

# Postmastectomy Radiation Therapy and Breast Reconstruction

## *An Analysis of Complications and Patient Satisfaction*

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**Abstract:** The indications for postmastectomy radiotherapy (PMRT) have expanded over the past decade. This study examines PMRT and reconstruction compared with a control group without radiotherapy. There were 919 reconstructed breasts identified (1999–2006) and separated into 3 groups: mastectomy with PMRT before reconstruction ( $n = 57$ ), immediate reconstruction then PMRT ( $n = 59$ ), and reconstruction without PMRT ( $n = 665$ ). A validated questionnaire assessed patient satisfaction (response rate 73.7%). Overall complication rates for patients undergoing PMRT (before and after reconstruction) were higher than that of the controls (39.66% vs. 23.16%,  $P < 0.001$ ). Immediate reconstruction before PMRT had increased overall and late ( $>90$  days) complication rates, compared with controls (47.46% vs. 23.16%,  $P < 0.001$ ; 33.90% vs. 15.59%,  $P < 0.001$ , respectively); however general and aesthetic satisfaction was similar. In contrast, PMRT before reconstruction has similar complication rates and general satisfaction with controls, but decreased aesthetic satisfaction (50% vs. 66.88%,  $P < 0.035$ ).

**Key Words:** breast reconstruction, mastectomy, breast cancer, radiation therapy

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The use of postmastectomy radiation therapy (PMRT) to prevent locoregional failure and improve overall breast cancer-specific survival has expanded over the past decade.<sup>1,2</sup> This poses a dilemma for the reconstructive surgeon as to the timing of mastectomy, reconstruction, and PMRT.

Early recommendations were to delay breast reconstruction until after PMRT to reduce the risk of complications and poor cosmetic outcomes.<sup>3–10</sup> However, some investigators have advocated using a delayed-immediate approach to reconstruction, placing a temporary tissue expander before definitive reconstruction.<sup>11,12</sup> Other centers have shifted to perform immediate reconstruction followed by PMRT, accepting the potential risks to accommodate patients' desire for an immediate reconstruction.<sup>13–15</sup>

Deciding between these 2 options is limited by the lack of data on the timing and incidence of different types of complications, particularly in relation to the sequencing of PMRT and reconstruc-

tion. Certain complications after surgery (such as infections and wound healing problems) may occur predominantly in the early postoperative period (within a few months of surgery), but the effects from radiation therapy may extend into the late postoperative period (months or even years later).<sup>4–7</sup> The early and late postoperative time frames can manifest different types of complications. Such late complications may include capsular contracture in implants or fat necrosis in autologous flaps.

Another obstacle to decide the best sequence of PMRT and reconstruction is inadequate information about how patients view the results of treatment. Patient satisfaction has become an essential tool for evaluating reconstructive outcomes while providing another metric for evidence-based practice.<sup>16–19</sup> As patients become more involved with their medical decision-making process, their satisfaction with the general reconstructive experience and their aesthetic result are both extremely important. It is critical that patients understand the consequences of their medical decisions, especially in a complex field such as breast reconstruction with a multitude of procedures and treatment options. Adding to this confusion is the effect of PMRT and its proper timing and sequence; this is not well understood even among reconstructive surgeons.

Therefore, the purpose of this study is to analyze complication risks and reported satisfaction in patients who undergo PMRT and reconstruction in relation to whether PMRT was given before or after reconstruction and to compare their results to a control group of patients who had reconstruction without PMRT.

## METHODS AND MATERIALS

### Patient Population

All women who underwent breast reconstruction at the Beth Israel Deaconess Medical Center, Boston between January 1999 and December 2006 were identified through the operating room case logs. Only simple and modified radical mastectomies were included; women who had partial mastectomy, subtotal mastectomy, radical salvage mastectomy, or reconstruction for micromastia or Poland syndrome were excluded. There were 707 women who underwent 919 breast reconstructions during the study period. Patients having previous radiation therapy for failed breast conservation therapy, Hodgkin disease, or lymphoma were excluded. In addition, patients that had a planned delayed-immediate reconstruction (mastectomy and tissue expander followed by PMRT and then definitive autologous reconstruction) were excluded ( $n = 5$ ). Patients undergoing revisions of reconstructions initially performed elsewhere were also excluded.

The reconstructed breasts were then separated into 3 groups. The first group had PMRT before breast reconstruction ( $n = 57$ ). The second group had immediate reconstruction followed by PMRT ( $n = 59$ ). The third group (control group) had breast reconstruction, but no PMRT ( $n = 665$ ).

Data was gathered from a retrospective review of online medical records, office charts, and inpatient hospital records. Patient demographics are presented in Table 1. Seven surgeons performed breast reconstruction during the study period, and the type of reconstruction was chosen after informed discussion with the pa-

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**TABLE 1.** Patient Demographics

	PMRT Then Reconstruction (n = 57)		Reconstruction Then PMRT (n = 59)		Reconstruction Only No PMRT (n = 665)		P
	n	%	n	%	n	%	
Reconstruction type							
Autologous	43	75.44	36	61.02	371	55.79	0.004
Autologous + implant	13	22.81	10	16.95	139	20.90	
Implant	1	1.75	13	22.03	155	23.31	
Timing							
Immediate	7	12.28	59	100	564	84.81	<0.001
Delayed	50	87.72	—	—	101	15.19	
Laterality*							
Unilateral	44	77.19	44	74.58	332	62.41	0.022
Bilateral	13*	22.81	15*	25.42	200†	37.59	
Reason for mastectomy							
Cancer	57	100.00	59	100.00	494	74.29	<0.001
Prophylaxis	—	—	—	—	171	25.71	
Age at reconstruction							
Younger than 40	8	14.04	15	25.42	115	17.29	0.591
40–49	31	54.39	25	42.37	305	45.86	
50–59	15	26.32	14	23.73	192	28.87	
60+	3	5.26	5	8.47	53	7.97	

PMRT indicates postmastectomy radiotherapy.

\*One breast had PMRT, and the other breast did not.

†Sixty-seven breasts in the bilateral category had no radiation of one breast and either breast conservation therapy or PMRT of the other breast. These were included for complication data, but not satisfaction.

tient. Reconstructions were grouped into 3 categories: autologous, autologous with implant, and tissue expander/implant. Autologous reconstruction included latissimus dorsi muscle flap without an implant (53), pedicled transverse rectus abdominus musculocutaneous (TRAM) flap (170), free TRAM flap (39), deep inferior epigastric perforator (DIEP) and superficial inferior epigastric artery flap (172), and superior gluteal artery perforator flap (14). Autologous with implant reconstructions included latissimus flap and an implant (158), pedicled TRAM flap with an implant (2), free TRAM flap with an implant (2), DIEP flap with an implant (1), and superior gluteal artery perforator flap with an implant (1). Finally, all tissue expander/implant-based reconstructions (169) were grouped together.

There were differences in patient demographics between these groups (Table 1). Patients who had PMRT before reconstruction were less likely to have implant-based reconstructions. Also, all patients receiving PMRT were more likely to have a unilateral reconstruction. The average age of patients in the PMRT-first group was 46.1 years (range, 34.4–62.9 years), in the reconstruction before PMRT group 45.3 years (31.9–69.6 years), and in the control group 49.3 years (23.1–72.6 years).

The length of follow-up was defined as the interval between the date of reconstruction and the date of the last documented note from either the plastic surgeon or another provider directly involved in the patient's breast cancer care. Median follow-up was 28.3 months in the PMRT before reconstruction group, 63.6 months in the reconstruction before PMRT group, and 56.8 months in the control group.

### Definition of Complications

Complications were assessed through a review of patients' medical records and included those noted either by a plastic surgeon or by other providers. Complications were scored in relation to each reconstructed breast, rather than per patient, and were categorized as

early (within 90 days of the date of reconstruction) or late. This cutoff was selected as it is a standard time point for postoperative evaluation and documentation of late complications such as fat necrosis. General complications included hematoma, seroma, delayed wound healing, mastectomy skin loss, and infections. Additional complications associated with autologous reconstruction included total and partial flap loss, and fat necrosis (any area of firmness). Complications associated with implants included capsular contracture, rupture, extrusion, malposition, and removal for pain. Only those complications requiring additional surgery were scored.

### Patient Satisfaction

Patients received a mailed questionnaire surveying demographic information, health status, and patient satisfaction.<sup>20</sup> Patients who were deceased or with known metastatic disease were excluded. The questions used were developed by the Michigan Breast Reconstruction Outcome Study (MBROS).<sup>17</sup> General satisfaction was evaluated based on the following 5 questions: (1) Knowing what I know today, I would choose to have breast reconstruction; (2) Knowing what I know today, I would choose to have the type of reconstruction I had; (3) Overall, I am satisfied with my reconstruction; (4) I would recommend the type of reconstructive procedure to a friend; and (5) I felt I had sufficient information to make an informed choice. Aesthetic satisfaction was based on the following 2 questions: (1) The size and shape of breasts are the same and (2) My reconstructed breasts feel soft to the touch.

Questionnaire answers were graded on a 5-point Likert scale, with possible answers that ranged from "very dissatisfied" (1) to "very satisfied" (5). Patients responding with an answer of 4 or 5 were scored as "satisfied," whereas all others were scored as being "dissatisfied." Satisfaction, unlike complication data, was scored per patient and not per breast. Patients with bilateral reconstruction were

TABLE 2. Early and Late Complications

	PMRT Then Reconstruction (n = 57)		Reconstruction Then PMRT (n = 59)		Reconstruction Only No PMRT (n = 665)	
	Early (<90 Days)	Late (>90 Days)	Early (<90 Days)	Late (>90 Days)	Early (<90 Days)	Late (>90 Days)
Total	17.54% (10/57)	14.03% (8/57)	13.56% (8/59)	33.90% (20/59)	7.66% (51/665)	15.59% (103/665)
Autologous	20.93% (9/43)	11.62% (5/43)	11.11% (4/36)	19.44% (7/36)	10.51% (39/371)	10.51% (39/371)
Autologous + implant	7.69% (1/13)	23.07% (3/13)	20.0% (2/10)	50.0% (5/10)	7.19% (10/139)	23.02% (32/139)
Implant/expander	0% (0/1)	0% (0/1)	15.38% (2/13)	61.54% (8/13)	1.29% (2/155)	20.65% (32/155)
All complications (early and late)	31.58% (18/57)		47.46% (28/59)		23.16% (154/665)	

PMRT indicates postmastectomy radiotherapy.

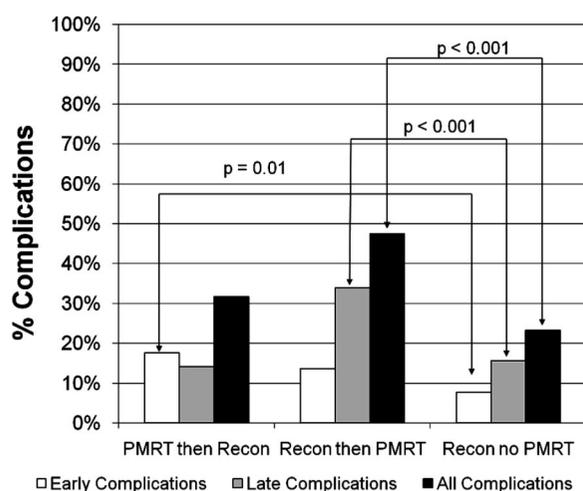


FIGURE 1. Complications.

only included in the control group if both breasts did not have radiation.

The survey was pretested on a sample of 30 clinic patients to assess readability and clarity of questions. To maximize response rates, the Dillman method<sup>21</sup> was used, which involved a letter reminder, additional mailings, and finally phone calls to nonresponders over the course of 1 month.<sup>22</sup> The overall survey response rate was 73.69%.

### Statistical Analysis

Statistical analysis was performed using SPSS (Chicago, IL) version 17.0 software. The statistical significance of differences between groups for dichotomous variables was evaluated using the Fisher exact test or  $\chi^2$  tests, with  $P < 0.05$  considered to represent a significant difference. The study and survey protocol were approved by our institutional review board.

### RESULTS

The overall complication rate for any patient that received PMRT was significantly higher than that of the control group (39.66% vs. 23.16%,  $P < 0.001$ ) (Table 2, Fig. 1). The overall complication rate in patients having reconstruction followed by PMRT was also significantly higher than that of the control group (47.46% vs. 23.16%,  $P < 0.001$ ). Patients who had PMRT before reconstruction had a lower rate of complications than patients who underwent radiation treatment after reconstruction, but this difference was not statistically significant (31.58% vs. 47.46%,  $P = 0.081$ ).

TABLE 3. Patient Satisfaction

	PMRT Then Reconstruction	Reconstruction Then PMRT	Reconstruction Only No PMRT*
Patients surveyed, n	53	57	426
Survey response, % (n)	75.47% (40/53)	66.67% (38/57)	74.41% (317/426)
General satisfaction	67.50% (27/40)	68.42% (26/38)	67.20% (213/317)
Autologous	74.07% (20/27)	75.0% (18/24)	74.05% (137/185)
Autologous + implant	58.33% (7/12)	75.0% (6/8)	63.07% (41/65)
Implant/expander	0% (0/1)	33.33% (2/6)	51.52% (34/66)
Aesthetic satisfaction	50.0% (20/40)	63.16% (24/38)	66.88% (212/317)
Autologous	59.25% (16/27)	66.67% (16/24)	75.68% (140/185)
Autologous + implant	33.33% (4/12)	62.50% (5/8)	61.54% (40/65)
Implant/expander	0% (0/1)	50.0% (3/6)	46.97% (31/66)

PMRT indicates postmastectomy radiotherapy.

\*One reconstruction only patient had autologous for one breast and autologous + implant for the other.

The lowest incidence of early complications was in the control group (7.66%), which is significantly different from patients who had PMRT followed by reconstruction (17.54%,  $P = 0.01$ ). The highest incidence of late complications was in the group having reconstruction followed by PMRT (33.90%), which was statistically significant when compared with the control group (15.59%,  $P < 0.001$ ). The late complications in the tissue expander/implant group were significantly higher compared with controls (61.54% vs. 20.65%,  $P = 0.003$ ). In any patient with an implant (autologous with implant, implant groups) before PMRT, capsular contracture was the most common complication (11/23, 47.83%). Patients treated with autologous reconstruction and subsequent PMRT had a comparable rate of fat necrosis compared with the control group (11.11% vs. 11.59%); 2 of these patients required a secondary flap for reconstruction (5.56%).

The overall general satisfaction rate was uniformly high across all 3 groups (Table 3, Fig. 2). Subgroup analysis showed a higher rate of general satisfaction with autologous reconstruction; however, the numbers of implant-based reconstructions in the PMRT groups were small.

Aesthetic satisfaction rate was lowest in the group receiving PMRT before reconstruction, which was statistically significant

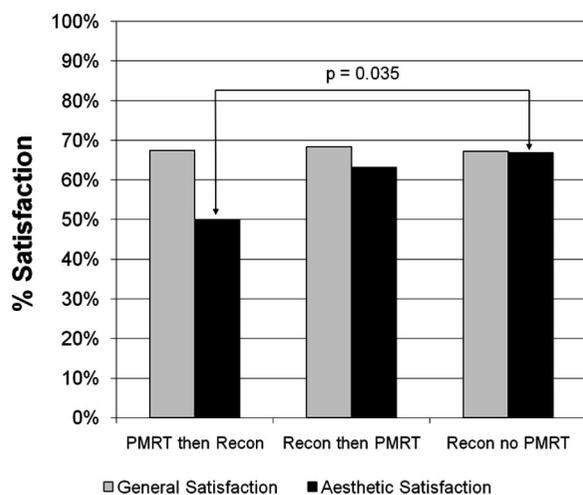


FIGURE 2. Patient satisfaction.

when compared with the control group (50% vs. 66.88%,  $P < 0.035$ ). Aesthetic satisfaction was similar between patients with immediate reconstruction followed by PMRT and controls (63.16% vs. 66.88%).

## DISCUSSION

This study shows that the sequencing of PMRT and reconstruction has an effect on both complications and satisfaction. There is an increase in early complications for patients receiving PMRT before reconstruction compared with the control group. Most of these complications are infections, seromas, and delayed wound healing, as would be expected because of previous radiation damage. These patients have a similar rate of general satisfaction compared with the control group; however, they rate the aesthetic results significantly lower.

In contrast, patients who have immediate reconstruction before PMRT have an increase in overall and late complications. There was a high risk of implant complications, such as capsular contracture or implant malposition, in this group. Patients having autologous reconstruction that subsequently had PMRT did not have a higher rate of fat necrosis than the control group. Interestingly, this group of patients had similar general and aesthetic satisfaction ratings to control group patients.

We have analyzed results in patients having PMRT in more detail elsewhere.<sup>23</sup> There were few differences between complication rates or general or aesthetic satisfaction in relation to the exact type of reconstruction whether PMRT or reconstruction was performed first. However, the number of patients in these subgroups was small. Direct comparison with a control group, which did not receive PMRT, was necessary to highlight potential advantages.

Other groups have also found a high rate of overall complications and capsular contracture for patients undergoing implant-based reconstruction and PMRT, similar to our study. Spear and Onyewu examined a group of 40 patients; 9 patients had mastectomy and radiation before reconstruction, 19 patients had radiation during tissue expansion, and 5 had radiation after reconstruction.<sup>10</sup> The overall complication rate in this irradiated group was 52.5%, with a 32.5% capsular contracture rate. Vandeweyer and Deraemaeker evaluated 124 cases of immediate breast reconstruction, of whom 6 received radiation therapy.<sup>24</sup> All 6 patients developed grade III or IV capsular contracture, with poor to fair overall results. Cordeiro et al reviewed results in 81 patients treated with PMRT after mastectomy, tissue expander, chemotherapy, and implant ex-

change.<sup>14</sup> In this series, 68% of patients developed capsular contracture compared with 40% in a control group, which was not irradiated. Ascherman et al reported on 27 patients treated with mastectomy, tissue expander/implant reconstruction, and radiation therapy (8 before and 19 after mastectomy).<sup>25</sup> The irradiated group had a higher overall complication rate compared with a control group (40.7% vs. 16.7%) and a higher rate of complications required removal of the implant (18.5% vs. 4.2%). Interestingly, there was no reported capsular contracture in the radiated group.

Other studies of patients treated with immediate autologous reconstruction followed by PMRT have shown high rates of complications because of fat necrosis, firmness, and contracture, and the need for secondary flap reconstruction. These results are substantially different from our study, which had low rates of fat necrosis and use of secondary flaps. Carlson et al compared 25 patients treated with a pedicled TRAM and PMRT with 149 patients undergoing pedicled TRAM without PMRT.<sup>26</sup> The incidence of flap complications was 34% in the unirradiated group, compared with 44% in the irradiated group. The incidence of fat necrosis was also lower in the unirradiated group (15% vs. 32%). Rogers and Allen evaluated 30 DIEP flap reconstructions treated with postoperative irradiation, compared with a control group of 30 unirradiated DIEP flaps.<sup>4</sup> There was a higher rate of fat necrosis (23% vs. 0%), fibrosis/shrinkage (57% vs. 0%), and contracture (17% vs. 0%) in the irradiated group; however, there were no differences in rates of flap revision or dehiscence. Tran et al compared 32 patients undergoing immediate free TRAM flap reconstruction followed by PMRT to 70 patients with PMRT followed by delayed free TRAM.<sup>7</sup> When PMRT was given after reconstruction, patients had significantly higher rate of fat necrosis (44% vs. 9%), volume loss (88% vs. 0%), and flap contracture (75% vs. 0%). A second flap was necessary to correct the effects of volume loss in 28% of patients undergoing PMRT after reconstruction compared with 0% in patients who had PMRT first.

Recently, there has been increasing evidence that autologous reconstruction followed by PMRT can be successfully performed with a low risk of complications. The strategy has been used to create a larger autologous construct that may decrease in volume slightly after PMRT or to revise the contralateral breast for volume match. In a recent study by Chatterjee et al, 22 patients with a DIEP flap then PMRT were compared with 46 patients with a DIEP flap and no PMRT.<sup>15</sup> Volumetric assessment was performed. Although there was a slight decrease in volume after PMRT (65 mL vs. 0 mL), this was not statistically significant. Our series further supports the reasonableness of performing immediate autologous reconstruction and then giving PMRT, as the rate of fat necrosis is not higher than for the control group patients undergoing autologous reconstruction. In addition, secondary flap reconstruction was necessary in only a small number of patients (5.56%).

Experience in patients with mixed autologous and implant reconstruction performed before PMRT is limited. In our study, there was a high rate of complications in this subgroup (70%), but the numbers were too small to be meaningful. Interestingly, these patients had high general and aesthetic satisfaction scores. Whitfield et al evaluated 34 patients undergoing a latissimus flap with implant reconstruction followed by PMRT.<sup>27</sup> They found that 24% of patients required an implant exchange for severe capsular contracture, compared with none of 49 unirradiated patients. Chang et al examined the effects of radiation (not exclusively PMRT) on autologous flaps with implant reconstruction; 53 patients had preoperative irradiation and only 4 patients had reconstruction then PMRT.<sup>28</sup> Although these 4 patients had few complications, the numbers were also too small to be meaningful.

There are few studies that evaluate the effect of PMRT on patient satisfaction with reconstruction. It was interesting to find that patients in our study with immediate reconstruction followed by PMRT had a higher rate of complications, but were equally satisfied as the control group. This is similar to the study by Cordeiro et al, who reported 80% of PMRT patients with implant reconstruction rated their result as “acceptable” compared with 88% without PMRT, despite a 68% capsular contracture rate.<sup>14</sup> In addition, 72% of their PMRT patients reported that they would choose the same form of reconstruction again, compared with 85% of patients not having PMRT. Carlson et al used an independent grading system using patient pictures to evaluate postoperative results. In that series, patients having pedicled TRAM and PMRT had a significantly lower aesthetic score compared to those undergoing pedicled TRAM without PMRT; however, there were no differences between those patients receiving PMRT before or after reconstruction.<sup>26</sup> Only one study used a validated satisfaction survey to evaluate results from PMRT.<sup>29</sup> Using the MBROS questionnaire, 19 patients with tissue expander- and implant-based reconstruction and PMRT were compared with 62 patients with reconstruction and no PMRT. In that small series, there were no differences in general or aesthetic satisfaction between groups. The use of a validated survey is crucial for obtaining meaningful metrics that can be translated across institutions and studies. This study uses the same MBROS questionnaire for evaluating general and aesthetic satisfaction and provides a validated basis for comparison; as such, we found similar satisfaction results.

There are limitations to this study. As the study was retrospective in nature, it was not possible to influence the type of reconstruction and timing with PMRT. The number of patients with PMRT before reconstruction and reconstruction before PMRT was small, especially after subgroup analysis. For example, very few patients had implant-based reconstruction after previous PMRT either by patient or surgeon choice. This limits the ability to adequately gather data within that subgroup. Ideally, much larger numbers within each type of reconstruction would increase the statistical power. Finally, as with any satisfaction survey, there can be responder bias. By increasing the response rate through the Dillman technique, we were able to minimize the number of non-responders.

Conventional wisdom holds that breast reconstruction should be delayed for women requiring radiation therapy; however, these patients have a lower aesthetic satisfaction. The increasing trend toward immediate reconstruction followed by PMRT can improve satisfaction, but this must be balanced against the higher risk of overall and late complications. Finally, there was a high risk of complications (predominantly capsular contractures requiring surgery) for patients having implant-based reconstruction followed by PMRT, whereas there was a low risk of complications for patients having autologous reconstruction before PMRT. Proper counseling of patients who may need PMRT must include information on how the timing of reconstruction and PMRT may be affected by the type of reconstruction and how this affects the risk of complications and patient satisfaction.

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