal matrix in breast reconstruction has been widely reported. This survey did not capture information regarding the use of ADM, which could impact clinical decision-making. Furthermore, this is a subjective study of surgeon’s opinion and does not guarantee that the responses correlate with actual clinical practice. Finally, the nature of this survey allows us to glean insight into the current landscape of clinical practice among breast reconstructive surgeons. However, it does not speak to the superiority or inferiority of one technique compared with another. We

can identify areas that lack consensus among our respondents, but additional research will be necessary to guide us forward in their resolution.

## CONCLUSIONS

Autologous reconstruction seems to be gaining popularity in the setting of perioperative radiation treatment when examining surgeon preference in respect to their years in practice. Most surgeons prefer to wait 3–6 or 7–12 months after radiation treatment to perform the second stage of reconstruction. The ideal timing and type of reconstruction in the setting of perioperative radiation treatment are not well established despite years of research. Critical analysis of current literature and targeted future studies are likely necessary to establish a better evidence-based guideline for patient care.

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