Pilomatrix Carcinoma

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Background. **Pilomatrix carcinoma, a malignant variant of pilomatrixoma, is extremely rare. The authors report 20 patients with pilomatrix carcinoma and review the pertinent literature.**

Methods. **Tumors showing histologic features of pilomatrix carcinoma were selected from the files of the Armed Forces Institute of Pathology. Clinical data of the 20 selected patients were reviewed, and follow-up information was obtained. Sections stained with hematoxylin and eosin were studied in all patients. Special stains were used in selected patients.**

Results. **Pilomatrix carcinomas were asymptomatic dermal and subcutaneous masses with a predilection for the posterior neck and back. Tumors varied in size, from 1–10 cm (mean, 4.6 cm), and occurred more often in middle-age men, with a male:female ratio of 4:1 (mean age, 45 years). Histologically, pilomatrix carcinomas are characterized by sheets and islands of proliferating atypical basaloid cells with an infiltrating border. Transition to squamous cells, clear cells, areas of necrosis and mitoses often are seen. Keratinization with formation of keratin cysts, shadow cells, and trichohyalin and keratohyalin granules are found in all tumors, in conjunction with calcification and foreign body giant cell reaction, just as are seen in benign pilomatrixoma. Follow-up of 17 patients revealed local recurrence in 10 (59%), with multiple recurrences in 3. One patient had pulmonary metastasis, and one died of extensive local spread of the tumor.**

Conclusion. **Pilomatrix carcinomas are locally aggressive tumors that have a tendency to recur, especially when they are incompletely excised. Greater anaplasia and deep soft tissue infiltration were associated with a higher incidence of recurrence and death. Wide excision is the preferred treatment. The role of radiation therapy is unclear. *Cancer* 1993; 71:2491–8.**

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Accepted for publication November 23, 1992.

Key words: pilomatrixoma, pilomatrix carcinoma, basaloid cells, shadow cells, clear cells.

Pilomatrixoma was first described in 1880 by Malherbe and Chenantais[1] as a "calcifying epithelioma" that was thought to be derived from the sebaceous gland. In 1949, Lever and Griesemer[2] suggested that the origin of the tumor was hair matrix cells. Forbis and Helwig[3] reviewed a series of 228 patients in 1961 and proposed the currently accepted name of "pilomatrixoma."

Pilomatrixomas are slow-growing, benign dermal or subcutaneous tumors, 0.5–5.0 cm in diameter. However, most such tumors measure 1–3 cm.[2] These tumors are found most frequently in young age groups. Forty percent of the tumors occur in individuals younger than 10 years of age, and more than 60% are diagnosed during the first two decades of life. The male:female ratio is approximately 2:3. The tumor involves (in decreasing frequency) the head, upper extremity, neck, trunk, and lower extremity.[4] Light and electron microscopic and histochemical studies support the hair matrix origin of this tumor.[2,3,5,6]

The malignant variant of pilomatrixoma (pilomatrix carcinoma) is extremely rare. Only 24 patients have been reported in the literature. We report 20 patients with pilomatrix carcinoma, one of whom has been previously reported. This study was done to delineate the histologic features, differentiate them from their benign counterpart, determine the clinical and biologic behavior, and recommend appropriate therapy.

Materials and Methods

All tumors designated as pilomatrixoma (702 patients), adnexal tumor and adnexal carcinoma (650 patients), and adnexal tumors of pilar origin (98 patients) were retrieved from the files of the Armed Forces Institute of Pathology. Tumors with histologic features of pilomatrixoma that exhibited unusual features, such as excessive basaloid cell proliferation, cytologic atypia, deep soft tissue infiltration, rapid growth, and recurrence, were studied. Twenty patients were selected from this

group. Available clinical data were reviewed. A questionnaire was sent to the contributing physicians and to the patients to obtain follow-up information. Sections stained with hematoxylin and eosin were studied in all patients. Special stains were used in selected patients: periodic acid–Schiff with and without diastase digestion, colloidal iron with and without hyaluronidase digestion, alcian blue at pH 2.5 and 0.4, Manuel reticulum, and Movat pentachrome. Peroxidase–antiperoxidase techniques for cytokeratin using polyclonal antibodies directed against keratin protein, carcinoembryonic antigen, and S-100 protein were used in 6 patients.

Results

Clinical Findings

The clinical data are summarized in Table 1. The tumors were described as slow-growing, asymptomatic masses or cysts. Seven patients noticed recent enlargement of the tumor, two of which were rapidly growing. The duration of the tumors before surgery in 15 patients ranged from 4 months to 10 years. The clinical diagnoses submitted before histologic examination included cyst (7), mass or nodule (8), and lipoma (2). They occurred in 16 male patients and 4 female patients (M:F, 4:1), ranging in age from 10 to 88 years (mean, 45 years). The patients were white, with the exception of one black and one Hispanic. Sites of involvement included: neck (7), back (4), face (3), upper extremities (3), and one each on the occipital scalp, breast, and buttock. The tumors showed a predilection for the posterior neck and back. None were found on the lower extremity. The tumors varied in size from 1 to 10 cm (mean, 4.6 cm).

Pathologic Findings

Gross. Most tumors were circumscribed dermal and subcutaneous nodules or cystic masses. The epidermis overlying the tumor was absent in six patients, thinned and elevated in two, ulcerated in four, and unremarkable in the others. The consistency of the tumors varied from soft and friable to firm and sometimes hard because of the presence of calcification. The cut surfaces were gray-white to tan or yellow and lobulated. Some were partially cystic and were filled with caseous, granular, chalky, or gelatinous material. The initial pathologic diagnoses in 14 patients included calcifying epithelioma of Malherbe or pilomatrixoma (7), malignant pilomatrixoma (2), adnexal carcinoma (2), sebaceous epithelioma (1), carcinoma in a dermoid cyst (1), and squamous cell carcinoma (1).

Microscopic. The tumors were characterized by proliferating basaloid cells arranged in sheets, irregular

Table 1. Clinical Features of Pilomatrix Carcinoma

Patient no.	Age (yr)	Sex	Duration	Clinical diagnosis	Site	Size (cm)
1	22	M	5 mo	Fat necrosis	Left shoulder	3
2	18	M	NK	Sebaceous cyst	Left post neck	2.5
3	57	F	3 yr	Nodule	Left breast	2.5
4	10	M	4 mo	Mass	Left lower back	3
5	71	M	NK	NK	Post neck	2
6	52	M	Many yr	Cyst	Right back	2.7
7	73	M	6 mo	Mass	Left preauricular	10
8	28	M	Many yr	Cyst	Right occipital scalp	3
9	28	M	6 yr	Mass	Post neck	9
10	63	F	Many yr	Cyst	Right buttock	5
11	28	F	3 yr	Lipoma	Back	4
12*	57	M	10 yr	Cyst	Upper back	6
13	51	M	7 yr	Cyst	Right post neck	3
14	26	M	1 yr	Mass	Left upper neck	8
15	48	M	6 mo	NK	Left lower eyelid	1
16	37	M	NK	NK	Left arm	10
17	69	F	4 mo	Mass	Post neck	7
18	88	M	Many yr	Mass	Right preauricular	1.8
19	15	M	NK	Dermoid cyst	Right post neck	1
20	71	M	10 yr	Lipoma	Left forearm	8

post: posterior; NK: not known.

* Previously reported in reference 14.

islands, and bands (Fig. 1). The basaloid cells infiltrated the entire dermis and extended into the subcutaneous fat (Fig. 2). Deep fascia was infiltrated in three patients (Patients 1, 9, and 14) and skeletal muscle in two (Patients 13 and 14). The peripheral border of the tumors were infiltrative in 13 patients (Figs. 3 and 4). In five patients, the tumors demonstrated a predominantly pushing border. However, on closer inspection, extension of small lobules and strands of tumor into the surrounding stroma was found. In 3 of 11 patients (Patients 3, 8, and 18) the tumor showed focal connection with the epidermis or hair follicle. The tumor extended into the epidermis, resulting in ulceration in four patients (Patients 10, 16, 18, and 19). The basaloid cells were large and contained a small amount of pale cytoplasm and hyperchromatic nuclei. The nuclei frequently were vesicular and had prominent nucleoli (Fig. 5). The degree of anaplasia was variable.

In the most actively proliferative basaloid cell areas, the mitoses varied from 12 to 62 per 10 high power field (hpf), with an average of 31/10 hpf. Areas of necrosis were noted frequently. The basaloid cells demonstrated keratinization and squamous differentiation in the form of squamous pearls or nests, horn cysts, shadow cells, and sometimes translucent or hyalinized keratinous masses (Fig. 6). The keratinization was sometimes abrupt and at other times gradual through several layers of squamous epithelium to laminated keratin. In several patients, the basaloid cells acquired a large amount of clear cytoplasm before undergoing keratinization (Fig. 7). Many tumor lobules demonstrated cystic spaces with a rim of basaloid cells at the periphery. These cystic spaces contained abundant necrotic debris, keratinous material, calcification and shadow cells.

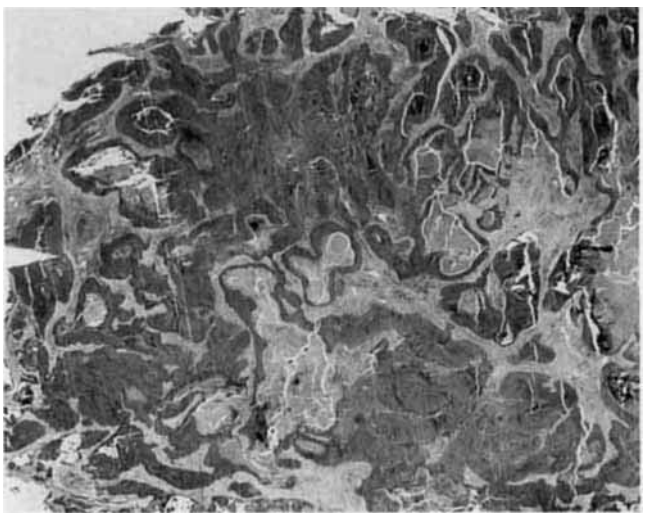

Figure 1. Basaloid cells infiltrate throughout the tumor mass in sheets and bands with areas of necrosis forming cystic spaces (H & E, original magnification ×10).

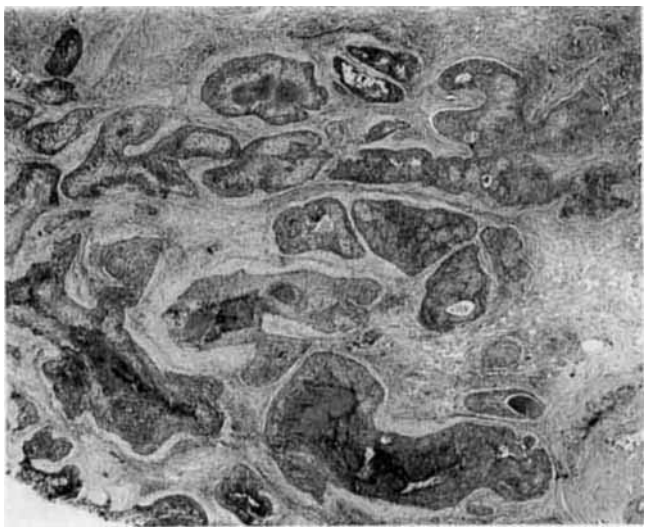

Figure 2. Islands of basaloid cells infiltrate the dermal collagen and subcutaneous fat (H & E, original magnification ×15).

In three patients (Patients 3, 6, and 18), the tumor resembled a keratinizing basal cell carcinoma, displaying irregular islands of keratinizing basal cells with cen-

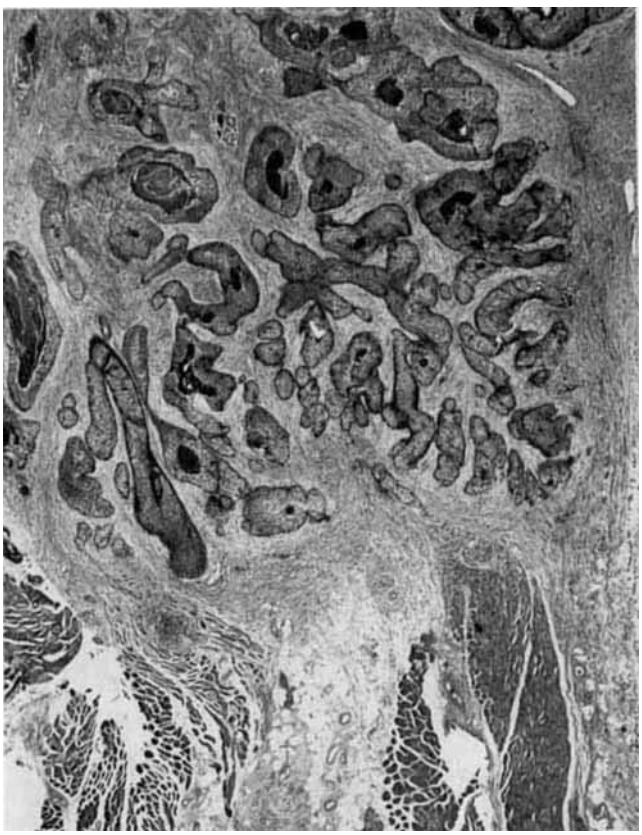

Figure 3. Pilomatrix carcinoma demonstrates infiltrative peripheral border and extension of the tumor into the skeletal muscle (lower end) (H & E, original magnification ×15).

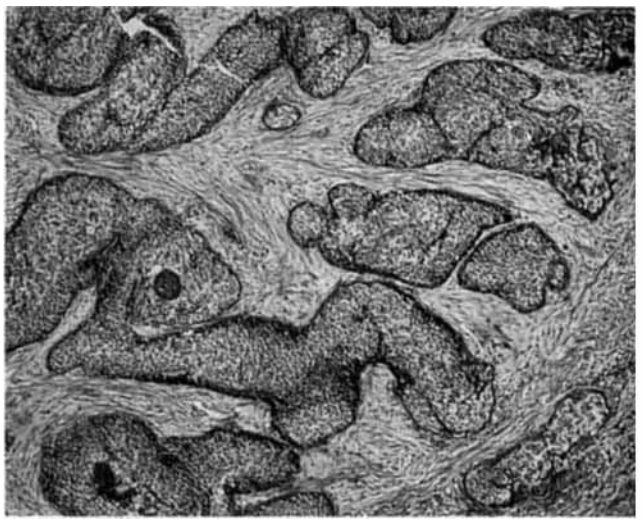

Figure 4. Higher magnification of Figure 3 demonstrates islands of basaloid cells surrounded by fibrocollagenous stroma (H & E, original magnification ×60).

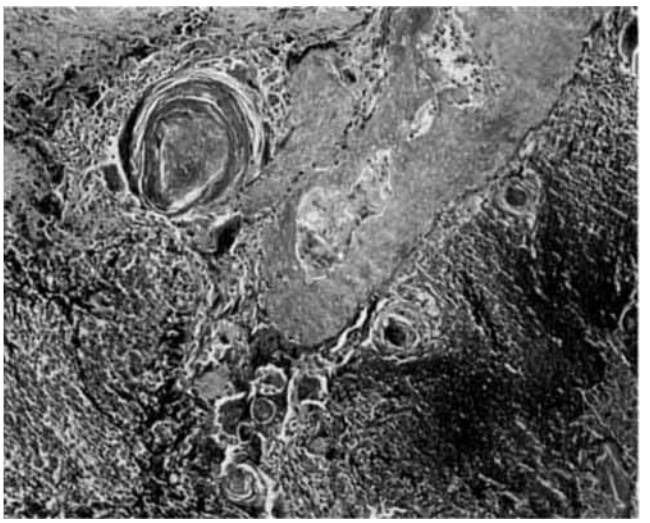

Figure 6. Pilomatrix carcinoma showing basaloid cells, squamous nests, shadow cells, keratin cyst, and foreign body giant cell reaction (H & E, original magnification ×100).

tral necrosis, peripheral nuclear palisading, and retraction spaces between the tumor islands and the stroma. Several areas of transition to shadow cells also were found in these tumors (Fig. 8).

Trichohyalin granules or trichohyalin-like eosinophilic globules were observed in 13 patients. These granules were found within the basaloid cells, especially in the clear cell and keratinous areas. Keratohyalin granules were found less frequently. Shadow cells were identified in all patients. They were less frequent in areas showing prominent basaloid cell proliferation and especially in the recurrent tumors. Three tumors (Patients 7, 10, and 20) had marked anaplasia with brisk mitoses (as high as 62/10 hpf) (Fig. 9). These tumors also demonstrated large areas of squamous differentiation and shadow cell formation. These shadow cells formed a nested pattern (Fig. 10) instead of the flat sheet-like pattern usually observed in benign pilomatrixoma. Abundant foreign body giant cell reaction was observed in association with keratin, shadow cells, and calcification.

The tumor islands were surrounded by a moderately cellular fibrocollagenous stroma. A small number of lymphocytes, histiocytes and plasma cells sprinkled the stroma. Vascular invasion (Fig. 11) was found in one patient (Patient 7) and perineural invasion in another (Patient 1).

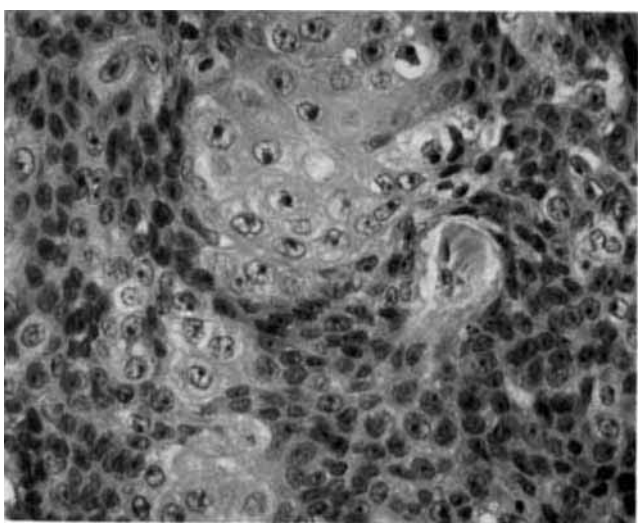

Figure 5. Basaloid cells show pleomorphism, vesicular nuclei, and prominent nucleoli (H & E, original magnification ×400).

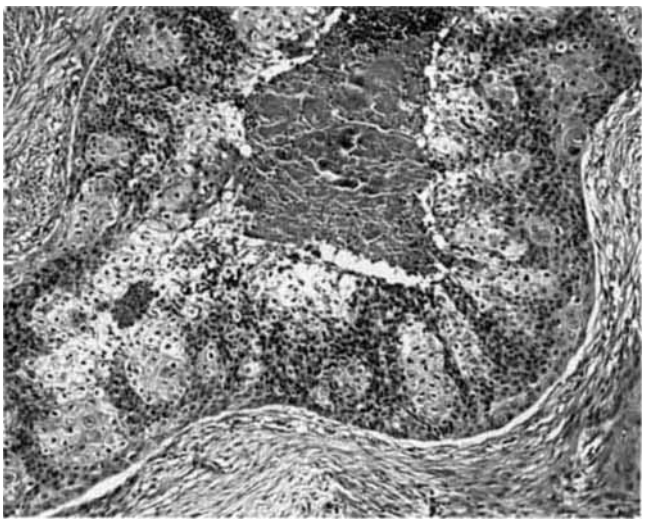

Figure 7. Basaloid cells showing transition to clear cells, central area of necrosis, and fibrocollagenous stroma (H & E, original magnification ×100).

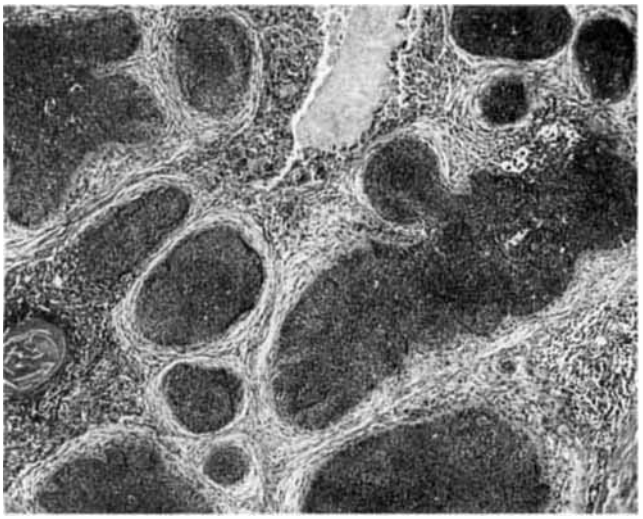

Figure 8. Pilomatrix carcinoma demonstrating islands of keratinizing basal cells, peripheral palisading of the nuclei, and loose fibroblastic stroma. Shadow cells and foreign body giant cell reaction are noted in the upper middle portion of the photomicrograph (H & E, original magnification ×60).

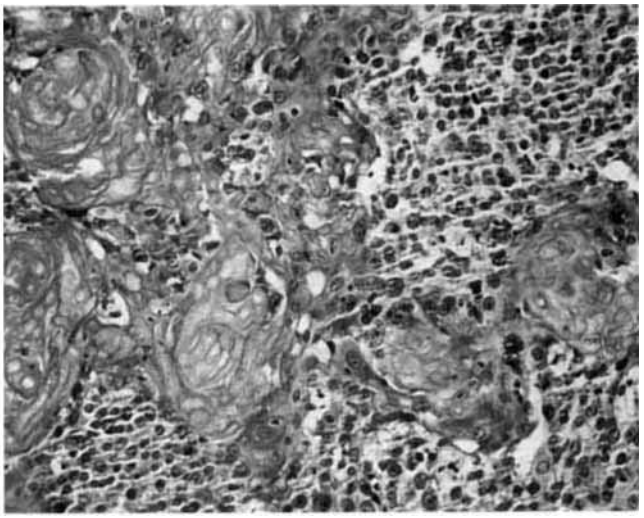

Figure 10. Anaplastic basaloid cells and shadow cells showing a nested pattern (Patient 7, H & E, original magnification ×250).

Results of Histochemical Procedures. Periodic acid-Schiff stains before and after diastase digestion were negative in all but two patients. Focal positive reaction was noted in the more differentiated areas of these two tumors, and the substance was removed by diastase digestion.

Colloidal iron with and without hyaluronidase digestion, and alcian blue stains at pH 2.5 and 0.4 demonstrated the presence of mucin in the stroma in the immediate vicinity of the tumor masses. The intensity of the staining reaction with colloidal iron was reduced after hyaluronidase digestion and alcian blue at pH 0.4. Elastic tissue was absent in the tumors stained with Movat pentachrome. Fine reticulum fibers were demonstrated in the stroma around the epithelial islands in a few patients, but this feature was not prominent.

Immunohistochemical staining for cytokeratin was positive in the areas of squamous differentiation, keratinization, and in the shadow cells; it was negative in the basaloid cells. The immunohistochemical stains for S-100 protein and carcinoembryonic antigen were negative.

Treatment and Follow-up. Follow-up data are summarized in Table 2; information was available in 17 patients. The duration of follow-up ranged from 5 months to 18 years. Ten (59%) tumors recurred within

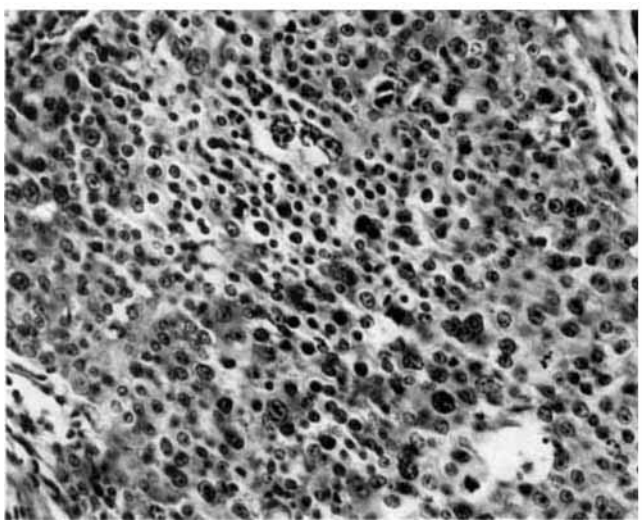

Figure 9. Pilomatrix carcinoma (Patient 7) demonstrates marked anaplasia and many mitoses (H & E, original magnification ×300).

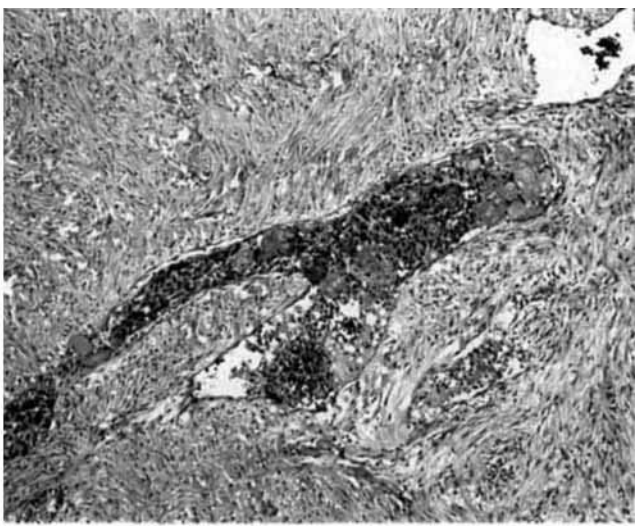

Figure 11. Pilomatrix carcinoma demonstrates vascular invasion (Patient 7, H & E, original magnification ×100).

Table 2. Follow-Up Data and Treatment of Pilomatrix Carcinoma

Patient no.	Initial treatment	Duration of follow-up	Follow-up	Treatment of recurrence/ metastasis	Alive/dead
1	Exc	18 yr	1st rec in 10 mo, 2nd rec in 4 yr	Wide exc and STSG	Alive
2	Exc	16 yr	Rec in 16 mo	Wide exc	Alive
3	Exc	2 yr	No rec	—	Alive
4	Exc	11 yr	Rec in 8 mo	Wide exc	Alive
5	Exc	8 yr	Rec in 4 mo	Exc	Died of COPD
6	Exc	6 yr	Rec in 1 yr	Wide exc	Alive
7	Wide exc and flap closure	5 mo	Rec in 4 mo	Palliative rad	Died of tumor
8	Wide exc and STSG	3 yr	No rec	—	Alive
9	Wide exc, STSG, and rad	18 mo	No rec	—	Alive
10	Exc	4 yr	Rec in 8 mo	Wide exc and STSG	Alive
11	Exc	7 mo	No rec	—	Alive
12	Exc	4 yr	1st rec in 17 mo, 2nd rec with pulmonary metastasis	Wide exc and rad thoracotomy	Alive
13	Wide exc and STSG	8 yr	Rec in 1 yr	Wide exc and STSG	Alive
14	Wide exc, radical neck diss, and parotidectomy	1 yr	Rec in 1 yr	Incomplete exc and rad	Lost to follow-up
15	Exc	—	Lost to follow-up	—	—
16	Exc	—	Lost to follow-up	—	—
17	Biopsy followed by rad and wide exc	3 yr	No rec	—	Alive
18	Exc	—	Lost to follow-up	—	—
19	Exc	10 mo	No rec	—	Alive
20	Exc	3 yr	No rec	—	Alive

exc: excision; rec: recurrence; rad: radiation; diss: dissection; STSG: split thickness skin graft; COPD: chronic obstructive pulmonary disease.

5–17 months after initial surgery, and among these, three (Patients 1, 12, and 13) had multiple recurrences. One patient, who was previously reported[14] (Patient 12), had pulmonary metastasis, and one (Patient 7) died of extensive local spread of the tumor.

Fifteen tumors were removed by simple excision; of these, 8 recurred. Three patients had wide excision, followed by flap closure, split thickness skin graft, or radical neck dissection and parotidectomy. Two patients (Patients 9 and 17) were treated initially by wide excision and radiation.

Of three patients whose tumors demonstrated greater anaplasia, one died of widespread local infiltration, and another experienced tumor recurrence within 8 months. The third did not have tumor recurrence; that patient's tumor displayed a predominantly pushing peripheral border on histologic examination. Among four patients with deep fascial and skeletal muscle tumor infiltration, three experienced tumor recurrence. The patient who did not have tumor recurrence was treated initially by wide excision with split thickness skin graft and radiation.

Discussion

Pilomatrix carcinoma with aggressive behavior was first described by Gromiko[7] in 1927. Lopansri and Mihm[8] reported a patient with pilomatrix carcinoma in 1980 and reviewed the data of five other patients previously reported in the literature. Subsequently, several reports of patients have been published. Review of the literature revealed a total of 24 patients with pilomatrix carcinoma.[7–26] These previously reported tumors occurred in 18 male patients and 6 female patients (M:F, 3:1), ranging in age from 8 to 86 years, with a mean of 49 years. The tumors were located on the face (10), neck (5), upper back (3), upper extremities (3), and one each on the buttock, hip, and occipital scalp.

Seven of the tumors occurred in the occipital scalp, posterior neck, and upper back areas and six in the preauricular area. The size of the tumors was known in 20 patients and ranged from 1 cm to 20 cm, with a mean of 4 cm (median, 2 cm). Of 22 tumors for which follow-up was available, 10 (46%) recurred, with multiple recur-

rences in 7. Two patients had metastasis.[14,20] One tumor metastasized to the axillary lymph nodes and the lung.[20] This patient subsequently died of widespread metastasis. Another patient had pulmonary metastasis.[14] In one patient, the tumor extended through the temporal bone into dura.[25] In 10 of 12 patients in whom a simple excision was performed and follow-up was available, the tumor recurred. In contrast, no recurrences have been reported after wide excision, radiation therapy, or a combination of these modalities.[11,13,17,18,21–24]

The histologic features of previously reported pilomatrix carcinomas included proliferation of hyperchromatic and vesicular basaloid cells with numerous mitoses and infiltration into fat or underlying structures. Areas of necrosis and vascular invasion were described in some patients.

In our series of 20 patients, a similar age and sex incidence to previously published cases was observed. The tumors in our report had a predilection for the posterior neck and back, but we had only two patients with tumors in the preauricular area. Although the average size of the pilomatrix carcinoma in our series was 4.6 cm, compared with 1–3 cm for the benign pilomatrixoma, this was not predictive of malignancy. Several tumors were within the size range for nonaggressive pilomatrixoma.

Pilomatrixomas usually are 1–3 cm circumscribed dermal tumors occurring in young individuals. They are slightly more common in females. Histologically, they are characterized by sharply circumscribed dermal and subcutaneous nodules. These nodules are composed of sheets and bands of basaloid cells usually arranged at the periphery of the tumors. The basaloid cells display scanty pale cytoplasm, small and uniform nuclei, and small nucleoli. These basaloid cells undergo extensive areas of keratinization, squamous differentiation, and shadow cell formation. Foreign body giant cell reaction and calcification are prominent features. The squamous differentiation and shadow cell formation occur in an organized manner toward the center of the nodules. The entire tumor sometimes is replaced by keratinous material, shadow cells, and foreign body reaction, leaving only a thin rim of basaloid cells at the periphery.[2,3]

However, pilomatrix carcinomas occur more often in middle-age to older individuals, are more common in men, and show a predilection for the posterior neck, upper back, and preauricular area. The average size of these tumors is slightly larger than that of the benign pilomatrixoma. Microscopically, they are characterized by exuberant proliferation of basaloid cell masses arranged haphazardly throughout the tumor. They display an infiltrative growth pattern and extend into deeper soft tissues. Varying degrees of cytologic atypia, frequent mitoses, and areas of necrosis are commonly observed. The keratinization with shadow cell formation is found in all patients, but it is less extensive than in benign pilomatrixoma. Atypical mitoses and vascular and perineural invasion may be present. The features that differentiate benign pilomatrixoma from pilomatrix carcinoma are depicted in Table 3.

Pilomatrix carcinoma may be confused histologically with basal cell carcinoma and proliferating pilar cyst.

Table 3.

Characteristic	Pilomatrixoma	Pilomatrix carcinoma
Clinical		
Age	Children and young adults; usually younger than 20 yr	Middle aged and elderly; usually older than 40 yr
Sex (M:F)	2:3	3–4:1
Common sites	Head, upper extremity, and neck	Posterior neck, back, and preauricular area
Histologic		
Location	Dermal or subcutaneous	Dermal/or subcutaneous; deeper soft tissue may be involved
Peripheral border	Sharply defined	Infiltrative
Basaloid cells	Basaloid cells arranged in bands or sheets at the periphery of the tumor	Masses of basaloid cells infiltrate throughout the tumor
Cytology	Uniform with a small nucleus and a small nucleolus	Large, pleomorphic with hyperchromatic and vesicular nucleus and large nucleolus
Clear cell change	Rare	Frequent
Necrosis	Rare	Frequent
Atypical mitoses	Absent	May be seen
Keratinization	Exuberant keratinization and shadow cell formation in an organized manner toward the center of the tumor	Keratinization and shadow cell formation less frequent and occur haphazardly throughout the tumor
Invasion	Perineural and vascular invasion absent	Perineural and vascular invasion may be seen
Recurrence	Rare	Frequent (46–59%)
Metastasis	Absent	May occur

Basal cell carcinoma[27] usually presents clinically as a waxy nodule with telangiectasia. The nodule often undergoes ulceration and is surrounded by a rolled pearly border. Microscopically, the neoplasm is characterized by basal cell proliferation in continuity with the surface epidermis, peripheral nuclear palisading, and retraction spaces between the epithelium and the stroma. Adenoid and cystic patterns, and areas of keratinization are commonly observed, but follicular differentiation toward matrix cells and shadow cells are not found in basal cell carcinoma.

Proliferating pilar cysts[28] are cystic tumors occurring preponderantly on the scalp of middle-age or older women. Microscopically, they are well circumscribed dermal and subcutaneous tumors characterized by sheets and anastomosing bands of hyperplastic epithelium, demonstrating trichilemmal keratinization. The cells at the periphery palisade and rest upon a thick hyalinized basement membrane. Foci of cellular atypia and premature keratinization often are seen. Shadow cells are not found in proliferating pilar cysts.

Pilomatrix carcinomas are locally aggressive tumors that have a tendency to recur, especially when they are incompletely excised; they have a recurrence rate as high as 59%. Metastasis and death have resulted from these tumors but are rare. In 8 of 15 patients in our series and 10 of 12 previously reported patients for whom simple excision was performed initially, the tumor recurred. A greater degree of anaplasia and deep soft tissue infiltration were associated with higher incidences of recurrence and death.

Wide excision is the preferred treatment. The role of radiation therapy is unclear because of limited experience with the treatment. Two previously reported patients[13,17] and two patients in our series (Patients 9 and 17) who were treated initially by radiation or surgery followed by radiation did not experience tumor recurrence. In patients in whom wide excision is not possible, radiation therapy should be considered.

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