Abstract: Background. We sought to determine the effect of positive neural margins on subsequent facial nerve function following facial nerve grafting.

Methods. In this retrospective review, 19 patients had sacrifice of their facial nerve with immediate facial nerve grafting, 8 had positive neural margins, and 11 had negative neural margins. Facial nerve function was analyzed using the House–Brackman scale.

Results. In the first group (8 patients), 5 had positive proximal margins and 3 had positive distal neural margins. Outcome by House-Brackman score was III (2 patients), IV (3 patients), V (1 patient), and VI (2 patients). In the second group (no evidence of neural spread, 11 patients), outcome was III (3 patients), IV (2 patients), V (2 patients), and VI (4 patients).

Conclusion. No significant difference in the outcome of facial nerve function was seen between these 2 groups. Facial nerve grafting should be considered in patients whose facial nerve is sacrificed, even when there is evidence of tumor in the perineurium at the margin of resection.

Keywords: perineural; parotid cancer; facial nerve; grafts

Surgical treatment of high-grade malignancies (particularly those with facial nerve invasion) requires radical parotidectomy. This procedure involves complete resection of the parotid gland, including the facial nerve. Radical parotidectomy has also been used in select recurrent benign tumors that intimately involve the facial nerve.1,2 Loss of the facial nerve has significant aesthetic and functional deficits. Therefore, when the facial nerve is sacrificed, some form of facial reanimation is essential. Immediate nerve repair with direct anastomosis of the nerve ends or placement of a cable nerve graft provides the best potential cosmetic and functional results.3,4 Dynamic or static slings can be used but provide results that are inferior to those which can be obtained with immediate facial nerve grafting.4,5

Unfortunately, a significant number of patients with high-grade malignancies will have evidence of perineural invasion at the margins of resection. Continued removal of the nerve is often not practical. Thus, these patients are candidates for postoperative radiation if they have not received it in the past.

When the surgical margins demonstrate perineural invasion, it is unknown whether facial nerve grafting should be done. The ability of the facial nerve to regenerate in the presence of perineural spread of tumor is unknown. To our knowledge, no reports have been published on the outcome of a
facial nerve graft in this circumstance. Further confounding the clinical picture is the effect of previous or future radiotherapy.

We performed a retrospective analysis to compare facial nerve function in patients who had nerve grafts and the presence of positive and negative margins for perineural invasion.

MATERIALS AND METHODS

Querying billing and hospital records identified patients who underwent facial nerve grafting at The Oregon Health & Sciences University. From this group of patients, those who underwent radical parotidectomy, facial nerve excision, and immediate facial nerve grafting during the same operative sitting were identified. Charts, both hospital and clinic, were reviewed. Eleven patients had inadequate follow-up (less than 3 months), were unreachable, or died within 1 year of surgery and were excluded. This left 19 patients (mean follow-up, 26 months) to be analyzed.

Pathology records were then reviewed and the status of the neural margins was determined. The presence or absence of perineural invasion at the margin was determined. The pathologic status of the margin of the resected specimen was examined. Patients with tumor invading the perineurium or actual nerve at the margin were considered to be positive. We recorded the proximal or distal margin was involved. Patients were divided into 2 groups. The first group of patients ($n = 8$) showed evidence of perineural invasion at the margin of resection on final pathology. The second group of patients ($n = 11$) showed no evidence of perineural invasion at the margin of resection. Facial nerve function was analyzed using the House–Brackman scale, both preoperatively and on last follow-up. Age, sex, pathology of tumor, and presence of preoperative or postoperative radiotherapy were analyzed. The donor site of the nerve grafts was also noted. All nerve grafts and anastomoses were performed by a fellowship-trained otolaryngologist.

RESULTS

The first group of patients ($n = 8$) consisted of 6 male patients and 2 female patients (mean age, 63.5 years). Perineural invasion was present at the proximal margin in 5 patients, whereas it was present at the distal margins in 3 patients. Seven of these 8 patients received postoperative radiotherapy, and 1 received preoperative radiotherapy. Pathology demonstrated squamous cell carcinoma ($n = 2$), adenocarcinoma ($n = 1$), adenoid cystic carcinoma ($n = 2$), poorly differentiated salivary duct carcinoma ($n = 1$), high-grade mucoepidermoid carcinoma ($n = 1$), and metastatic squamous cell carcinoma of the skin ($n = 1$). According to the House–Brackman scale, the preoperative facial nerve function was grade I in 6 patients and grade II in 2 patients, and the postoperative facial nerve function was grade II in 2 patients, grade III in 2 patients, grade IV in 3 patients, grade V in 1 patient, and grade VI in 2 patients. The postoperative nerve function in 5 patients was House–Brackman score III/IV. The preoperative and postoperative facial function is shown in Table 1. The effect of radiotherapy on preoperative and postoperative facial function is shown in Table 2. The majority of patients had sural nerve grafts used for reconstruction ($n = 16$). Three patients had medial anterbrachial grafts.

The second group of patients ($n = 11$) consisted of 9 male patients and 2 female patients (mean age, 68 years). On pathologic examination, no patient demonstrated perineural invasion of either the proximal or the distal margins of the facial nerve. In this group of patients, 8 received postoperative radiotherapy, 2 underwent preoperative radiotherapy, and 1 received no radiation either preoperatively or postoperatively. Pathology demonstrated squamous cell carcinoma ($n = 5$), adenocarcinoma ($n = 1$), mucoepidermoid carcinoma

| HB I | – |
| HB II | – |
| HB III | – | 5 |
| HB IV | – | 4 |
| HB V | 1 | 2 |
| HB VI | 2 | 4 |
(n = 1), metastatic renal carcinoma (n = 1), squamous cell carcinoma of the skin (n = 1), and recurrent mixed tumor (n = 1). The preoperative nerve function was graded based on the House–Brackman score (I in 5 patients, II in 2 patients, III in 1 patient, IV in 1 patient, and VI in 1 patient). According to the House–Brackman score, the postoperative nerve function was III in 3 patients, IV in 2 patients, V in 2 patients, and VI in 4 patients. The preoperative and postoperative nerve function is shown in Table 3. The effect of either preoperative or postoperative radiotherapy on facial function is seen in Table 2.

Overall, 5 patients in each group had good facial nerve function, with House–Brackman grade III or IV. Patients who underwent preoperative radiotherapy had House–Brackman grade V or VI facial nerve function. Patients who had poor preoperative facial function (House–Brackman VI) remained the same after the grafting.

**DISCUSSION**

Bunnell successfully performed the first autologous cable nerve graft in a human in 1927. He was quoted as saying, “if one does not succeed in grafting, no harm is done by the operation.” In fact, if one is not successful, then the patient is left with the morbidity of facial nerve palsy, which is considerable. The morbidity of harvesting a nerve graft is what is minimal.

The emotional and functional morbidity of facial paralysis is significant. Loss of facial nerve function affects mastication, speech, and eye closure. Damage to the cornea by way of corneal ulceration can put the eye at risk for complete corneal loss. Loss of support of the lateral commissure leads to drooling and inability to contain food against the buccal surface. This in turn inhibits proper nutrition. The change in facial appearance and complete lack of expression is very noticeable. Constant attention by strangers may lead the individual to become a social recluse. Depression is common and potentially devastating. The potential for such significant morbidity supports an aggressive management of patients with facial nerve paralysis. Many surgical procedures exist for the treatment of unilateral facial paralysis. They range from direct facial anastomosis, insertion of a cable nerve graft, anastomosis to other motor nerves (ie, hypoglossal nerve or the spinal accessory nerve), dynamic musculofascial transpositions (ie, temporalis muscle, masseter muscle), static musculofascial transpositions, and facial plastic procedures (ie, blepharoplasty, brow lift, tarsorrhaphy, gold-weighted implants in the upper eyelid). Each of these procedures has its proponents. When the paralysis is surgically induced, as was encountered in our patients, it is best to address the severed nerve at the time of the initial procedure. Although the reconstruction cannot be undertaken until the ablation is completed, the exposure and potential for rehabilitation are greatest at this time.

Direct anastomosis without tension or cable nerve grafting when there is a neural gap are the only methods of restoring spontaneous emotional expression to the face. A cable nerve graft forms a conduit for the regenerating facial nerve axons. The most commonly used graft is the sural nerve. It is an ideal nerve for grafting because its diameter is appropriately matched to that of the facial nerve and arborization of the distal branches allows the anatomicing of up to 4 branches. Many of our patients underwent mandibular reconstruction with a free fibular tissue transfer. The sural nerve was within the field and easily harvested. Other options are the greater auricular nerve or the medial antebrachial nerve. The greater auricular nerve is within the surgical field and is associated with little postoperative morbidity. Unfortunately, it may be involved by tumor. The length of nerve that can be harvested limits the defects that can be reconstructed. The medial antebrachial nerve is also easily harvested and sacrifice has little morbidity. When a radial forearm flap is used, the nerve is within the field and is easily harvested. In our practice, the sural nerve was used most commonly (Table 3).

In our series, all facial nerves were resected because either the nerve was directly affected by tumor or the ablative surgeon felt that sacrifice was necessary for oncologic reasons. We believe in an aggressive approach to neural reconstruction in these patients. Recently, we had the opportunity of examining a subset of patients who underwent MRI scans and facial nerve resection. We

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<th>House–Brackman scale</th>
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<tr>
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demonstrated that MRI could predict facial nerve outcome. Examination of the data revealed that the few patients with perineural invasion did not regain much function. This led us to examine the issue of perineural invasion at the margin of the nerve and the effect on postoperative function. Many of our patients had perineral invasion on final pathology. Theoretically, we were concerned that doing a neural anastamosis with a cable graft to a nerve that had microscopic evidence of perineural invasion at the margin would lead to a less favorable result. This in fact was not proven, as the same number of patients developed grade 3/4 function in both groups (5 of 8 in the group with perineural invasion and 5 of 11 in the group without perineural invasion). Our local control rate in this group of patients was excellent. This is most likely due to the majority of the patients receiving postoperative radiotherapy.

Performing a facial nerve graft in patients who are to receive postoperative radiotherapy has also been controversial. Conley reported that irradiation was not a significant deterrent to nerve regeneration after nerve grafting, whereas Lathrop reported that none of his 9 patients, with facial nerve grafts, who received postoperative radiotherapy demonstrated function of the nerve graft with improvement in their facial paralysis.

McGuirt and McCabe performed unilateral facial nerve grafting in cats. A cohort of these cats received postoperative radiotherapy 10 to 14 days after surgery. At 4 to 5 months after surgery, analysis of the pontograms (blinded to group) revealed no differences in the quality of function between the irradiated and unirradiated nerves. The nerve grafts and contralateral (control) facial nerves were removed 6 to 7 months after surgery, and axon counts were performed. An approximately 80% return of axon fibers was seen for both groups. The investigators concluded that their results supported performing facial nerve autografting even when postoperative radiotherapy is planned.

Ours is the first series to evaluate facial nerve function in patients who had positive perineural tumor margin with those who did not have positive perineural tumor margin of the nerve. The majority of patients were irradiated. Our results are similar to others that have looked at facial nerve grafting. However, what is unique is the evaluation of the marginal perineural status.

Our study has a number of limitations. It is retrospective, and we could not determine why the facial nerve was sacrificed in some cases. Furthermore, it was not known why some patients had frozen section evaluation of the neural margin done intraoperatively. In some of these cases, further nerve was resected until a negative margin was obtained. When we evaluated the proximal margin, we found 3 patients with positive margins. A number of them had mastoidectomies, and it was felt not worthwhile to “chase” the tumor proximally. In the 1 patient who did not have a mastoidectomy, the nerve and soft tissue was positive. Unfortunately, we are unable to comment on why the distal margin was positive in the majority of the cases. The reasoning was not in the chart.

CONCLUSION

Our study demonstrated that in a group of patients with a positive margin for perineural spread, facial nerve grafting yielded results similar to those in patients with no evidence of perineural invasion. Facial nerve grafting is warranted in patients whose facial nerve is resected.

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REFERENCES