Parotid and Temporal Bone Resection for Skull Base Malignancies: Outcome

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ABSTRACT

We reviewed the outcome of and determined prognostic factors for patients undergoing combined lateral skull base resection for advanced lateral skull base malignancies. We performed a retrospective, single-institution case series in an academic tertiary care hospital. Seventy-nine patients with combined temporal bone resection and parotidectomy for advanced lateral skull base malignancy were included. Main outcome measures were overall survival and disease-free survival. The mean follow-up time was 18.3 months, with an overall survival of 64.5 months and disease-free survival of 42.6 months. Disease-free survival was 36.2 months for skin tumors, 42.7 months for salivary glands tumors, and 8.5 months for tumors of mesenchymal origin. Log-rank tests for prognostic indicators demonstrated that temporal bone erosion on computed tomography (CT) scan ($p = 0.009$) and histology ($p = 0.045$) were statistically significant predictors of poor outcome. Subtotal resection of the facial nerve and positive lymph nodes were associated with poor outcome in tumors arising from skin. Advanced malignancies of the lateral skull base are best managed using a combined lateral temporal bone resection and parotidectomy, with a 50% disease-specific survival of 32 months. Malignant mesenchymal tumors as well as presence of temporal bone erosion on preoperative CT scan are associated with poor prognosis.

KEYWORDS: Malignant tumor, temporal bone, parotid, treatment

Combined approaches involving parotidectomy and temporal bone resection are often needed as part of an oncological resection for treatment of malignancies involving the anatomic area encompassing the cheek, parotid gland, auricle, and infratemporal fossa. Advanced lateral skull base malignancies requiring this approach typically arise from auricular and periauricular skin, external auditory canal (EAC) or parotid gland. When the temporal bone is involved by direct extension, temporal bone resection is performed to clear the disease. Furthermore, the complexity of the anatomic recesses in

these regions often mandates addressing the temporal bone surgically even if it is not grossly involved for optimal exposure and for facial nerve identification. Conversely, parotidectomy may be included with temporal bone resection without evidence of direct invasion of the parotid gland from tumors arising from the auricle or EAC to address the lymphatics in combination with a neck dissection, or to address potential microscopic direct invasion of the parotid gland.

The concept of combining temporal bone resection with an oncologic resection for lateral skull base

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malignancies is not new; however, indications in the absence of temporal bone involvement are not standardized. Prior to the 1950s, radical mastoidectomy, piecemeal resections, and radiotherapy were the primary treatments for patients presenting with advanced lateral skull base malignancies.¹ In 1954, Parsons and Lewis first described en bloc total temporal bone resection for malignancies of the EAC and temporal bone.² A less radical surgical option is subtotal temporal bone resection, including removal of the bony EAC, tympanic membrane, malleus, incus, and otic capsule, with preservation of the petrous apex. However, these procedures resulted in loss of inner ear function, facial paralysis, and high perioperative morbidity.³ Allen introduced the lateral temporal bone resection (LTBR) in 1966 as an option less invasive than either subtotal or total temporal bone resections, but more extensive than a radical mastoidectomy. A LTBR consists of removal of the bony EAC, tympanic membrane, malleus, and the incus, with preservation of the stapes, facial nerve, and bony labyrinth.⁴ Allen postulated that an LTBR is indicated in patients with carcinoma of the parotid with preexisting facial paralysis, or highly malignant carcinomas of parotid involving its posterosuperior portion, malignancy invading the parotid from the pinna or EAC, or multiply recurrent tumors of the region. Subsequent investigators have made significant strides to improve the effectiveness of the oncologic resection while minimizing the morbidity of temporal bone resection by tailoring the extent of resection to the extent of local disease.³

This article reviews our institution's experience with combined surgical approach including temporal bone resection and parotidectomy for advanced lateral skull base malignancies. One purpose of this study is to clarify indications for combined surgical approaches in this patient population. The primary purpose of this study is to analyze outcomes when such combined approaches are employed, and to identify prognostic factors that significantly affect patient outcomes. A comprehensive approach to multidisciplinary surgical treatment and multimodality adjuvant treatment of these patients is presented based on outcomes analysis.

METHODS

A retrospective chart review was conducted on patients who were treated for advanced malignancies of the lateral skull base between 1999 and 2008 at the University of Miami/Jackson Memorial Hospital. Patients who were included underwent a combined parotidectomy and temporal bone resection for malignancy of the lateral skull base. Cancers limited to the EAC where parotidectomy and LTBR were not performed as part of the surgical procedure were not included in this series.

Patient demographics, tumor characteristics, surgical intervention, adjuvant therapy, and clinical follow-up were recorded. Tumor characteristics included presenting symptoms, radiographic data, histopathology, intraoperative margins, final margins, lymph node involvement, and perineural invasion. Surgical variables included type of temporal bone resection, extent of parotidectomy, neck dissection, auriculectomy, temporomandibular joint resection, mandible resection, skull base resection, facial nerve resection, neurosurgical approach, and reconstruction. Adjuvant nonsurgical treatment was reviewed. Outcome data included recurrence, death, and length of follow-up.

Overall survival (OS) and disease-free survival (DFS) curves were generated using the Kaplan-Meier method, and survival curves were compared using the log-rank test. The effects of potential risk factors were evaluated with Cox proportional hazards models, and the threshold for statistical significance was $p=0.05$. Analyses were performed with XLSTAT system software (version 2008.7, Addinsoft, XLSTAT Institute Inc., Paris, France).

RESULTS

Patients and Tumors Characteristics

Seventy-nine patients (17 women and 62 men) with a mean age of 65 years (ranging from 12 to 90) were included. Of these, 57 patients had skin cancer, whether locally advanced primary involving the cheek or auricle, or advanced metastatic disease in the parotid gland secondary to a previously diagnosed skin cancer of the face or scalp. Forty-three of 57 had squamous cell carcinoma, 5 of 57 had basal cell carcinoma, and 9 of 57 had other cutaneous malignancies (five poorly differentiated carcinomas, one malignant melanoma, one Merkel cell carcinoma, one sweat gland carcinoma, and one sebaceous carcinoma). Seventeen patients had salivary malignancies arising from the parotid, including 10 mucoepidermoid carcinomas, 3 adenoid cystic carcinomas, 2 primary squamous cell carcinomas of the parotid, 1 poorly differentiated carcinoma arising from the parotid, and 1 poorly differentiated carcinoma ex pleomorphic adenoma. Also included were five patients who had mesenchymal tumors: two osteosarcomas, one malignant fibrous histiocytoma, one synovial sarcoma, and one desmoid fibromatosis.

Preoperative Data

Thirteen patients had facial nerve weakness and 10 had complete facial nerve paralysis. Nine patients had other cranial nerve weakness or paralysis. Thirty patients had pain and 15 had trismus. Eighteen patients had temporal bone erosion on preoperative computed tomography

(CT) scan (Fig. 1). Twenty-three patients had previous surgeries to the lateral skull base, 26 patients had received radiation preoperatively, and 13 patients had received preoperative chemotherapy.

Surgery

Sixty-eight patients underwent an LTBR, six had less than an LTBR, and five had a subtotal temporal bone resection. Sixty-five patients underwent a total parotidectomy and 14 had a partial parotidectomy. The facial nerve was preserved in 32 patients, partially sacrificed with a graft in 7 patients, partially sacrificed without a graft in 6 patients, completely sacrificed with a graft in 17 patients and completely sacrificed without a graft in 17 patients. The auricle was completely preserved in 35 patients, partially resected in 21 patients, and completely resected in 23 patients. The EAC was completely resected in 70 patients, preserved in 7, and partially sacrificed in 2 patients. The temporomandibular joint contents, including mandibular condyle, were resected in 30 patients, and additional mandible inferior to the condyle was resected in 26 patients. Twenty-eight patients had extracranial resection of the infratemporal fossa contents, and 8 patients had a neurosurgical approach as part of their surgery, 5 of which included dural repair (Fig. 2). Sixty-four patients had cervical lymphadenectomy. Repair of the surgical defect was performed with primary closure in 6 patients, local/regional skin flap closure in 9 patients, local/

regional myocutaneous flap closure in 39 patients, and free flap in 25 patients.

Postsurgical Course

Mean hospital stay was 9.67 days (ranging from 2 to 73 days). Five patients died during the initial hospital stay: two patients had intracranial complications, and three patients died from myocardial infarction, sepsis, and multiple-organ failure, respectively. Wound-healing complications occurred in 34 patients (43%), 12 of which were major (as defined by the need for at least one revision surgery in the operating room). In the 26 patients with history of prior radiation, 10 had wound-healing complications and three died in the immediate postoperative period. Thirty-eight patients had postoperative radiotherapy, 10 of whom had history of prior radiotherapy as well. Twenty-six patients had postoperative chemotherapy, nine of whom had prior chemotherapy as well.

Overall Outcome

Mean follow-up was 18.3 months (ranging from 0.1 to 88.9 months). Mean OS was 65 months, although many censored cases were actually lost to follow-up with extensive local or metastatic disease. DFS was realistically lower, with an overall mean DFS of 42.5 months and a 50% DFS at 32.0 months (Fig. 3). Twenty-four patients (30.4%) had recurrences during the follow-up

Figure 1 Patient characteristics (percent). CT, computed tomography.

Figure 2 Extent of surgery (percent). EAC, external auditory canal; LTBR, lateral temporal bone resection; TMJ, temporomandibular joint.

period. Log-rank test results for potential prognostic indicators are shown in Table 1. Mean DFS time was 52.3 months without temporal bone erosion on preoperative CT scan and 18.1 months with temporal bone erosion on CT ($p = 0.009$). Histology was also predictive of outcome. Mean DFS for malignancies of the lateral

skull base in this study was 36.8 months for skin cancers, 42.7 months for salivary cancers, and 8.5 months for mesenchymal cancers ($p = 0.045$). Other prognostic factors, including pain at presentation, preoperative facial nerve paralysis, margin status, and radiation history did not have statistically significant prognostic implications.

Figure 3 Series disease-free survival.

Table 1 Log-Rank Test for Prognostic Indicators

Potential Prognostic Indicators—Overall	<i>p</i> Value
Temporal bone erosion on preoperative CT	0.009
Histology type (epithelial, salivary, mesenchymal)	0.045
Facial nerve resection	0.093
Free flap versus other reconstruction	0.101
Positive lymph nodes	0.120
Positive postoperative margins	0.179
Pain at presentation	0.203
Surgery at skull base	0.222
Trismus at presentation	0.346
Duration of symptoms > 6 mo	0.349
Perineural invasion	0.490
Prior surgery	0.518
Surgery alone versus with any radiotherapy	0.564
Gender	0.832
Pain and facial nerve paralysis	0.910
Facial nerve dysfunction	0.998

CT, computed tomography.

Outcomes

SKIN TUMORS

Mean follow-up for the 57 patients with skin tumors was 15.9 months (ranging from 0.1 to 88.9 months). Mean OS for this group was 59.8 months and mean DFS was 36.8 months. The 50% DFS was 14.6 months (Fig. 4). Nineteen patients (33.3%) had recurrences after surgery after a mean time of 41.9 months. Prognostic indicators are shown in Table 2. The presence of positive lymph

nodes on the postoperative pathology report conferred a 17.4-month mean DFS as opposed to a 38.0-month mean DFS without positive nodes ($p = 0.003$). The mean DFS was 43.6 months if the facial nerve was completely preserved, 7.2 months if it was partially sacrificed, and 31.1 months if it was completely sacrificed ($p = 0.007$). The presence of temporal bone erosion on preoperative CT scan was borderline significant ($p = 0.054$) in this subgroup. Mean DFS was 47.4 months without temporal bone erosion and 10.6 months with temporal bone erosion ($p = 0.054$).

SALIVARY TUMORS

Mean follow-up for the 17 patients with salivary tumors was 28.0 months (ranging from 3.7 months to 79.8 months). Mean OS for this group was 72.9 months and mean DFS was 42.7 months (Fig. 4). Two patients (11.8%) had recurrences in this group after a mean time of 45.2 months. Temporal bone erosion on preoperative CT scan was the only statistically significant prognostic indicator ($p = 0.01$). Mean DFS time was 26.4 months with temporal bone erosion on CT and 65.6 months without temporal bone erosion.

MESENCHYMAL TUMORS

Mean follow-up for the five patients with mesenchymal tumors was 12.5 months (ranging from 3.7 to 28.3 months). Mean OS for this group was 9.3 months. Mean DFS was 8.47 months with a 50% DFS at 9.8 months (Fig. 4). Three patients (60%) had recurrences in this group at a mean time of 7.6 months. No significant prognostic indicators were identified for this small subgroup of patients.

Figure 4 Disease-free survival by histological subtype.

Table 2 Log-Rank Test for Prognostic Indicators in Patients with Skin Malignancies

Potential Prognostic Indicators—Skin	p Value
Positive lymph nodes	0.003
Facial nerve resection	0.007
Temporal bone erosion on preoperative CT	0.054
Positive postoperative margins	0.144
Facial nerve dysfunction.	0.296
Facial nerve paralysis and pain	0.300
Prior skin cancer	0.427
Pain at presentation	0.502
Chemotherapy with radiotherapy	0.574
Free flap versus other reconstruction	0.671
Surgery at skull base	0.773
Perineural invasion	0.998

CT, computed tomography.

DISCUSSION

A multidisciplinary approach to the surgical treatment of advanced lateral skull base malignancies is critical to the success of both oncologic and functional outcomes. Surgical resection of tumors in this complex anatomic location requires careful coordination and planning by the head and neck surgeon, the neurotologist, the neurosurgeon, and the reconstructive surgeon. Successful surgical treatment of these tumors depends upon an understanding of the anatomic areas at risk of involvement by tumor, either by direct extension or by lymphatic spread. Although small or localized tumors either of the parotid gland or ear canal may require a single approach such as parotidectomy with facial skin resection, or sleeve resection of the EAC, a combined approach with both the head and neck surgeon and the neurotologist is frequently necessary. The need for combined approaches is obvious when there is gross involvement of both the extratemporal soft tissues such as the parotid gland as well as erosion of the temporal bone. This represents the clearest indication for a combined surgical approach, assuming that the degree of temporal bone involvement does not preclude a complete surgical resection. Additional indications for combining an otologic approach with parotidectomy for malignant tumors of the parotid gland or facial soft tissues include tumor fixation to the EAC or tumor abutting the temporal bone at the stylomastoid foramen. Combining an otologic approach when planning parotidectomy for malignant disease is also indicated when facial nerve identification within the mastoid is necessary. This may be required to gain a negative margin on a pathologically involved facial nerve and to facilitate subsequent nerve grafting. Alternatively, this may be the only means of safely identifying a functioning facial nerve proximal to the site of tumor involvement when the tumor abuts the bone or stylomastoid foramen. Identification and pres-

ervation of a functioning facial nerve within the mastoid may also facilitate rerouting the nerve to enhance exposure of the primary tumor mass for complete resection, even if the EAC is preserved. Moreover, a head and neck surgical approach is combined with LTBR for EAC tumors that invade underlying cartilage or bone with potential for microscopic direct extension to the parotid or involvement of the parotid regional lymphatics. Larger cutaneous malignancies involving the auricle and perifacial soft tissues may require resection of the ear canal for functional reasons and are typically combined with parotidectomy and cervical lymphadenectomy for clearance of regional lymphatics and for removal of tissues at risk of direct tumor extension.

The combined surgical approach for these tumors is specifically tailored to the extent of disease in each patient. In virtually all cases, a total or subtotal parotidectomy will be necessary. This can be performed with preservation of the facial nerve, sacrifice of a portion of the facial nerve, or complete sacrifice of the facial nerve. Parotidectomy may be combined with en bloc resection of the overlying facial skin, including partial or total auriculectomy. Frequently, the mandibular condyle is involved and may be resected with the contents of the glenoid fossa. Less commonly, the subcondylar or posterior mandible may require resection as well. A comprehensive cervical lymphadenectomy is also commonly required, depending upon tumor type. From the otologic perspective, a limited mastoidectomy with resection of the mastoid tip may sometimes be combined with parotidectomy, but this approach provides limited additional exposure and is rarely used in our hands other than for proximal facial nerve identification for grafting. More complete mastoidectomy combined with facial nerve rerouting out of the stylomastoid foramen can provide significant additional exposure when preservation of the ear canal is oncologically feasible. The most common otologic approach utilized in this series is the LTBR with sacrifice of the ear canal. Subtotal or total temporal bone resections may also be performed, although are infrequent. Combined resection of the lateral temporal bone and parotid gland with or without mandibulectomy may also be combined with resection of the infratemporal fossa contents with or without craniotomy for intracranial extension of disease. In the current series, the vast majority of patients underwent formal LTBR, and the majority also underwent total or subtotal parotidectomy. A relatively large percentage of patients had bony or soft tissue resections extending beyond the temporal bone or parotid gland, including 30 of 79 with resection of portions of the mandible or temporomandibular joint, and 43 of 79 with partial or total auriculectomy. Complete preservation of the facial nerve was possible in only 32 of 79 patients. The defects that result from such combined procedures require

careful attention to reconstruction, the success of which is particularly critical in patients who have had combined neurosurgical resections and are at risk of cerebrospinal fluid leak. Complications in wound healing as well as failure of reconstruction may significantly delay adjuvant treatment that is often recommended in those cases.

A total of 79 patients were analyzed in our series, with a mean follow-up of 18.3 months (ranging from 0.1 to 88.9 months). Mean OS was 65 months regardless of tumor type or surgical procedure, with DFS of 42.5 months. A 50% DFS was demonstrated at 32.0 months. Although we could not find in the published literature a series with the same inclusion criteria including advanced lateral skull base malignancies based on the extent of surgery (temporal bone resection and parotidectomy), these outcomes seem to be comparable to other published series and are reasonable treatment goals in the properly selected patient with advanced local disease. Patient selection is critical, however, as complication rates are significant. Complications included 6% mortality and an overall rate of wound complications of 43% (34/79) and a major wound complication rate of 15% (12/79) as defined by the need for at least one revision surgery. Interestingly, this rate of overall wound complications is similar in those patients who had been irradiated prior to their salvage surgery (38%), although it is important to note that this group of patients was more likely to have a pedicled or free flap utilized in their reconstruction. Analysis of overall prognostic factors identified temporal bone erosion at presentation as the single most important factor. Mean DFS was 52.3 months without temporal bone erosion on preoperative CT scan and 18.1 months with temporal bone erosion on CT ($p=0.009$). The difference in overall prognosis between tumor type as defined by cutaneous (36.8 months) versus salivary (42.7 months) versus mesenchymal (8.5 months) malignancies was also significant ($p=0.045$). Results for mesenchymal malignancies must be interpreted with caution due to their small number in this series (5 of 79).

Although many series address the surgical treatment of benign tumors of the lateral skull base, a significantly smaller number of reported series exist that address the problem of advanced lateral skull base malignancies. The recent series that have addressed this subject have reported prognostic indicators and outcomes using a variety of measures, and with variable findings.⁵⁻⁸ Manolidis et al presented a series of 81 patients with malignant lateral skull base lesions and reported a 58% treatment success rate with a mean follow-up of 54 months.⁵ Poor prognosis was noted with pain or facial nerve dysfunction at presentation, as well as with epithelial or salivary tumor origin. Our series showed no statistically significant difference in prognosis with presence of pain, only borderline significance with facial weakness and significant poor prognosis for mes-

enchymal tumors. The retrospective nature of our study could have biased the association between pain and outcome, as this may not have been systematically documented in the preoperative evaluation. With regard to tumor histology, the mesenchymal group in the series by Manolidis et al contained a larger number and variety of tumors, including seven sarcomas, five malignant glomus tumors, six chordomas, three hemangiopericytomas, three tumors of the central nervous system, two malignant neuromas, one rhabdomyosarcoma, and one lymphoma.⁵ McGrew et al also demonstrated a better outcome with 32 tumors of mesenchymal origin (82% local disease control for mesenchymal versus 74% overall) in a series of 95 patients.¹ In their series, mesenchymal tumors also included chordomas, hemangiopericytomas, schwannomas, and lymphoma. Although the small number of mesenchymal tumors in the current series was associated with a statistically significant poor prognosis, the small number and aggressive tumor types in the current series likely explain the difference between these results and those of other reported series.

McGrew et al reported that local control rates were similar regardless of whether the facial nerve was sacrificed or not.¹ Results of our study suggest that facial paralysis at presentation is not associated with overall prognosis. One possible explanation of this result is that all malignancies were treated in this series with a more extensive combined head and neck/otologic surgical resection regardless of facial nerve status. This more complete resection (as compared with parotidectomy with nerve sacrifice alone) may offset the potentially ominous prognostic sign of facial paralysis at presentation. Stated another way, the more complete resection afforded by resection of the ear canal may be critical to the success of the surgical management of parotid malignancies already involving the facial nerve at presentation. These results suggest that strong consideration should be given to the addition of an otologic resection to total parotidectomy with facial nerve sacrifice in these patients.

Moore et al reported a series with a mean DFS of 34 months and worse prognosis associated with positive final surgical margins.⁶ This series represents a group of 35 patients with tumors of the EAC, of which 27 had parotidectomy in addition to the LTBR. Sixteen patients had "residual disease" (two macroscopic and 14 microscopic). In our series, only five patients had confirmed positive margins, and this small number may explain the fact that we were unable to find statistically significant difference in outcome with positive margins. This being said, it is conceivable that false-negative margins could bias the results as accurate sampling of the complex surgical bed after resection may be very difficult. Another prognostic factor that does not appear to be a significant predictor of outcome in the current

series is the use of radiotherapy. This counterintuitive finding is likely explained by the fact that the series is limited to tumors of advanced local extent by virtue of the use of the combined surgical approach in all patients. The vast majority of patients received radiation, although 26 presented as radiation failures with 38 treated postoperatively.

When subgroup analysis is performed by tumor type, it is not surprising that more prognostic factors of significance are identified in the largest subgroup of cutaneous malignancies. Mean OS in this group of 57 patients was 59.8 months, with mean DFS of 36.8 months. The most powerful prognostic factor in this group was the presence or absence of positive lymph nodes (mean DFS of 17.4 versus 38.0 months, $p=0.003$). Temporal bone erosion at presentation in this group conferred a dramatic reduction in mean DFS of 47.4 months versus 10.6 months, although this difference was of borderline significance ($p=0.054$). Although facial nerve paralysis at presentation is not a significant prognostic factor in this subgroup, surgical management of the facial nerve is a significant factor that is itself instructive. Mean DFS was 43.6 months if the facial nerve was preserved, 31.1 months if the nerve was completely sacrificed, but only 7.2 months if the nerve was partially sacrificed ($p=0.007$). Sacrifice of the entire facial nerve allows for the most complete resection of extratemporal soft tissue with widest margins, and preservation of the facial nerve usually implies a complete resection of tumor but with much closer margins as the tumor usually has to be surgically peeled along with the epineurium of the adjacent nerve segment. The facial nerve is only preserved when it is not grossly involved by tumor or its function is normal. These results support the standard practice of preserving the facial nerve in malignancy if it is not directly involved by tumor, suggesting that perineurium provides a close but adequate margin. In addition, these results also suggest that if one of the main divisions of the nerve is involved such that the remaining division and main trunk of the nerve are anatomically and functionally intact, preserving the uninvolved portion of the nerve may be associated with a reduction in mean DFS when compared with outcomes of complete facial nerve sacrifice. This finding most likely applies to tumors involving the facial nerve in close proximity to the pes anserinus as compared with very distal involvement of a peripheral nerve branch, but the analysis of our data does not permit such a distinction. Regardless, although we encourage individualizing the surgical management in advanced skin cancers of the face and skull base, this finding is evidence in support of total facial nerve sacrifice in the context of obvious intraneural invasion of the nerve's main trunk or any of its main divisions.

Of the remaining two subgroups, only temporal bone erosion appeared to be a factor with significant

effect on prognosis, and only for salivary gland malignancies. In this subgroup, mean DFS was 26.4 months with temporal bone erosion versus 65.6 months without temporal bone erosion ($p=0.01$). Salivary malignancies were characterized by a mean OS of 72.9 months with a mean DFS of 42.7 months among 17 patients. OS (9.8 months) and mean DFS (8.47 months) were lowest among the five mesenchymal tumors studied. This small subgroup does not lend itself to further characterization of prognostic factors in these patients.

CONCLUSION

The surgical treatment of malignancy affecting the anatomic area encompassing the auricle and cheek/parotid gland should be approached first with an analysis of the potential need to combine an otologic resection of temporal bone structures with soft tissue resection of the parotid gland, facial skin, and/or auricle. The extent of disease may be underestimated on physical examination alone, with imaging critical to accurate assessment of disease extent. Results of this study show the consistent prognostic significance of radiographic evidence of temporal bone erosion on preoperative imaging. A combined approach to surgical resection of these tumors allows for a more complete resection of disease in this complex anatomic area in a stepwise and tailored fashion. Although the morbidity of surgical resection may be significant (6.3% mortality), necessitating careful attention to patient selection with regard to comorbidities, overall DFS of 50% at 32 months is acceptable in this patient population with advanced local disease. DFS is longest for salivary gland malignancies (42.7 months), followed by cutaneous malignancies (36.8 months). Surgical management of the facial nerve is an important prognostic factor for cutaneous malignancies and may be interpreted as a surrogate indicator for the completeness of the surgical resection. Although this analysis does not permit a definitive statement regarding the effectiveness of radiation therapy in this patient population given that most in the series received radiation, the importance of combined modality therapy in addition to combined surgical approaches cannot be overestimated.

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