Patterns of Post-Mastectomy Radiotherapy in Immediate Breast Reconstruction – Results from the iBRA-2 Cohort Study

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Abstract

Purpose

Long-term data indicates that post-mastectomy radiotherapy (PMRT) is associated with improved overall survival in all node-positive breast cancer patients. Immediate breast reconstruction (IBR) remains controversial in the context of planned PMRT, but rates of IBR are increasing. The aim of this study was to examine current practice of PMRT in patients undergoing mastectomy +/- IBR.

Methods

Data were collected from 2,526 patients enrolled in the iBRA-2 prospective cohort study undergoing mastectomy +/- IBR between 1st July and 31st December 2016, recruited consecutively at 71 centres across the United Kingdom, Ireland, and five international centres.

Results

Of a total of 2,590 breast procedures included in the analysis, 696 were implant-based, 105 pedicled flap and 230 free-flap reconstruction. 31.4% of implant-based, 34.3% of pedicled, and 32.5% of free-flap reconstructions were recommended for PMRT. PMRT recommendation by cancer stage was 21% for T1-2 N0, 65% for T1-2 N1, and 89% for T_{any} N2 and T3 N_{any} disease. On multivariate analysis, patients undergoing IBR were no less likely to be recommended for PMRT than patients having mastectomy only. However, patients in Northern Ireland/Ireland, the North of England, and Scotland were less likely to be recommended for PMRT.

Conclusion

Although IBR was more likely to be performed for lower stage cancers and younger patients with fewer co-morbidities, patients undergoing IBR were no less likely to be recommended for PMRT, irrespective of reconstruction technique. This study also highlighted regional variation in PMRT practice within the UK which merits further investigation.

Introduction

Breast cancer is the most common female cancer in Europe with 562,000 new cases diagnosed in 2018 [1]. Despite advances in treatment and early diagnosis, almost 40% of women undergo mastectomy as their primary surgery [2, 3]. After surgery, radiotherapy is the second most commonly used treatment for breast cancer. Long-term data combining a number of previous randomised-controlled trials demonstrates that post-mastectomy radiotherapy (PMRT) reduces recurrence rate and improves survival in all node-positive breast cancer patients [4]. As a result, the indications for PMRT in women with breast cancer are widening. Population-based data from the US shows that use of PMRT in patients with 1-3 positive lymph nodes increased significantly between 2003 and 2012 [5, 6]. Several national treatment

guidelines now recommend that radiotherapy be considered for all patients with node-positive disease after mastectomy [7–9].

Women undergoing mastectomy are offered immediate breast reconstruction (IBR) with the aim of improving quality of life [10]. IBR remains controversial in the context of planned PMRT [11]. However, an analysis of the US Surveillance, Epidemiology, and End Results (SEER) database indicates that an increase in PMRT amongst women with stage I to III breast cancer undergoing mastectomy did not lead to a concomitant decrease in IBR [6]. In fact, data from the US Mastectomy Reconstruction Outcomes Consortium (MROC) for >2,000 patients demonstrates that around 25% of implant-based and half of autologous reconstructions received PMRT [12]. The UK National Institute of Health and Care Excellence (NICE) recently reviewed 23 observational studies and concluded that there was insufficient evidence to indicate worse patient outcomes from PMRT in the setting of IBR, and that IBR should be offered even if adjuvant RT is anticipated [13].

Currently, high quality evidence for the use of PMRT in intermediate-risk breast cancer (defined as pT1–2N1; pT3N0; or pT2N0 if also grade III or with lympho-vascular invasion) is lacking and the results of a large European randomized-controlled trial are awaited [14]. At the same time, rates of IBR in the UK, in particular implant-based reconstruction, are increasing [15], yet large scale population-based data on the use of PMRT in patients undergoing IBR has not been published to date. In reconstructive breast surgery, the trainee research collaborative model has recently emerged as a time and cost-effective method for delivering large-scale prospective studies [16, 17].

This Breast Reconstruction Research Collaborative of breast and plastic surgeons was utilized to deliver the iBRA-2 study to determine the impact of IBR on the delivery of adjuvant treatment [18]. The present study was undertaken to analyse patterns of PMRT amongst patients undergoing mastectomy with and without IBR enrolled in the iBRA-2 cohort.

Methods

The methods of the iBRA-2 cohort study have been reported elsewhere [18, 19]. Briefly, all breast and plastic surgical units performing mastectomy with and without IBR were invited to participate in the study via the professional associations (Association of Breast Surgery [ABS] and British Association of Plastic Reconstructive and Aesthetic Surgeons [BAPRAS] and the breast and plastic surgery collaborative research networks (Reconstructive Surgery Trials Network [RSTN] and the Mammary Fold Academic and Research Collaborative [MFAC]). Of 90 centres, who expressed an initial interest, 76 centres enrolled 2,526 consecutive patients between 1st July and 31st December 2016. The study sample covered approximately half of all UK breast units as well as five centres in Ireland (recruiting n=103), four centres in Italy and one in Egypt (recruiting n=145).

Consecutive women aged 18 or over undergoing mastectomy with or without IBR using any technique for invasive or pre-invasive (ductal carcinoma in situ, DCIS) breast cancer with curative intent were included. Patients were identified from multidisciplinary team (MDT) meetings; unit operating records and clinics.

Excluded were patients undergoing risk-reducing surgery (without a therapeutic mastectomy for breast cancer), partial mastectomy including wide local excision with volume replacement (latissimus dorsi mini-flaps; lateral intercostal perforator (LICAP) or thoracodorsal artery perforator (TDAP) flaps) or displacement techniques (therapeutic mammoplasty), and those with distant metastatic disease.

The iBRA-2 study was classified as service evaluation according to the NHS Health Research Authority online decision tool <http://www.hra-decisiontools.org.uk/research/>, so ethical approval was not required. Each participating centre obtained local governance approvals prior to entering patients into the study. Data were collected prospectively, including baseline demographic and operative data. Oncological data and adjuvant treatment recommendations were collected from post-operative MDT meeting records. Pilot data collected at a number of participating sites between 1st May and 30th June 2016 suggested that adjuvant therapy was unlikely to commence earlier than six weeks post-operatively. Data collection in patients not requiring adjuvant treatment therefore continued from the last definitive cancer surgery until six weeks following surgery.

Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at the Kennedy Institute of Rheumatology, University of Oxford [20, 21]. REDCap is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources. For quality assurance purposes, the lead investigator at each site was asked to independently validate 5-10% of the data. If concordance between the data entered on REDCap and that independently-validated was <90%, the unit's data were excluded from the analysis, consistent with the QA procedure used in other collaborative projects.

Study definitions and endpoints

Primary and secondary outcomes in iBRA-2 were selected based on current best practice [22] and national breast cancer guidelines [23]. The endpoint in the present study was use of adjuvant radiotherapy, defined as the recorded post-operative MDT outcome “radiotherapy recommended” or “radiotherapy to be discussed”. For analysis purposes, patients in iBRA-2 were categorised into four groups according to the most complex surgical procedure received as: i) mastectomy only (no reconstruction), ii) mastectomy and IBR with implant-only techniques, iii) mastectomy and IBR with pedicled flaps, and iv) mastectomy and IBR with free-flap techniques.

Implant-based procedures included any reconstruction in which only expanders/implants were used to reconstruct the breast, either with or without biological (e.g. acellular dermal matrix) or synthetic (e.g. titanium-coated polypropylene) mesh irrespective of whether the implant/expander was placed in a pre or sub-pectoral position. Pedicled-flap procedures included any pedicled-flap used to reconstruct the breast with or without an implant/expander, including latissimus dorsi (LD) and transverse rectus abdominus

myocutaneous (TRAM) flaps. Free-flap procedures included any technique in which a microvascular free-flap was used for IBR, including deep inferior epigastric perforator (DIEP), superficial inferior epigastric perforator (SIEA), superior and inferior gluteal artery perforator (SGAP and IGAP), and transverse upper gracilis (TUG) flaps. All complications were defined a priori [19]. Major complications were defined as any complication requiring re-admission or re-operation. Minor complications were defined as those managed conservatively. An analysis of short-term complications is described elsewhere [18].

Statistical analysis

Descriptive summary statistics were calculated for each variable in the whole cohort and sub-divided by procedure type (mastectomy only; implant-based reconstruction; pedicled reconstruction; and free-flap reconstruction). Categorical data were summarised by counts and percentages, and continuous data by median, interquartile range (IQR), and range. Procedure groups were compared using appropriate non-parametric statistics. Univariable and multivariable logistic regression were used to explore associations between clinico-pathological variables and use of PMRT, including patient and procedure-related factors, namely, age, body mass index (BMI), smoking status, American Society of Anaesthesiologists' (ASA) grade; diabetes, ischaemic heart disease (IHD); other comorbidities, chemotherapy, ER- and HER-2 status, lymphovascular invasion, tumour grade, multi-focality, and procedure type.

To assess selection bias, correlation between proportions of patients undergoing PMRT and IBR was determined by region using Pearson's *r*. Regional trends in PMRT across the United Kingdom and Ireland were further assessed in multivariable logistic regression, adjusted for BMI, co-morbidities, smoking status, ASA, ER- and HER2-status, lymphovascular invasion, multi-focality and tumour grade, and including clustering by centre. All analyses were performed in STATA 15 (STATA Inc, Texas).

Results

Of 2,526 patients recruited into the iBRA-2 study, 666 underwent implant-based reconstruction, 105 received pedicled flaps, and 227 underwent free-flap reconstruction. The remainder of patients underwent mastectomy only without reconstruction. As 80 patients had bilateral cancer surgery and there were 16 procedures with missing outcome data, a total of 2,590 breast procedures were included in the analysis. On a per breast basis, Table 1 summarises patient demographics and adjuvant therapy decisions by procedure type. Patients undergoing mastectomy alone ($n=1,559$ breast procedures) were older than those undergoing IBR and were more likely to have co-morbidities as indicated by ASA grade. Patients undergoing IBR were more likely to have lower stage cancers. Adjuvant chemotherapy was more likely to be recommended after mastectomy-only than after IBR. Adjuvant radiotherapy was recommended or for discussion in 44.9% of mastectomies, 31.4% of implant-based reconstructions, and in 34.3% and 32.5% of pedicled and free-flap reconstructions, respectively ($p<0.001$).

Table 1
Patient demographics and proportion of patients offered adjuvant radiotherapy in the iBRA-2 study by type of surgical procedure.

Per breast data	Mastectomy only		Implant reconstruction		Pedicled flap reconstruction		Free flap reconstruction		p-value
	(n=1559)		(n=696)		(n=105)		(n=230)		
Age (median, IQR)	65	54-75	50	43-57	52	47-60	50	45-56	<0.001
ASA grade (n, %)									
1	333	21.4%	273	39.2%	40	38.1%	59	25.7%	<0.001
2	906	58.1%	379	54.5%	61	58.1%	160	69.6%	
3	279	17.9%	23	3.3%	3	2.9%	8	3.5%	
Missing data	72	4.6%	21	3.0%	1	1.0%	3	1.3%	
T stage (n, %)									
Tis	141	9.0%	161	23.1%	26	24.8%	57	24.8%	<0.001
T1-2	1199	76.9%	448	64.4%	64	61.0%	139	76.9%	
T3	189	12.1%	53	7.6%	9	8.6%	18	12.1%	
Missing data	30	1.9%	34	4.9%	6	5.7%	16	1.9%	
N stage (n, %)									
N0	910	58.4%	524	75.3%	71	67.6%	158	68.7%	<0.001
N1	372	23.9%	110	15.8%	16	15.2%	42	18.3%	
N2	247	15.8%	41	5.9%	12	11.4%	14	6.1%	
Missing data	30	1.9%	21	3.0%	6	5.7%	16	7.0%	
Chemotherapy (n, %)									
Recommended	421	27.0%	154	22.1%	28	26.7%	46	20.0%	0.001
For discussion	138	8.9%	36	5.2%	5	4.8%	9	3.9%	
For Oncotype DX™	95	6.1%	64	6.1%	5	4.8%	17	7.4%	
Missing data	6	0.4%	6	0.9%	0	0%	0	0%	
Radiotherapy (n, %)									

Per breast data	Mastectomy only		Implant reconstruction		Pedicled flap reconstruction		Free flap reconstruction		p-value
Recommended	614	39.4%	198	28.4%	35	33.3%	62	27.0%	<0.001
For discussion	86	5.5%	19	2.7%	1	1.0%	19	5.5%	
Missing data	4	0.3%	9	1.3%	0	0%	0	0%	

PMRT recommendation by tumour and nodal stage

Figure 1 shows the proportion of patients on a per-breast basis (n=2,590) recommended for PMRT by tumour stage. Out of all patients with T3, N2 or N3 stage disease, 89% were recommended for radiotherapy, while 64.7% of patients with N1 stage disease were recommended for radiotherapy. Interestingly, 13.2% of Tis and 21.1% of N0 stage patients were also recommended for radiotherapy. When sub-divided by tumour and nodal stage, there were no differences between surgical procedure types (see Supplementary Table).

Table 2 shows the patient and tumour variables associated with PMRT recommendation. In multivariable analysis, patients with larger tumours and more advanced lymph node state were more likely to receive a recommendation for PMRT. However, patients undergoing IBR were as likely as those having simple mastectomy to be recommended for PMRT, although there was evidence of a trend for women receiving implant-based reconstruction to be less likely to be offered PMRT compared to patients undergoing mastectomy only (OR 0.56, CI 0.44-0.73, p<0.001 univariable; OR 0.69, 0.45-1.04, p=0.08 multivariable).

Table 2. Predictors of PMRT recommendation. MVA also included age, body mass index, co-morbidities (ischaemic heart disease, diabetes, other), smoking status, chemotherapy recommendation, ASA grade, ER and HER-2 status, lymphovascular invasion, multi-focality, and tumour grade (CI = confidence interval). Full results are shown in Supplementary Tables.

Per breast data	Univariable analysis			Multivariable analysis (n=2,000)		
	Odds ratio	95% CI	p value	Odds ratio	95% CI	p value
Tumour size (invasive)						
0-9 mm	1	Comparator		1	Comparator	
10-20 mm	0.74	0.57-0.95	0.02	0.75	0.51-1.08	0.12
20-50 mm	1.91	1.48-2.46	<0.001	1.44	1.01-2.06	0.046
>50 mm	14.07	8.91-22.24	<0.001	18.45	8.45-40.26	<0.001
Lymph nodes						
N0	1	Comparator		1	Comparator	
N1	8.02	6.10-10.54	<0.001	4.86	3.40-6.96	<0.001
N2	31.37	19.87-49.50	<0.001	15.54	8.53-28.33	<0.001
Type of surgery						
Mastectomy only	1	Comparator		1	Comparator	
Implant	0.56	0.44-0.73	<0.001	0.69	0.45-1.04	0.08
Pedicled flap	0.61	0.35-1.08	0.09	0.63	0.33-1.19	0.15
Free flap	0.65	0.42-1.00	0.05	0.63	0.30-1.33	0.23

Impact of PMRT use on IBR

Excluding patients from five centres outside the United Kingdom and Ireland, Figure 2 shows no clear correlation between the proportion of patients recommended for PMRT and of the proportion receiving IBR across the 14 regions ($r=-0.23$, $p=0.41$).

Regional variation in PMRT

Table 3 shows the proportion of patients recommended for PMRT subdivided by regions, excluding 145 patients from centres outside the UK and Ireland. Complete datasets for multivariable analysis were available for 2,010 breast procedures. Adjusting for patient, tumour and other treatment co-variables, women undergoing mastectomy in Northern Ireland/Ireland (OR 0.37, 0.18-0.76, $p=0.007$), the North of England (0.38, 0.17-0.83, $p=0.016$), West Midlands (0.43, 0.20-0.92, $p=0.029$), and Scotland (0.36, 0.18-0.75, $p=0.006$) were less likely to be recommended for PMRT than in London and the Southeast. For patients undergoing IBR, the regional numbers were too small to subdivide further by procedure type. Nevertheless, women undergoing IBR in Yorkshire/Humberside were less likely to be recommended for PMRT (OR 0.25, 0.09-0.69, $p=0.007$) than in London and the Southeast.

Table 3. Rates of PMRT by region in patients undergoing mastectomy only and those undergoing IBR. Multivariable analysis (MVA) also included age, body mass index, co-morbidities (ischaemic heart disease, diabetes, other) smoking status, chemotherapy recommendation, ASA grade, ER and HER-2 status, lymphovascular invasion, multi-focality, lymph node status, and tumour size and grade (CI = confidence interval, NI = Northern Ireland). Full results are shown in Supplementary Tables.

Per breast data	Mastectomy only (n=1,184)			Breast reconstruction (any) (n=816)		
	Percentage RT recommended	OR (95% CI) MVA	p value MVA	Percentage RT recommended	OR (95% CI) MVA	p value MVA
London/Southeast	53 %	1		39 %	1	
East	48 %	0.73 (0.35, 1.49)	0.381	39 %	0.54 (0.20, 1.45)	0.221
East Midlands	49 %	0.85 (0.38, 1.94)	0.704	24 %	0.47 (0.17, 1.30)	0.145
Yorkshire/Humber	37 %	0.50 (0.20, 1.22)	0.129	24%	0.25 (0.09, 0.69)	0.007
NI/Ireland	52 %	0.37 (0.18, 0.76)	0.007	47 %	1.23 (0.41, 3.65)	0.708
North	41 %	0.38 (0.17, 0.83)	0.016	25 %	0.38 (0.15, 0.95)	0.038
Scotland	44 %	0.36 (0.18, 0.75)	0.006	48 %	1.03 (0.38, 2.82)	0.952
Wales/Southwest	47 %	0.76 (0.35, 1.67)	0.493	34 %	1.43 (0.46, 4.47)	0.542
West Midlands	47 %	0.43 (0.20, 0.92)	0.029	37 %	1.24 (0.29, 5.25)	0.773

Discussion

The aim of this study was to analyse patterns of PMRT amongst patients undergoing mastectomy with and without IBR. The short-term outcomes and rates of complications in the iBRA-2 patient cohort have been reported elsewhere [18]. In relation to PMRT, the present study found that between 31.4% and 34.3% of women undergoing IBR were recommended for or for discussion of radiotherapy compared to 44.9% of those receiving simple mastectomy. These figures are in keeping with several previously published observational studies showing that between 29% and 43% of patients with IBR are irradiated [12, 17, 24, 25]. Although IBR was more likely to be performed for lower stage cancers and in younger patients with fewer co-morbidities, women undergoing IBR were no less likely to be recommended for radiotherapy after adjusting for patient and tumour variables. This adds to a growing body of evidence that in the setting of PMRT, IBR is becoming an acceptable option for women requiring PMRT [26–28] and that PMRT is only one of many factors in the decision for/against IBR which include consideration of patient

and oncological factors as well as surgeon and patient preferences. Indeed, it has been shown that breast cancer multi-disciplinary teams (MDTs) cannot predict with certainty whether a patient will require adjuvant PMRT [29].

We found no clear correlation between higher proportions of patients recommended for PMRT and lower proportions of IBR across different UK regions. This suggests that participating centres offered all types of IBR irrespective of whether PMRT was likely to be needed in the adjuvant setting, in keeping with findings from a similar US population-based study [6] and current clinical guidelines [13]. The individual choice of IBR technique is likely to depend on several patient and surgical factors as well as locally available expertise and access to immediate free-flap reconstruction. However, in patients requiring PMRT, implant-only IBR is generally associated with more complications compared to autologous IBR [12, 17]. Early follow-up data from two prospective cohort studies shows lower satisfaction among patients with irradiated implant-only reconstruction [30, 31]. Nevertheless, further work is required to establish the impact of PMRT on the long-term outcomes of IBR to provide high-quality data to inform practice. Initial results from non-randomised studies comparing neoadjuvant versus adjuvant radiotherapy in patients scheduled for IBR are promising and demonstrate the feasibility and safety of this approach [32] but the results of randomized trials will take some years to mature.

Compared to previous population-based analyses showing between 30.3% and 40.5% of patients with N1 disease (1-3 positive lymph nodes) receiving PMRT by 2012 [5, 6], in our study, 64.7% of such patients were recommended for PMRT. This confirms the trend of an increasing number of patients with N1 disease being considered for PMRT and it is in keeping with national clinical guidelines [7–9]. Furthermore, the number of patients in our study with non-invasive cancer receiving post-mastectomy radiotherapy appears relatively high compared to an earlier UK study [33], although our study was not restricted to the breast screening population, and the receipt of radiotherapy following mastectomy y for DCIS may be related to margin status, grade, and presence of micro-invasion.

Subdividing the data by UK regions, we found in our study that patients in Northern Ireland/Ireland, Scotland, the North of England and the West Midlands were significantly less likely to be recommended for PMRT. This highlights some interesting geographical variation, which merits further investigation. A similar US-based study found that density of radiation oncology practices was associated with receipt of PMRT in patients with N1 stage breast cancer [5]. Results of the Selective Use of Post Mastectomy Radiotherapy (SUPREMO) trial are awaited and are likely to reduce the variation in practice of PMRT use in intermediate-risk breast cancer (defined as pT1–2N1; pT3N0; or pT2N0 if also grade III or with lympho-vascular invasion) [14].

There is accumulating evidence that individual patient and tumour molecular profiles will be able to predict the response to adjuvant treatment. Several phase III trials are currently underway [34] or have already reported on the effectiveness of the 70- or 21-gene recurrence scores in selecting patients for adjuvant chemotherapy [35, 36]. Genomic-adjusted radiation dose (GARD) therapy may allow personalisation of radiotherapy on the basis of the biological effect of a given physical dose of radiation,

calculated using individual tumour genomics, and has been shown to predict time to recurrence and overall survival [37]. In terms of complications from IBR, predictive risk models have been externally validated with receipt of PMRT (or not) as a predictor [38, 39]. Other risk prediction models for individual radiotherapy side-effects in the breast have been validated [40, 41], though none in the setting of IBR. In the future, personalised medicine approaches including the patient germline and tumour genomic profile may aid decision-making around IBR and PMRT.

Strengths and Limitations

To our knowledge, this is the largest prospective cohort study to date in the UK and Ireland investigating patterns of PMRT in patients undergoing mastectomy with and without IBR, but there are several limitations. Due to its observational design, the study is at risk of bias. Patients were recruited consecutively from participating centres but there were baseline differences between the treatment groups. Although we adjusted for known confounders such as cancer stage, patient age, BMI, smoking status, and ASA grade, we acknowledge that it is not possible to adjust for all potential confounders. Our study included patients from 71 centres in the UK and Ireland as well five centres in Italy in Egypt. It is possible that participating units differed from those not taking part. However, approximately half of all UK breast units were represented in the study.

Due to the short follow-up period (up to initiation of first adjuvant treatment), we were only able to analyse treatment recommendations and were unable to ascertain successful receipt or completion of PMRT in all patients. It was not possible to follow patients up to completion of adjuvant therapy with this surgical trainee collaborative design, but collaborations with oncology trainees should allow us to address this issue in the future. Moreover, a data-linkage study is planned in future to explore oncological outcomes in terms of local recurrence, disease-free and overall survival. While it is not possible to establish causation with this observational study design, the design and conduct of randomized controlled trials in the setting of IBR are perceived as difficult due to patient and surgeon's preference for type and timing of breast reconstruction [25].

Conclusions

The present study provides evidence that approximately one third of patients undergoing IBR were recommended for PMRT. About two thirds of patients with T1-2 N1 disease were recommended for PMRT, which reflects current clinical treatment guidelines for this patient group. Within the UK and Ireland, the study also highlighted regional variation in PMRT practice which merits further investigation. Although IBR was more likely to be performed for lower stage cancers and in younger patients with fewer co-morbidities, patients undergoing IBR were no less likely to be recommended for radiotherapy, irrespective of reconstruction technique. Further work is required to establish the impact of PMRT on the long-term outcomes of different types of IBR to help women and surgeons make more informed decisions about breast reconstruction options.

Declarations

Competing interests

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The other authors have no competing interests to declare.

Data availability statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Authors' contributions

SP and TR conceived the study design (subgroup analysis); TR contributed to the design, conduct, analysis of the data, interpretation of the results and wrote the first draft of the paper. AT performed the analysis, contributed to data interpretation, and drafted the manuscript. RLOC, TR, RVD, SP contributed to the study design for iBRA-2; MDG and JS contributed to study design and interpretation of the data. All authors read and approved the final manuscript.

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Figures

Figure 1

Proportion of patients (% , per-breast data) in the study recommended for post-mastectomy radiotherapy by tumour stage.

Figure 2

Reconstruction percentages and PMRT recommendation percentages (n=2,381, excluding centres outside UK and Ireland).

Supplementary Files

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