Efficacy of surgical treatments for squamous cell carcinoma of the temporal bone: A literature review

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A review of all publications dealing with surgical treatment for squamous cell carcinoma of the temporal bone was performed. No randomized or nonrandomized control studies were identified. All studies were case series without control subjects. Twenty-six of 96 publications, which contained information on 144 patients, were analyzed. Several inferences are suggested by the available evidence; however, these areas should be investigated by properly designed randomized clinical trials: (1) patients with carcinoma that is confined to the external auditory canal have similar survival, regardless of whether mastoidectomy, lateral temporal bone resection (TBR), or subtotal TBR is performed: the addition of radiation therapy to lateral TBR does not appear to improve survival; (2) when disease extends into the middle ear, survival of patients treated with subtotal TBR appeared to be improved over those treated with lateral TBR or mastoidectomy: it remains uncertain if the addition of radiation therapy to mastoidectomy improves survival; (3) the value of surgical resection when carcinoma extends to involve the petrous apex remains unclear; (4) resection of involved dura mater does not appear to improve survival; however, incomplete data regarding margins of resection were reported; and (5) determination of the value of resection of involved brain parenchyma or internal carotid artery will require further study. (OTOLARYNGOL HEAD NECK SURG 1994;110:270-80.)

Cranial base surgery has seen many changes since its "birth" in the early 1960's through the pioneering efforts of William House, Ugo Fisch, Michael Glasscock III, and Madgid Samii. The cooperation of multiple disciplines coupled with technical advances in preoperative imaging, preoperative carotid artery testing, operative approaches and neurophysiologic monitoring have contributed greatly to this advancing frontier.

Despite these advances, skeptics claim that cranial base surgeons have focused on technical aspects of surgery; namely, on the development of operative approaches rather than on more pertinent issues such as morbidity, quality of life, survival, and impact on health care costs.

Clearly the major impediment in assessment of survival and outcome has been the rarity of the lesions encountered. No single institution has, by itself, sufficient data that allow analysis of results.

Squamous cell carcinoma of the temporal bone is an example of a lesion in which no uniformity, in regard to treatment, exists. A literature review and analysis was performed to provide answers to the following questions.

1. What is the survival of patients with lesions confined to the external auditory canal, treated by surgical resection, and what type of operation should be performed in this instance?
2. Once the disease enters the middle ear, what is the operation that provides optimal survival?
3. Is total temporal bone resection ever indicated?
4. How does prognosis change as structures such as the dura mater, brain, and internal carotid artery become involved? Is there a role for surgery in these instances?

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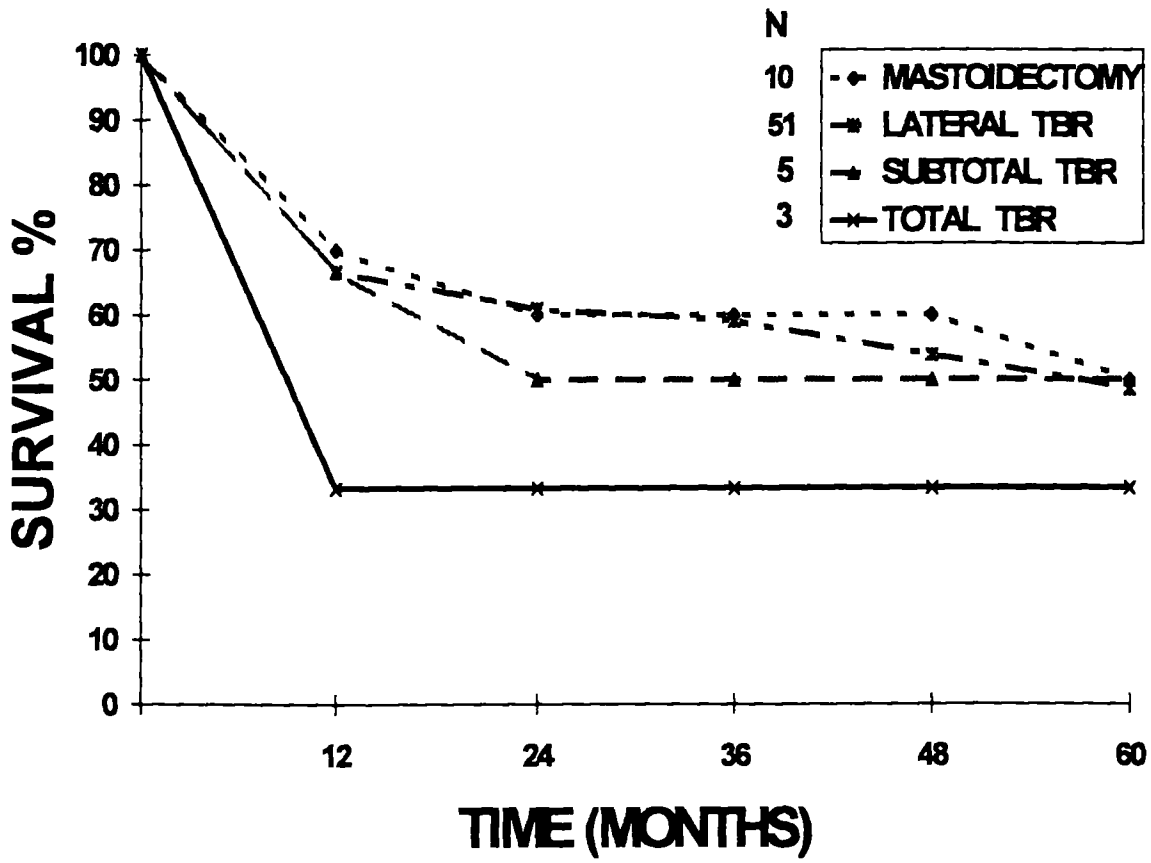

Fig. 1. Treatment-specific survival for patients with carcinoma confined to the external auditory canal.

5. Does the addition of preoperative or postoperative radiation therapy enhance survival?

METHODS AND MATERIALS

A MEDLINE search was performed to identify all publications in the English language, dating back to 1966, dealing with the treatment of squamous cell carcinoma of the temporal bone. Manuscripts dating back to 1915 were identified by searching the *Cumulative Index Medicus* and by reviewing references quoted in recent papers.

Ninety-six publications[1-96] were encountered, of which 26 articles,[71-96] containing information on 144 patients, were analyzed extensively. Reasons for exclusion of a study included the lack of information describing the extent of disease (as determined by clinical examination and preoperative imaging), type of treatment, and followup for each patient.

Terms used throughout this manuscript are now defined for clarity. The term *mastoidectomy* includes all types of modified radical and radical mastoidectomy. *Lateral temporal bone resection* (TBR) is defined as the removal of the osseous and cartilaginous external auditory canal, malleus and incus. *Subtotal TBR* includes the additional removal of the otic capsule. *Total TBR* involves the additional removal of the petrous apex.

Several assumptions were required for simplicity in analysis. Because of the lack of adequate preoperative imaging in studies up until 1975, surgical findings were used to accurately stage extent of disease. When referred to throughout the manuscript, *middle ear involvement* includes tumors that extend from the external canal to involve either the lateral or both the lateral and medial compartments of the middle ear. Most authors did not make this distinction.

All patient records were entered into dBASE III Plus software on an IBM-compatible personal computer. Twenty-eight fields were opened and labelled as follows; author, year of publication, patient number, age, sex, histology, extent of disease, presence of regional metastases, presence of distant metastases, preoperative radiation, type of preoperative radia-

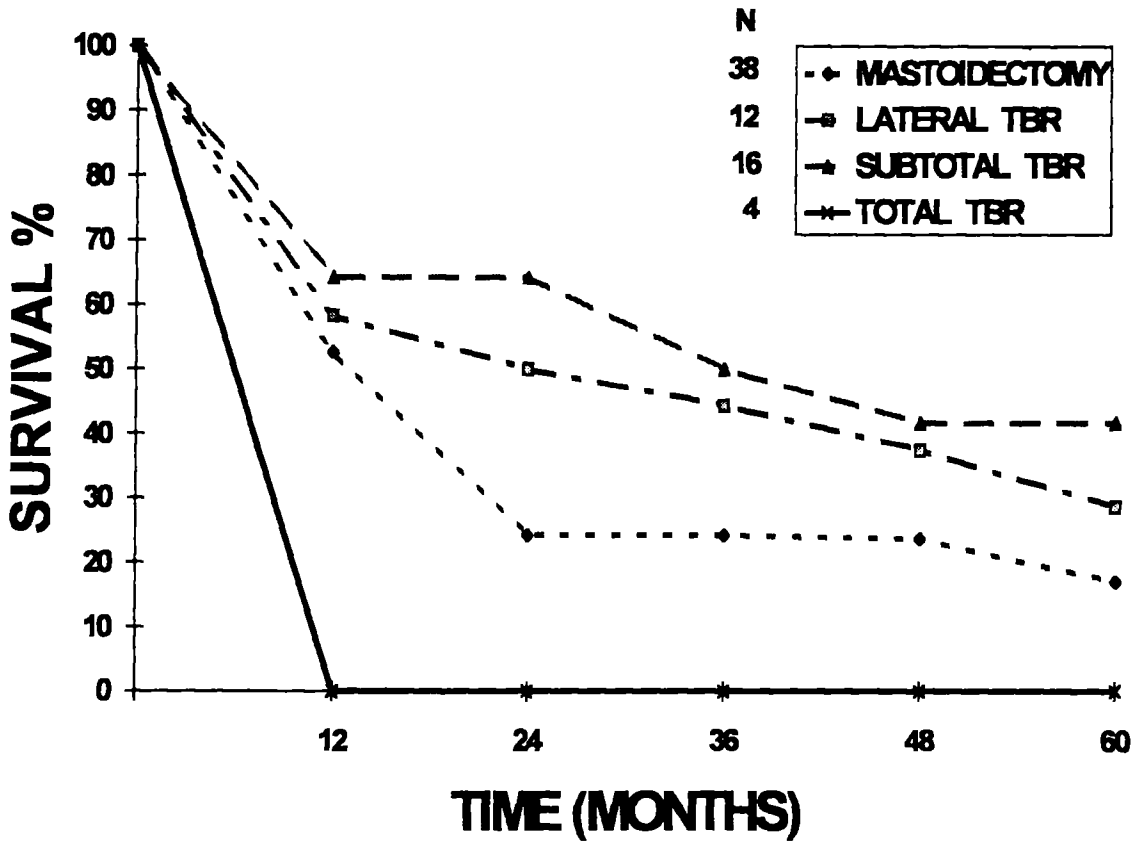

Fig. 2. Treatment-specific survival for patients with carcinoma extending to involve the middle ear.

tion, preoperative chemotherapy, previous surgery, type of previous surgery, type of operation performed, internal carotid artery (ICA) involvement, resection of ICA, dural invasion, resection of dura, brain invasion, resection of brain tissue, postoperative radiation, type of postoperative radiation, postoperative chemotherapy, survival, followup (years), presence of failure to control disease, and site of failure. Each record was given a numeric value under each field, denoting a specific characteristic of the patient. Data retrieval was performed using commands stated in the software manual.[97]

For the purpose of analysis, all patients who were reported as *alive with disease* were considered *dead of disease* because it was presumed their survival would be short. All patients who died of other causes and those who had no evidence of disease with 1 year after treatment were excluded from the analysis because of inadequate followup. Those who died during surgery were considered *dead of disease* (DOD) and were included in the analysis. Patients who were dead of other causes beyond 1 year after treatment were considered disease-free up to that time.

Chi-square analysis was used to determine the statistical significance between compared groups. A p value of less than 0.05 was considered significant.

RESULTS

Publication Analysis

The quality of the studies was evaluated using the five Levels of Evidence stated by Cook et al.[98] No prospective randomized trial (level I or II) was identified. Nonrandomized concurrent cohort comparison studies (level III) were also not found. A nonrandomized historical cohort comparison study (level IV) was found. All remaining studies were case series without control subjects (level V).

Of the ninety-six publications identified, twenty-six articles contained sufficient information on 144 patients in regard to extent of disease, type of treatment rendered, and followup. Seventy publications were excluded from the analysis for one or more of the following reasons. Eight articles combined mul-

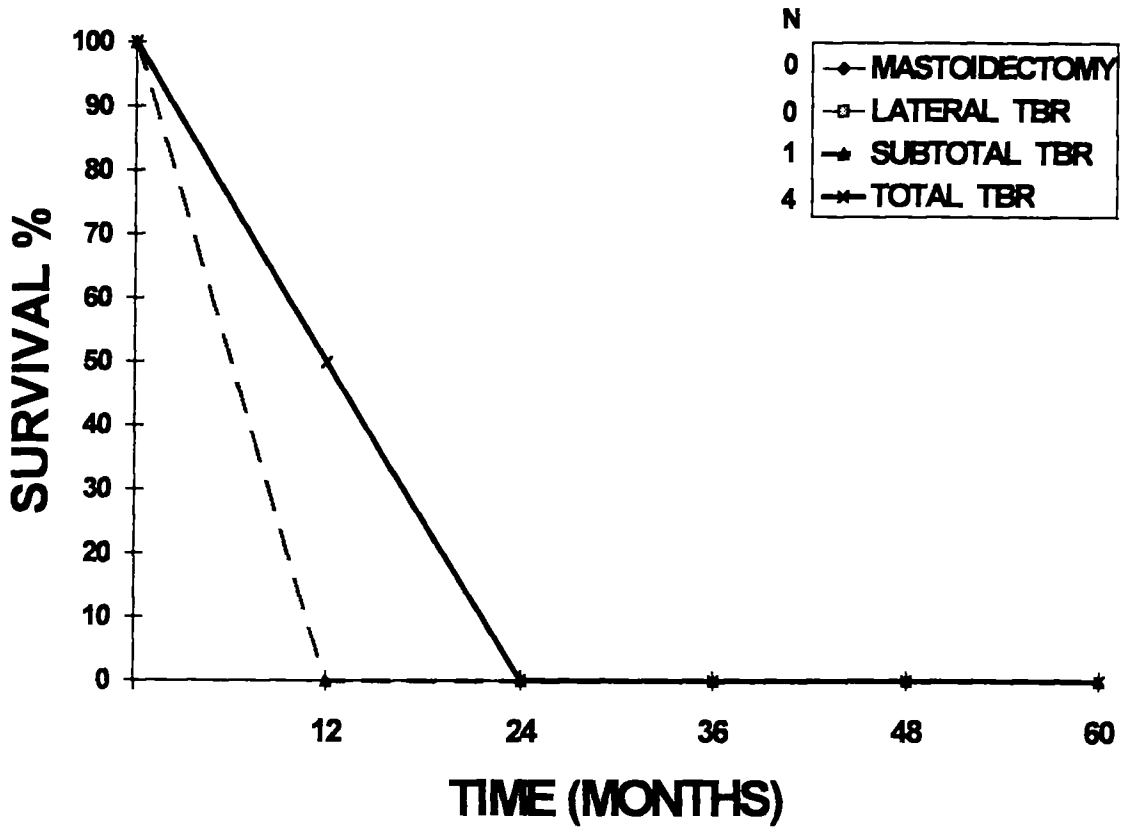

Fig. 3. Treatment-specific survival for patients with carcinoma extension into the petrous apex.

tiple histologic types in their report of overall survival. Inadequate information on extent of disease, type of treatment, and followup was provided in eight, four, and fourteen papers, respectively. Forty-five manuscripts failed to report all three parameters for each individual patient.

Overall Survival

No statistically significant difference in survival was found between mastoidectomy (5 of 10 or 50% five-year survival), lateral TBR (17 of 35 or 48.6% five-year survival), or subtotal TBR (1 of 2 or 50% five-year survival) when disease was confined to the external canal (Fig. 1). There were three perioperative deaths in the group that underwent lateral TBR, one in the group that underwent subtotal TBR.

When disease extended into the middle ear (Fig. 2), patients who had subtotal TBR had a 41.7% five-year survival (5 of 12), and those who had lateral TBR had a 28.7% five-year survival (2 of 7); the difference was not statistically significant. There was a trend toward lower survival for patients who had a mastoidectomy (6 of 35 or 17.1% five-year survival) than those who had subtotal TBR ($\chi^2 = 3.17$; $0.05 < p < 0.10$). The observed difference in survival between patients who underwent lateral TBR and those who underwent mastoidectomy was not statistically significant. The four patients who underwent total TBR had a 0% one-year survival. There were two perioperative deaths in the subtotal TBR group and one in the total TBR group.

Carcinoma that invaded the petrous apex (Fig. 3) was seen in one patient treated with subtotal TBR (who was dead of disease at 1 year) and in four patients treated with total TBR (2 of 4 or 50% one-year survival and 0 of 4 or 0% two-year survival). The small numbers precluded statistical analysis.

Value of Radiation Therapy

The value of preoperative or postoperative radiation therapy (RT) was analyzed. All patients with disease confined to the external canal treated with mastoidectomy or subtotal or total TBR received

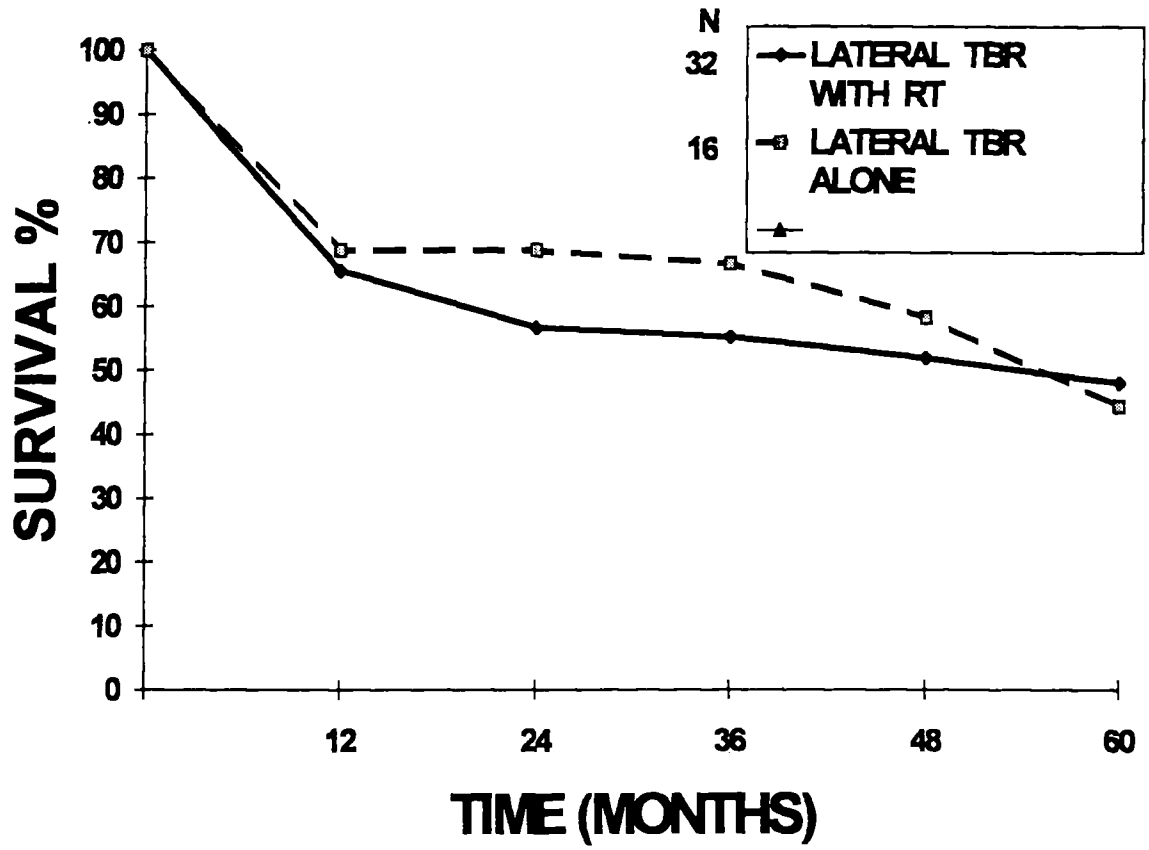

Fig. 4. Survival of patients with carcinoma confined to the external auditory canal treated with lateral TBR with or without preoperative or postoperative radiation therapy *(RT)*.

RT, precluding analysis of these groups. No statistically significant difference in survival was seen between patients treated with lateral TBR and RT (12 of 25 or 48.0% five-year survival) or lateral TBR alone (4 of 9 or 44.4% five-year survival) (Fig. 4).

Patients with carcinoma extending into the middle ear treated with mastoidectomy and RT (6 of 30 or 20% five-year survival) had better survival than with mastoidectomy alone (0 of 4 or 0% two-year survival (Fig. 5). All patients treated with lateral or total TBR received preoperative or postoperative RT precluding analysis of the value of RT. The 10 patients treated with subtotal TBR and RT had a 30% five-year survival (3 of 10), whereas the three patients treated with subtotal TBR alone had a 100% five-year survival (3 of 3) (Fig. 6). This difference was statistically significant ($\chi^2 = 4.61$, $0.01 < p < 0.05$).

All patients with extension of cancer into the petrous apex had either preoperative or postoperative RT and the value of RT could not be determined.

Dural Invasion

Patients who had carcinomatous involvement of the dura mater had a (1 of 9) 11.1% five-year survival and treatment by resection of the dura did not change survival (Fig. 7). Margins of resection, however, were not stated by the authors.

Internal Carotid Artery (ICA) Involvement

Four patients had extension of disease to involve the ICA. Of the two patients treated with total TBR and ICA sacrifice, one died from postoperative cerebral ischemia and the other was DOD at 14 months with failure at regional and distant sites. Another patient was treated with total TBR alone and was dead of disease at 8 months with local persistence. The remaining patient was treated with preoperative RT and lateral TBR and was dead of disease at 21 days with local persistence.

Brain Invasion

Two patients had local invasion of carcinoma into the temporal lobe treated with mastoidectomy and

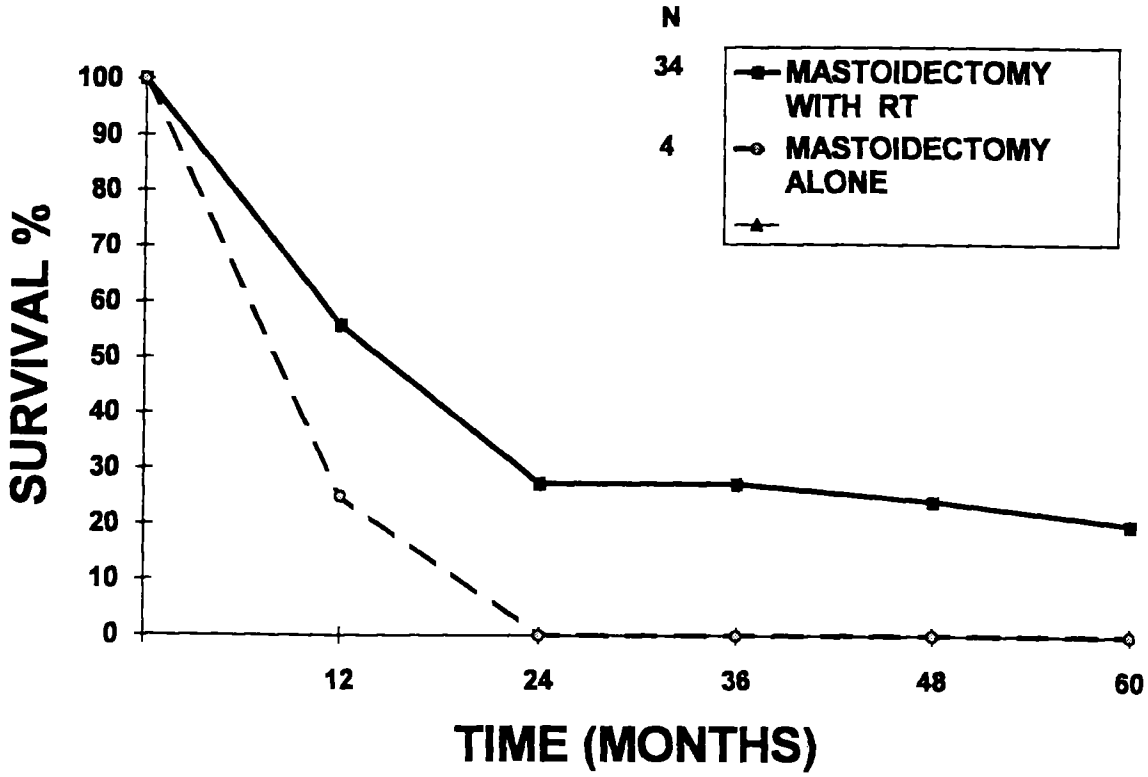

Fig. 5. Survival of patients with carcinoma extending to involve the middle ear treated with mastoidectomy with or without preoperative or postoperative radiation therapy.

preoperative or postoperative RT. One patient was dead of disease at 1 month with local persistence and the other, who was treated with mastoidectomy, brachytherapy, and teletherapy, was also dead of disease at 5 months with local persistence. No patient was treated with resection of involved cerebral/cerebellar tissue.

Site of Failure

Of 77 patients who died of their disease, site of failure was reported by the authors in 54 patients—45 patients had local failure, five had local/regional failure, three had regional failure alone, and one had regional/distant failure.

DISCUSSION

The overall incidence of tumors of the temporal bone is six cases per million population, and 86% of these lesions are squamous cell carcinoma.[99] The relative scarcity of these tumors prevents any individual, group, or institution from gathering sufficient data for the purpose of analysis of survival and outcome.

An extensive review of literature identified 96 publications in the English language, of which 26 contained adequate information that allowed analysis. Reasons for rejection of unacceptable studies and necessary compromises are repeated because they have a direct bearing on any conclusions drawn. In our analysis, studies were rejected if careful documentation of the preoperative extent of disease, histology, type and extent of treatment, survival, and followup for each patient was not performed. Because of the lack of specific information in most studies, carcinomatous involvement of the middle ear includes tumors that extend from the external canal to the lateral compartment of the middle ear, as well as those that erode the medial wall of the middle ear.

Controllable and uncontrollable variables enter into the analysis of combined retrospective studies. To counter preoperative understaging of tumors in studies performed before the advent of computerized tomography and magnetic resonance imaging, surgical findings were used to accurately stage the preoperative extent of disease in studies before 1975. Also, many authors did not report details on the type and duration of radiation therapy used.

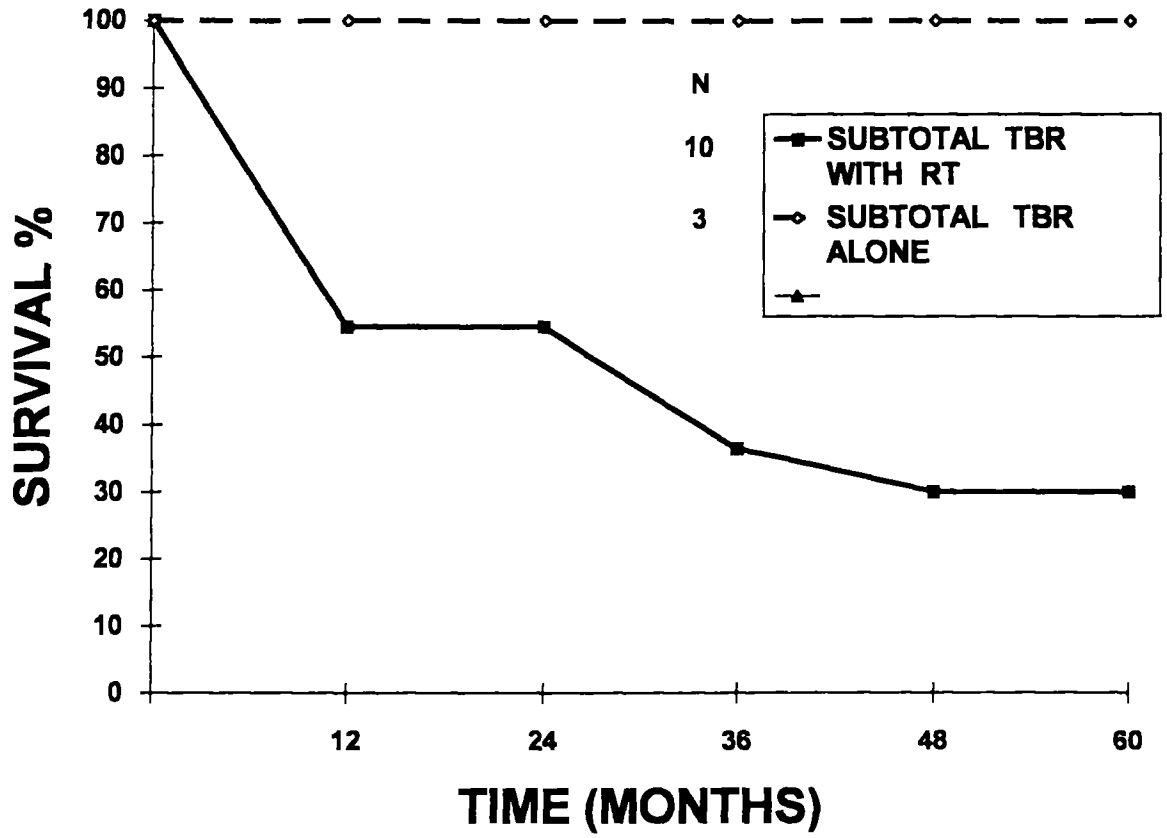

Fig. 6. Survival of patients with carcinoma extending to involve the middle ear treated with subtotal TBR with or without preoperative or postoperative radiation therapy.

Consequently, improvements in radiation therapy, from the use of radium and cobalt to the use of electron beam teletherapy and brachytherapy, and their impact on survival could not be adequately studied. Similarly, improvements in surgical resection with the formation of cranial base teams—using the operating microscope and microsurgical techniques—and their impact on survival also did not allow analysis. The advent of intraoperative neurophysiologic monitoring and refinements in antibiotics, as well as preoperative and postoperative care, are other uncontrollable variables.

Nevertheless, on the basis of the available data, the following inferences could be suggested. These areas should be investigated by properly designed clinical trials before definitive recommendations will be possible. Carcinoma confined to the external canal (Fig. 1) appeared to have similar survival after mastoidectomy or lateral or subtotal TBR (50%, 48.6%, and 50% five-year survival, respectively). Our preference for lateral TBR, which allows en bloc resection of tumor for these lesions, remains unchanged.

When carcinoma extended to involve the middle ear (Fig. 2), survival of patients treated with subtotal TBR (41.7% five-year survival) appeared improved over those treated with lateral TBR (28.6% five-year survival) or mastoidectomy (17.1% five-year survival). It appears that more extensive surgery than lateral TBR, can prolong survival. Patients who underwent total TBR demonstrated poor overall survival (0% one-year survival), probably related to understaging of the disease.

Patients with carcinomatous invasion of the petrous apex (Fig. 3) also appeared to have poor survival following subtotal TBR (0% one-year survival) or total TBR (50% one-year survival and 0% two-year survival). The small sample size did not permit assessment of survival after resection for petrous apex carcinoma.

Some inferences regarding the value of preoperative or postoperative RT for squamous cell carcinoma of the temporal bone are also suggested by the review. For tumors confined to the external canal, the addition of RT to lateral TBR appeared to have no survival advantage (Fig. 4). The morbidity of RT

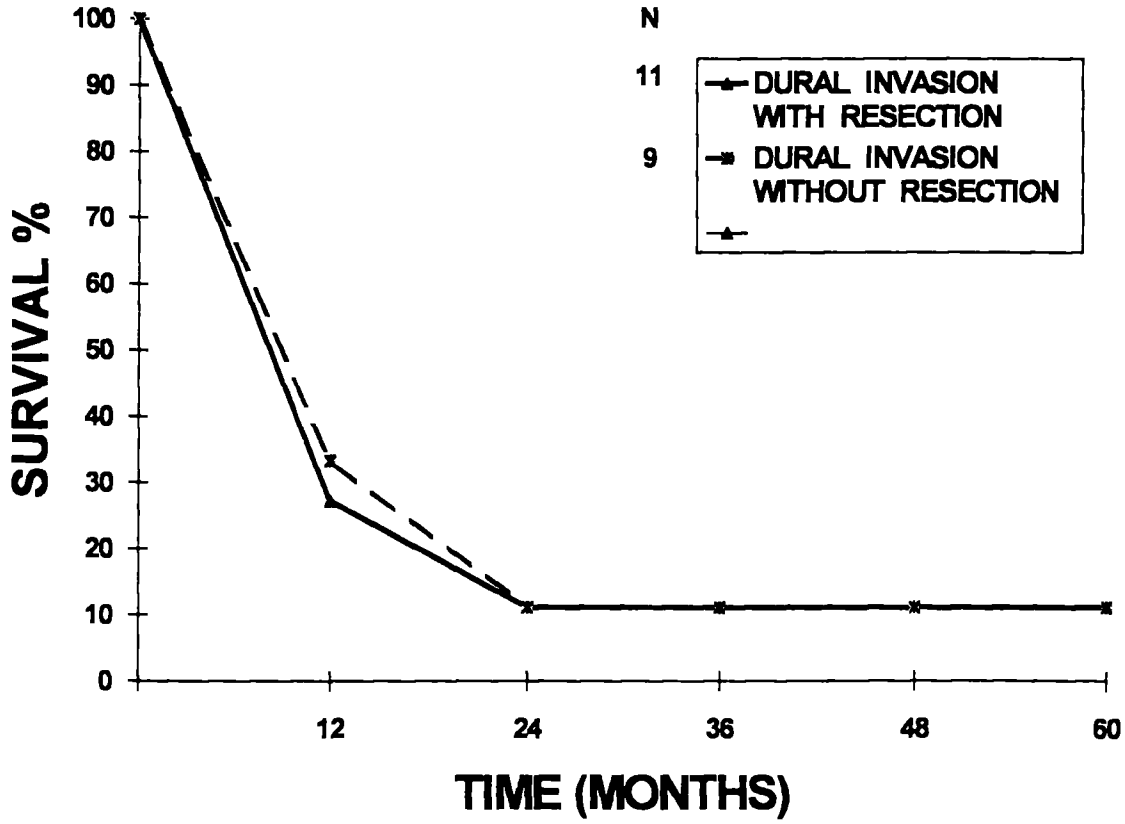

Fig. 7. Survival of patients with carcinoma extending to involve the dura who were treated with or without dural resection.

may possibly be avoided in these patients. For tumors extending into the middle ear, RT appeared to improve survival in patients treated with mastoidectomy (Fig. 5). Survival for patients treated with subtotal TBR with or without RT were paradoxical (Fig. 6). Patients treated without RT fared better than those with RT. Perhaps the small sample size in the former contributed to the discrepancy.

Carcinomatous invasion of the dura mater or brain implies aggressive biologic behavior of the tumor. The role for surgical resection of these structures remains unclear. In our study, resection of involved dura did not appear to improve overall survival (Fig. 7); however, margins of resection could not be adequately studied. Experience with lesions that extend to involve cerebral tissue has been limited. The two patients in our study who were treated with mastoidectomy and RT were both dead of disease at 1 month and 5 months, respectively. It is unclear what the survival advantage of surgical removal of resectable brain parenchyma would be, because we were unable to identify any patients who had such radical treatment.

Experience with carcinomatous involvement and resection of the internal carotid artery has also been limited. Of the four patients who had such involvement, two were dead of disease at 8 months and 21 days with local persistence, respectively. Of the remaining two patients who had resection of the ICA, one patient died from cerebral ischemia and the other was dead of disease at 14 months with regional and distant failure. The recent addition of improved preoperative carotid artery testing, such as the balloon occlusion test of the ICA with Xenon CT[100], may better identify those patients with adequate, marginal, or minimal contralateral cerebral blood flow, enabling better selection of patients for ICA sacrifice. Determination of the value of ICA resection – especially as it relates to survival – will require further study.

Several other aspects of this disease could not be studied because of the lack of information provided by the authors. The histologic differentiation of the tumor and its relationship to overall survival is an example. The method of temporal bone removal – whether by en bloc resection, piecemeal resection,

or a drillout—and its relationship to survival will also require further study. Although the answer may be intuitively obvious, a formal study evaluating margins of resection in this disease and overall survival has been lacking.

In conclusion, it appears that when carcinoma is confined to the external canal, mastoidectomy, lateral, or subtotal TBR have similar survival. There appears to be no advantage to the addition of RT to patients treated with lateral TBR. Once tumor involves the middle ear, subtotal TBR has improved survival over lateral TBR and mastoidectomy. The experience has been too small to comment on survival after treatment for patients with carcinomatous involvement of the petrous apex. Resection of involved dura does not appear to improve survival; however, the influence of negative margins of resection will require further study. The experience regarding resection of involved ICA or brain parenchyma is too limited for any conclusions to be drawn.

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