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CLINICAL INVESTIGATION **Skin**

RADIOTHERAPY FOR EPITHELIAL SKIN CANCER

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Purpose: To retrospectively review patterns of failure, cosmesis, and outcomes according to treatment modality of patients with histologically confirmed epithelial skin cancer.

Methods and Materials: The records of 468 patients having 531 lesions were analyzed; 389 basal cell carcinomas and 142 squamous cell carcinomas were treated, 167 of which were recurrent tumors. Median follow-up was 5.8 years. Electron beam irradiation was used in 19%, superficial x-rays in 60%, a combination of electron beam and superficial x-rays in 20%, and megavoltage photons in <2%.

Results: The overall local tumor control rate was 89%; it was 93% for previously untreated lesions and 80% for recurrent lesions. Patients with basal cell carcinoma had a 92% overall control rate; patients with squamous cell carcinoma 80%. Multivariate analysis showed that local failure was related to the daily dose fractionation. The maximal diameter of the lesion and pathologic tumor type were also significant ($p \leq 0.01$). Treatment type, patient age, and treatment duration were not significant. Overall, 92% of the treated population with cosmesis data had excellent or good results. The overall complication rate was 5.8%, consisting primarily of soft-tissue necrosis.

Conclusions: Radiotherapy remains an excellent treatment modality for epithelial skin cancer. Local tumor control, cosmesis, and complications are related to the size of the primary lesion. Recurrent lesions fared worse, and therefore treatment at the earliest possible stage is strongly recommended. **© 2001 Elsevier Science Inc.**

Epithelial skin cancer, Treatment modality, Radiotherapy.

INTRODUCTION

Epithelial skin cancer remains a common neoplasm that affects more than, 500,000 persons in the United States each year. The overwhelming majority of these lesions are basal cell, the remainder are squamous cell. Both types of malignancies are related to ultraviolet light exposure from the sun. With thorough screening, neoplasms can be identified at an early stage, and appropriate treatment can result in excellent local control and cosmesis in many patients. The approach to treatment is diverse, with surgical excision, Moh's chemosurgery, electrocautery, and radiotherapy (RT) among the available options. RT techniques are varied and include superficial photons, electrons, and, on rare occasions, such as with advanced or diffuse disease over curvilinear surfaces, megavoltage photons. Treatment with RT requires additional considerations such as the dose per fraction, the total dose, bolus use, and the field size. The consideration of these factors is important, because they may have an impact on the treatment results.

METHODS AND MATERIALS

Patient material

A total of 531 biopsy-proven skin cancers (364 initial tumors and 167 recurrent tumors) in 468 patients treated consecutively from January 1966 to December 1997 were retrospectively analyzed to determine the patterns of failure, cosmesis, and outcome according to treatment modality.

The patient records were reviewed and data recorded using a computer-compatible form. Patients were followed for a minimum of 2 years, until death, or until lost to follow-up. The median follow-up was 5.8 years (range 2–24). There were 389 basal cell carcinomas and 142 squamous cell carcinomas; 318 of the lesions were in males and 213 were in females. The age range of the patients with basal cell carcinoma was 11–100 years (median 73). The age range of the patients with squamous cell carcinoma was 32–97 years (median 72). A topographic distribution of these lesions is shown in Fig. 1. Thirteen percent of patients with squamous cell carcinoma had lymph node metastasis, with those with recurrent lesions having a higher incidence (32%) (Table 1). The American Joint Committee on Cancer staging system for epithelial skin cancer was used (1).

Treatment

RT was delivered in 531 patients; electron beam therapy was used in 100 (19%), superficial therapy in 317 (60%), a

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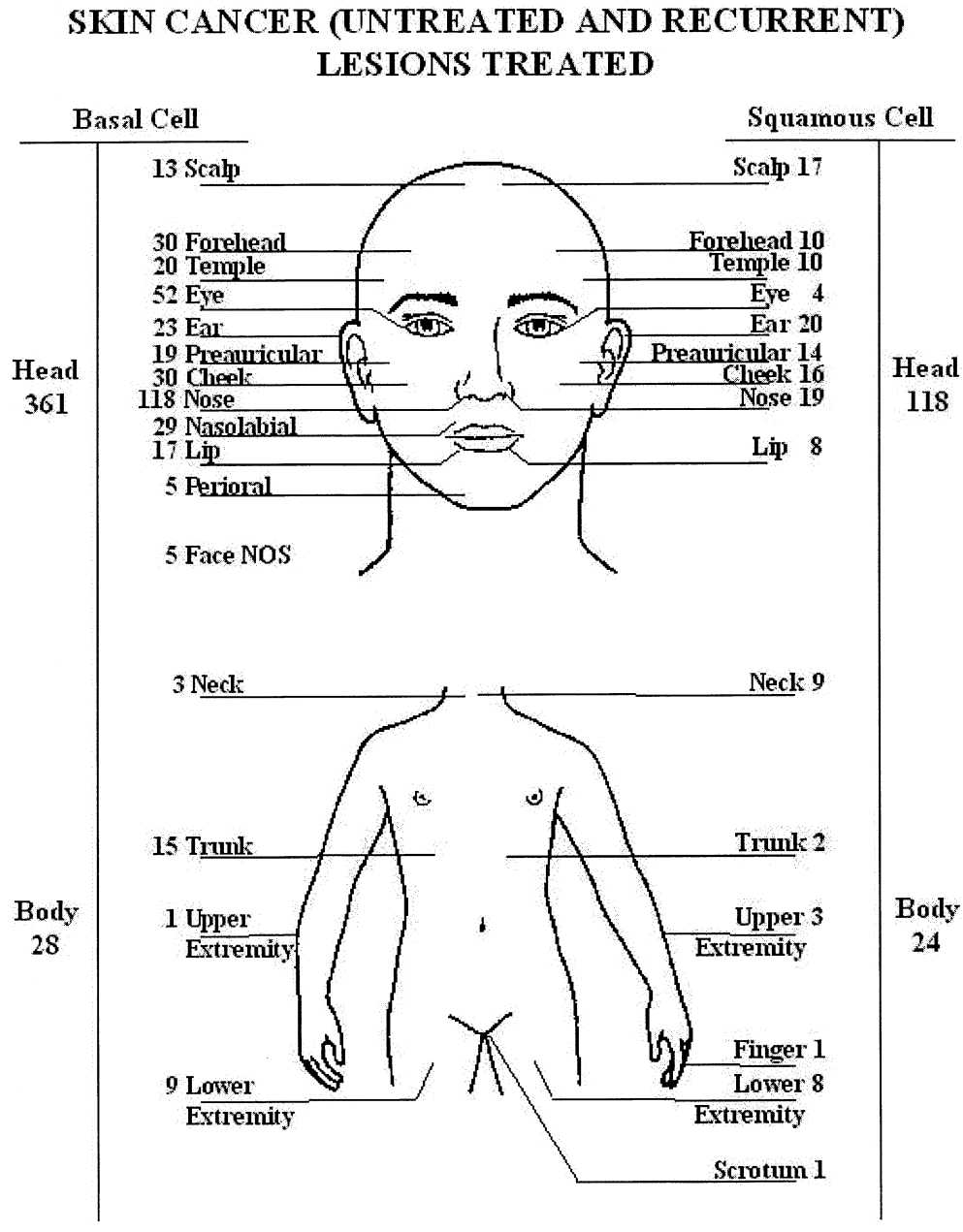

Fig. 1. Location and number of skin cancers treated (previously untreated and recurrent lesions).

combination of electron beam and superficial therapy in 108 (20%), and megavoltage photons in 6 (<2%) patients.

Beams were shaped with collimators, cones, or custom-made lead or Cerrobend shields or blocks. The eyes were shielded with lead contact lens shields when the treatment area encompassed or was adjacent to the eye; the treatment was typically with superficial photons. When electrons were used, a lead shield with wax coating was used to minimize the scattered dose to the lens. The use of bolus varied over time, as the treatment policies for using electron beam therapy evolved. The treatment area was defined as the volume of the tumor plus microscopic extension, with an additional margin of 1 cm depending on tumor size. Patients were examined at the beginning of treatment, each week during treatment, within 6 weeks of completing treatment, and periodically thereafter.

Follow-up and cosmesis evaluation

The time of relapse-free survival was calculated from the onset of RT. Patients were considered relapse free, if no evidence of locoregional disease had been found at the last follow-up visit or death.

Cosmesis was measured on a scale according to the amount of telangectasia, pigmentation change, and skin fibrosis. A patient with no telangectasia, pigment change, or fibrosis was considered to have excellent cosmesis. Good cosmesis was defined as a mild telangectasia or slight pig-

Table 1. Squamous cell carcinoma of the skin: Regional lymph node involvement

Site	Size (cm)			Recurrent total
	<3	>3 or unspecified	Total	
Forehead, temple	1/4	3/7	4/11	3/9
Eyelid	0/1	—	0/1	1/2
Ear	2/11	0/1	2/12	4/8
Cheek, nasolabial preauricular	1/9	1/7	2/16	5/14
Nose, lip, face NOS	0/11	0/4	0/15	0/11
Scalp	1/6	0/3	1/9	1/8
Neck	0/2	—	0/2	4/7
Trunk	0/1	—	0/1	1/1
Extremity	1/6	0/4	1/10	0/1
Other	0/1	1/1	1/2	1/1
Total (%)	6/52 (12)	5/27 (18)	11/79 (14)	20/62 (32)

Abbreviation: NOS = not otherwise specified.

ment change or mild-to-moderate fibrosis, and poor cosmesis was severe fibrosis or skin contracture.

Statistical analysis

All relapse-free survival and survival functions used the actuarial life-table as applied by Cutler and Ederer (1,2), and the test statistics provided are the generalized Wilcoxon (Breslow), generalized Savage (Mantel-Cox), and Tarone-Ware (2–4). Trend analysis was performed by the Tarone method (5). Survival analysis with covariates was performed using the Cox proportional hazards regression model (6). p Values were calculated using Fisher's exact test (two-tailed) when the minimum expected value was ≤ 0.05 (7). If the minimal expected value was >0.05, the Pearson chi-square test was used. All analyses were performed using a statistical package on a centralized computing system (BMDP Statistical Software, Los Angeles, CA and VAX 8600 Digital Equipment Corp., Mayword, MA).

RESULTS

The overall local tumor control rate in 531 patients was 89%. Previously untreated lesions had a local control rate of 93% (338 of 364) compared with 80% in recurrent lesions (133 of 167). Patients with basal cell carcinoma had a tumor control rate of 92% (358 of 389) and squamous cell carcinoma patients 80% (113 of 142). Recurrent lesions had a poorer local tumor control rate: 90 (86%) of 104 for basal cell carcinoma and 43 (68%) of 63 for squamous cell carcinoma compared with untreated patients (94% and 89%, respectively). The tumor control was best (96% to 100%) in lesions ≤ 1 cm in diameter and lower in larger or recurrent tumors (Table 2).

Table 3 shows that small basal cell lesions (<1 cm) had similar local control rates with all treatment modalities compared with larger lesions, which did more poorly when electron beam therapy was used as the sole modality ($p < 0.01$ for lesions 1.1–5 cm in size when superficial RT was compared with electron beam and combination therapy; all other comparisons were not significant). The tumor control of squamous cell lesions by size, T stage, and treatment modality is shown in Table 4. No advantages were seen with any treatment modality for squamous cell lesions, regardless of size. The local tumor control rate for T4 tumors with cartilage invasion was 75% (9 of 12), and for bony invasion, it was 67% (14 of 21). Node-positive patients ($n = 36$) had a local tumor control rate of 81%, nodal control rate of 86%, and a 5-year disease-free survival rate of 53% compared with node-negative patients ($n = 495$) with 90% local tumor control, 98% nodal control, and 83% 5-year disease-free survival.

The overall local tumor control rate for all lesions was

Table 2. Carcinoma of the skin: Tumor control correlated with histologic findings and presentation

Stage	Size (cm)	Basal Cell (%)		Squamous Cell (%)	
		Untreated	Recurrent	Untreated	Recurrent
T1	≤1	120/125 (96)	31/32 (97)	17/17 (100)	9/11 (82)
	1.1–2	70/72 (97)	23/29 (79)	22/24 (92)	7/10 (70)
T2	2.1–5	36/40 (90)	25/28 (89)	18/21 (86)	11/16 (69)
T3	>5	15/16 (94)	1/3 (33)	6/7 (86)	7/8 (88)
T4	Bone/cartilage invasion	9/9 (100)	4/6 (67)	3/4 (75)	6/12 (50)
Unspecified (%)		18/23 (78)	6/6 (100)	4/6 (67)	3/6 (50)
Total (%)		270/285 (95)	90/104 (86)	70/79 (89)	43/63 (68)

Table 3. Basal cell carcinoma of the skin: Local tumor control correlated with modality and tumor size

Stage	Size (cm)	Modality (%)			
		Superficial X-ray	Electron beam	Combination	Photons
T1	≤1	128/133 (96)	15/16 (94)	8/8 (100)	—
	1.1–2	79/82 (96)	5/7 (71)	9/11 (82)	0/1
T2	2.1–5	34/36 (94)	16/20 (80)	11/12 (92)	—
T3	>5	6/6 (100)	5/6 (83)	5/7 (71)	—
T4	Bone/cartilage invasion	1/1 (100)	9/10 (90)	3/4 (75)	—
Unspecified		15/18 (83)	2/3 (67)	6/6 (100)	1/1 (100)

94% (299 of 317) for superficial x-rays, 82% (82 of 100) for electron beams, 82% (89 of 108) for combination therapy, and 50% (3 of 6) for megavoltage photons. Local tumor control rates were superior in smaller lesions treated with superficial x-rays.

Larger lesions tended to have poorer local tumor control regardless of the histologic findings or presentation (Table 2). Basal cell lesions 1.1–5 cm exhibited a trend for better tumor control as the fraction size increased from <2 to 3.01 to 4 Gy. These lesions were also controlled with higher total doses; patients receiving >60 Gy had significantly lower local control when a <2-Gy fraction size was used compared with a larger fraction size ($p = 0.01$) (Tables 5 and 6). The local tumor control rates were also stratified by tumor size vs. treatment modality and field margins for squamous cell and basal cell carcinomas (Tables 7 and 8). In patients with squamous cell carcinoma, local tumor control was decreased when a ≤1 cm margin was used with electron therapy, but the differences were not statistically significant.

A review of our treatment failure rates by 5-year increments was performed, starting with 1980 to 1985. No clear trend indicating that the failure rates had either increased or decreased regardless of treatment type (superficial, combination, or electron therapy) was found. Multivariate analysis showed that local failure was related to daily fraction size (larger fraction size associated with better local tumor control, $p = 0.01$), maximal lesion diameter, and pathologic type (squamous cell vs. basal cell) ($p < 0.01$). The treatment modality was not significant (electrons versus other types, $p = 0.345$), nor was age or number of treatment days ($p = 0.164$ and 0.144, respectively).

Cosmesis and Complications

Cosmesis was evaluated by the presence of skin atrophy, telangectasia, pigmentation change, or fibrosis. RT records, clinic notes, hospital records, and autopsy records were used to evaluate cosmesis. Cosmesis data were available for 85% of the basal cell and 75% of the squamous cell lesions in previously untreated patients. Overall, 92% of the treated population with cosmesis data had excellent or good results. Patients were stratified by total dose and dose per fraction, and neither parameter had a significant relationship with cosmesis (Table 9). Most patients with fair or poor cosmesis received >50 Gy at <3 Gy per fraction. Patients with previously untreated squamous cell carcinoma had a higher rate of fair or poor cosmesis (7 of 52, 13%) than did those with basal cell carcinoma (15 of 255, 5.9%), which was related to the higher doses administered for squamous cell carcinoma.

Patients with recurrent squamous cell lesions had an 18% (12 of 66) incidence of fair or poor cosmesis vs. 1.8% (3 of 164) for patients with basal cell carcinoma (Tables 10 and 11). Fair or poor cosmesis occurred in 10 (12%) of 81 lesions treated with electron therapy, compared with 15 (19%) of 77 lesions treated with combination treatment and 12 (4%) of 276 tumors treated with superficial RT.

The overall complication rate was 5.8% (13% in lesions >5 cm), with soft-tissue necrosis the most common sequela. Soft-tissue necrosis occurred in 13 (9%) of 142 squamous cell carcinomas and in 8 (2%) of 389 basal cell carcinomas. Cartilaginous necrosis occurred in none of the 142 squamous cell lesions and in 1 of 389 basal cell lesions. Bone necrosis occurred in 1 of 142 and 2 of 389 and

Table 4. Squamous cell carcinoma of the skin: Local tumor control correlated with modality and tumor size

Stage	Size (cm)	Modality			
		Superficial X-ray	Electron beam	Combination	Photons
T1	≤1	15/16 (94)	5/5 (100)	6/7 (86)	—
	1.1–2	14/14 (100)	4/5 (80)	11/15 (73)	—
T2	2.1–5	6/9 (67)	11/12 (92)	11/15 (73)	1/1 (100)
T3	>5	1/1 (100)	6/7 (86)	6/7 (86)	—
T4	Bone/cartilage invasion	—	3/7 (43)	5/7 (71)	1/2 (50)
Unspecified		1/1 (100)	1/2 (50)	5/9 (56)	—

Table 5. Basal cell carcinoma of the skin: Local control correlated with total dose, dose per fraction, lesion size, and tumor dose

Lesion size (cm)	Dose/fraction (Gy) ≤2	2.01–3	3.01–4	>4	Total (%)
≤1					
≤40 Gy	1/1	13/14	4/4	1/1	19/20 (95)
40.01–50 Gy	19/20	65/68	7/7	8/8	99/103 (96)
50.01–60 Gy	6/7	19/20	4/4	2/2	31/33 (94)
>60 Gy	—	2/2	—	1/1	3/3 (100)
Total (%)	26/28 (93)	99/104 (95)	15/15 (100)	12/12 (100)	
1.1–5					
≤40 Gy	5/9	5/5	1/1	4/4	15/19 (79)
40.01–50 Gy	12/16	44/45	7/7	9/9	72/77 (94)
50.01–60 Gy	16/18	32/35	1/1	6/6	55/60 (92)
>60 Gy	5/8	8/9	1/1	—	14/18 (78)
Total (%)	38/51 (75)	89/94 (95)	10/10 (100)	19/19 (100)	
		$p = 0.01$			
>5					
≤50 Gy	1/1	3/4	—	—	4/5 (80)
50.01–60 Gy	6/7	8/8	—	—	14/15 (93)
>60 Gy	1/1	2/3	—	—	3/4 (75)
Total (%)	8/9 (89)	13/15 (87)	—	—	

For lesions 1.1–5 cm, for dose/fraction of ≤2 Gy vs. 2.01–3, 3.01–4, and >4, $p = 0.01$.

cataracts in 3 of 142 and 3 of 389 of squamous cell and basal cell lesions, respectively.

DISCUSSION

Epithelial skin cancer remains one of the few tumors that is readily diagnosed through routine physical examination and easily cured with thorough treatment when detected early. Adequate treatment at the initial presentation is critical; highlighting this is that one third of our patients had experienced failure at a first treatment attempt with surgery, electrodessication, or prior RT at another institution. An unsuccessful initial treatment carries a high price; patients with recurrent tumors have poorer tumor control. It cannot be overemphasized that early intervention can dramatically improve disease control and minimize cosmetic detriment.

RT remains an excellent treatment modality for epithelial skin cancer. Local tumor control, cosmesis, and complications are related to the size of the primary lesion. Recurrent

Table 6. Squamous cell carcinoma of the skin: Local control correlated with total dose, dose per fraction, lesion size, and tumor dose

Lesion size (cm)	Dose/fraction (Gy) ≤2	2.01–3	3.01–4	>4	Total (%)
≤1					
≤50 Gy	1/2	5/5	1/1	3/3	10/11 (91)
50.01–60 Gy	2/4	5/5	1/1	—	8/10 (80)
>6 Gy	5/5	3/4	—	—	8/9 (89)
Total (%)	8/11 (73)	13/14 (93)	2/2 (100)	3/3 (100)	
		$p = 0.13$			
1.1–5					
≤40 Gy	3/3	3/3	2/2	—	8/8 (100)
40.01–50 Gy	1/1	12/12	1/1	—	14/14 (100)
50.01–60 Gy	18/24	7/11	3/3	—	28/28 (100)
>60 Gy	7/9	3/7	1/1	—	11/17 (65)
Total (%)	29/37 (78)	25/33 (76)	7/7 (100)	—	
>5					
≤50 Gy	3/3	1/1	1/1	—	5/5 (100)
50.01–60 Gy	6/8	—	—	—	6/8 (75)
>60 Gy	4/4	3/4	—	—	7/8 (88)
Total (%)	13/15 (87)	4/5 (80)	1/1 (100)	—	

Table 7. Squamous cell carcinoma of the skin: Local tumor control correlated with tumor size, margins of portals, and treatment modality

	Margins (cm)		
Tumor size (cm)	≤1	1.1–2	>2
Superficial			
≤3	23/23 (100)	3/4 (75)	6/7 (86)
3.1–5	2/2 (100)	1/1 (100)	0/2
>5	—	—	1/1 (100)
Unspecified	—	—	1/1 (100)
Electrons ± combinations			
≤3	3/3 (100)	7/8 (88)	25/35 (71)
3.1–5	4/5 (80)	4/5 (80)	9/12 (75)
>5	3/5 (60)	2/3 (67)	11/11 (100)
Unspecified			8/11 (73)
	—	—	

Numbers in parentheses are percentages.

lesions fare worse, and therefore treatment at the earliest possible stage is strongly recommended. Continued careful attention to treatment technique is also required. For squamous cell carcinoma, no clear pattern of dose response for higher doses was found (Table 6), and a comparison of the dose fraction size showed no statistically significant difference.

Overall, better tumor control was achieved in previously untreated patients. Smaller tumors had better local tumor control, regardless of the histologic findings; basal cell lesions were better controlled than squamous cell tumors. Patients treated with external beam irradiation had lower rates of tumor control (not statistically significant), which differs from a previous publication in which this finding was significant (8). This result was due to the use of larger margins when treating patients with electron therapy in recent years.

Cosmetic information was obtained retrospectively using subjective descriptions of telangectasia, skin pigmentation, and fibrosis. Available patient photographs were also used to help assess cosmesis. The cosmetic outcome after stratification for pathologic findings and type of presentation showed no significant difference between untreated or recurrent lesions; however, when stratified for the histologic findings, recurrent squamous cell lesions had more fair or poor cosmesis (18% vs. 13%). Patients treated with superficial therapy had better cosmesis than patients treated with other treatment modalities. Larger lesions tended to have poorer cosmesis.

The incidence of significant complications was low, indicating that RT is both highly effective and well tolerated as a first-line treatment. Our rate of severe late complications from RT for skin cancer is comparable to that found in other series, which typically range from 0% to 5% (9–13).

Table 8. Basal cell carcinoma of the skin: Local tumor control correlated with tumor size, margins of portals, and modality

	Margins (cm)		
Tumor size (cm)	≤1	1.1–2	>2
Superficial			
≤3	144/150 (96)	72/76 (95)	14/15 (93)
3.1–5	7/7 (100)	3/4 (75)	—
>5 cm	3/3 (100)	3/3 (100)	—
Unspecified	0/1	14/14 (100)	2/3 (67)
Electrons ± combinations			
≤3	13/16 (81)	15/16 (94)	28/34 (82)
3.1–5	3/3 (100)	4/4 (100)	5/8 (63)
>5	8/10 (80)	2/3 (67)	11/11 (100)
Unspecified	—	3/3 (100)	7/9 (78)

Numbers in parentheses are percentages.

Table 9. Carcinoma of the skin: Cosmetic results correlated with total dose of irradiation and average dose per fraction

		Cosmesis (%)			
Dose (Gy)	Total Patients (*n*)	Excellent	Good	Fair	Poor
≤40					
≤2	7	3 (43)	3 (43)	—	1 (14)
2.01–3	20	12 (60)	6 (30)	—	2 (10)
3.01–4	6	5](86)	—	—	1](14)
>4	1	1	—	—	0
40.01–50					
≤2	41	18 (44)	23 (56)	—	—
2.01–3	123	62 (50)	58 (47)	—	3 (2)
3.01–4	16	5 (31)	11 (69)	—	—
>4	19	5 (26)	13 (68)	1 (5%)	—
50.01–60					
≤20	58	30 (52)	20 (34)	2 (3)	6 (10)
2.01–3	75	46 (61)	23 (31)	1 (1)	5 (7)
3.01–4	9	5 (56)	4 (44)	—	—
>4	7	2 (29)	5 (71)	—	—
>60					
≤2	25	13 (52)	3 (12%)	4 (16%)	5 (20)
2.01–3	25	12 (48)	7 (28%)	—	6 (24)
3.01–4	2	2](100)	—	—	—
>4	1	1	—	—	—

Table 10. Squamous cell carcinoma of the skin: Cosmetic results correlated with treatment status at presentation and maximal tumor diameter

		Cosmesis (%)			
Tumor diameter (cm)	Total Patients (*n*)	Excellent	Good	Fair	Poor
Previously untreated					
≤1	16	8 (50)	8 (50)	0	0
1.1–3	28	15 (54)	11 (39)	0	2 (7)
3.1–5	10	6 (60)	1 (10)	0	3 (30)
>5	4	1 (25)	3 (75)	0	0
Not specified	4	0	2 (50)	1 (25%)	1 (25)
Recurrent					
≤1	8	5 (62)	1 (13)	1 (13)	1 (13)
1.1–3	9	5 (56)	3 (33)	1 (11)	0
3.1–5	14	7 (50)	3 (21)	2 (14)	2 (14)
>5	8	2 (25)	2 (25)	0	4 (50)
Not specified	5	3 (60)	1 (20)	0	1 (20)

Table 11. Basal cell carcinoma of the skin: Cosmetic results correlated with treatment status at presentation and maximal tumor diameter

Tumor diameter (cm)	Total Patients (*n*)	Cosmesis			
		Excellent	Good	Fair	Poor
Previously untreated					
≤1	113	65 (58)	46 (41)	0	2 (2)
1.1–3	87	47 (54)	33 (38)	1 (1)	6 (7)
3.1–5	11	3 (25)	6 (50)	2 (17)	0
>5	16	10 (63)	3 (19)	0	3 (19)
Not specified	21	8 (38)	13 (62)	0	0
Recurrent					
≤1	31	14 (45)	17 (55)	0	0
1.1–3	41	20 (49)	19 (46)	0	2 (5)
3.1–5	5	1 (20)	3 (60)	0	1 (20)
>5	2	1 (50)	1 (50)	0	0
Not specified	3	3 (100)	0	0	0

Our results reflect those of the literature. Of note, in patients with pinna lesions, Silva *et al.* (14) found on multivariate analysis that a tumor size >2 cm (>T1) was significant for predicting the outcome time to local failure. Other significant variables on univariate analysis included increasing T stage, presence of cartilage or bone invasion, and increasing field size. These variables can be surrogates for local tumor extent. Other studies have found an association between the extent of the primary lesion and local tumor control (8–10). Our multivariate analysis found the maximal tumor diameter to be a statistically significant prognostic factor for recurrence ($p < 0.01$). Similar to the data of Silva *et al.* (14), we found on multivariate analysis that a lower dose (<2 Gy) per fraction was a significant factor for recurrence *($p = 0.01$)*.

In our institution's prior publication in 1986, Lovett *et al.* (8) found treatment with electron beam irradiation to be associated with worse local tumor control on multivariate analysis. Silva *et al.* (14) also found on univariate analysis that electron beam irradiation was associated with increased local failure. Selection bias may explain some of their results, because superficial therapy is usually selected for only the most favorable (usually smaller) lesions, and electrons are used to treat larger tumors. In their analysis, field sizes <6 cm^2 were associated with lower recurrence rates. Our updated analysis did not show that electron beam therapy resulted in higher local failure rates after the update of > 10 additional years of treatment data ($p = 0.345$). This may reflect improved electron technique.

The use of electron beam irradiation requires additional technical details. Considerations for prescription depth, bolus, and sufficient margin (for penumbra at field edge) are critical. The minimum typical margin ranges from 2 to 3 cm. Small field sizes require even more margin because of changes in the beam profile. The appropriate bolus for 6–12 MV photons is necessary (0.5–1 cm) to ensure a 100% dose at the surface. The selection of high enough energy to ensure a full dose throughout the depth of the tumor bed is crucial. Inferior technique can result in underdosage of the tumor bed (15–17). With proper attention to detail, the use of electrons is not inferior to superficial RT, as shown by our data and others (18).

Similar to that of other authors, our data demonstrated worse local tumor control for recurrent tumors. Lee *et al.* (19) noted that ultimate local control in 67 patients receiving RT for T4 lesions of the skin from the head and neck was worse for patients with recurrence and bone and nerve involvement on multivariate analysis.

The histologic subtype has not been found to be a statistically significant prognostic factor for local tumor control in many studies, including our prior publication in which a multivariate analysis showed beam type, dose per fraction, and primary vs. recurrent tumor to be significant factors (8,13). Petrovich *et al.* (10) showed local tumor control for squamous cell lesions to be worse at 5 and 10 years compared with basal cell carcinoma. A review of the literature by Rowe *et al.* (20) could not confirm a statistically significant difference between the 5-year local tumor failure rate of basal cell (8.7%) and squamous cell (10%) carcinomas. Our multivariate analysis, however, indicated that the pathologic type is a risk factor for recurrence ($p < 0.01$).

When comparing RT versus surgical excision, if cosmesis is not a concern, local excision is more cost effective. However, if cosmesis is a concern, RT is more advantageous compared with excision and reconstructive plastic surgery. Furthermore, in larger lesions, an inadequate excision with positive margins can result in the need for additional excisions or the addition of RT, significantly increasing the treatment cost.

Our institutional treatment guidelines are as follows. For basal cell carcinoma lesions of <1 cm, 40 Gy is appropriate, and for basal cell carcinoma lesions ≤3 cm or squamous cell carcinoma <1 cm, we recommend 45–50 Gy. For larger basal cell and squamous cell carcinoma lesions, we recommend 60 Gy. Treatment is given in 2.5-Gy fractions/day, 4 days/wk.

CONCLUSIONS

Skin cancer remains a common problem throughout the world. Appropriate screening and careful examination can detect lesions at an early stage. Intervention soon after diagnosis for the common early-stage basal cell or squamous-cell carcinoma can result in complete cure with effective treatment. RT is an appropriate curative choice for early-stage lesions and can improve local control in more advanced cases, with satisfactory cosmesis in most patients. Close attention to technical details, particularly when electron beams are used, optimizes therapeutic results.

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