Management of temporal bone carcinomas: A therapeutic analysis of two groups of patients and long-term followup

J. GERSHON SPECTOR, MD, St. Louis, Missouri

Fifty-one patients with squamous cell carcinomas arising within the temporal bone were subdivided into two groups. The initial group of 17 patients, seen between 1960 and 1980, were reviewed retrospectively and staged into four subgroups on the basis of initial tumor presentation and location (i.e., external auditory canal, superficial invasion, deep invasion, and tumors beyond the temporal bone). After treatment in a variety of surgical and radiotherapeutic combinations, the 5-year cure rates were: 70%, 70%, 50%, and 9%, respectively. Thirty-four patients, seen between 1980 and 1989, were placed in a new prospective protocol for combined surgery and postoperative irradiation. These patients were subdivided into the same subgroups on the basis of tumor location. The surgical procedures were formalized to be more encompassing (i.e., external canal tumors were treated by sleeve resection of the internal auditory canal and tympanic membrane, superficial invasion by superficial temporal bone resection, deep tumors by radical temporal bone resection, and those beyond the temporal bone by an infratemporal fossa approach). Radical neck dissections were performed where needed. The irradiation dosage was increased to 6250+ cGy, with a 4:1 ratio in favor of electrons for deeper penetration, and the fields were widened. At 36.6-month average followup, the cure rates were: 100%, 100%, 70%, and 65%, respectively. Six of ten patients with neck metastases at presentation had tumor recurrence or distant disease (60%). (OTOLARYNGOL HEAD NECK SURG 1991;104:58.)

Radiation therapy and surgery have been advocated for squamous cell carcinomas of the temporal bone.[1-5] Total or subtotal temporal bone resections are generally performed for tumors that invade the mastoid and middle ear. Lesions that involve the external auditory canal only may be removed by en bloc resection of the bony and cartilaginous external auditory canal (i.e., the so-called sleeve resection). Lesions that extend beyond the temporal bone usually require greater resection of the skull base, parotid, temporomandibular joint (TMJ), and neck dissection.

This analysis deals with two groups of patients in whom the squamous cell malignancy originated within the confines of the temporal bone and external auditory canal. Excluded are lesions that originated in the facial skin, conchal skin, preauricular and postauricular skin, parotid and other visceral compartments, and metastatic lesions to the temporal bone. Also excluded are non-epithelial malignancies.

Table 1. Temporal bone carcinoma—initial presentation (1960-1980)

Location	No. of patients	Metastases
External auditory canal	4	0
Superficial invasion	3	1
Deep invasion	4	0
Beyond temporal bone	6	2

METHODS AND MATERIALS

The first group of patients included 17 cases with epidermoid carcinoma treated between 1960 and 1980, with a variety of approaches and on whom long-term followup is available.[6] The second group of patients are of recent vintage (1980-1989). This group included 34 patients with squamous cell carcinomas who have an average followup of 36.6 months.

From the Department of Otolaryngology–Head and Neck Surgery, Washington University School of Medicine.

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Reprint requests: J. Gershon Spector, MD, Department of Otolaryngology–Head and Neck Surgery, Washington University School of Medicine, St. Louis, MO 63110.

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Table 2. Temporal bone carcinoma—initial presentation (1980-1989)

Location	No. of patients	Metastases
External auditory canal	7	1
Superficial invasion	3	0
Deep invasion	10	4
Beyond temporal bone	14	5

Table 3. Surgical methods

Location of tumor	Surgical method
External canal	Sleeve resection of EAC
Superficial invasion	Partial temporal bone resection
Deep invasion	Radical temporal bone resection
Beyond temporal bone	Infratemporal fossa

EAC, External auditory canal.

Table 4. Treatment modalities

I	II
Formalized prospective protocol	Combined therapy A. Wider excisions B. Postoperative radiotherapy 1. 4:1 in favor of electrons 2. 6000+ cGy 3. Wider fields 4. 180-200 cGy/day

Initial Group of Patients

Seventeen patients with epidermoid carcinoma of the temporal bone were seen between 1960 and 1980 (Table 1). Their ages ranged between 44 and 95 years, with an average age of 64.7 years. There were 9 men and 8 women. At presentation, four patients had disease that was confined to the external auditory canal, three had superficial invasion of the temporal bone (one had neck node metastasis), four had deep temporal bone invasion, and six had tumor extension beyond the temporal bone (two had neck metastasis).

The treatment plan was individualized with no formal protocol. The four patients with external canal lesions were treated as follows: one had a sleeve resection of the external canal, two had combined superficial temporal bone resections and radiation therapy, and one received irradiation only. Three patients with superficial invasion had combined superficial temporal bone resection (one patient also had a radical neck dissection) and postoperative radiation therapy. Four patients with deep invasion were treated as follows: three patients had radical temporal bone resections and postoperative radiation therapy and one was treated with radiation therapy only. Six patients with tumors beyond the temporal bone were treated as follows: one extremely old patient refused therapy, one received radiation therapy only, and four had radical temporal bone resections, total parotidectomies, partial mandibulectomies and wide excision of the surrounding tissues (two patients also had radical neck dissections) and postoperative irradiation.

Radiation therapy was given via a 5 × 5 cm to 10 × 15 cm ipsilateral port centered on the external auditory canal. Doses ranged from 5000 to 6000 cGy. Radiation consisted of photons and electrons with an energy of 13 to 18 million electron volts. When necessary, the neck was also treated.

Recent Group of Patients

Thirty-four patients with epidermoid carcinoma of the temporal bone were treated between 1980 and 1989 (Table 2). Their ages ranged from 56 to 98 years, with an average of 72.6 years. There were 24 men and 10 women. At presentation, seven had tumor confined to the external auditory canal (one had a parotid metastasis), three had superifical invasion of the temporal bone, ten had deep invasion of the temporal bone (four had parotid or neck metastases or both), and fourteen had tumor beyond the temporal bone (five had parotid or neck metastases or both).

The treatment plan was formalized into a prospective protocol (Table 3). All patients were treated with combined surgery and postoperative irradiation. Lesions of the external auditory canal had sleeve resections of the bony and cartilaginous canal, including the tympanic membrane, malleus, and bony anulus, followed by postoperative irradiation. Superficially invasive tumors were treated with a superficial temporal bone resection (i.e., the medial border was the end organ, stapes, tegmen, and posterior fossa bone plate). In many cases the posterior and middle fossa dura were completely exposed as the free margin. The facial nerve in all cases was spared or rotated anteriorly or both. Deeply invasive lesions had radical temporal bone resections (usually sparing the petrous apex tip) and postoperative irradiation. The medial border was the residual tip of the petrous apex. Usually a superficial parotidectomy, mandibular condyle, and zygomatic root were also resected. The facial nerve was resected if surrounded by tumor and repaired by means of a cable graft, facial hypoglossal anastomosis, or a Dott procedure (Fig. 1).[7] Lesions that extended beyond the temporal bone were resected via an infratemporal fossa approach. The depth of the resection was determined by clinical and pre-

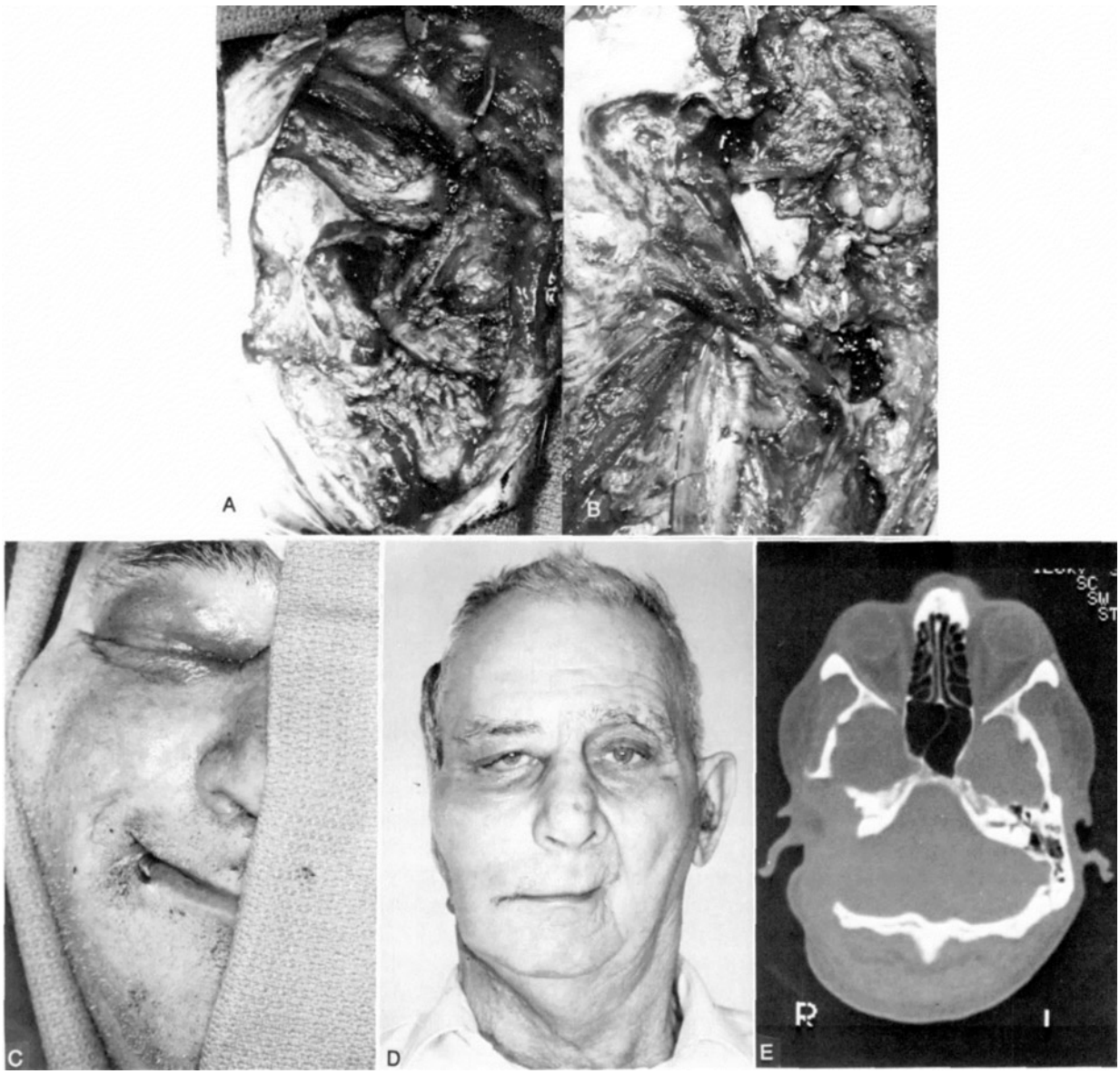

Fig. 1. Radical temporal bone resection with superficial parotidectomy, partial mandibulectomy, and radical neck dissection for squamous cell carcinoma invading deeply into the temporal bone. **A,** Post-resection retroposition of the parotid gland and preparing the dual temporalis flap. **B,** Obliteration of the petrous apex, middle ear, and mastoid with the posterior temporalis muscle, and the use of the middle portion of the muscle to reanimate the face. **C,** Reanimation of the eyelids and the lips with dynamic temporalis slings. The defect was closed with a latissimus dorsi myocutaneous flap. **D,** The patient at 3 years NED followup. **E,** CT demonstrates surgical defect.

operative radiologic evaluation of the tumor extent (CT with contrast and/or MRI and/or arteriography with subtraction technique). After wound healing—usually at 4 to 6 weeks postoperatively—irradiation therapy was given. The repair was facilitated by regional flaps (temporalis or sternomastoid muscle), myocutaneous flaps (latissimus dorsi or pectoralis major), or free flaps (rectus abdominis). The facial nerve was invariably sacrificed and repaired with either a cable graft or facial hypoglossal anastomosis. The latter has become the main repair in the absence of other neurologic deficits. When no neural structures were available for repair, a dynamic temporalis musculofascial sling was used for reanimation (Fig. 1).

It should be noted that in this group of patients, 13 received some initial surgery or irradiation elsewhere

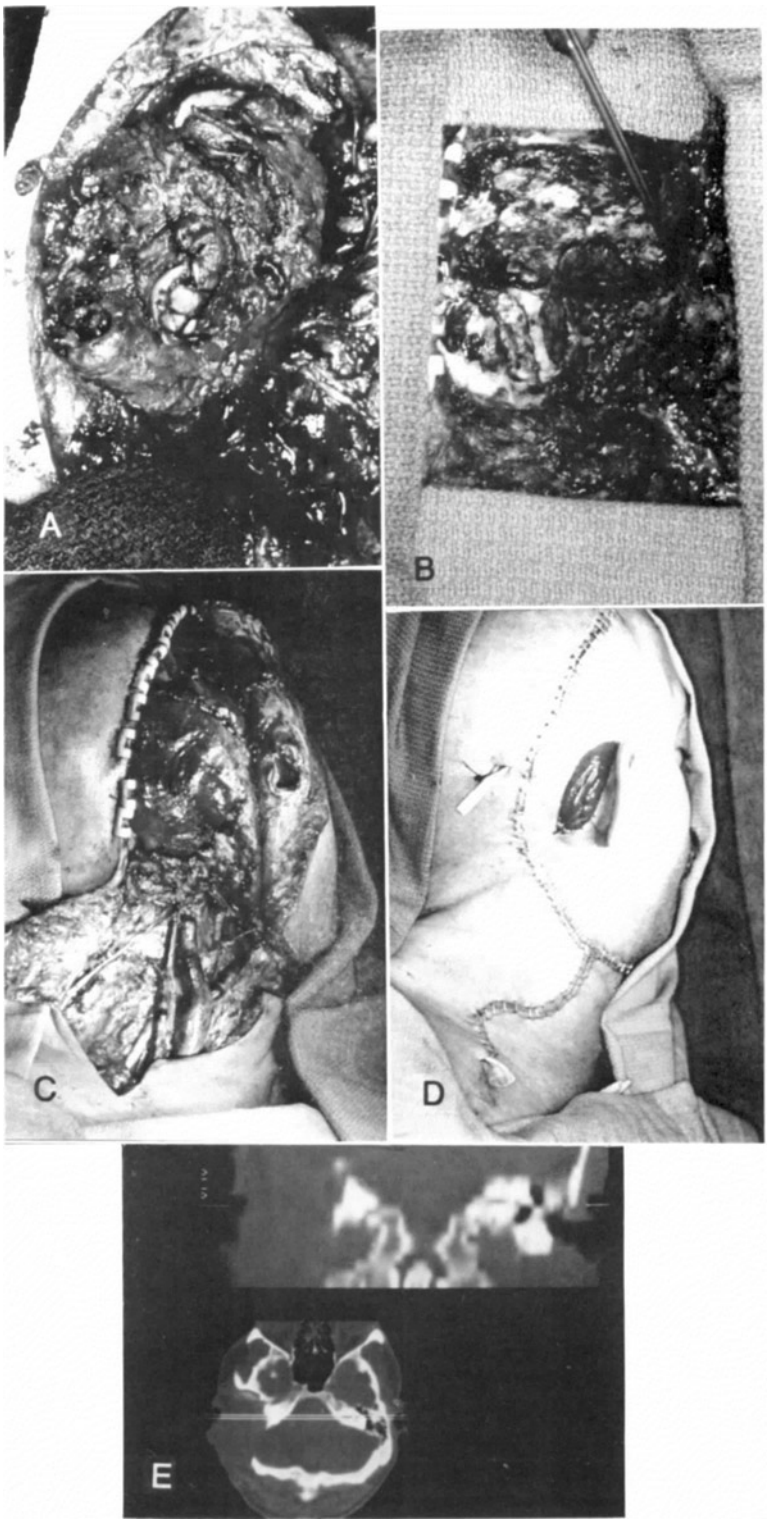

Fig. 2. Radical temporal bone resection for squamous cell carcinoma invading the posterior and middle fossa dura. **A,** Obliteration of the external canal, superficial parotidectomy, and delineation of the tumor margins. **B,** Radical temporal bone resection including the middle and posterior fossa dura. **C,** Rectus abdominis free flap with microvascular anastomoses positioned to obliterate defect. **D,** Closure of defect. The previous postauricular incision is excised for tumor margins and left open to follow viability of the free flap. This area epithelializes in 3 weeks. **E,** Residual defect demonstrated by CT. *Upper figure* is a reformatted A-P view; *lower figure* is a coronal view.

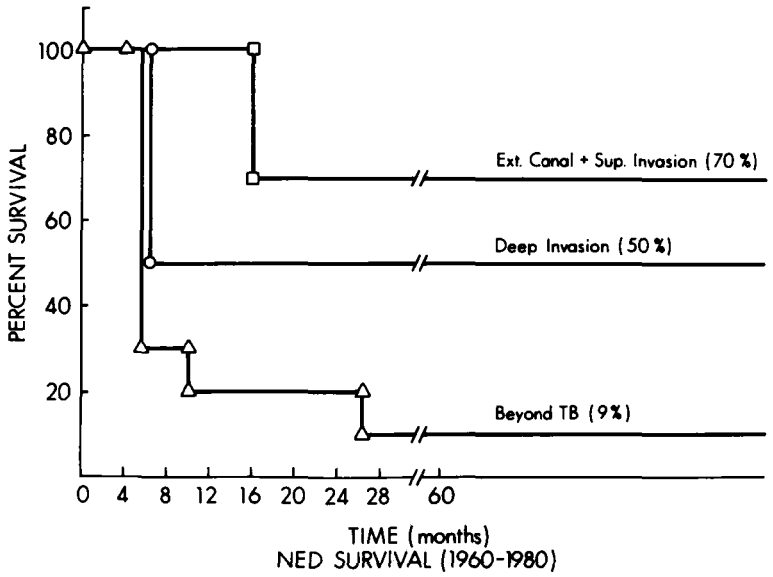

Fig. 3. Survival data with no evidence of disease (NED) for the initial group of patients (1960-1980).

before referral to our institution. Furthermore, our recent radiotherapy policy was changed. A computerized treatment plan to achieve optimal combination of photons and electrons was initiated (Table 4). The recent policy was formulated to treat exclusively with electrons or a combination of 4-to-1, in favor of electrons. The daily fractionations were varied between 180 and 200 cGy to a maximal dose in excess of 6250+ cGy to the primary site. The radiation ports were increased in diameter, except superiorly where central nervous system (CNS) sparing was required. The radiation fields included the postauricular, parotid, and neck areas. Many patients selected to receive radiation near their homes at other institutions. One patient was treated with hyperfractionation doses for cure elsewhere (6072 cGy in 35 fractions [43 days]; 780 Cobalt 60 for 3872 cGy and 15 mEV electrons).

In addition, we have increased the scope of our surgical field. Our present protocol in treatment of tumors limited to the external auditory canal or with superficial bony invasion is an en bloc resection of the entire cartilaginous and bony external auditory canal. This includes the tympanic membrane, malleus, incus, zygomatic root cells, and the entire mastoid. Superficial parotidectomy, preauricular and postauricular lymph nodes, and a functional neck dissection are performed when necessary. With deep invasion, total or subtotal temporal bone resection is performed. The facial nerve may need to be mobilized, rotated, or even sacrificed. The subtotal resection includes removal of the sensory end organs, jugular bulb, facial nerve, ascending process of the mandible, zygoma, and the entire parotid gland. The carotid artery is spared (in one case, the common cartoid and both major divisions were sacrificed without sequelae). These procedures are usually performed via a posterior infratemporal fossa approach. Total temporal bone resections include removal of the entire tegemen and posterior fossa bony plate and almost the entire petrous apex. We do not routinely perform total petrousectomies (except in three patients with deeply invasive carcinomas). Tumors that extend beyond the temporal bone may undergo more extensive surgery, depending on tumor location and extent. Lesions that *invade* the dura but not *through* the dura are resected. The dural repair is usually by means of the galea aponeurotica, calvarial periosteum, or temporalis fascia (most common). Lesions that penetrate the dura and enter the CNS directly or extend along the foramina at the base of the skull receive operations through the level of the dura and are followed by repair and irradiation therapy.

Recently, in the past 18 months, we have used brachytherapy with implantation of radioactive materials at the resection sites (2 cases). We use either radioactive iodine sutures (I125) at the time of surgery if we wish to deliver slow long-term irradiation, or blind-ended catheters for irridium implantation at a later date if we wish to deliver high doses of immediate irradiation. Radioactive iodine seeds are sutured to the undersurface of the vascularized flaps and placed on top of the resected temporal bone margins. Distant metastasis preclude massive resections.

After resection, the exposed skull base and large infratemporal and temporal defect are obliterated by vascularized temporalis, sternomastoid muscle (SCM), latissimus dorsi (most common), or pectoralis major pedicled or myocutaneous flaps (most common).[7] The eustachian tube is obliterated, the facial nerve deficits are corrected at the time of surgery[7] and the external auditory canal defect is closed. Recently we have used a free microvascular rectus abdominis flap (N = 3) to close the skull base defect. The latter appears to be the superior type of repair from a functional and cosmetic point of view (Fig. 2).

RESULTS

Initial Group

At 5 years, one of four patients with external auditory canal tumor died of the disease. Two patients died of intercurrent disease, with no evidence of tumor. One patient is alive. One of three patients with superficially invasive carcinoma died of disease. This patient had cervical node metastasis at the time of diagnosis. Two of four patients with deeply invasive tumor died of their disease and one died of intercurrent causes (at 28 months) with no evidence of disease (NED). Five of six patients (including two with neck node metastasis) with tumors beyond the temporal bone died of their disease. The surviving patient had tumor of the temporal bone with parotid extension. She underwent subtotal temporal bone resection, total parotidectomy, and received 6000 cGy postoperatively. She is free of disease 12 years after therapy (Fig. 3).

On long-term followup, it appears that patients who failed therapy did so because of local recurrence or regional disease. One patient who had a superficial invasive tumor and neck metastasis was treated with subtotal temporal bone resection, total parotidectomy, and right radical neck dissection. She then received 5220 cGy postoperative radiation. The cancer recurred at 11 months, both locally and in the neck. She died at 22 months after therapy. Eight other patients had recurrent disease. Of these, 6 had recurrence within 1 year of diagnosis and two had recurrence within 3 years. These patients underwent single modality or combination therapy with or without chemotherapy for salvage. None of these were saved. All died within 14 months of recurrence presentation (Fig. 4).

Complications of radiation therapy include minor local infections (N = 2), osteitis (N = 1), neurosensory hearing loss (N = 1), loss of vestibular function (N = 1), and radiation dermatitis (N = 1). Surgical complications include cerebrospinal fluid (CSF) leak (N = 1), superficial soft tissue sepsis (N = 1), permanent facial nerve palsy (N = 2), and delayed healing (N = 2). There were no perioperative or intraoperative deaths or major CNS complications.

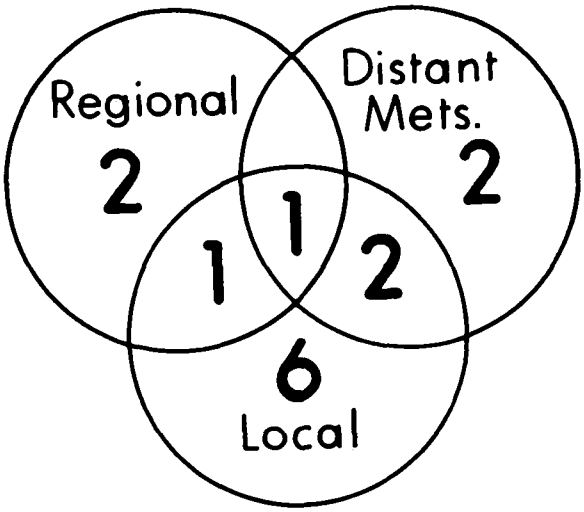

Fig. 4. Sites of tumor recurrence in the initial group of patients (1960-1980).

Recent Group of Patients

The average followup was 36.6 months and the overall cure rate was 76% after combined therapy. Seven patients with external canal tumors are alive and free of disease. A second biopsy was performed in the infraauricular region of the patient with neck metastasis (in this group) for a painful small mass. This proved to be a post-traumatic neuroma of the greater auricular nerve. The three patients with superficial invasion of the external canal are free of disease.

The 10 patients with deeply invasive tumors—four of whom had neck metastasis—have poorer results. Distant pulmonary and liver metastasis developed in one patient with neck metastasis, who died at 16 months after treatment. Two patients (one with neck metastasis) have local recurrences. None of the latter have neck recurrence. An anaerobic infection under the free flap developed in one patient at 6 months after treatment. After exposure, debridement, and irrigation, positive ctyology was obtained at the level of the dural repair for tumor recurrence. Of the 14 patients with tumor beyond the temporal bone, three have persistent disease deep in the infratemporal fossa at the level of the clivus, and one has tumor invaison via the foramen ovale into the middle cranial fossa. Hematogenous metastasis developed into the facial skin, neck skin, and distant metastasis to the viscera and lungs of one patient. Within this group, three of five patients with neck metastasis have recurrent disease. The remaining nine patients are free of disease at an average of 36.6 months followup.

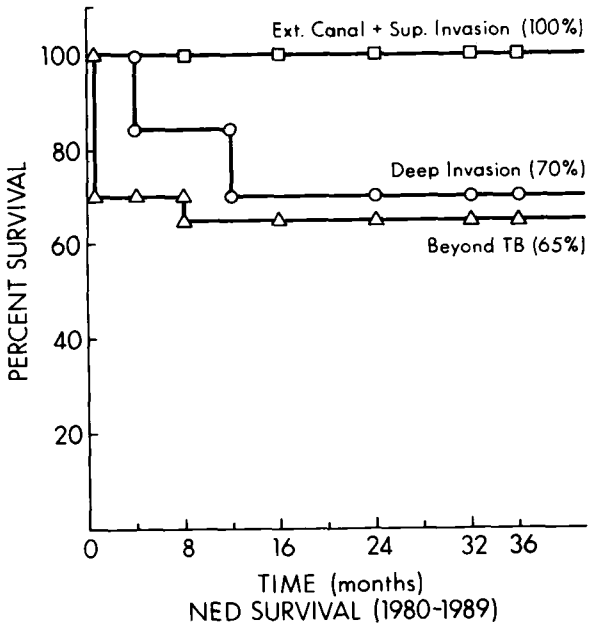

Fig. 5. Survival data with no evidence of disease (NED) for the most recent group of patients with at least 36-month followup (1980-1989).

Three of these patients, however, have less than 28 months followup. (Four recent patients with less than 15 months followup are not included in this study; however, one has tumor recurrence at the deep margin) (Fig. 5).

Two patients received additional irradiation by means of irridium implants (N = 1) and radioactive iodine (N = 1). In both cases there was partial loss of the vascularized flaps. These required additional reconstructive surgery (Fig. 6).

The complications of radiation therapy included osteitis (N = 2), partial loss of the vascularized flaps (N = 2), and unexpected loss of end organ function (N = 3). Surgical complications included CSF leak (N = 1), loss of tissue and sepsis (N = 2), facial palsy (N = 18), and delayed healing (N = 1). The facial paralysis in all cases was repaired at the time of the initial surgery. The repair consisted of either a facial hypoglossal anastomosis (N = 9), neural cable grafts (N = 3), or dynamic temporalis fascial-muscle slings (N = 6).[7]

DISCUSSION

Poor results in the treatment of temporal bone cancer led Parsons and Lewis[8] to develop the en bloc subtotal temporal bone resection. Later refinements to this operation allowed for total temporal bone removal and infratemporal fossa surgery. Today we are approaching the limits of resectability in this region. Most recently, studies have demonstrated the superiority of combined therapy for epithelial tumors. Nevertheless, in an evaluation of the literature and our own initial group of patients, we noted that the 5-year survival rate for deeply invasive temporal bone tumors and for lesions that extend beyond the temporal bone ranges between 9% and 38%.[9-13]

Wagenfeld et al.[3] reviewed 25 cases at Toronto's Princess Margaret Hospital. They had three groups of patients: (1) unresectable lesions treated with radiation–7 cases, no survivors; (2) radiotherapy for cure and surgery for salvage–12 cases, 30% of whom survived 4 years NED; and (3) primary surgery and postoperative radiation–4 of 6 cases survived 4 years NED.

In 136 cases, of squamous cell carcinoma, basal cell carcinoma, and salivary gland tumors of the external canal and temporal bone at M.D. Anderson Hospital, there was a 29% 5-year survival (35 patients) with deep temporal bone invasion.[13] The major failure was incomplete tumor resection. Postoperative radiation did not benefit those with incomplete tumor resection, but did improve local control rates in patients with complete tumor removal. In the latter group, however, there was no corresponding rise in 5-year survival. The 5-year cure rate with radiotherapy alone is 0% to 22%. The incidence of metastasis is 12% to 16.5%.[2,5,16] An evaluation of the reported series of temporal bone resections and radiation therapy for squamous cell carcinomas demonstrate an overall 25% to 45% 5-year survival NED. Lewis[9] reported on 100 cases with a 27% 5-year survival. The following data is reported in the literature for 5-year survivals: Conley and Schuller[5] (25 cases)–36.8% (20.8% for irradiation alone); Hana et al.[14] (12 cases)–42%; Coleman[15] (7 cases)–42%; Lederman[12] (31 cases)–33%; Wang[2] (20 cases)–45%; and Sinha and Aziz[1] (15 cases)–40%. We therefore initiated a new policy of treatment for the recent group of patients.

The recent approach is based mainly on a more extensive resection of the temporal bone and higher doses of irradiation with deeper penetrability. The main objective was to increase the cure rates in three groups of patients (i.e., external canal tumors, superficially invasive tumors, and those beyond the temporal bone). We do not anticipate a change in the cure rate of deeply invasive tumors, even if we add a total petrosectomy as a routine procedure. We always use radiation therapy postoperatively with doses greater than 6000 cGy to the primary site and favor electron beam therapy at 13 to 18 million electron volts. The fractionation is usually at 200 cGy per day, with lateral and oblique ports centered on the external canal. We enlarge our ports to include the parotid, the postauricular area, and the upper (or total) neck.

We noted that many of the local recurrences resulted

primarily from unexpected tumor extensions beyond the operative area. These extensions may not be diagnosed radiologically preoperatively and may be missed even with rigorous intraoperative monitoring of the surgical margins. We have seen tumor extension along both motor and sensory nerves (many times without neural deficits), various fascial planes (especially along the masseter and pterygoid muscles), underneath and deep to the maxilla and zygoma, and along vascular planes. Most commonly, tumor extends along the fallopian canal, around the facial nerve, to invade the stylomastoid foramen, mastoid tip, upper SCM, and parotid. This allows for deeper extensions into the skull base. Furthermore, anterior breakthrough via the tympanic bone and zygomatic root to involve the temporomandibular joint, parotid, temporal, and infratemporal fossae is frequent. Tumors in this region can expose the internal carotid artery and extend to the level of the foramen lacerum. This early breakthrough of tumor beyond the confines of the temporal bone denotes a grave prognosis because the tumor spread may go beyond the apparent boundaries of our resection. Tumor extension along the infratemporal fossa planes may not be diagnosed or determined at the time of surgery. Tumors, at presentation, that have associated regional lymph node metastasis have a poor prognosis for survival. In our series, metastases reduce survival by 60% (i.e., four of 10 patients have no recurrences). In addition, because of the high vascular nature of this area, we have noted 3 cases of hematogenous tumor spread after therapy. At least one of these cases may, perhaps, have been caused by operative seeding.

In many respects, our population of patients may not be representative of the general occurrence of squamous cell carcinoma in the temporal bone. Because of the nature of our referral patterns and institutional practices, we tend to accumulate cases of more advanced disease. For example, the incidence of metastasis in our recent group of patients was 29.4% (25.5% in our overall population) as compared to that reported in the literature (12% to 16%). Our data are based on pathologic analysis of resected specimens. Since we tend to perform superficial parotidectomies and neck dissections more routinely, this discrepancy in the metastatic rate may reflect inapparent tumor spread that is not delineated when only the temporal bone is treated.

Within our population of patients, the two therapeutic groups may also not be comparable to each other. In our initial group, the sex distribution was approximately equal, and in the latter group there was a male preponderance with a 2.4:1 ratio. Furthermore, the initial age of tumor presentation in the first group was 64.7 years, and in the latter group was 72.6 years. In addition, the metastatic rate within the groups is not comparable because the initial group had a metastatic rate of 18% (in agreement with data presented in the literature), and the latter group had a rate of 29.4% (almost double). Nevertheless, despite the poorer prognosis for survival and cure in the latter group of patients, their overall 3-year NED cure rate is significantly higher than in the former group of patients. We believe this difference is a reflection of our formalized therapeutic protocol.

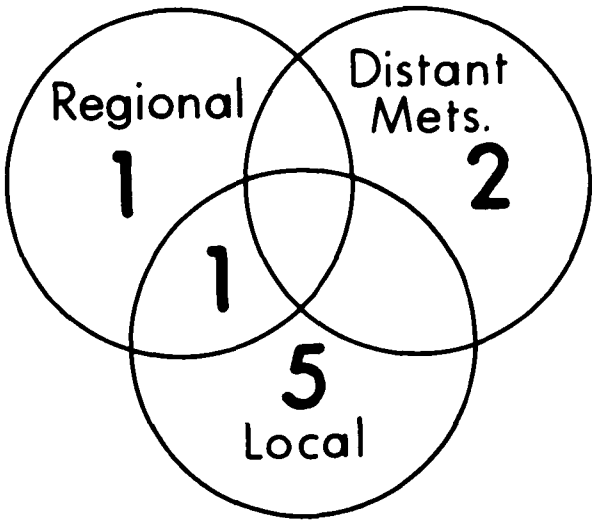

Fig. 6. Sites of failure in the most recent group of patients (1980-1989).

In conclusion, a systematic therapeutic approach to temporal bone carcinomas based on more extensive, but definitive resections, and higher doses with deep penetrability of irradiation therapy has significantly improved survival in localized epithelial tumors of the temporal bone (i.e., external canal tumors and superficially invasive tumors). The final results with deeply invasive tumors and those beyond the temporal bone are still open to debate. In the latter two instances, we elect to alter the radiotherapeutic modality by giving teletherapy of over 6000 cGy of mostly electrons. The use of brachytherapy with irridium or radioactive iodine has not been explored adequately at the present time. Whether more extensive intracranial therapy with resection of a major portion of the skull base will provide better results in deeply penetrating tumors and those beyond the temporal bone is unknown at the present time.

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