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Current Trends in Prepectoral Breast Reconstruction: A Survey of American Society of Plastic Surgeons Members

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Background: Prepectoral implant-based breast reconstruction has recently gained increasing popularity, but there are limited data regarding national trends in the use of this technique. Our aim was to determine practice patterns related to prepectoral breast reconstruction among plastic surgeons, as well as to identify perceived advantages and disadvantages of this technique.

Methods: A 16-question electronic survey tool was distributed to 2535 members of the American Society of Plastic Surgeons. Survey items focused on surgeon practices related to prepectoral reconstruction, in addition to their motivations for and concerns with performing the procedure.

Results: A total of 274 responses were received (10.8% response rate). Nearly half of respondents (48.4%) reported using prepectoral techniques in all or most of their procedures. Decreased animation deformity was identified as the most significant advantage by 76.3% of respondents. Increased rippling and potential wound healing complications were identified as the most significant disadvantages to the procedure by 49.1% and 40.4% of respondents, respectively. The majority of surgeons reported using acellular dermal matrices in their procedures, with most surgeons demonstrating preferences for cohesive and shaped devices.

Conclusions: Prepectoral breast reconstruction is being widely adopted by plastic surgeons, with the majority of surgeons in our sample using prepectoral techniques in their practices. Responses demonstrate that this technique offers several perceived advantages, most notably the avoidance of animation deformity. However, our data also highlight that there are still many unanswered questions in the community about the complication profile and technical aspects of prepectoral techniques that warrant further investigation. *(Plast Reconstr Surg Glob Open 2020;8:e3060; doi: 10.1097/GOX.0000000000003060; Published online 19 August 2020.)*

INTRODUCTION

More than 80% of the 100,000 breast reconstruction procedures performed annually in the United States are implant based, with implant use increasing by an average of 11% per year.[1,2] The ideal plane for implant placement has been debated since the inception of alloplastic breast reconstruction. Early efforts with prepectoral reconstruction were largely abandoned in the 1980s due to high rates of implant extrusion, infection, and capsular contracture.[3] Subpectoral reconstruction techniques subsequently became the standard of care,[4] although long-term data have revealed several disadvantages, including discomfort, pain,[5] and animation deformity.[6,7] Trends toward less-invasive oncologic resection techniques, use of acellular dermal matrix (ADM), advances in expander technology, and use of adjunctive fat grafting have diminished many of the concerns about inadequate soft-tissue coverage that plagued

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early prepectoral efforts.[8] Collectively, these advances have revived prepectoral reconstruction as a viable option, with the topic gaining significant attention in the literature and discussion forums.

Although the pendulum appears to be swinging toward increased interest in prepectoral reconstruction, there are limited data regarding the current national trends on the use of this technique. Furthermore, perceptions among practicing plastic surgeons regarding the advantages and disadvantages of this approach are not well understood. This study aimed to determine practice patterns related to prepectoral breast reconstruction, as well as to identify surgeons' motivations for including or excluding this technique in their practices. By elucidating the attitudes toward prepectoral reconstruction, we hoped to identify areas for further study to improve patient outcomes and reduce complications associated with this technique.

METHODS

A 16-question voluntary electronic survey was distributed to 2535 members of the American Society of Plastic Surgeons (ASPS). The survey was designed in conjunction with the University of Wisconsin Survey Center, and all questions were reviewed by the ASPS before distribution. The survey was administered using the online tool Survey Monkey (www.surveymonkey.com). Survey items focused on surgeon practices related to prepectoral reconstruction, in addition to motivations for and concerns with performing the procedure (**see appendix, Supplemental Digital Content 1,** which shows the survey items included in the questionnaire, **http://links.lww.com/PRSGO/B454**). Two email reminders were sent 2 weeks apart after initial distribution of the survey. Recipients were given 6 weeks to complete the survey. All responses remained anonymous.

The collected responses were fed into and analyzed with Microsoft Excel. Free-text responses were manually coded using inductive coding and organized into a flat code frame. Accuracy of coding was verified using a test–retest method. Statistical analysis was performed using SAS 9.4. A Fischer exact test was used to compare trends in response data for each question, with $P < 0.05$ indicating statistical significance.

RESULTS

Survey Response

A total of 274 responses were received (10.8% response rate). This response rate is consistent with that of previous surveys distributed by the ASPS (**see table, Supplemental Digital Content 2,** which displays nonresponder analysis and justification statement, http://links.lww.com/PRSGO/B455).[9,10] Demographic data are demonstrated in Table 1. The majority of respondents had been in practice for at least 10 years (72.9%), with 42.6% in practice for >20 years. Similarly, most surgeons were in solo or group practice (77.4%), with only 15.7% in academic practice. Of those analyzed, 185 surgeons (74.5%) indicated that reconstructive surgery constituted at least 50% of their practice, whereas 113 surgeons (45.6%) indicated that it accounted for at least 75% of their practice.

Table 1. Demographic Characteristics of Survey Respondents

	No. (%)
How many years have you been in practice?	
<5	33 (13.3)
5–9	34 (13.7)
10–14	42 (16.9)
15–19	34 (13.7)
20–24	38 (15.3)
≥25	67 (27.0)
Which best describes your practice type?	
Solo practice	89 (35.9)
Solo practice-shared facility	11 (4.4)
Small plastic surgery group practice (2–5 plastic surgeons)	54 (21.8)
Large plastic surgery group practice (≥6 plastic surgeons)	11 (4.4)
Medium multispecialty group practice (6–20 physicians)	3 (1.2)
Large multispecialty group practice (>20 physicians)	24 (9.7)
Academic practice	37 (14.9)
Academic practice (salaried with private practice)	2 (0.8)
Military	1 (0.4)
Employed physician	16 (6.5)
Practice in terms of time spent?	
100% reconstructive	29 (11.7)
25% cosmetic and 75% reconstructive	84 (33.9)
50% cosmetic and 50% reconstructive	72 (29.0)
75% cosmetic and 25% reconstructive	41 (16.5)
100% cosmetic	22 (8.9)

Prevalence of Prepectoral Reconstruction

There were 247 surgeons in our sample (90.2%) who reported performing breast reconstruction within the past year. On average, participants reported performing 57 procedures per year. The majority of providers (82.6%) reported performing alloplastic reconstruction "all" or "most" of the time, which reflected national trends. Of the 247 respondents with experience in breast reconstruction, 187 surgeons (75.7%) had performed prepectoral reconstruction in their practice. Almost half of respondents (48.4%) with previous experience in prepectoral reconstruction reported performing "all" or "most" of their reconstructions using a prepectoral technique, whereas 24.5% reported performing "few" or "none" of their reconstructive procedures with this technique. The likelihood of having performed a prepectoral reconstruction was significantly associated with years of experience in practice ($P = 0.0109$). Surgeons with <15 years in practice were more likely to adopt prepectoral techniques (91 respondents, 87%) when compared with surgeons with >15 years of experience (81 respondents, 69%). Additionally, surgeons with fewer than 15 years in practice were more likely to perform "all" or "most" of their breast reconstruction procedures using a prepectoral technique (47 respondents, 43%) than surgeons with >15 years in practice (35 respondents, 25%). Similarly, surgeons whose practices consisted of at least 50% reconstructive procedures were more likely to perform prepectoral reconstruction than surgeons with a predominantly cosmetic practice (83.5% versus 66.7%), and were more likely to perform "all" or "most" of their breast reconstruction procedures

with prepectoral techniques ($P = 0.0140$). The likelihood of having performed prepectoral reconstruction was not significantly associated with practice setting ($P = 0.1471$), but performing "all" or "most" procedures with prepectoral techniques was more likely for surgeons in solo or group practice ($P = 0.0307$).

Surgeon Motivations for Prepectoral Reconstruction

The sample of 187 surgeons with previous experience in prepectoral reconstruction were asked to identify the factors that contributed to their decision to perform this technique. Figure 1 illustrates the Likert-scaled responses for the following factors: decreased acute pain, decreased chronic pain, decreased animation deformity, improved cosmetic outcomes, and improved control of breast shape. Decreased animation deformity was selected as an "important" or "extremely important" factor in the decision to perform prepectoral reconstruction by 76.3% of respondents. This trend was even more pronounced in subgroup analysis of those surgeons who perform "all" or "most" of their reconstructions with prepectoral techniques, with 94.3% of respondents selecting decreased animation deformity as an "important" or "extremely important" factor. The prevention of pain was also a significant factor, with 50.3% and 54.7% of respondents citing alleviation of acute and chronic pain, respectively, as "important" or "extremely important" factors. Similarly, improved cosmesis and control of breast shape were selected as "important" or "extremely important" factors by 52.5% and 50.3% of respondents, respectively.

Surgeons were also invited to describe other factors that influenced their decision to perform prepectoral reconstruction. Sixty-eight free-text responses were analyzed (Fig. 2). The most frequently cited reasons for choosing to perform prepectoral reconstruction related to improved outcomes in the setting of radiation (20.6%), the technical ease of the reconstruction (16.2%), and improved outcomes in patients with high athletic demand (14.7%).

Surgeon Concerns with Prepectoral Reconstruction

All respondents, regardless of previous experience with prepectoral reconstruction, were asked about their concerns with the procedure. Figure 3 illustrates the Likert-scaled responses for the following concerns: lack of long-term data, difficulty in detecting cancer recurrence, induced changes in the radiation field, increased duration of surgical drains, increased cost, increased wound healing complications, and increased rippling. Among response choices, 49.1% of respondents reported that they were "very" or "extremely" concerned about increased rippling with this technique. Additionally, 40.4% of respondents indicated that they were "very" or "extremely" concerned with an increased potential for wound healing complications. The level of concern with rippling or wound healing was not found to be significantly

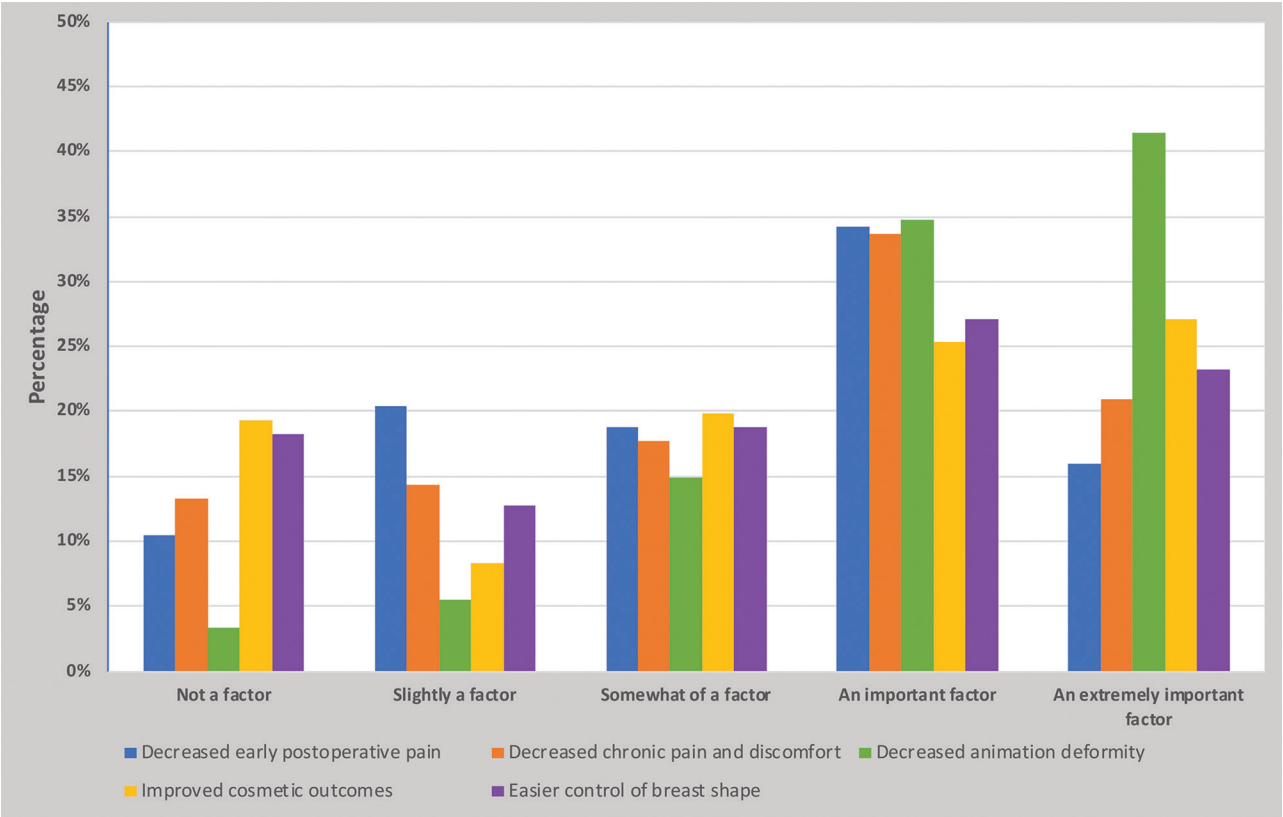

Fig. 1. Motivating factors for performing prepectoral reconstruction, as indicated by survey respondents. Each factor was scored by Likert-scaled responses. Decreased animation deformity was identified as an "important" or "extremely important" factor by 76.3% of respondents, more than any other factor.

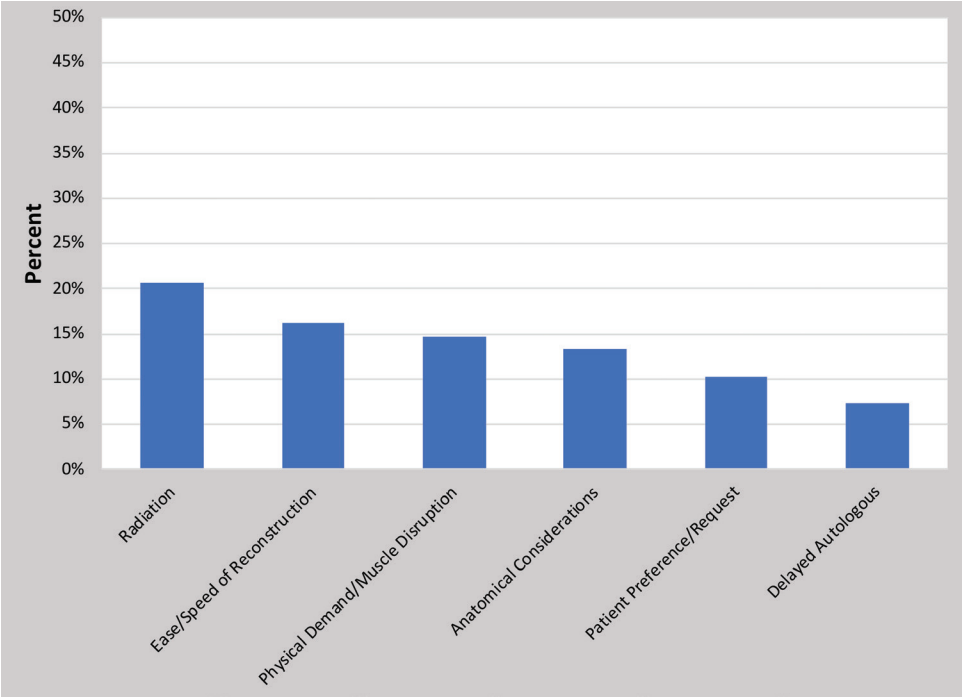

Fig. 2. Percentage of respondents identifying additional free-text indications for performing prepectoral breast reconstruction. Improved outcomes in the setting of radiation (20.6%), technical ease of the reconstruction (16.2%), and improved outcomes in patients with high physical demand (14.7%) were among the most frequently cited indications.

associated with demographic differences in practice type or setting. However, subgroup analysis was performed to analyze leading concerns among those respondents performing "few" or "none" of their reconstruction procedures with prepectoral techniques. Among this cohort of 45 surgeons, rippling and wound healing complications remained the leading concerns, with 65% and 58.5% of respondents, respectively, indicating that they were "very" or "extremely" concerned. The majority (53.7%) of respondents in this cohort also identified a lack of long-term data regarding the procedure as a significant concern. Alternatively, a subgroup analysis of 32 surgeons performing the highest volume of prepectoral reconstructions demonstrated that rippling and wound healing complications were less of a concern, with 28% and 9% of respondents in this group indicating that they were "very" or "extremely" concerned with these complications, respectively.

Participants were also given the opportunity to voice additional concerns in free-text format. Seventy-five free-text responses were analyzed (Fig. 4). The most common responses related to insufficient mastectomy flap thickness and viability (18.7%) and/or the need for additional fat grafting (18.7%). Similarly, concerns regarding increased rates of infection (9.3%), malposition and longevity of the reconstruction (9.3%), capsular contracture (8%), poor cosmesis (8%), seroma (6.7%), and radiation (6.7%) were frequently expressed.

Techniques for Prepectoral Reconstruction

Technical preferences related to prepectoral breast reconstruction were also assessed and are demonstrated in Table 2. The vast majority of surgeons who performed prepectoral reconstruction covered the expander or implant with human ADM (162 respondents, 92.6%), whereas 8 surgeons (4.6%) reported using no mesh or ADM in their reconstruction. When performing prepectoral reconstruction, 29.1% of respondents preferentially selected a specific type of prosthesis. Surgeon device preferences are illustrated in Table 3. For implant selection, 21.6% preferred cohesive implants, 27.5% preferred shaped implants, and 15.7% preferred round implants. Surgeons reported that they perform these reconstructions most frequently in a 2-stage fashion (100 respondents, 57.2%), as opposed to direct to implant (47 respondents, 26.9%).

DISCUSSION

This study demonstrates that prepectoral breast reconstruction techniques are experiencing a resurgence, with 76% of surgeons in our sample reporting that they have performed the technique. The plurality of respondents in our sample preferred prepectoral to submuscular reconstruction, with 48.4% of respondents using prepectoral techniques in all or most of their cases, as opposed to 29.9% who performed few or none. Although prepectoral reconstruction has recently been a leading topic of discussion in the literature, this survey reveals its attractiveness to a large and diverse group of practicing plastic surgeons. The survey data illustrate various perceived benefits of prepectoral reconstruction that have likely contributed to its rising popularity. However, it also highlights a myriad of existing concerns related to the procedure.

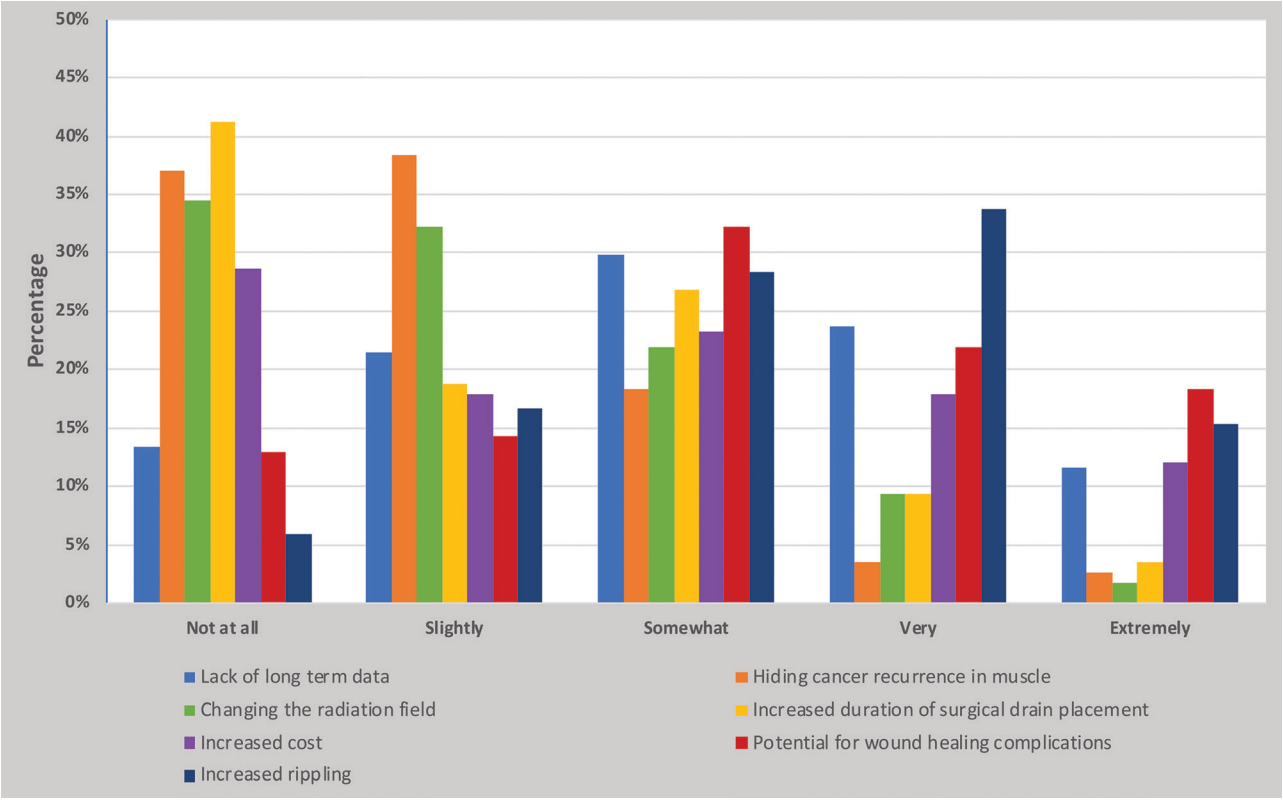

Fig. 3. Level of concern regarding the potential drawbacks of prepectoral breast reconstruction, as indicated by survey respondents. Responses are scored using the Likert scale. Implant rippling and the potential for wound healing complications were the leading concerns among respondents, with 49.1% and 40.4% of respondents, respectively, indicating that they were "very" or "extremely" concerned about these factors.

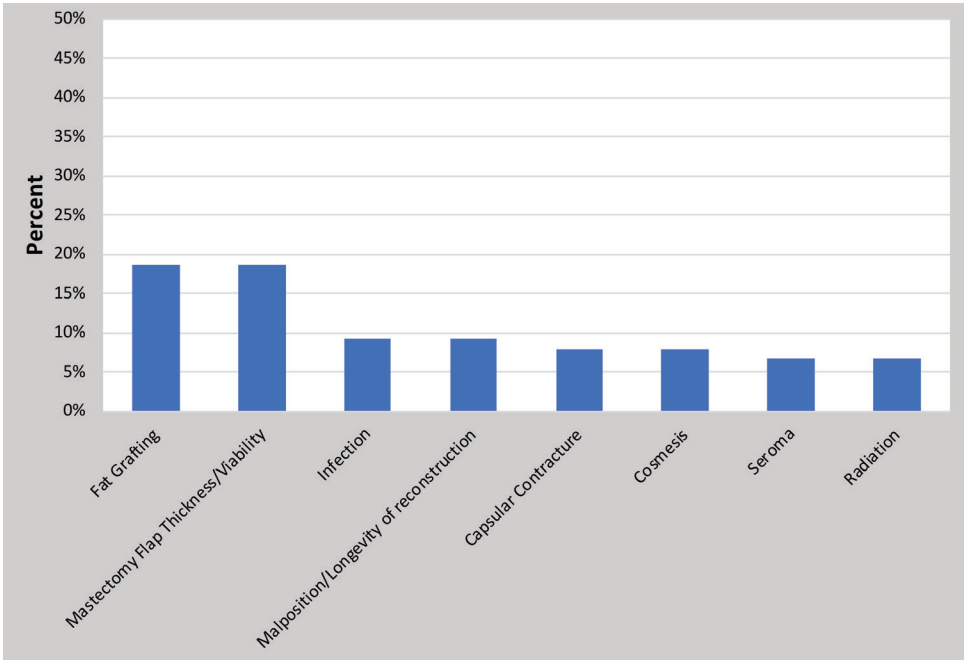

Fig. 4. Percentage of respondents identifying additional concerns related to prepectoral breast reconstruction. Concerns related to mastectomy flap thickness and viability (18.7%) and the need for additional fat grafting (18.7%) were the most commonly expressed.

Table 2. Survey Respondent Technical Preferences in Prepectoral Breast Reconstruction

	No. (%)
Coverage of implant or expander	
Acellular human dermal matrix	162 (92.6)
Acellular bovine or porcine dermal matrix	2 (1.1)
Absorbable synthetic mesh	2 (1.1)
Permanent synthetic mesh	0 (0)
Some other mesh*	9 (5.1)
Staging of reconstruction	
Always direct to implant	15 (8.6)
Mostly direct to implant	32 (18.3)
Both direct-to-implant and 2 stage	28 (16.0)
Mostly 2 stage	53 (30.3)
Always 2 stage	47 (26.9)
Implant or expander type/style preference	
No	124 (70.9)
Yes	51 (29.1)

*Eight of 9 respondents reported using no ADM or mesh for coverage of the implant or expander.

Table 3. Survey Respondent Prosthetic Device Preferences in Prepectoral Breast Reconstruction

	No. (%)
Implant	
Smooth	8 (15.7)
Textured	14 (27.5)
Round	8 (15.7)
Shaped	14 (27.5)
Cohesive	11 (21.6)
Saline	2 (3.9)
Adjustable	2 (3.9)
Expander	
Smooth	7 (13.7)
Textured	2 (3.9)
Round	1 (2.0)
Shaped	14 (27.5)
Tall	3 (5.9)
Integrated drain	5 (9.8)
Tabbed	3 (5.9)
Aeroform	1 (2.0)
Air filled	1 (2.0)

The majority of respondents in our survey indicated that prevention of animation deformity is the most significant advantage of prepectoral techniques. Overall, decreased animation deformity was selected as an "important" or "extremely important" factor in the decision to perform prepectoral reconstruction by 138 respondents (76.3%). This effect was even more pronounced in those surgeons who performed "all" or "most" of their reconstructions with prepectoral techniques, with 94.3% of respondents indicating that this was an important motivation in their own practices. Animation deformity has traditionally been a frustrating problem to address, with previous solutions often proving ineffective or resulting in compromised muscle function.[11–13] Adoption of prepectoral techniques eliminates the possibility for this complication. Similarly, an additional 14.7% of respondents indicated in their free-text responses that they would consider prepectoral reconstruction in athletic patients for whom muscle function is paramount. Submuscular dissection results in functional deficits in muscle strength and shoulder stability, although the clinical significance of these deficits is debated.[14–16] Although activities of daily living may not be affected in most patients, avoiding muscular dissection could benefit high-performance athletes or those patients for whom further loss of muscle function could be detrimental.

More than half of respondents classified all of the other potential advantages (ie, decreased early or chronic pain, improved cosmesis, and easier control of breast shape) as "important" and "very important" factors for choosing prepectoral reconstruction. Recent reports have associated prepectoral reconstruction with improved pain scores and decreased analgesic requirements, and this assertion was supported by study participants.[17–19] Cosmetic outcomes of prepectoral reconstruction, although difficult to evaluate objectively, were also felt to be superior to outcomes of submuscular reconstruction by a majority of survey respondents. Participants cited factors such as "improved cleavage" and "more natural breast position" as significant considerations for choosing prepectoral reconstruction. Previously reported surgeon assessments of cosmetic outcomes have supported these claims,[20] and patient-reported outcome data, while limited, suggest comparable or improved satisfaction with outcomes.[19,21,22] Free-text response data from survey participants also emphasized other factors driving the decision to offer prepectoral breast reconstruction, with the most common indication being prior or planned radiation (20.6%). Radiation is known to cause fibrosis and contraction of the pectoralis major muscle and is a known risk factor for implant malposition and reconstructive failure in implant-based reconstruction.[23] Prepectoral implant placement has been shown to have similar overall morbidity to submuscular reconstruction in the setting of postmastectomy radiation,[24,25] but with possibly decreased capsular contracture and less pain.[26] Prepectoral reconstruction bypasses the scarred radiated muscle, which is much more likely to contract than the overlying skin.

The literature is conflicted on the complication rates for prepectoral reconstruction, and our study highlighted several of the concerns that are frequently mentioned when criticizing this technique. Although many articles are reporting close to zero failure rate, others are reporting significant rates of complications.[5,27–30] Overall, 40.4% of respondents reported being "very" or "extremely" concerned about the possibility for wound healing complications in their prepectoral reconstruction cases. Open response data from the survey similarly echoed these concerns, with providers citing mastectomy flap necrosis, seroma, and infection as barriers to using this technique. Similarly, 49.1% of respondents reported that they were "very" or "extremely" concerned about increased rippling with prepectoral techniques. Many respondents mentioned the frequent need for fat grafting to decrease rippling, which is routinely described in the literature.[5,31,32] The existing patient-reported outcome data further substantiate these concerns, with greater dissatisfaction related to rippling in prepectoral reconstructions.[22] Although Nahabedian[32] suggests that prepectoral reconstruction can be performed safely with thin flaps, it is unclear if cosmetic outcomes, rippling, and long-term durability will be affected in those cases. The prevalence of these concerns raises the question if a minimum flap thickness is required when performing prepectoral

reconstruction, and the importance of coordinating reconstructive efforts with an oncologically safe operation.

When queried about additional barriers to performing this technique, respondents were less concerned about cancer surveillance and changes in the radiation field. This finding is unsurprising, as cancer recurrence typically occurs in the subcutaneous tissue of the breast, with survival rates unaffected by the plane of reconstruction.[33–35] However, there was significant concern among study participants about increased cost, particularly as it relates to the use of ADM and the need for additional fat grafting procedures. In our study, the vast majority of respondents (92.6%) reported using human ADM when performing prepectoral reconstruction, despite the fact that high-quality data regarding ADM use in prepectoral reconstruction are limited.[36] Several study participants also cited the increased cost generated by additional fat grafting procedures as a significant limiting factor to adopting this technique. Further studies will be required to reach consensus on the overall cost-effectiveness for this technique as these data are currently lacking in the literature. However, some early studies have indicated that prepectoral reconstruction might actually be more cost-effective than subpectoral reconstruction, particularly with regard to shorter hospital length of stay, operative costs, and analgesic requirements.[37]

A noteworthy 29% of respondents have changed their choice of device specifically for use in prepectoral reconstruction, possibly signifying a learning curve associated with the procedure. The use of cohesive devices was frequently endorsed, likely to improve rippling. A slight predisposition for shaped implants was also seen. The popularity of shaped devices in this specific procedure is expected, as the shape of the breast in prepectoral reconstruction is dictated by the implant to a large extent. This is in contrast to submuscular implant placement, where the pectoralis muscle will convey an anatomical shape to a round device. However, it should be noted that the survey data were collected before the withdrawal of certain textured implant devices from the market and the increased attention to their association with breast implant-associated anaplastic large cell lymphoma. Surgeons in our sample also frequently performed prepectoral reconstruction using human ADM for device coverage. A small proportion of respondents alternatively endorsed performing their reconstruction procedures without the use of mesh. However, given historical experience with purely subcutaneous breast reconstructions, the ability to exclude mesh is likely dependent on the thickness and viability of the available mastectomy flaps. Most respondents also preferred a 2-stage reconstruction to a direct-to-implant reconstruction. With the changing Food and Drug Administration recommendation for implants and ADM, and the rising concern about breast implant-associated anaplastic large cell lymphoma. and breast implant illness, these practice patterns may be significantly affected.

As in any survey, our results are subject to sampling bias and recall bias. The effects of sampling bias were minimized through random distribution of the survey by the ASPS, which reviews cohort characteristics to ensure a representative sampling of its membership. Recall bias was minimized by providing an explicit, limited reference period for all survey questions. The 12-month reference period was intended to provide adequate time to capture surgeon practices while avoiding inaccurate recall of procedures. Our response rate was comparable to other surveys targeting ASPS members.[9,10] The biggest strength of this work is that it captured a large and diverse group of surgeons from different practice types and different experience, rather than relying on single-center or single-author experiences. Request for additional commentary yielded an additional 55 free-text responses, with a nearly even distribution among negative, positive, and neutral responses. The strongest proponents of the technique feel that "[prepectoral breast reconstruction] has transformed [their] approach to implant-based reconstruction," citing outcomes that are "vastly improved over subpectoral approaches." Alternatively, critics of the procedure describe it as the "wrong choice in most patients," a "profit-driven push for decades-old proven poor results," and "prone to early complications."

CONCLUSIONS

This survey demonstrates that prepectoral breast reconstruction is being widely adopted in the plastic surgery community. Surgeons are finding that prepectoral implant placement offers various unique advantages over submuscular approaches, and this has contributed to the increasing use of this technique. Despite the perceived benefits, our data show that rippling, wound healing complications, and costs are still significant disadvantages. Additionally, there are many questions yet to be answered regarding indications, technique, and choice of implants/biologic materials for successful use of this technique. As with any swing of the pendulum, careful consideration of well-designed research studies will be paramount to our understanding of the risks and benefits of this surgical approach. As noted by one of our respondents: "This should be a focus of [research] efforts, since its use is expanding so rapidly—we need data on patient satisfaction, complication rates and costs" before routinely offering this procedure to patients.

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