

Positive or close margins: reoperation rate and second conservative resection or total mastectomy?

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Introduction: Reoperation after breast-conserving surgery (BCS) could be proposed for positive or close margins. Reoperation type, re-excision or mastectomy, depends on several factors in relation to patient's and tumor's characteristics. We have analyzed our breast cancer (BC) database in order to determine second and third attempts for BCS and mastectomy rates, as well as associated factors for type of surgery.

Methods: All patients with BCS between 1995 and 2017 were included. Patient's characteristics, pathologic results, and treatments were analyzed. Reoperation rate, type of reoperation, second reoperation, and associated factors of reoperation, mastectomy, and third intervention were determined. Three periods were determined: P1–P3.

Results: We analyzed 10,761 patients: 1,161 with ductal carcinoma in situ (DCIS) and 9,600 with invasive BC. The reoperation rate was 41.4% for DCIS and 28.0% for invasive BC. Using multivariate analysis, we identified tumor size >20 mm as being a risk factor for reoperation, whereas age >50 years, P2–3, and some localization decreased reoperation rates. For invasive BC, age >40 years, triple-negative tumors, neoadjuvant chemotherapy, and noncentral tumors decreased reoperation rates and lobular tumor, multifocal tumors, lymphovascular invasion, DCIS component, and Her2-positive tumors increased reoperation rates. For patients requiring reoperation, re-excision was performed in 48.1% (1,523/3,168) and mastectomy was required after first re-excision in 13.46% (205/1,523). For DCIS, mastectomy rates were higher for grade 2 and tumor ≥20 mm. For invasive BC, mastectomy rates were higher for lobular, multifocal, ≥20 mm, Her2-positive tumors and diffuse positive margins and lower for age >50 years and during the last period. Even if interval time between surgery and adjuvant treatments was higher for patients with reoperation, survival rates were not different between patients with and without reoperation.

Conclusion: A decrease in reoperation and mastectomy rates had been reported with several associated factors. A third intervention with mastectomy was required in 13.5% of patients. This information should be done in case of reoperation.

Keywords: breast cancer, conservative surgery, mastectomy, reoperation, margins

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Introduction

Reoperation after breast-conserving surgery (BCS) for breast cancer (BC) could be proposed for positive or close margins. Guidelines for reoperation have evolved during the past years: for invasive BC, margins ≥5 mm and then 2 mm and “no ink on tumor” are required, and for ductal carcinoma in situ (DCIS), margins ≥2 mm are usually required.

Reoperation type, re-excision or mastectomy, depends on several factors in relation to patient's and pathological tumor characteristics, mainly 1) patient's choice informed of third reoperation risk and no postmastectomy radiotherapy (PMRT) for patients without axillary lymph node macrometastases; 2) breast size, tumor size, and tumor localization; and 3) possibility of surgical resection (ie, oncoplasty).

Several studies have reported reoperation rate and type of reoperation after BCS,^{1–15} but only a few focused on predictive factors determining reoperation type.^{11,13,16} We have analyzed institutional BC database in order to determine rates and associated factors for reoperation, mastectomy, and third reoperation.

Patients and methods

All patients undergoing BCS in our institution, between January 1995 and December 2017, were included, except those with cT4 and inflammatory BC. A process is in place for institutional BC database to ensure data integrity, accuracy, and completeness. Patient's and clinical characteristics (cTN stage, age, breast tumor localization), pathologic results (tumor size, Scarff–Bloom–Richardson [SBR] grade, lymphovascular invasion, histological type, tumor focality, phenotype, in situ component, focal [<3 fields at magnification 40], or diffuse positive margins), and treatment (adjuvant chemotherapy [AC] or neoadjuvant chemotherapy [NAC]) were analyzed. Three periods were determined: P1 (1995–2004) with ≥ 5 mm margins required, P2 (2005–2010) with ≥ 2 mm margins required, and P3 (after 2010) with negative margins with no ink on tumor.

Reoperation rate and type of reoperation rates (re-excision or mastectomy) and second reoperation after re-excision were analyzed. Factors associated with reoperation, mastectomy, and third intervention were determined. We analyzed interval times between first surgery and reoperation for DCIS, for invasive BC with distinction between patients with or without AC. Overall survival and disease-free survival were compared between patients with and without reoperation.

BCS was undertaken with systematic resection from the subcutaneous layer to major pectoralis muscle and cutaneous resection when tumor was near the skin or when cutaneous retraction was observed. The specimen was pinned on a plate, oriented, and lateral margins inked.

We performed literature review in order to discuss these results.

Statistics

Univariate comparisons were performed using chi-square test. To assess the independent prognostic effect of the

variables, a multivariable analysis, using binary logistic regression, was performed. The multivariable model was fitted for those factors that were statistically significant in the univariate analyses. ORs and 95% CIs were estimated for each variable compared to the reference group. Survival results were compared using the log-rank test. A two-sided *P*-value of <0.05 was considered as statistically significant. Data analysis was performed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA).

Results

Patients

A total of 10,761 patients were included in the analysis: 1,161 DCIS and 9,600 invasive BC. The characteristics of patients are reported in Table 1.

Reoperation

Reoperation rate was 29.4% (3,168/10,761; 95% CI 28.5–30.3): 41.4% (481/1,161) and 28.0% (2,687/9,600) for DCIS and invasive BC, respectively. For the total cohort, all factors analyzed were significantly different for reoperation rate in the univariate analysis (Table 1). In the multivariate analysis for DCIS, tumor size ≥ 20 mm increased reoperation rate and age >50 years, P2–3 periods, and tumor localization (upper superior quadrant and external superior and inferior quadrants) decreased reoperation rates (Table 2). In multivariate analysis for invasive BC, lobular tumor, bifocal or multifocal tumors, presence of lymphovascular peritumoral invasion (LVI), DCIS component, and Her2-positive tumors increased reoperation rates and age >40 years, triple-negative tumors, NAC, and noncentral tumors decreased reoperation rates (Table 3).

Reoperation type

For patients, who needed reoperation, a mastectomy was performed at first reoperation in 51.9% (1,645/3,168; 241/481: 50.1% for DCIS and 1,404/2,687: 52.2% for invasive BC) and mastectomy was required after first reoperation with re-excision in 13.46% (205/1,523: 35 for DCIS and 170 for invasive BC) with a total mastectomy rate of 58.4% (1,850/3,168; 276/481: 57.4% for DCIS and 1,574/2,687: 58.6% for invasive BC). For DCIS, the mastectomy rate was higher for grade 2 tumors and tumor sizes ≥ 20 mm (Table 4). For invasive BC, the mastectomy rate was higher for lobular tumors, bifocal or multifocal tumors, tumor sizes ≥ 20 mm, Her2-positive tumors, and diffuse positive margins and lower for age >50 years and patients treated during the last period (Table 5).

Table 1 Reoperation rates for all patients and for DCIS or invasive BC

10,761 patients	Total		Reoperation		χ^2	P-value	DCIS n	Reoperation		χ^2	P-value	Invasive n	Reoperation		χ^2	P-value	Mastectomy (invasive) n (1,404)	χ^2	P-value	
	n	n	%	n				%	%				%							
Age, years	≤40	867	348	40.1	<0.0001		79	54.4				788	38.7				192		63.0	<0.0001
	41–50	2,364	851	36.0		259	51.4					2,105	34.1				428		59.6	
	51–74	6,563	1,799	27.4		770	37.4					5,793	26.1				709		46.9	
	≥75	967	170	17.6		53	32.1					914	16.7				75		49.0	
DCIS – IT and peripheric	No (<25%)	7,456	1,859	24.9	<0.0001							6,308	22.0				678		48.9	<0.0001
	Yes (≥25%)	3,306	1,309	39.6								3,292	39.5				726		55.8	
Focality	Unifocal	9,456	2,578	27.3	<0.0001	945	43.5			0.002		8,511	25.5				1,017		46.9	<0.0001
	Bifocal	607	308	50.7		55	45.5					552	51.3				185		65.4	
	Multifocal	251	164	65.3		17	76.5					234	64.5				131		86.8	
	Unknown	269	110	40.9		96	30.2					173	46.8				68		84.0	
Chemotherapy	No	5,751	1,357	23.6	<0.0001							4,623	19.3				363		40.8	<0.0001
	Adjuvant	4,453	1,711	38.4								4,432	38.3				983		57.9	
	Neo-adjuvant	525	91	17.3								514	17.3				55		61.8	
	ER+ Her2–	6,159	1,737	28.2	<0.0001							6,062	27.8				761		45.1	<0.0001
Phenotype	ER+ Her2+	609	219	36.0								577	35.0				107		53.0	
	ER–Her2+	284	118	41.5								260	38.8				64		63.4	
	ER–Her2–	862	201	23.3								846	22.9				106		54.6	
	ER+ Her2?	1,426	381	26.7								1,336	24.9				242		72.7	
	ER–Her2?	318	108	34.0								299	32.4				73		75.3	
	No	8,037	2,241	27.9	<0.0001							6,973	25.6				844		47.3	<0.0001
LVI	Yes	2,150	771	35.9								2,146	35.9				479		62.2	
	Unknown	574	156	27.2								481	27.2				81		61.8	
	I	2,969	715	24.1	<0.0001	205	45.4			0.013		2,955	24.0				310		43.8	<0.0001
Grade	2	4,145	1,190	28.7		420	40.0					4,125	28.6				626		53.1	
	3	2,173	678	31.2		401	44.6					2,156	31.1				384		57.2	
	No grade	16	3	18.8		117	29.1					364	35.2				84		65.6	
Global tumor size, mm	<20	5,032	833	16.6	<0.0001	468	23.7					4,566	15.8				186		25.8	<0.0001
	20–49.9	4,072	1,298	31.9		361	49.9					3,711	30.1				500		44.7	
	≥50	1,232	946	76.8		200	82.0					782	75.8				677		86.6	
Histology	DCIS	1,161	481	41.4	<0.0001															
	Ductal	7,278	1,926	26.5								7,278	26.5				948		49.2	<0.0001
	Lobular	1,215	461	37.9								1,215	37.9				289		62.7	
	Others	1,107	300	27.1								1,107	27.1				167		55.7	
Periods	1995–2004	3,407	1,117	32.8	<0.0001	283	55.1					3,124	30.8				672		69.9	<0.0001
	2005–2010	2,511	788	31.4		281	50.9					2,230	28.9				369		57.2	
	>2010	4,843	1,263	26.1		597	30.5					4,246	25.5				363		33.6	

(Continued)

Table 1 (Continued)

10,761 patients	Total	Reoperation		χ^2	DCIS	Reoperation		χ^2	Invasive	Reoperation		χ^2	Mastectomy (invasive)		χ^2
		766	27.3			<0.0001	86			46.5	0.016		503	26.3	
Stage cT	2,805	766	27.3	<0.0001	86	46.5	0.016	503	26.3	<0.0001	311	46.8	<0.0001		
0	4,003	999	25.0		8	12.5		190	24.8		464	47.6			
1	2,148	683	31.8		1,040	41.1		8,743	31.8		415	61.8			
2	174	83	47.7						47.6		69	85.2			
3	589	235	39.9	<0.0001					38.8	<0.0001	110	56.4	<0.0001		
Central	198	57	28.8						29.5		12	21.4			
Axillary									27.1		1,244	52.5			
Others															

Note: ^aMastectomy rate for invasive BC among patients with reoperation. Abbreviations: DCIS, ductal carcinoma in situ; BC, breast cancer; Her2, Her2 unknown; IT, intratumoral; LVI, lymphovascular peritumoral invasion.

Among patients with re-excision, factors associated with reoperation with mastectomy in binary logistic regression were tumor size ≥ 20 mm; multifocal tumors, which increased mastectomy rates; and age >50 years, which decreased mastectomy rates (Table 6).

Interval time

The median interval time between first surgery and reoperation for DCIS was 35 days (mean: 44.58, 95% CI 41.3–47.8) and 78 days for patients with a second reoperation (mean 90.9, 95% CI 75.9–105.8). Median interval time between first operation and radiotherapy for patients with DCIS was 55 days (mean 63, 95% CI 60.4–65.6) and for patients with re-excision (n = 238) or no reoperation (n = 562), it was 77 days (mean 89.8, 95% CI 83.4–96.1) or 47 days (mean 51.7, 95% CI 49.8–53.6), respectively.

The median interval time between first surgery and reoperation (first reoperation) for invasive BC was 29 days (mean 47.7, 95% CI 39.6–55.8) and 123 days for patients with a second reoperation (mean: 133, 95% CI 121–145). When AC was administered, reoperation was performed before or after chemotherapy. The median interval time between first surgery and reoperation for invasive BC was 28 days (mean 33, 95% CI 31.8–34.1) for patients without any treatment before reoperation (AC after reoperation or patients with previous NAC or patients without AC before reoperation) and 173.5 days (mean 179, 95% CI 174–184) for patients with AC before reoperation.

The median time interval between first operation and radiotherapy for patients with invasive BC without AC was 73 days (mean 142 days, 95% CI 14–270) and 46 days for patients with or without reoperation (mean 47.3 days, 95% CI 46–48), respectively.

For patients with invasive BC and AC, the median interval time between first operation and AC was 42 days (mean 47.3 days, 95% CI 45.8–48.9) and 34 days (mean 36.9 days, 95% CI 36–38) for patients with reoperation and without reoperation, respectively, and the median interval time between first operation and radiotherapy was 188 days (mean 186.5 days, 95% CI 184–189) and 167 days (mean 158 days, 95% CI 156–160) for patients with reoperation and without reoperation, respectively.

Survival

The median follow-up was 53.2 months (95% CI 56.7–89.0 months). Overall survival and disease-free survival were not different between patients with and without reoperation (log-rank test: 0.393 and 0.963 for invasive BC and 0.212 and 0.231 for DCIS).

Table 2 Factors associated with reoperation for DCIS BC: multivariate analysis

Reoperation DCIS		P-value	OR	95% CI	
				Inferior	Superior
Localization	Central		1		
	Axillary	0.122	0.149	0.013	1.662
	ElQ	0.052	0.481	0.230	1.008
	IlQ	0.922	1.040	0.474	2.283
	ESQ	0.036	0.531	0.295	0.958
	ISQ	0.092	0.538	0.261	1.106
	eEQ	0.572	1.233	0.596	2.554
	eInfQ	0.911	0.951	0.393	2.299
	eIntQ	0.740	1.150	0.505	2.620
	eSupQ	0.056	0.489	0.235	1.018
Age, years	≤40		1		
	41–50	0.961	0.984	0.522	1.856
	51–74	0.010	0.464	0.259	0.831
	≥75	0.054	0.425	0.177	1.016
Periods	1995–2004		1		
	2005–2010	0.019	0.601	0.392	0.920
	>2010	<0.0001	0.337	0.232	0.488
Grade	1		1		
	2	0.347	0.813	0.529	1.251
	3	0.209	0.756	0.488	1.170
	Unknown	0.028	0.499	0.268	0.929
Size, mm	<20		1		
	20–49.9	<0.0001	3.759	2.697	5.240
	≥50	<0.0001	17.76	11.18	28.21

Abbreviations: DCIS, ductal carcinoma in situ; BC, breast cancer; ElQ, external inferior quadrants; IlQ, internal inferior quadrant; ESQ, external superior quadrant; ISQ, internal superior quadrant; eEQ, equatorial external quadrant; eInfQ, equatorial inferior quadrant; eIntQ, equatorial internal quadrant; eSupQ, equatorial superior quadrant.

Discussion

In our study, the reoperation rate for DCIS was high (41.4%) but lower during the two last periods (decrease of 24.6%), and higher mastectomy rates (49.9%) were reported for tumors ≥ 20 and < 50 mm. These results are concordant with literature results.¹⁷ Higher reoperation rates were also observed in the literature survey results for lobular carcinomas. The reoperation rate for invasive BC was 28.0%, higher for young patients, triple-negative and Her2-positive tumors, lobular carcinomas, and multifocal tumors and lesser after NAC. Higher mastectomy rates for reoperation were also observed in our study mainly for these same factors. However, NAC was proposed for patients who need mastectomy before NAC or for patients with aggressive tumors (ie, SBR grade 3, Her2-positive, triple negative) and axillary involvement at ultrasonography and percutaneous biopsy.

In literature review, the mean reoperation rate (re-excision or mastectomy) was 27.49% (95% CI 27.4–27.6, range: 10.2%–34%) among 402,357 patients with BC (DCIS or invasive) operation.^{1–15}

Re-excision rates for BCS are extremely variable across the literature. This is mainly due to no clear consensus regarding the definition of a negative margin, different preoperative and intraoperative tumor localizing methods, differences in intraoperative imaging techniques, specimen inking by surgeons or pathologists, the use of shave margins, tumor vs lumpectomy size, oncoplastic resections, volume of breast surgery per year by surgeons, and surgeon threshold to offer re-excision vs mastectomy for positive margins.^{13,18,19}

When analysis of reoperation rates was performed according to three periods of treatment, we observed a decrease in reoperation rates among successive periods from 28.96% (4,594/15,861, 95% CI 28.3–29.7) to 30.66% (79,708/259,943, 95% CI 30.5–30.8) and 21.34% (20,016/93,779, 95% CI 21.1–21.6).^{1,3–7,9–15} In the study reported by Morrow et al,⁹ surgery after initial lumpectomy declined by 16% ($P < 0.001$) from 2013 to 2015.

Reoperation rates were different for invasive BC and DCIS in literature reviews: 26.56% (86,797/326,828, 95% CI 26.4–26.7, range: 10.4–30.5) and 33.1% (21,594/65,261, 95% CI 32.7–33.5, range: 8.97–41.4),^{1–3,7,14} respectively.

Table 3 Factors associated with reoperation for invasive BC: multivariate analysis

Reoperation invasive		P-value	OR	95% CI	
				Inferior	Superior
Localization	Central		1		
	Axillary	0.020	0.618	0.412	0.927
	EIQ	<0.0001	0.582	0.445	0.762
	IIQ	<0.0001	0.563	0.413	0.766
	ESQ	<0.0001	0.527	0.422	0.659
	ISQ	<0.0001	0.505	0.392	0.651
	Inf M fold	0.001	0.087	0.020	0.383
	eEQ	<0.0001	0.624	0.480	0.813
	eInfQ	<0.0001	0.431	0.310	0.601
	eIntQ	<0.0001	0.494	0.352	0.693
eSupQ	<0.0001	0.531	0.412	0.684	
Age, years	≤40		1		
	41–50	0.019	0.786	0.642	0.961
	51–74	<0.0001	0.558	0.463	0.672
	≥75	<0.0001	0.276	0.212	0.359
Periods	1995–2004		1		
	2005–2010	0.613	0.041	0.891	1.217
	>2010	0.863	0.013	0.876	1.170
NAC	NAC	0.006	0.651	0.478	0.886
Histology	Ductal		1		
	Lobular	<0.0001	0.960	1.678	2.290
	Others	0.819	0.979	0.818	1.172
Focality	Unifocal		1		
	Bifocal	<0.0001	2.911	2.398	3.534
	Multifocal	<0.0001	4.717	3.448	6.454
	Unknown	<0.0001	3.481	2.214	5.472
LVI	No		1		
	Yes	0.004	1.211	1.064	1.378
	Unknown	0.025	1.383	1.042	1.836
DCIS component	DCIS – IT/peripheric	<0.0001	2.490	2.237	2.772
Grade	1		1		
	2	0.954	0.004	0.884	1.140
	3	0.766	1.026	0.867	1.213
	Unknown	0.474	1.152	0.782	1.698
Phenotype	ER+ Her2–		1		
	ER+ Her2+	0.037	1.252	1.014	1.545
	ER– Her2+	0.001	1.692	1.235	2.317
	ER– Her2–	0.041	0.802	0.649	0.991
	ER+ Her2?	<0.0001	0.608	0.504	0.733
	ER– Her2?	0.302	0.848	0.619	1.160
Size invasive, mm	<20		1		
	20–49.9	<0.0001	1.434	1.280	1.607
	≥50	<0.0001	9.324	7.389	11.766

Abbreviations: BC, breast cancer; EIQ, external inferior quadrant; IIQ, internal inferior quadrant; ESQ, external superior quadrant; ISQ, internal superior quadrant; Inf M fold, inferior mammary fold; eEQ, equatorial external quadrant; eInfQ, equatorial inferior quadrant; eIntQ, equatorial internal quadrant; eSupQ, equatorial superior quadrant; NAC, neoadjuvant chemotherapy; LVI, lymphovascular peritumoral invasion; DCIS, ductal carcinoma in situ; IT, intratumoral.

However, reoperation rates differed between histological types of invasive BC: 26.98% for ductal invasive BC, 40.6% for lobular invasive BC, and 21.83% for others invasive histological types.²

For DCIS, there was no statistically significant difference in locoregional recurrence (LRR) for patients with margins

<2 versus ≥2 mm who received radiotherapy (10-year LRR 4.8% vs 3.3%, respectively; $P = 0.72$).²⁰ One other large study evaluating the relationship between margin width and recurrence did not identify a significant association of recurrence with margin width of ≤2 mm compared with larger margins for patients receiving radiotherapy.²¹ However, Morrow et al²²

Table 4 Factors associated with reoperation with mastectomy for DCIS BC: multivariate analysis

Mastectomy reoperation DCIS		P-value	OR	95% CI	
				Inferior	Superior
Localization	Central All others	NS	1		
Age, years	≤40		1		
	41–50	0.854	0.920	0.380	2.228
	51–74	0.740	0.870	0.381	1.986
	≥75	0.939	0.947	0.230	3.896
Periods	1995–2004		1		
	2005–2010	0.877	1.047	0.586	1.870
	>2010	0.129	0.648	0.369	1.135
Grade	1		1		
	2	0.048	1.931	1.005	3.712
	3	0.980	1.008	0.527	1.928
	Unknown	0.202	1.966	0.695	5.557
Size, mm	<20		1		
	20–49.9	0.007	2.389	1.265	4.510
	≥50	<0.0001	18.02	9.189	35.34

Abbreviation: DCIS, ductal carcinoma in situ; BC, breast cancer; NS, not significant.

Table 5 Factors associated with reoperation with mastectomy for invasive BC: multivariate analysis

Re-excision vs mastectomy Invasive		P-value	OR	95% CI	
				Inferior	Superior
Histology	Ductal		1		
	Lobular	<0.0001	1.820	1.369	2.418
	Others	0.348	1.175	0.839	1.646
LVI	No Yes	0.066	1 1.247	0.985	1.578
Periods	1995–2004		1		
	2005–2010	0.552	0.917	0.688	1.221
	>2010	<0.0001	0.429	0.328	0.562
Focality	Unifocal		1		
	Bifocal	<0.0001	2.955	2.161	4.041
	Multifocal	<0.0001	9.334	5.497	15.85
Grade	1		1		
	2	0.024	1.336	1.039	1.719
	3	0.039	1.393	1.016	1.909
DCIS component	DCIS – IT and periphric	0.393	0.911	0.736	1.128
Positive margins	Focal Diffuse	<0.0001	1 2.508	1.880	3.346
Age, years	≤40		1		
	41–50	0.835	0.963	0.673	1.377
	51–74	0.002	0.602	0.433	0.836
	≥75	0.309	0.768	0.462	1.276
Global size, mm	<20		1		
	20–49.9	<0.0001	2.372	1.856	3.032
	≥50	<0.0001	18.16	13.32	24.75
Phenotype	ER+ Her2–		1		
	ER+ Her2+	0.048	1.453	1.003	2.105
	ER– Her2+	0.007	2.085	1.228	3.540
	ER– Her2–	0.20	1.294	0.873	1.919

Abbreviations: BC, breast cancer; LVI, lymphovascular peritumoral invasion; DCIS, ductal carcinoma in situ; IT, intratumoral.

Table 6 Factors associated with third operation with mastectomy: multivariate analysis

Factors of mastectomy third operation Among re-excision		P-value	OR	95% CI	
				Inferior	Superior
Histology	DCIS		1		
	Ductal	0.937	1.033	0.463	2.305
	Lobular	0.622	1.244	0.523	2.960
	Others	0.903	1.060	0.414	2.717
Global size, mm	<20		1		
	20–49.9	<0.0001	2.374	1.463	3.852
	≥50	<0.0001	16.72	9.841	28.42
Focality	Unifocal		1		
	Bifocal	0.205	1.471	0.809	2.675
	Multifocal	0.017	3.120	1.225	7.948
LVI	No		1		
	Yes	0.532	0.868	0.556	1.355
DCIS component	DCIS – IT and peripheric	0.539	0.884	0.596	1.311
Phenotype	ER+ Her2–		1		
	ER+ Her2+	0.175	1.503	0.834	2.709
	ER– Her2+	0.524	1.338	0.546	3.277
	ER– Her2–	0.787	0.896	0.403	1.989
Age, years	≤40		1		
	41–50	0.811	1.073	0.601	1.916
	51–74	0.005	0.448	0.256	0.784
	≥75	0.033	0.281	0.087	0.902

Abbreviations: DCIS, ductal carcinoma in situ; LVI, lymphovascular peritumoral invasion; IT, intratumoral.

reported in 2016 that 2 mm margin minimizes the risk of ipsilateral breast tumor recurrence (IBTR) compared with smaller negative margins, using a meta-analysis of margin width and IBTR from a systematic review.

A conservative reoperation was done in ~50% of patients with DCIS or ductal invasive BC and lesser for lobular invasive BC (~30%) with a decrease in mastectomy rates among successive periods analyzed. In our study, interval times between first surgery and adjuvant treatments increased for patients who needed reoperation but without significant impact on survival.

A third intervention for mastectomy had been reported in three studies,^{1,3,6} and in our study: mastectomy rate after re-excision was 13.54% (1,059/7,818, 95% CI 12.8–14.3). Mastectomy rates among 108,446 patients with reoperation in the literature review were 40.77% (95% CI 40.5–41.1, range: 10.7–62.1) and 55.4% (95% CI 54.6–56.2) for studies with analysis of a third intervention for mastectomy (8,309/14,998).^{1,3,6}

When analysis of mastectomy rates was performed according to the three periods of treatment (DCIS and invasive), we observed a decrease in mastectomy rates among successive periods from 59.62% (2,739/4,594, 95% CI 58.2–61.0) to 48.8% (2,532/5,191, 95% CI 47.4–50.2) and 36.81% (6,892/17,903, 95% CI 36.1–37.5).^{3,4,6,7,9,11} In the

study reported by Wilke et al,⁵ the mastectomy rate was 37.9% for patients operated between 2004 and 2010.

Mastectomy rates were different according to histological types of tumor: 49.7% (1,960/3,942, 95% CI 48.1–51.3) for DCIS,^{1,4–6,8,11,13,14} 50.9% (9,446/18,566, 95% CI 50.2–51.6) for invasive BC, 55.7% (95% CI 54.5–56.9) for ductal invasive BC, 70.5% (95% CI 68.3–72.7) for lobular invasive BC, and 60.9% (95% CI 57.8–64.0) for other invasive histological types.²

After initial oncoplastic surgery, close or positive margins was reported in 12.3% (342/2,772, 95% CI 11.1–13.5) of patients in a meta-analysis reported in 2014,²³ and the mastectomy rate for reoperation after initial oncoplastic resection was high: 64% in Clough et al's²⁴ study and 61.3% in Losken et al's²³ meta-analysis.

Interval time between surgery or first surgery for patients who need reoperation and adjuvant treatment: even if interval time was higher for patients with reoperation, we did not observe impact on survival results between patients with or without reoperation.

Conclusion

A decrease of reoperation rate and mastectomy rate in future years is probably in relation with negative margin resection without several mm of margin, more accurate preoperative radiologic analysis, particularly for lobular and multifocal

tumors; more oncoplastic resections; and more NAC. A third intervention with mastectomy was required in about 13%–14% of patients. Information about risk of a third intervention should be given to patients who require reoperation.

Even if interval time between surgery and adjuvant treatments was higher for patients with reoperation, survival results were not different between patients with and without reoperation.

Ethics approval and consent to participate

This work was approved by our institutional review board (IPC – Comité d’Orientation Stratégique). All procedures performed in this study involving human participants were done in accordance with the French ethical standards and 2008 Declaration of Helsinki. All included patients provided written informed consent before surgery, including for the use of their data for research.

Author contributions

All authors contributed equally to this study. All authors contributed toward data analysis, drafting and critically revising the paper, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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