Resection of Cavity Shave Margins in Stage 0–III Breast Cancer Patients Undergoing Breast Conserving Surgery

A Prospective Multicenter Randomized Controlled Trial

Elisabeth Dupont, MD,[*] Theodore Tsangaris, MD,† Carlos Garcia-Cantu, MD,‡ Marissa Howard-McNatt, MD,§ Akiko Chiba, MD,§ Adam C. Berger, MD,† Edward A. Levine, MD,§ Jennifer S. Gass, MD,¶ Kristalyn Gallagher, DO,|| Sharon S. Lum, MD,[**] Ricardo D. Martinez, MD,‡ Alliric I. Willis, MD,† Sonali V. Pandya, MD,¶ Eric A. Brown, MD,†† Andrew Fenton, MD,‡‡ Amanda Mendiola, MD,‡‡ Mary Murray, MD,‡‡ Naveenraj L. Solomon, MD,[**] Maheswari Senthil, MD,[**] David W. Ollila, MD,|| David Edmonson, MD,¶ Melissa Lazar, MD,† Jukes P. Namm, MD,[**] Fangyong Li, MPH,§§ Meghan Butler, BS,§§ Noreen E. McGowan, RN,[*] Maria E. Herrera, RN,‡ Yoana P. Avitan, CCRC,|| Brian Yoder, DO,¶¶ Laura L. Walters, MD, PhD,†† Tara McPartland, MSW,§§ and Anees B. Chagpar, MD, MSc, MPH, MA, MBA§§✉

Objective: Single-center studies have demonstrated that resection of cavity shave margins (CSM) halves the rate of positive margins and re-excision in breast cancer patients undergoing partial mastectomy (PM). We sought to determine if these findings were externally generalizable across practice settings.

Methods: In this multicenter randomized controlled trial occurring in 9 centers across the United States, stage 0–III breast cancer patients undergoing PM were randomly assigned to either have resection of CSM (''shave'' group) or not (''no shave'' group). Randomization occurred intraoperatively, after the surgeon had completed their standard PM. Primary outcome measures were positive margin and re-excision rates.

Results: Between July 28, 2016 and April 13, 2018, 400 patients were enrolled in this trial. Four patients (2 in each arm) did not meet inclusion criteria after randomization, leaving 396 patients for analysis: 196 in the ''shave'' group and 200 to the ''no shave'' group. Median patient age was 65 years (range; 29–94). Groups were well matched at baseline for demographic and clinicopathologic factors. Prior to randomization, positive margin rates were similar in the ''shave'' and ''no shave'' groups (76/196 (38.8%) vs. 72/200 (36.0%), respectively, $P = 0.604$). After randomization, those in the ''shave'' group were significantly less likely than those in the ''no shave'' group to have positive margins (19/196 (9.7%) vs. 72/200 (36.0%), $P < 0.001$), and to require re-excision or mastectomy for margin clearance (17/196 (8.7%) vs. 47/200 (23.5%), $P < 0.001$).

Conclusion: Resection of CSM significantly reduces positive margin and re-excision rates in patients undergoing PM.

From the [*]Watson Clinic, Lakeland, FL; †Thomas Jefferson University, Philadelphia, PA; ‡Doctors Hospital at Renaissance, Edinburg, TX; §Wake Forest University, Winston-Salem, NC; ¶Women and Infants Hospital, Providence, RI; ||University of North Carolina, Chapel Hill, NC; [**]Loma Linda University, Loma Linda, CA; ††Beaumont Hospital, Troy, MI; ‡‡Cleveland Clinic Akron General, Akron, OH; §§Yale University, New Haven, CT; and ¶¶MicroPath Laboratories, Lakeland, FL.

✉anees.chagpar@yale.edu.

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While breast conservation yields overall survival outcomes equivalent to mastectomy,[1,2] obtaining negative margins is critical to reducing local recurrence.[3] Single-center studies have shown that resection of additional tissue circumferentially around the cavity from which the tumor was resected (cavity shave margins [CSM]) can reduce the positive margin rate by 50%.[4,5] These findings have not been widely validated in a robust fashion across a range of practice settings.[6] Some argue that resection of CSM may not be useful for surgeons who take selective margins based on intraoperative imaging, use oncoplastic techniques, or have a positive margin rate less than 25%. External generalizability remains questionable. We sought to determine, in a multicenter randomized controlled trial, the effect of resection of CSM on margin status and re-excision rate after partial mastectomy.

METHODS

Study Design

Nine centers from across the United States (Table 1) participated in this prospective randomized controlled trial. This study was approved by the Yale University Human Investigations Committee, and each of the participating site's Institutional Review Board. The study protocol is attached in the Appendix here.

Participants

This trial enrolled 400 female Stage 0–III breast cancer patients aged 18 years or older undergoing partial mastectomy. All patients were diagnosed on core needle biopsy. Exclusion criteria included excisional biopsy for diagnosis, prior attempt at partial mastectomy, bilateral breast cancer, and plan for intraoperative radiation therapy. Patients were screened for eligibility at each site, and written informed consent was obtained.

Randomization

Each site's patients were stratified according to stage (stage 0–II vs. stage III), and in each stratum, randomly assigned in a 1:1 ratio to either have circumferential CSM excised at the time of

TABLE 1. Participating Sites

Site	Location	Practice Type	No. (%) Patients Accrued	No. Surgeons	Positive Margin Rate	
					"Shave"	"No Shave"
Watson Clinic	Lakeland, FL	Community	92 (23.2)	1	3/45 (6.7%)	9/47 (19.1%)
Thomas Jefferson University	Philadelphia, PA	University	71 (17.9)	4	3/35 (8.6%)	13/36 (36.1%)
Doctors Hospital Renaissance	Edinburg, TX	Community	60 (15.2)	4	5/30 (16.7%)	10/30 (33.3%)
Wake Forest University	Winston-Salem, NC	University	58 (14.6)	3	4/29 (13.8%)	17/29 (58.6%)
Women's and Infants Hospital of Rhode Island	Providence, RI	Academic-Affiliated Hospital	33 (8.3)	4	1/16 (6.3%)	6/17 (35.3%)
Loma Linda University	Loma Linda, CA	University	27 (6.8)	4	2/13 (15.4%)	4/14 (28.6%)
Cleveland Clinic Akron General	Akron, OH	Academic-Affiliated Hospital	26 (6.6)	3	1/14 (7.1%)	5/12 (41.7%)
University of North Carolina Chapel Hill	Chapel Hill, NC	University	18 (4.5)	2	0/8 (0%)	5/10 (50.0%)
William Beaumont Hospital	Troy, MI	Community	11 (2.8)	1	0/6 (0%)	3/5 (60.0%)

surgery ("shave" group) or not ("no shave" group). Randomization lists were generated a priori by the Yale Center for Analytical Sciences; study personnel were unaware of study group assignments until the point of randomization intraoperatively.

Procedures

Surgeons were instructed to perform partial mastectomy according to their usual practice, including excision of selective margins based on intraoperative imaging and/or their own gross evaluation. Intraoperative pathologic margin evaluation was not permitted. Once the surgeon completed the partial mastectomy, a phone call was placed to the coordinating center at Yale and the patient's randomization group was revealed to the surgical team (Fig. 1). For patients randomized to the "no shave" group, surgeons were instructed to close with no further excision. For patients randomized to the "shave" group, surgeons were instructed to take CSM encompassing the entire partial mastectomy cavity. Superior, medial, inferior, and lateral margins were mandated; anterior and posterior margins could be omitted if resection had extended to the skin or pectoralis fascia, respectively. Thickness of CSM was left to the discretion of the surgeon. Partial mastectomy specimens were oriented at a minimum of 2

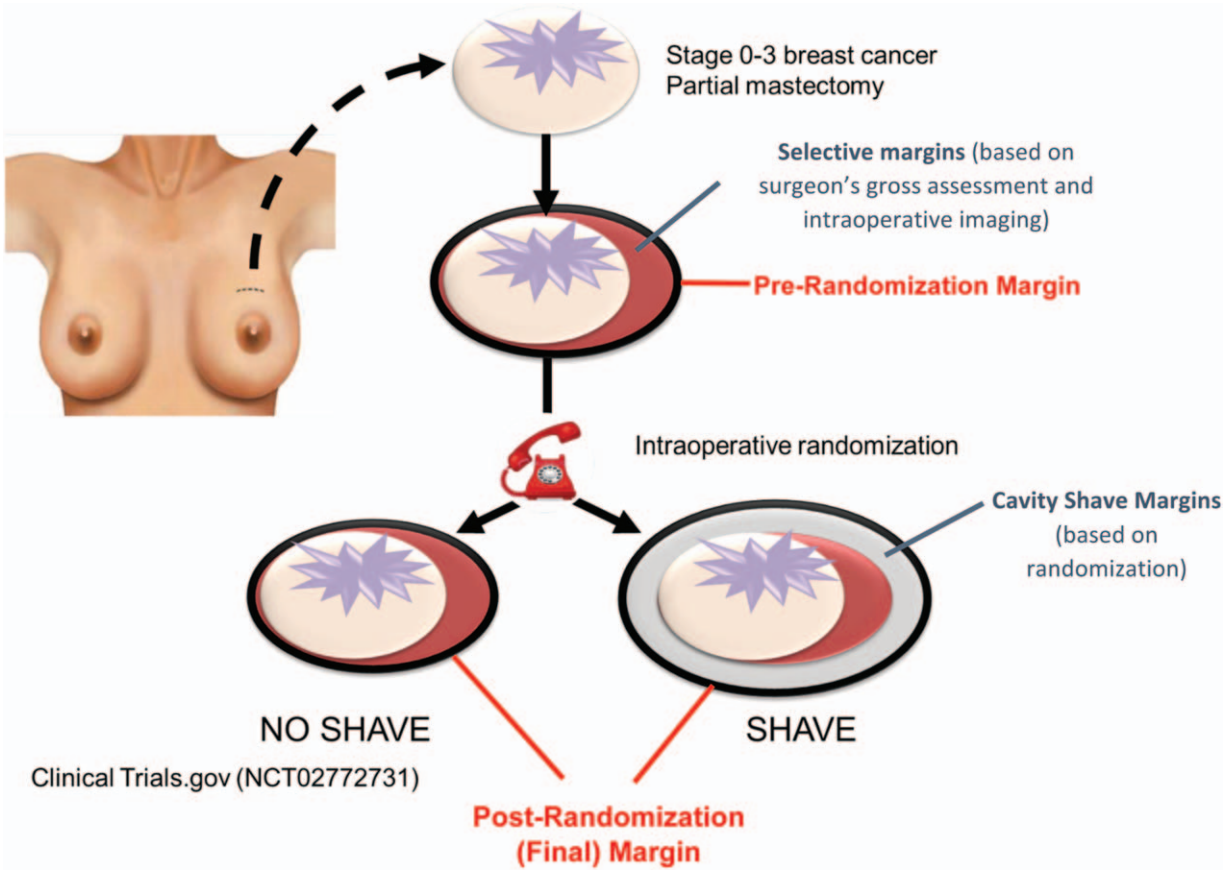

FIGURE 1. Study schema.

orthogonal faces; additional margins were designated by location and oriented to the true margin.

Partial mastectomy specimens were processed per local policies, serially sectioned for gross evaluation, with representative sections submitted for histologic evaluation. CSM were generally submitted in their entirety. Sections were taken perpendicular to each margin allowing quantitative margin distances to be reported. Pathologists were blinded as to which patients participated in the trial.

Outcomes

The primary end point of this trial was the final positive margin rate, defined by the study protocol as invasive cancer touching the edge of the specimen and/or ductal carcinoma in situ (DCIS) within 2 mm of the resected edge.[7,8] The decision to re-excise a positive final margin was left to the surgeon's discretion. Secondary end points included volume of tissue excised (length × width × height for all specimens removed) and postoperative complications (hematomas/abscesses requiring operative intervention and seromas requiring drainage). Cosmetic outcome and quality of life (each measured at 1- and 5-yrs), and 5-year local recurrence rate will be reported in due course.

Statistical Analysis

Sample size calculation was based on the primary endpoint (positive margin rate) using PASS 2012 (Kayesville, UT). The original SHAVE trial observed a 19% positive margin rate in the ''shave'' arm compared to 34% in the ''no shave'' arm.[4] We estimated that a sample size of 180 per arm would allow detection of the same difference with 90% power and a 0.05 two-sided significance. In the SHAVE trial, we observed a re-excision rate of 10% in the ''shave'' arm and 21% in the ''no shave'' arm.[4] This sample size and a 0.05 two-sided significance level would provide 90% power to detect a difference of 9% re-excision in ''shave'' arm and 21% in ''no shave'' arm.

Group comparisons were made using Fisher exact or chi square tests for categorical variables and Mann–Whitney *U* tests for continuous variables. Multivariate logistic regression analysis was used to assess the effect of resection of CSM, independent of potential confounders. IBM SPSS Statistics version 24.0 was used for statistical analysis.

The study was monitored biannually by the Yale Cancer Center Data Safety Monitoring Committee. Site initiation visits, including review of good clinical practice, the study protocol, and technique of resection of CSM, were conducted for each site by the senior author and staff from the Yale Center for Clinical Investigation (YCCI). The YCCI Office of Quality Assurance and Training remotely monitored each site according to a schedule and conducted internal audits of the trial to ensure data integrity and study compliance. The trial was registered at ClinicalTrials.gov (NCT02772731).

RESULTS

Between July 28, 2016 and April 13, 2018, 400 patients were enrolled in this trial. Four patients (2 in each arm) were found not to meet inclusion criteria after randomization. These were excluded, leaving 396 patients for analysis (see Fig. 2).

Median patient age was 65 years (range, 29–94). Median follow-up time was 13 months (range, 4–31). On final pathology, 117 patients (29.5%) had invasive disease, 72 (18.8%) had DCIS, and 178 (44.9%) had both. Twenty-nine (7.3%) patients had no further disease at the time of final pathology, either due to pathologic complete response to neoadjuvant chemotherapy (n = 14) or because all disease was removed on core needle biopsy (n = 15). Median invasive tumor size was 1.2 cm (range, 0.1–8.0). Of cases with DCIS alone, the median extent was 1.0 cm (range, 0.1–6.4). Of cases with DCIS and invasive carcinoma, 57 (31.8%) had an extensive intraductal component (EIC; defined as DCIS comprising 25% or more of the tumor volume).

Baseline Characteristics

A total of 196 patients (49.5%) were randomized to the ''shave'' arm, and 200 (50.5%) to the ''no shave'' arm. The groups were well matched with respect to demographic and clinicopathological variables at baseline (Table 2). Twenty-six surgeons participated in the trial, each with a similar proportion of cases in each arm ($P = 0.412$). More patients in the ''no shave'' arm had selective margins resected prior to randomization than in the ''shave'' group (133/200 (66.5%) vs. 96/196 (49.2%), respectively, $P = 0.001$). After resection of these selective margins, but prior to randomization, the rate of positive margins was not significantly different between the ''shave'' and ''no shave'' group (76/196 (38.8%) vs. 72/200 (36.0%), respectively, $P = 0.604$).

Positive Margin Rate

After randomization 91 patients (23.0%) had a final positive margin defined as invasive cancer at ink and/or DCIS within 2 mm of the resected edge: 31 (34.1%) had a margin involving invasive cancer, 53 (58.2%) had DCIS within 2 mm, and 7 (7.7%) had both. Patients in the ''shave'' group had a significantly lower positive margin rate after randomization than those in the ''no shave'' group (19/196 (9.7%) vs. 72/200 (36.0%), $P < 0.001$). Patients with DCIS and those with larger invasive tumor size were more likely to have a positive final margin; no other clinicopathologic factors predicted positive margins (Table 3). On multivariate analysis controlling for the presence of DCIS and the size of invasive cancer, randomization to the ''no shave'' arm significantly increased the odds of a positive final margin (OR = 7.75; 95% CI: 3.86–15.58, $P < 0.001$). The individual surgeon did not have a significant influence on the final positive rate ($P = 0.442$) independent of these factors.

Re-excision Rate

Of the 91 patients who had a positive final margin, 61 (67.0%) underwent a re-excision. Re-excision was left to the discretion of the surgeon. Of the 30 patients in our study who did not have a re-excision, 19 (63.0%) had DCIS within 2 mm of the margin with concomitant invasive disease not at the margin—10 of whom had EIC. Seven patients (23.3%) had DCIS alone within 2 mm of the margin, and 3 patients (10.0%) had invasive disease at the resected margin (in 2 of these, the involved margin was either anterior or posterior). One patient (3.3%) was recommended to have a re-excision but did not comply.

Patients randomized to the ''shave'' arm were significantly less likely to have a re-excision than those randomized to the ''no shave'' arm (17/196 (8.7%) vs. 47/200 (23.5%), $P < 0.001$). Four patients, all in the ''no shave'' group, required a second re-excision for margin clearance; 2 of these required a mastectomy ($P < 0.001$ compared to the ''shave'' group).

Volume of Tissue Excised

The volume of tissue resected (including selective margins) prior to randomization was similar between the ''shave'' and ''no shave'' groups (61.6 cm^3 vs. 73.4 cm^3, respectively, $P = 0.054$). The median cumulative volume of the CSM resected in the ''shave'' arm was 36.1 cm^3. There was a correlation between the volume of the CSM and the volume of tissue resected prior to randomization (Spearman correlation coefficient, 0.616, $P < 0.001$), suggesting that the volume of CSM was related to the size of the cavity itself. The median total volume of tissue resected was significantly greater

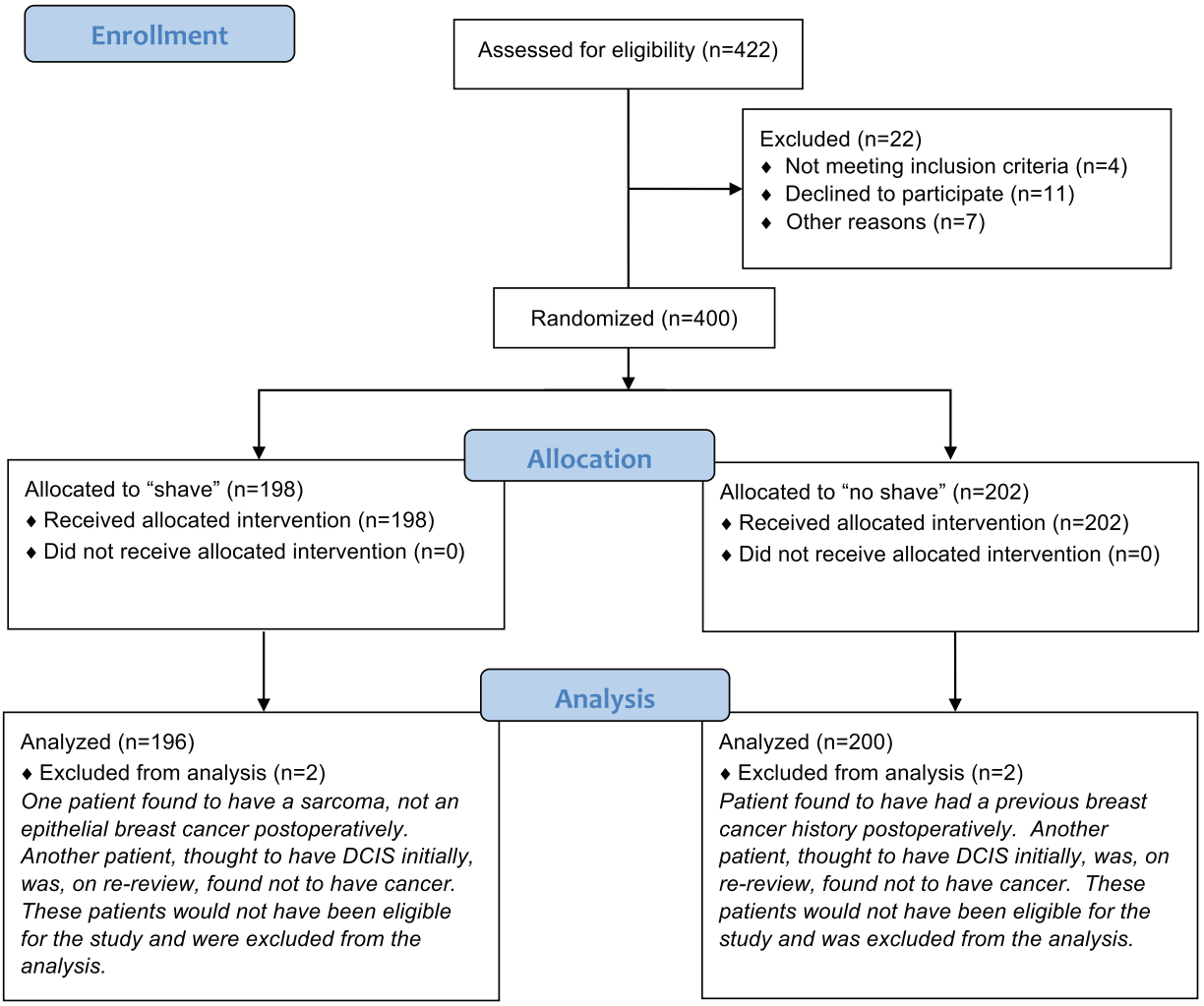

FIGURE 2. CONSORT diagram.

in patients randomized to the "shave" arm compared to the "no shave" arm (101.1 cm^3 vs. 73.4 cm^3, respectively, $P < 0.001$).

Postoperative Complications

There was no significant difference in the postoperative complication rate between the "shave" and "no shave" arm (5/196 (2.6%) vs. 2/200 (1.0%), respectively, $P = 0.280$). There was no significant difference in the rate of seromas (1.5% vs. 0.5%, $P = 0.368$), hematomas (0.5% vs. 0.5%, $P = 1.000$), or abscesses requiring drainage (0.5% vs. 0%, $P = 0.495$) between the "shave" and "no shave" arm, respectively.

Selective Margins and Oncoplastic Procedures

Resection of selective margins had no impact on final post-randomization positive margin rates compared with those who did not have selective margins taken prior to randomization (Table 3). Excision of circumferential CSM, however, significantly reduced the likelihood of a final positive margin when compared to those who did not have CSM taken, both in the cohort of patients who had selective margins taken prior to randomization (6.3% vs. 30.1%, $P < 0.001$), and in those who did not (13.0% vs. 47.8%, $P < 0.001$).

Oncoplastic resection and/or complex wound closure was performed in 91 (23.0%) patients; these were equally distributed between the "shave" and "no shave" arms (23.5% vs. 22.5%, respectively, $P = 0.905$). The positive margin rate was significantly lower in the "shave" arm than the "no shave" arm, regardless of whether patients had an oncoplastic procedure/complex closure (6.5% vs. 33.3%, $P = 0.001$) or not (10.7% vs. 36.8%, $P < 0.001$).

Further Cancer in Shave Margins

Of the 76 patients in the "shave" arm who had a positive margin prior to randomization, further cancer was detected in 26 (34.2%) in the CSM specimen; 59 (77.6%) had their positive margins cleared after having CSM resected. Of the 120 patients in the "shave" arm who had negative margins prior to randomization, cancer was found in the CSM in 17 (14.2%); all but 2 of these patients had this cancer excised with clear margins with the resection of CSM.

DISCUSSION

In this multicenter, prospective, randomized controlled trial, we found that resection of CSM reduced the rates of positive margins by over 70% and re-excision by nearly 2 thirds. These findings echo prior single institution randomized controlled trials that evaluated resection of CSM in this setting,[4,5] as well as a plethora of data from

TABLE 2. Characteristics of Patients at Baseline

Characteristic	Shave (n = 196)	No Shave (n = 200)
Age—yr		
Median	67	64
Range	36–94	29–89
Race/ethnicity —no. (%)*		
White	172 (87.8)	164 (82.0)
Black	20 (10.2)	32 (16.0)
Asian	2 (1.0)	2 (1.0)
Other	2 (1.0)	2 (1.0)
Hispanic ethnic group—no./total no. (%)*	28/193 (14.5)	32/198 (16.2)
Palpable tumor—no. (%)	57 (29.1)	56 (28.0)
Clinical stage—no. (%)		
0	38 (19.4)	33 (16.5)
I	130 (66.3)	149 (74.5)
II	27 (13.8)	16 (8.0)
III	1 (0.5)	2 (1.0)
Invasive tumor size in greatest diameter—cm		
Median	1.3	1.2
Range	0.1–8.0	0.1–7.5
Invasive histologic subtype—no./total no. (%)		
Ductal	125/143 (87.4)	137/152 (90.1)
Lobular	15/143 (10.5)	13/152 (8.6)
Mucinous	2/143 (1.4)	2/152 (1.3)
Other	1/143 (0.7)	0/152 (0)
Node-positive disease—no./total no. (%)	24/147 (16.3)	16/150 (10.7)
Extensive intraductal component—no./total no. (%)	23/90 (25.6)	34/89 (38.2)
DCIS size in greatest diameter, cm†		
Median	1.0	1.0
Range	0.1–6.4	0.1–5.5
Neoadjuvant chemotherapy—no. (%)	15 (7.7)	19 (9.5)
No residual disease—no. (%)	14 (7.1)	15 (7.5)
Selective margins taken prior to randomization—no. (%)	96 (49.0)	133 (66.5)
Initial volume of tissue resected, including selective margins, before randomization, cm^3		
Median	61.7	73.4
Range	2.9–554.5	7.6–1038.8
Positive margins before randomization—no. (%)	76 (38.8)	72 (36.0)

*Race and ethnicity were self-reported; ethnicity not stated in 5 patients.
†DCIS size in patients with DCIS alone (n = 72).

TABLE 3. Factors Associated With Final Margin Positivity

Characteristic	Positive Margin	*P* Value
Randomization arm—no./total no. (%)		<0.001
Shave	19/196 (9.7)	
No shave	72/200 (36.0)	
Race/ethnicity—no. (%)*		0.502
White	81/336 (24.1)	
Black	9/52 (17.3)	
Asian	1/4 (25.0)	
Other	0/4 (0)	
Hispanic ethnic group—no./total no. (%)*		0.268
Yes	14/60 (23.3)	
No	77/331 (23.3)	
Palpable tumor—no. (%)		0.292
Yes	30/113 (26.5)	
No	61/283 (21.6)	
Clinical stage—no. (%)		0.387
0	19/71 (26.8)	
I	60/279 (21.5)	
II	12/43 (27.9)	
III	0/3 (0)	
Median invasive tumor size in greatest diameter—cm†	1.5	0.022
Invasive histologic subtype—no./total no. (%)		0.419
Ductal	65/262 (24.8)	
Lobular	7/28 (25.0)	
Mucinous	0/4 (0)	
Other	0/1 (0)	
Presence of DCIS—no./total no. (%)		<0.001
Yes	72/250 (28.8)	
No	19/146 (13.0)	
Extensive intraductal component—no./total no. (%)		0.162
Yes	21/57 (36.8)	
No	32/122 (26.2)	
Neoadjuvant chemotherapy—no. (%)		0.527
Yes	6/34 (17.6)	
No	85/362 (23.5)	
Selective margins taken prior to randomization—no. (%)		0.117
Yes	46/229 (20.1)	
No	45/167 (26.9)	

*Race and ethnicity were self-reported; ethnicity not stated in 5 patients.
†The comparator was the group with negative final margins, in whom the median invasive tumor size was 1.2 cm.

retrospective studies (Table 4).[8–15] We found that, across institutions, resection of CSM resulted in substantial reduction in the positive margin rate (Table 1). Further, we demonstrated that the effect of resecting CSM in reducing positive margin and re-excision rates holds regardless of a surgeon's prior positive margin rate, use of selective margins or oncoplastic surgery.

Some have argued that the value of resecting CSM is limited to surgeons who have positive margin rates greater than 25%.[16,17] Of the 26 surgeons who participated in this trial, 3 had a positive margin rate less than 25% prior to randomization. When considering the 106 cases of these surgeons, resection of CSM still resulted in a 68% reduction in the positive margin rate (5.8% vs. 18.5%, in the ''shave'' vs. ''no shave'' groups). Controlling for the presence of DCIS and invasive tumor size (factors found to affect positive margin rates), patients in the ''no shave'' group were significantly more likely to have positive final margins compared to those in the ''shave'' group (OR: 9.42; 95% CI: 1.02–87.15, $P = 0.048$), even for surgeons with low positive margin rates.

While resection of selective margins reduced the prerandomization positive margin rate compared to those who did not have selective margins taken (32.3% vs. 44.3%, $P = 0.016$), the rate of positive margins was still greater than 30% despite taking selective margins. This is similar to our previous trial findings,[4] and those of Huston et al.[18] However, resection of circumferential CSM significantly reduced final positive margin rate, even in the group of patients who had selective margins taken prior to randomization (6.3% to 30.1%, ''shave'' vs. ''no shave'', $P < 0.001$).

There was no difference in the rate of oncoplastic procedures or complex closures between the 2 arms of this trial. The positive margin rate was significantly lower in the ''shave'' arm than the ''no shave'' arm, regardless of whether patients had an oncoplastic procedure/complex closure (6.5% vs. 33.3%, $P = 0.001$) or not (10.7% vs. 36.8%, $P < 0.001$). These results are similar to those of Corsi et al,[9] who treated all patients with an oncoplastic approach. These data suggest that the technique of resection of CSM is not

TABLE 4. Studies Evaluating Cavity Shave Margins on Margin Positivity and Re-excision Rates

Study	Type	N	Positive Margin Rate (%)			Re-excision Rate (%)		
			"Shave"	"No Shave"	*P* Value	"Shave"	"No Shave"	*P* Value
Current	Multicenter RCT	396	9.7	36.0	<0.001	8.7	23.5	<0.001
Chagpar et al[4]	Single center RCT	235	19	34	0.01	10	21	0.02
Jones et al[5]	Single center RCT	75	15.6	45.2	0.005			
Corsi et al[9]	Retrospective	976	1.7	25.6	<0.001	1.9	18.9	<0.001
Marudanayagam et al[10]	Retrospective	786				5.6	12.5	<0.01
Unzeitig et al[11]	Retrospective	522				23.9	46.8	0.0003
Rizzo et al[12]	Retrospective	320	10.8	24.8	<0.05			
Kobbermann et al[13]	Retrospective	138				21.7	42.0	0.011
Mook et al[14]	Retrospective	144				18.1	34.6	0.03
Moo et al[15]	Retrospective	544	11	31*	<0.0001			

*Calculated based on a positive margin rate of 49% for 124 patients with tangential margins, and 15% for 140 patients with perpendicular margins. *P* value is per reported in Mook et al, based on 3-way comparison.

mutually exclusive from oncoplastic surgery; rather, the former may improve the margin positivity rate of the latter.[6]

Resection of CSM may also uncover occult multifocal disease in patients who have negative margins. We found that 14% of patients who had negative margins had further disease in their CSM, similar to the 12% finding of the same in the SHAVE trial.[4] Retrospective studies have found this rate to be between 8% and 19%.[19,20] We found that 1.7% of patients who had a negative margin prior to resection of CSM converted to being margin positive due to occult multifocal disease, similar to other studies.[4,18] The implication of finding and resecting of occult multifocal disease is currently unclear, given the nearly ubiquitous use of systemic and/or radiation therapy. Whether this has an impact on locoregional recurrence, particularly in those patients who decline adjuvant therapy, remains to be seen. We will report 5-year locoregional recurrence rates in due course.

Those randomized to the "shave" arm had a larger volume of tissue resected than those in the "no shave" group. The median total volume of CSM in this study (36.1 cm^3) is identical to the median volume of CSM in the SHAVE trial (36.1 cm^3).[4] This resection of further tissue, however, did not result in a greater rate of seromas, hematomas, or abscesses in either trial.[4] While some have argued that resection of a larger volume of tissue may negatively affect cosmetic outcome, we did not find any difference in patient-reported cosmetic outcome between the 2 groups postoperatively in the SHAVE trial.[4] Cosmesis may change with adjuvant radiation therapy, however. In the current study, cosmetic outcome in the "shave" and "no shave" groups will be assessed at 1- and 5 years to take into account the impact of adjuvant radiation therapy.

In conclusion, this multicenter trial demonstrates that, in patients with stage 0–III breast cancer undergoing breast conserving surgery, resection of CSM reduces the positive margin rate by over 70% and the re-excision rate by nearly two-thirds. These findings hold across institutions with various practice settings, and surgeons varying in operative technique and a priori margin positivity rate.

REFERENCES

1. Fisher B, Anderson S, Bryant J, et al. Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for the treatment of invasive breast cancer. *N Engl J Med*. 2002;347:1233–1241.
2. Veronesi U, Cascinelli N, Mariani L, et al. Twenty-year follow-up of a randomized study comparing breast-conserving surgery with radical mastectomy for early breast cancer. *N Engl J Med*. 2002;347:1227–1232.
3. Houssami N, Macaskill P, Marinovich ML, et al. The association of surgical margins and local recurrence in women with early-stage invasive breast cancer treated with breast-conserving therapy: a meta-analysis. *Ann Surg Oncol*. 2014;21:717–730.
4. Chagpar AB, Killelea BK, Tsangaris TN, et al. A randomized, controlled trial of cavity shave margins in breast cancer. *N Engl J Med*. 2015;373:503–510.
5. Jones V, Linebarger J, Perez S, et al. Excising additional margins at initial breast-conserving surgery (BCS) reduces the need for re-excision in a predominantly African American Population: a report of a randomized prospective study in a public hospital. *Ann Surg Oncol*. 2016;23:456–464.
6. Chagpar AB, Trial I. Cavity shave margins in breast cancer. *N Engl J Med*. 2015;373:2187–2188.
7. Moran MS, Schnitt SJ, Giuliano AE, et al. Society of Surgical Oncology-American Society for Radiation Oncology consensus guideline on margins for breast-conserving surgery with whole-breast irradiation in stages I and II invasive breast cancer. *Ann Surg Oncol*. 2014;21:704–716.
8. Morrow M, Van Zee KJ, Solin LJ, et al. Society of Surgical Oncology-American Society for Radiation Oncology-American Society of Clinical Oncology Consensus Guideline on margins for breast-conserving surgery with whole-breast irradiation in ductal carcinoma in situ. *Ann Surg Oncol*. 2016;23:3801–3810.
9. Corsi F, Sorrentino L, Bonzini M, et al. Cavity shaving reduces involved margins and reinterventions without increasing costs in breast-conserving surgery: a propensity score-matched study. *Ann Surg Oncol*. 2017;24:1516–1524.
10. Marudanayagam R, Singhal R, Tanchel B, et al. Effect of cavity shaving on reoperation rate following breast-conserving surgery. *Breast J*. 2008;14:570–573.
11. Unzeitig A, Kobbermann A, Xie XJ, et al. Influence of surgical technique on mastectomy and reexcision rates in breast-conserving therapy for cancer. *Int J Surg Oncol*. 2012;2012:725121.
12. Rizzo M, Iyengar R, Gabram SG, et al. The effects of additional tumor cavity sampling at the time of breast-conserving surgery on final margin status, volume of resection, and pathologist workload. *Ann Surg Oncol*. 2010;17:228–234.
13. Kobbermann A, Unzeitig A, Xie XJ, et al. Impact of routine cavity shave margins on breast cancer re-excision rates. *Ann Surg Oncol*. 2011;18:1349–1355.
14. Mook J, Klein R, Kobbermann A, et al. Volume of excision and cosmesis with routine cavity shave margins technique. *Ann Surg Oncol*. 2012;19:886–891.
15. Moo TA, Choi L, Culpepper C, et al. Impact of margin assessment method on positive margin rate and total volume excised. *Ann Surg Oncol*. 2014;21:86–92.
16. Pajak C, Pao J, Ghuman A, et al. Routine shave margins are not necessary in early stage breast cancer treated with Breast Conserving Surgery. *Am J Surg*. 2018;215:922–925.
17. Gray RJ, Pockaj BA, Garvey E, et al. Intraoperative margin management in breast-conserving surgery: a systematic review of the literature. *Ann Surg Oncol*. 2018;25:18–27.
18. Huston TL, Pigalarga R, Osborne MP, et al. The influence of additional surgical margins on the total specimen volume excised and the reoperative rate after breast-conserving surgery. *Am J Surg*. 2006;192:509–512.
19. Tang R, Coopey SB, Specht MC, et al. Lumpectomy specimen margins are not reliable in predicting residual disease in breast conserving surgery. *Am J Surg*. 2015;210:93–98.
20. Hequet D, Bricou A, Koual M, et al. Systematic cavity shaving: modifications of breast cancer management and long-term local recurrence, a multicentre study. *Eur J Surg Oncol*. 2013;39:899–905.