ORIGINAL ARTICLE

Long-Term Results of Conservative Surgery and Radiotherapy for Ductal Carcinoma In Situ Using Lung Density Correction: The University of Michigan Experience

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■ **Abstract:** The purpose of the study was to review the treatment outcomes of 198 patients treated with breast-conserving surgery (BCS) and whole breast radiation therapy using lung density correction for ductal carcinoma in situ (DCIS). Between April 1985 and December 2002, 198 patients with 200 lesions diagnosed as DCIS (AJCC stage 0) were treated at the University of Michigan. All underwent BCS and whole breast radiotherapy. Median total follow-up was 6.2 years (range: 0.8–18.2). The 5- and 10-year cumulative rates of in-breast only failure were 5.9% (95% CI: 2.6–9.3%) and 9.8% (95% CI: 5.2–14.4%), respectively. Factors that significantly predicted for an increased risk of local failure were family history of breast cancer, positive or close surgical margins and age ≤ 50 years at diagnosis. Cosmetic outcome was scored as "excellent" or "good" in 94% of the assessed patients. On multivariate analysis, only patient separation significantly predicted cosmetic outcome ($p = 0.04$). BCS and radiotherapy using lung density correction resulted in high rates of local control at 5 and 10 years with excellent cosmetic results. To the best of our knowledge, this is the first study to report outcome in a series of patients with DCIS treated with lung density correction and results compare favorably with other series in which plans were calculated using unit density. ■

Key Words: breast conservation, DCIS, lung density correction, radiotherapy

Breast-conserving treatment has become the standard of care for localized ductal carcinoma in situ (DCIS) of the breast (1). Lumpectomy followed by whole breast radiation therapy (RT) has been demonstrated by three large prospective randomized trials to significantly reduce the risk of local recurrence in the treated breast by approximately half compared to surgery alone (2–5). This approach allows women to preserve their breasts and avoid the psychological and physical morbidity associated with mastectomy.

Traditionally, the affected breast has been irradiated with two tangential fields with wedges or compensatory filters to achieve a homogeneous dose distribution in the breast without taking into account the presence of low-density lung tissue in the treatment fields. Treating the whole volume as unit density results in an underestimation of breast dose by as much as 10–20% (6,7). Computerized tomography (CT) enables distinction between different tissue densities and improves the ability to correctly account for the low lung density. Use of lung density corrections can then result in increased dose homogeneity throughout the treated volume (8,9).

To the best of our knowledge, all published series of breast-conserving surgery (BCS) and RT for the treatment of DCIS have included patients with treatment plans calculated without lung density correction. At the University of Michigan, we have been using lung density correction as the standard of care for all patients treated for DCIS since 1985. This

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retrospective report summarizes the results of 198 patients treated with whole breast RT with lung density correction for dose calculation following BCS for DCIS. The results demonstrate high rates of local control using lung density correction.

MATERIALS AND METHODS

Between April 1985 and December 2002, 198 patients with 200 lesions diagnosed as DCIS of the breast (AJCC stage 0) were treated in the Department of Radiation Oncology at the University of Michigan. All patients underwent BCS and whole breast radiotherapy. Following Institutional Review Board approval, the prospectively maintained Radiation Oncology data base was queried for the following clinicopathologic characteristics: age, race, weight, menopausal status, family history of breast cancer (BC) (first- or second-degree relative with history of BC), means of diagnosis, surgical procedures, tumor histology and size, volume excised, margin status, radiation treatment details, systemic hormone therapy, acute and late toxicity, and cosmetic outcome. In addition to the slide review at the time of initial diagnosis, all available pathology slides were re-reviewed at the time of this analysis for missing nuclear grade information (56 lesions, 28%). Excluded from this analysis are patients with a prior diagnosis of invasive BC.

Surgery

Surgical therapy consisted of excisional biopsy of the primary lesion. Resected specimens were routinely inked to assess microscopic margin status. Sixty-six percent of the patients underwent re-excision. Final microscopic margins were defined as positive, close (defined as ≤3 mm), or negative (≥3 mm). Axillary lymph node evaluation was performed in 15% of the lesions, either by a sentinel lymph node biopsy (4%), formal axillary lymph node dissection (10%), or both (1%). All lymph nodes were negative for metastatic cancer.

Radiotherapy

Whole breast RT was delivered using two opposed tangential fields. All patients were treated with megavoltage radiation, generally 6 MV, to a dose of 46–50 Gy in 1.8–2.0 Gy fractions over 4.5–5 weeks; a boost was delivered in 94% of cases. Specifically, the median dose to the whole breast was 50 Gy (range: 44.1–50.0 Gy); 88% were treated with 6 MV photons. A boost was delivered using 9 MeV or 12 MeV electrons in 78% of all cases; 12% with higher electrons energy; 10% received a boost utilizing photons or a combination of photons and electrons. The median boost dose was 10 Gy (range: 9.8–22.0 Gy). The median total tumor bed dose was 60 Gy (range: 48.6–70.6 Gy). No regional lymphatic radiation was delivered.

All treatment plans were calculated using lung density correction to correct for the increased photon transmission through the lung volume in the tangent fields. Specifically, since the lung mass density is only 0.2 g/cm^3 as opposed to ~1 g/cm^3 for soft tissue (referred to as "unit density") (9), the photon beam will have decreased attenuation in the lung area. To compensate for the resultant areas of dose inhomogeneity in the breast, a wedge was generally inserted as compensator in the lateral tangent beam to optimize the dose distributions at the medial, lateral, and apex of the breast. Both the dose calculation model and the treatment-planning system used were three-dimensional. Detailed description of the planning and the treatment techniques have been described elsewhere (10,11). Since 2001, all treatment plans have been generated using CT-based planning.

Follow-up Evaluation

After the completion of RT, patients were followed at 6-month intervals for 5 years and then yearly. Office visits included a physical exam and cosmesis evaluation by the attending physician. The overall cosmetic result was classified using criteria proposed by Harris et al. (12), including the presence and severity of breast edema, retraction, fibrosis, and telangiectasia (13), where excellent was defined as the treated breast looks essentially the same as the opposite breast; good: minimal but identifiable effects of radiation on the treated breast; fair: significant effect of radiation on the treated breast; and poor: severe normal tissue sequelae (12). In addition, for each patient, the following details were documented and incorporated into the final cosmetic score: presence of fibrosis, size, and location of telangiectasis and hyper- or hypopigmentation of the skin (13). Bilateral mammograms were performed yearly.

Data Analysis

Follow-up information for each patient included the date of in-breast (local), regional, and/or distant recurrence; contralateral breast cancer (CLBC) diagnosis;

date of death; or date of last known contact. Time-to-event end points included loco-regional, local and distant failure, breast cancer-specific survival and overall survival. A patient was considered recurrence-free if free from disease following the completion of RT until the last known contact date. The time interval to local recurrence was calculated from the completion of RT until the occurrence of a breast-only tumor failure or local component of first failure. Patients experiencing a regional and/or distant failure first, or who were disease-free until their last contact date, were censored at their date of failure or last contact, respectively. Total follow-up time for each patient was calculated from the completion of RT until the last date of contact; total follow-up time for the entire patient cohort was summarized by median and range.

The product-limit method of Kaplan–Meier was used to estimate the overall survival in this population (14). Confidence intervals were computed using Greenwood's estimate of the variance. The cumulative incidence method was used to estimate the time to local failure and breast cancer-specific survival, in order to appropriately account for competing events (15). Confidence intervals for the cumulative incidence estimates were based upon point-wise standard error estimates as calculated by the method of Pepe (16). For all time-to-event end points, bivariate analyses to detect significant associations with clinicopathologic features were conducted using the product-limit method and log-rank statistics, with censoring occurring at competing events (if present). Multivariate analyses were conducted using Cox proportional hazards regression, using only those clinicopathologic features found to be at least marginally significant (log-rank $p \leq .10$) during bivariate analysis. Parsimonious models were constructed using a backward stepwise elimination algorithm, with the models beginning with all marginally significant features, and a Wald-type p-value $\leq .05$ necessary for the feature to be retained in the model. Hazard ratios and 95% confidence intervals are reported.

Cosmetic and acute toxicity end points were analyzed for association with categorical clinicopathologic features using the chi-squared or Fisher's exact test statistic, and with continuous features using the Kruskal–Wallis nonparametric test. Unconditional logistic-regression was used to create multivariate models for each endpoint. Parsimonious models were constructed using only those features found to be at least marginally significantly associated ($p \leq .10$) with the endpoint, and the stepwise backward elimination algorithm described above. Models were specifically designed to predict a cosmesis assessment of "excellent," and separately the occurrence of acute radiation-induced toxicity grade of at least 2. For all analyses, missing data for the clinicopathologic features were assumed to be missing completely at random.

RESULTS

Patients and Tumor Characteristics

The median total follow-up period was 6.2 years (range: 0.8–18.2 years). Sixty-two percent (124 patients) had more than 5 years of follow-up; 23% (46 patients) had more than 10 years of follow-up. Patient characteristics are summarized in Table 1. The median age at diagnosis was 53.5 years (range: 30–83 years).

Tumor characteristics are presented in Table 2. Eighty-six percent of lesions were diagnosed by mammogram; re-excision was done in 66% of cases, and final margins were negative in 89% of cases. Tamoxifen was prescribed to all patients since the NSABP B-24 publication in 1999 (17). Forty-seven patients (24%) were treated with tamoxifen as adjuvant hormonal therapy, regardless of estrogen receptor status, according to the study design of the B-24.

Local and Regional Control

The 5- and 10-year cumulative rates of in-breast only failure were 5.9% (95% CI: 2.6–9.3%) and 9.8%

Table 1. Patient Characteristics

	Level	*N* (%)
Age (years)	≤35	2 (1.0)
	36–50	74 (37.0)
	>50	124 (62.0)
Race	African-American	11 (5.5)
	Caucasian	184 (92.0)
	Other/unknown	5 (2.5)
Weight (lb)	101–130	40 (20.0)
	131–160	71 (35.5)
	161–200	58 (29.0)
	>201	26 (13.0)
	Unknown	5 (2.5)
Menopausal status	Pre	61 (30.5)
	Post	123 (61.5)
	Peri	16 (8.0)
Family history of breast cancer	1st degree	29 (14.5)
	2nd degree	29 (14.5)

Table 2. Tumor Characteristics

	Level	*N* (%)
Primary size (cm)	≤1	121 (60.5)
	1.1–≤2	33 (16.5)
	2.1–≤3	10 (5.0)
	>3	7 (3.5)
	Unknown	29 (14.5)
Histology of DCIS*	Subtypes assessed	169 (84.5)
	Comedo	118 (70.0)
	Clinging	4 (2.5)
	Cribiform	52 (31.0)
	Micropapillary	16 (10.0)
	Papillary	19 (11)
	Solid	44 (26.0)
	Other	3 (1.9)
Nuclear grade	Low	32 (16.0)
	Intermediate	54 (27.0)
	High	81 (40.5)
	Unknown	33 (16.5)
Final margins status	Positive	6 (3.0)
	Close (≤3 mm)	15 (7.5)
	Negative (≥3 mm)	177 (88.5)
	Unknown	2 (1.0)
Volume of excision (cm^3)	Total (n = 156)	
	Median	70
	Range	2–580.0

*DCIS subtypes are not mutually exclusive. A tumor can be characterized as having more than one subtype.

(95% CI: 5.2–14.4%), respectively (Fig. 1). Breakdown of recurrence by the presence of invasion is presented in Figure 2. Sixteen patients had a local-only first failure; 75% (12/16) were DCIS only; and 25% (4/16) were invasive (3 lobular, 1 ductal). All recurrences (100%) were in the same quadrant as the original primary. Fifteen of the 16 patients with in-breast recurrences were salvaged successfully with mastectomy and one had a repeat lumpectomy. All 16 patients were free of disease at their last follow-up visit. Four patients not experiencing a local failure subsequently died as a result of BC: one developed an ipsilateral axillary recurrence with systemic failure thereafter; one developed bone metastasis; and two were diagnosed with locally advanced CLBC and failed systemically at 15 and 58 months following this diagnosis.

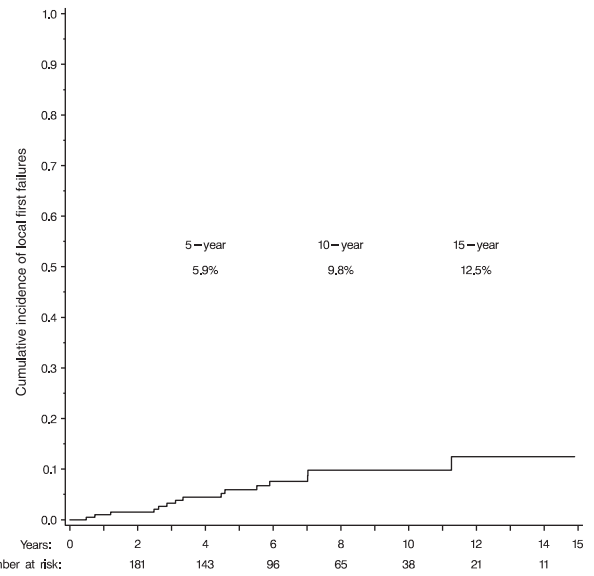

Figure 1. Cumulative incidence of local first failures.

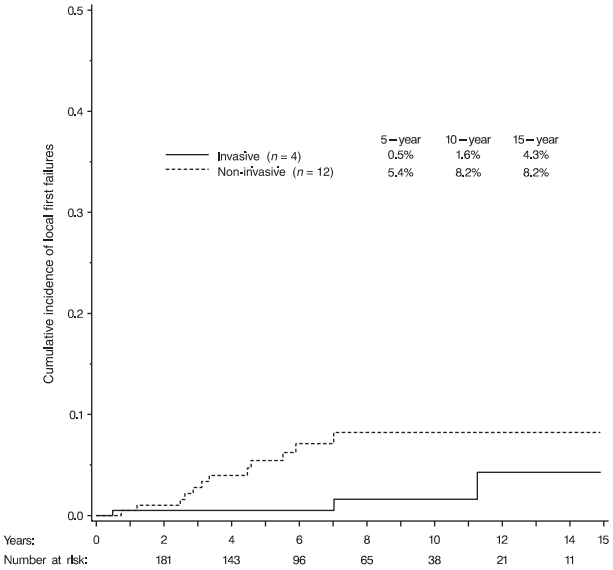

Figure 2. Cumulative incidence of local first failures by the presence of invasion at the time of recurrence.

Factors that significantly predicted for increased local failure were family history of BC, final margin status and patient's age at diagnosis (Table 3). Specifically, the 5-year rate of freedom from local recurrence was 83.8% if a patient had a family history of BC and 97.7% if no family history was present (p = .029); freedom from local recurrence if the surgical margins were positive was 62.5% versus 96.6% if the margins were negative (p = .002). Patients age 50 and younger had 89.4% freedom from local recurrence versus 97.0% inpatients older than age 50 (p = .052).

A multivariate Cox proportional hazard regression revealed that patient's age at diagnosis (≤age 50 versus >age 50), final surgical margins and family history of BC were independent predictors for local recurrence (Table 4).

Survival

As shown in Figure 3, the 5- and 10-year rates of breast cancer-specific survivals were 100% and 95.9%

Table 3. Bivariate Analysis of Time to Local Recurrence

	5-Year estimate (95% CI)	Log-rank p-value
Patient's age at diagnosis (years)		
≤50	89.4 (94.9–78.9)	0.052
>50	97.0 (99.0–90.7)	
Patient's weight (lb)		
101–130	91.8 (97.3–76.6)	0.576
131–160	96.5 (99.1–86.5)	
161–200	91.0 (96.6–77.4)	
201+	100	
Race		
African-American	90.9 (98.7–50.8)	0.768
Caucasian	94.1 (96.9–88.8)	
Menopausal status		
Premenopausal	94.6 (98.2–84.2)	0.743
Perimenopausal	92.3 (98.9–56.6)	
Postmenopausal	94.0 (97.3–87.1)	
Family history		
Yes	83.8 (92.1–68.4)	0.029
No	97.7 (99.2–92.9)	
Method of initial detection		
Mammography	94.5 (97.2–89.1)	0.531
Physical exam/other	92.2 (98.0–72.2)	
Tumor size (cm)		
≤1	96.9 (99.0–90.4)	0.259
1.1–≤2	88.9 (96.3–69.1)	
>2	100	
Nuclear grade		
Low	96.9 (99.6–79.8)	0.376
Intermediate	96.6 (77.9–99.6)	
High	90.1 (80.3–95.2)	
Histology		
Comedo	94.6 (98.0–86.1)	0.820
Non-comedo	93.4 (97.0–85.9)	
Final surgical margins		
Positive	62.5 (89.3–14.2)	0.002
Close	77.5 (92.3–44.8)	
Negative	96.6 (98–91.8)	
Total volume of excision		
≤60 cc^3	93.4 (96.8–82.5)	0.329
>60 cc^3	95.7 (98.6–87.2)	
Adjuvant tamoxifen use		
Yes	97.2 (99.6–81.9)	0.585
No	93.3 (96.5–87.5)	
RT total dose (cGy)		
≤6000	95.3 (97.9–89.6)	0.126
>6000	89.4 (95.9–74.1)	
RT delay		
<90th %tile (72 days)	93.9 (96.8–88.6)	0.691
>90th %tile	94.7 (99.2–68.1)	
Residual microcalcifications on mammography		
Yes	88.9 (97.1–62.4)	0.643
No	93.0 (96.8–84.8)	

(95% CI: 91.5–100%), respectively; and the overall survivals were 98.0% (95% CI: 94.0–99.4%) and 82.4% (95% CI: 72.6–88.9%), respectively.

Contralateral Breast Cancer

Of the 198 patients diagnosed with DCIS, nine were also diagnosed with either a synchronous or metachronous CLBC for a crude rate of 4.5%. The cumulative incidence of CLBC after 5 and 10 years was 4.3% and 6.0%, respectively. Three cases were DCIS and six were invasive cancers.

Table 4. Multivariate Cox Proportional Hazard Model Predicting Local Recurrence (n = 198)

	Hazard ratio	95% Confidence interval	p-value
Patient's age at diagnosis (years)			
≤50	3.12	1.10–8.89	0.033
>50	1.00		
Family history of breast cancer			
Yes	3.08	1.04–9.10	0.041
No	1.00		
Final surgical margins			
Negative	1.00		
Close	4.11	1.11–15.18	0.033
Positive	9.01	1.84–44.13	0.006

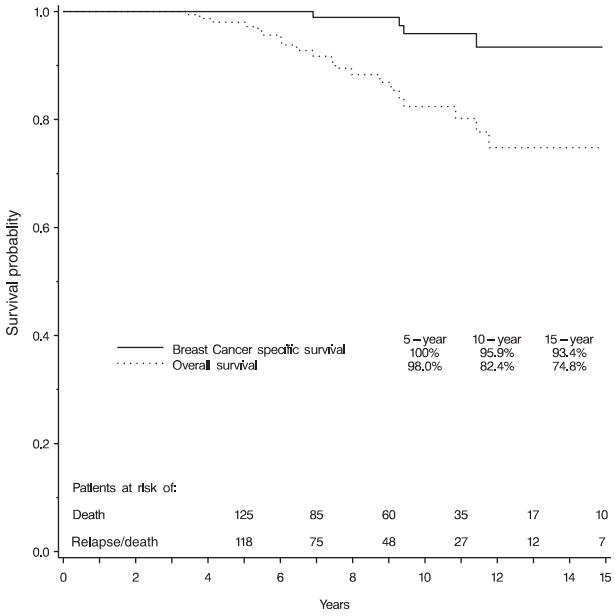

Figure 3. Overall and breast cancer-specific survival for all patients.

Acute Toxicity Assessment

The maximal acute skin toxicity was reported by a physician on a weekly basis during RT treatment, according to the NCI Common Terminology Criteria for Adverse Events V2/3 (18) and was available for 198 patients (100%). The toxicity was assessed as grade 0 in 13 patients (6.5%, no toxicity), grade 1 in 93 (46.5%; faint erythema or dry desquamation) and grade 2 in 94 (47%; moderate to brisk erythema, patchy moist desquamation, mostly confined to skin folds and creases or moderate edema). No toxicities beyond grade 2 were reported.

The maximal acute toxicity grade was significantly higher in women with larger separation ($p < 0.001$), higher weight ($p < 0.001$), machine energy greater than 6 MV ($p < 0.001$) and boost energy higher than 9 MeV ($p < 0.001$) or delivered by photons ($p < 0.001$). In multivariate analyses, weight and boost delivered by photons independently predicted grade 2 toxicity (Table 5).

Cosmetic Outcome

Cosmetic evaluation was available for 159 patients (85%). Fifteen women who had a mastectomy for local recurrence were not included in the analyses. This analysis refers to the last evaluation reported for each patient. The median time between the end of RT to the most recent cosmetic evaluation was 4.8 years (range: 0.3–16.3 years). Cosmetic outcome was scored as excellent in 119 patients (75%), good in 31 (19%), fair in 8 (5%) and poor in 1 (1%).

Total volume of excision information was available for 158 (79%) patients (Table 2). The median volume was 65 cm^3 for the 99 patients with excellent cosmesis, 131 cm^3 for 25 patients with good cosmesis and 110 cm^3 for seven patients with a fair cosmetic evaluation. When comparing the median total volume of excision between "excellent," "good" and "fair" categories, smaller volume was a predictor for better cosmetic outcome ($p = 0.003$). (The poor category was dropped as a result of the small sample size, $n = 1$). The total volume of excision did not uniformly increase with the size of the tumor ($p = 0.732$).

When comparing the distribution of cases by weight categories (101–130, 131–160, 161–200 and 201+ lbs) with the most recent cosmesis assessment, there was a significant association between the two covariates. Only 42% of patients in the heaviest weight group achieved "excellent" score compared to 75%, 63%, and 72% in the 101–130, 131–160, and 161–200 lb categories, respectively ($p = 0.012$); forty-two percent achieved only "good" score, as opposed to 11%, 12%, and 15% in the lower three weight categories, respectively ($p = .012$).

Table 5. Best Multivariate Model Predicting Grade 2 Maximal Acute Toxicity

	Odds ratio	95% Confidence interval	p-value
Weight (lb)			
≤200, $n = 169$	1.0		
201+, $n = 26$	9.0	2.6–31.7	<0.001
Boost energy			
Any photons, $n = 20$	5.1	1.4–19.1	0.015
All electrons, $n = 180$	1.0		

Patients who received therapy with 6 MV only to the whole breast were significantly more likely to receive an excellent cosmetic assessment (67%) when compared with patients treated with higher energy photons (35%) ($p = 0.002$). Similarly, when the boost was administered with electrons only (9–12 MeV) compared to photons, a higher proportion of excellent cosmetic results was achieved (62% and 71% for the 9 and 12 MeV, respectively versus 32% for any photons in the boost) ($p = 0.03$). Location of the primary tumor in the breast (lateral versus medial versus central) and age at diagnosis were not associated with cosmetic outcome.

A multivariate logistic regression model was used to determine independent predictors of an excellent cosmetic assessment versus good or fair. When patient weight, separation, total volume of excision, tumor size, and beam energy were tested in the model, only patient separation was found to significantly predict cosmetic outcome ($p = 0.004$).

Complications

Complications included pneumonitis in two patients (1%), and one patient each with chronic breast/chest wall pain, decreased shoulder mobility, cellulitis, and dermatosclerosis (<1%).

DISCUSSION

This study demonstrates high rates of local control and excellent cosmetic results for patients with DCIS treated with BCS and RT using lung density correction. The rates of local control compare favorably with the results of randomized prospective trials of adjuvant RT for patients with DCIS after BCS (2–5) and with other single institution retrospective studies (19–22) of women with DCIS irradiated using unit-density plans. Although differences in tumor characteristics and statistical methods (e.g., tumor size, margin evaluation, treatment factors, follow-up time and reporting methods) can result in differences in rates of local control between studies, the findings presented here demonstrate that treating patients with lung density correction is at least as effective as unit density treatment. Since treating the whole volume as unit density results in an underestimation of breast dose by as much as 10–20% (6,7), correction for the lung volume will optimize the plan for better homogeneity and less

dose at the edges of the field. As previously shown, the decreased attenuation of the photon beam by the lung tissue compensates for the extra thickness of the breast and eliminates the need for medial wedge (6). Thus, the use of lung density correction optimizes the plan and avoids regions of inhomogeneity in the medial, lateral, and apical parts of the breast. The consequences are reduced scatter dose to the opposite breast by elimination of the medial wedge and reduction in the monitor units required for the medial tangent (23).

The major factors associated with local recurrence in our series were young age, family history of BC and margin status. Young patients have been consistently described as being at higher risk for local recurrence compared with older patients following breast-conserving treatment (2–4,7,21,22,24–28). Our results demonstrate a failure rate of 3.1-fold for women age 50 and younger at diagnosis. The possible explanations for this finding include the smaller excisional volume described in younger patients (29), and a more aggressive biologic phenotype in younger women with DCIS as suggested by tumors associated with increased overexpression of Her-2/neu (30), and a higher proportion of lesions with high nuclear grade and central necrosis (29). Young women are also at higher risk of being carriers of genetic mutations, such as *BRCA1/2* or other familial clusters for BC. In our series, family history of BC in a first- or second-degree relative was by itself a significant risk factor for recurrence and could be associated, in part, with genetic mutation carriers in this population. Young women are less likely to die of any other cause and therefore may have longer follow-up periods to develop an in-breast recurrence.

Margin status is consistently reported as a risk factor for local recurrence after BCS and RT (2–4,20–22,24,25,28,31) and our data are in agreement with this finding. Variability exists regarding the width of margins determined as negative in the above studies. In the NSABP (3) and the EORTC trials (4) negative margins are described as histologically tumor-free with no quantitative measurement of the normal surrounding tissue. In the collaborative series reported by Solin et al., all institutions declared negative margins as 2 mm or greater (28), and in the French Cancer Center's experience, negative margins were of 1 mm width (21). The "Consensus Conference on the Treatment of In Situ Ductal Carcinoma of the Breast" that was held in 1999 by a panel of breast care experts reported that achievement of negative margins was considered a prerequisite for treatment of DCIS (32). Margin status is of crucial importance because it is the only variable the physician can control and that can be influenced by treatment. While some investigators have recommended 10 mm margins (33), such wide margins are rarely achieved and can be associated with decreased cosmetic results. The current study suggests that 3 mm minimum margins resulted in high rates of tumor control while maintaining excellent cosmesis.

High nuclear grade has also been found to be associated with local recurrence in large randomized trials (31,34); therefore, nuclear grade determination is generally included in the pathology evaluation for patients with DCIS, as was recommended in the pathology consensus report in 1997 (35). However, we found no evidence of a significant effect of nuclear grade on the probability of local recurrence. Whether this was due to the high percentage of women with negative margins (≥3 mm) in the present series is unclear. In other single institution reports in which nuclear grade was reported in the majority of the cohort, nuclear grade was also not significantly associated with local recurrence (20,22,26,36,37).

The rate of contralateral BC in the present series was 4.3% at 5 years and 6.0% at 10 years, rates that are in the lower range of the published data (3,4,19–22,26,28,36,38). In a recent report by Solin et al. the rates of CLBC were 4% and 9% at 5 and 10 years, respectively, among 1003 women treated for DCIS with BCS and RT in a multi-institutional report, with a median follow-up of 8.5 years (28). Rodrigues et al. reported a 7.1% rate of CLBC in a cohort of 515 patients treated with RT at a median follow-up of 7 years (19). The median follow-up of our series is only 6.2 years and only 1% of our patients are younger than age 35 at diagnosis. These factors could, in part, explain the low rate of CLBC in our report, as age has been reported as a risk factor for CLBC (39). We cannot rule out that reduced scatter from omission of the medial wedge made possible by the use of lung density correction could have contributed to the low rates of CLBC. Longer follow-up of our patients, particularly the younger women, will be required to assess the long-term effects of lung density correction on rates of contralateral breast events.

Only 24% of the patients in our study were treated with adjuvant tamoxifen. Tamoxifen was shown to significantly reduce both local recurrence and contralateral breast cancers in the NSABP B-24 trial (17), where the 7-year rate of local recurrence was reduced from 11.1% to 7.7% and the 7-year rate of CLBC

was reduced from 4.9% to 2.3% when tamoxifen was added to breast irradiation. Houghton et al. in the UK/ANZ DCIS trial demonstrated a nonsignificant reduction in ipsilateral local recurrence (15% versus 13%) and CLBC (3% versus 1%) with tamoxifen use (5). Therefore, even lower rates of local recurrence and contralateral breast cancers are possible by adding tamoxifen as adjuvant treatment for women diagnosed with DCIS and treated with BCS and RT. Since January 2003, all DCIS specimens are routinely evaluated for the presence of estrogen receptor, and tamoxifen is offered to patients with positive receptors.

Cosmetic outcome was scored as excellent or good in 94% of the evaluated patients. Cosmetic outcome after whole breast RT has been described as good/excellent in 81–88% of patients with early stage BC treated with BCS and RT, with the consistent finding that patient separation is a predictor for cosmetic outcome (40,41). Patient separation is measured at the level of the isocenter, where the dose is usually prescribed, and increasing separation is associated with increasing dose inhomogeneity particularly at off-axis points. Lung density correction improves the homogeneity inside the breast, which may help explain the higher rates of good/excellent cosmesis in our study. Obese women have greater separations and indeed were found to have worse cosmesis. Also, for women with larger breasts and separation, higher photon energy for the whole breast and higher electron energy or photons were used for the boost, explaining why these factors were associated with less favorable cosmesis and an increase in acute RT toxicity.

While our study demonstrates excellent rates of tumor control and favorable cosmesis in women with DCIS treated with lung density correction, we acknowledge its limitations. It is a single institution retrospective study with median total follow-up of 6.2 years. Additional follow-up is needed to insure long-term local control and high rates of good/excellent cosmesis. However, to the best of our knowledge, this is the first study to report outcome in a series of patients with DCIS treated with lung density correction and results compare favorably with other series in which plans were calculated using unit density.

CONCLUSION

The findings indicate that BCS and RT treatment for DCIS using lung density correction results in high rates of local control and breast cancer-specific survival at 5 and 10 years with excellent cosmetic results. These results compare favorably with published reports using non-corrected RT plans, and support the routine use of lung density correction for breast-conserving treatment for DCIS.

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