Original Article - Prospective Study

Facial nerve reconstruction following radical parotidectomy and subtotal petrosectomy for advanced malignant parotid neoplasms

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ABSTRACT

Introduction: To describe the oncological management and functional outcome of patients with advanced parotid malignant tumors undergoing facial nerve reconstruction after radical parotidectomy and subtotal petrosectomy. **Materials and Methods:** A combined approach was used to treat advanced stage parotid malignancies with intrapetrous involvement of the facial nerve main trunk or abutment on the stylomastoid foramen. Patients underwent facial nerve rehabilitation with cable graft reconstruction or with static techniques. **Results:** Six patients were included. All patients had Stage IV disease and underwent surgical treatment using a combined approach. Three patients underwent facial-nerve cable graft technique and three patients underwent static techniques to rehabilitate facial nerve function. Five patients received adjuvant treatment with radiotherapy and/or chemotherapy. The mean follow-up was 27.5 months, with a minimum of 7 months and a maximum of 8 years. Four patients remain disease-free, with an overall survival rate of 66%. Among the patients undergoing dynamic reconstruction, first signs of recovery were established at 6 months of follow-up. All patients achieved a House-Brackmann score of III-IV within the first two postoperative years. **Conclusions:** When possible, facial nerve grafting is the preferred method of facial nerve rehabilitation in an advanced stage parotid tumors. A multidisciplinary approach allows better functional and oncological outcomes.

Keywords: Facial nerve graft, facial nerve reconstruction, malignant parotid tumor, radical parotidectomy, subtotal petrosectomy

INTRODUCTION

Radical parotidectomy in conjunction with facial nerve resection is the standard surgical treatment for high-grade tumors of the parotid gland with facial nerve involvement. However, the management of advanced parotid tumors is not standardized in the literature. Cranial base invasion, intracranial extension, or involvement of the great vessels is not uncommon in advanced tumors, determining an obscure prognosis. Invasion of the facial nerve is recognized by the tumor, node, metastasis classification of the UICC as a strong indicator of poor prognosis, as it predicts

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distant metastasis and recurrences. In such advanced cases, rehabilitation of the facial nerve is not usually taken into account, playing a secondary role in the management of these patients.

The literature abounds with reports of the facial nerve rehabilitation in patients with benign conditions. However, the management of facial palsy in patients with advanced aggressive tumors remains controversial. The present study reviews the experience of our institution with combined approaches for advanced parotid malignancies. The aims of the study were to clarify an adequate surgical protocol to treat advanced-stage parotid malignancies with intrapetrous involvement of the facial nerve main trunk or abutment on the stylomastoid foramen and to analyze the facial nerve reconstruction criteria and the results of the facial nerve function after nerve grafting followed by radiotherapy (RT).

MATERIALS AND METHODS

Six patients with aggressive parotid malignant tumors were treated surgically at La Paz University Hospital from 2003 to 2011 using a combined approach. Three patients were treated with immediate cable nerve grafting. The other three patients underwent static reconstruction techniques of the facial nerve. A retrospective analysis was performed to collect data about demographic characteristics, tumor histology and grade, surgical technique, adjuvant therapy, postoperative complications and pre- and post-operative facial nerve function.

Imaging studies consisted of contrast-enhanced computed tomography (CT) in the axial and coronal projections and/or gadolinium-enhanced magnetic resonance imaging (MRI) [Figure 1].

A post-auricular approach with extension to the neck was performed to allow anterior auricular mobilization. The extent of the petrosectomy depended on the tumor extension. In all cases, the mastoid segment of the facial nerve was decompressed. Intraoperative biopsies of the nerve were made to determine the extent of the resection. A radical or conservative parotidectomy was performed as required and the carotid artery and jugular vein were identified in the neck. When neck dissection was needed, the incision was extended along the anterior border of the sternocleidomastoid muscle [Figure 2]. Zygomatic and/or buccal branches exiting the parotid gland were localized, incised and tagged for later graft reconstruction.

Immediate nerve repair was performed if proximal and distal facial nerve were available without evidence of tumor invasion, the expected survival was 12 months or higher and the medical conditions permitted the expected surgery time. Regarding facial nerve repair technique we perform cable nerve graft interposition. The donor nerve graft was harvested from the cervical plexus, using the great auricular nerve ($n = 2$). If cervical dissection included the great auricular nerve, a sural nerve graft was obtained ($n = 1$). After freshening the graft ends and the facial nerve, a microscopic epineural end to end anastomosis was performed using 9-0 monofilament nylon sutures [Figure 3]. A fibrin adhesive was added to the intra-mastoid anastomosis. Graft source and number of branches per graft were recorded.

Immediate static procedures of eye protection included gold or platinum weights. Patients with dynamic reconstruction techniques underwent facial rehabilitation therapy starting 6 months after surgery. Botulinum toxin therapy was given as required.

Patients receiving postoperative adjuvant RT were identified and total radiation doses to the primary field were recorded. The House-Brackmann (H-B) facial nerve grading system[1] was used to assess preoperative and postoperative facial nerve function, where I is normal and VI is complete paralysis. A good result from the facial nerve dynamic reconstruction was defined as H-B Grades III or IV and a poor result as H-B Grades V to VI.

RESULTS

Four patients were women and two were men, with an age range of 37-87 (mean 65) years. A palpable mass was demonstrated in all patients. Facial palsy was observed preoperatively in three patients, with H-B Grades II to III.

Based on the TMN staging system, five cases were classified as T4a and one case as T2. This latter case had ipsilateral stage N2 regional node involvement. No distant metastases were found. Stage IV disease was established in all patients.

All patients underwent fine-needle aspiration cytological evaluation to obtain the histologic diagnosis. The histopathology study was reported as epidermoid carcinoma in three cases, ductal carcinoma in one case, adenoid cystic carcinoma in one case and undifferentiated large cell carcinoma in one case.

In five cases a radical parotidectomy was performed. One patient underwent a superficial parotidectomy with conservation of the inferior branches of the facial nerve. In two patients a functional neck dissection was performed.

In three patients, immediate reconstruction of the facial nerve was performed. In two patients the major auricular nerve was employed. In another patient a sural nerve graft was obtained. In two patients a cable-graft was made to the buccal ipsilateral branch of the facial nerve. In one patient, ipsilateral buccal and zygomatic branches were anastomosed to the nerve graft. A platinum chain-weight was inserted during the same surgical procedure in four patients and a gold weight in two patients.

All patients received adjuvant treatment. Two patients received radio-chemotherapy (CT), two patients RT alone and one patient intensity-modulated radiation therapy. The radiation dose to the primary field ranged from 5000 cGy to 6600 cGy.

All three patients with dynamic facial reconstruction underwent rehabilitation therapy. In two patients infiltrations with botulium toxin were given to improve facial symmetry.

The first signs of facial activity were observed after 8 months in one patient and after 7 months in the other two patients. At the time of writing, one patient was classified as Grade IV 11 months after surgery, one patient as Grade III 2 years after surgery [Figure 4] and one patient Grade V 7 months after surgery.

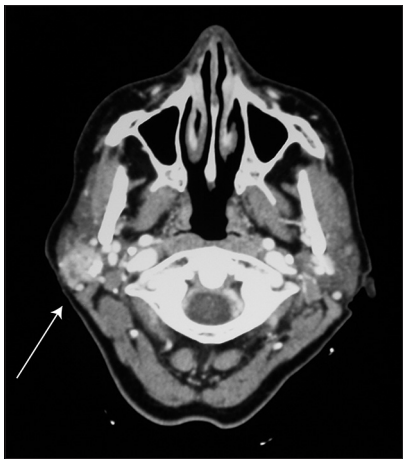

Figure 1: CT image. Arrow shows the tumor abutment on the stylomastoid foramen area

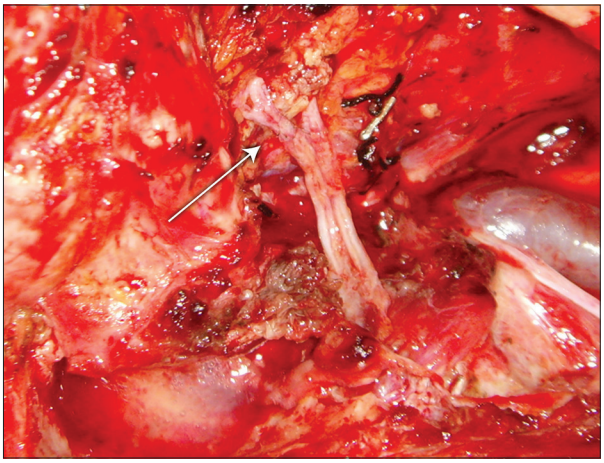

Figure 3: Detail of distal major anastomosis of the auricular nerve to buccal and marginal branches of the facial nerve (arrow)

The mean follow-up was 27.5 months, with a minimum of 7 months and a maximum of 8 years. Currently, four patients are free of disease with an overall survival rate of 66%. The two main complications were one case of shoulder pain and one case of cranial nerve VI palsy. In the static reconstruction group, two of the three patients died, one due to a relapse involving the cranial base 15 months after surgery and the other due to cardiovascular disease 1 year after the intervention. One patient is free of disease 8 years after surgery [Table 1]. In the group of patients with dynamic reconstruction, none of the three patients has had a recurrence, with a minimum follow-up of 7 months and a maximum of 24 months [Table 2].

DISCUSSION

Salivary gland tumors consist of a heterogeneous group of lesions with a wide range of histological types, biological behavior and prognosis. Benign tumors are far more common[2] whereas malignant tumors represent just 1-3% of all head and neck carcinomas[3] and are more frequently located in the parotid gland.[4] The median age of occurrence for malignant tumors is significantly higher than for benign tumors,[5] with

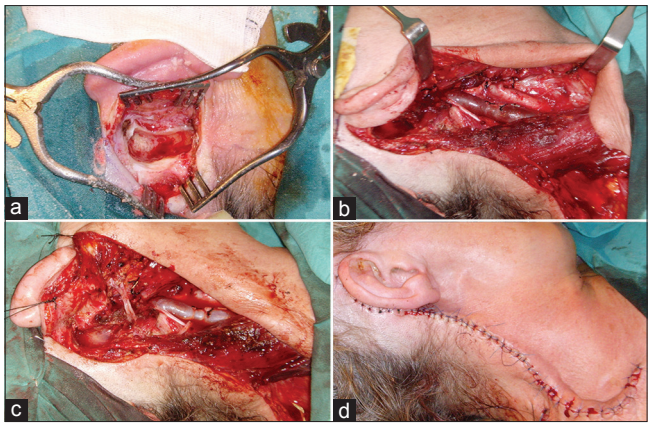

Figure 2: Intraoperative sequence. (a) Post-auricular approach and petrosectomy. (b) Extended neck incision to perform parotidectomy and neck dissection. (c) Distal nerve graft anastomosis. (d) Closed wound

Figure 4: Postoperative sequence of the facial nerve function after radical parotidectomy and nerve grafting to buccal and marginal branches of the facial nerve. (a, a') 3 months postoperatively. (b, b') 6 months postoperatively. (c, c') 12 months postoperatively. (d, d') 18 months postoperatively

the most common types being adenoid cystic carcinoma, adenocarcinoma and mucoepidermoid carcinoma.[2] In our series, all the patients presented advanced stage high-grade tumors. In radiological assessment, CT is indicated to define better the involved regions of the temporal bone and the skull base, while MRI defines better soft-tissue planes, facial nerve relations, or intradural invasion.[6]

The management of salivary gland malignancies remains primarily surgical.[4,7] For limited tumors surgical treatment is well-defined, based on parotidectomy with facial nerve conservation if possible.[8] However, advanced neoplasms present a surgical challenge. The risk of facial palsy is secondary compared to other tumor risk factors such as an invasion of the great vessels or intracranial extension. The indication for temporal bone resection is not standardized. A multidisciplinary approach is mandatory in cases with direct bone extension but it may be necessary in most cases to achieve tumor-free margins and to obtain optimal exposure of the intratemporal facial nerve. A combined approach involving a lateral skull base procedure has been used to assess oncological resection of advanced parotid neoplasms, with major morbidity being limited to lower cranial nerve palsies.[9]

Table 1: Static reconstruction cases

	Case 1	Case 2	Case 3
Age	87	78	60
Gender	Female	Male	Male
Histopathology	Epidermoid carcinoma	Epidermoid carcinoma	Epidermoid carcinoma
TNM stage	T4aN0M0	T4aN0M0	T4aN0M0
Surgical treatment	Radical parotidectomy + petrosectomy	Superficial parotidectomy (inferior facial nerve branches conserved) + petrosectomy	Radical parotidectomy + petrosectomy
Static reconstruction	Platinum weight	Gold weight	Gold weight
Adjuvant treatment	No	RT	RT
Pre-operative H-B stage	III	I	II
Follow-up	15 months (deceased)	96 months	12 months (deceased)

RT: Radiotherapy, H-B stage: House-Brackman scale, TNM: Tumor, node, metastasis

Table 2: Dynamic reconstruction cases

	Case 4	Case 5	Case 6
Age	37	69	63
Gender	Female	Female	Female
Histopathology	Adenoid cystic carcinoma	Undifferentiated large cell carcinoma	Ductal carcinoma
TNM stage	T4aN0M0	T4aN0M0	T2N2M0
Surgical treatment	Radical parotidectomy + petrosectomy	Radical parotidectomy (inferior branches of facial nerve conserved) + petrosectomy + neck dissection	Radical parotidectomy + petrosectomy + neck dissection
Dynamic reconstruction	Great auricular nerve graft	Sural nerve graft	Great auricular nerve graft
Static reconstruction	Platinum weight	Platinum weight	Platinum weight
Adjuvant treatment	IMRT	RT + CT	RT + CT
Pre-operative H-B stage	I	III	I
First sign of facial nerve recovery	8 months	No	7 months
Follow-up	11 months	6 months	24 months
H-B stage after follow-up	IV	V	III

IMRT: Intensity modulated radiotherapy, RT + CT: Radiotherapy and chemotherapy, H-B stage: House Brackman scale, TNM: Tumor, node, metastasis

A petrosectomy consists of the resection of part of the petrous portion of the temporal bone. When dealing with malignant tumors, usually a lateral temporal bone resection, which could be also named as a partial petrosectomy, is the minimal resection performed. More aggressive procedures may be also named as subtotal petrosectomies. Only in cases of total resection of the temporal bone, which is very seldom performed nowadays, due to its morbidity, the posterior or middle fossa dura are opened. Hence, in most cases of petrosectomy there is no need to seal the dura. In the present series, the extent of the petrosectomy was individualized in order to achieve free tumor margins and to expose the third portion of the facial nerve in the mastoid. No opening of the dura was performed in any of the cases, so no cerebrospinal fluid leak was seen.

The tumor diameter has been correlated with the risk of facial nerve invasion, with tumors larger than 4-5 cm having positive facial nerve margins in more than 80% of cases.[10,11] If the facial nerve is sacrificed, immediate reconstruction with an inter-positional nerve graft is indicated where possible. Good results have been reported in older patients with malignant tumors, adjuvant RT and long grafts.[12] We prefer to use the greater auricular nerve due to its proximity to the surgical site and multiple ramification anatomy, or alternatively, the sural nerve.

The best neural repair techniques result in tension-free anastomoses, facilitated proximally by the subtotal petrosectomy approach. Debate exists in the literature about nerve suture techniques. We prefer to use an epineural suture technique because no less precise fascicle alignment has been reported in comparison with fascicular suture techniques, with can lead to increased intraneural scarring and disruption of blood flow.[13]

Disease-specific survival ranges from 52% to 78% at 5 years and from 47% to 72% at 10 years.[14] However, in advanced lateral skull base malignancies a 50% disease-specific survival of 32 months has been described.[15] Margin status and extracapsular disease spread are the strongest independent predictors of survival and recurrence[16] and perineural invasion is an important predictor of short disease-free survival.[17] Some patients, such as our cases 4, 5 and 6, may not be candidates for nerve grafting because of advanced age, comorbidities or poor prognosis. In the group that underwent nerve graft reconstruction, the results show that these patients have a good prognosis.

Combined modality therapy with adjuvant RT and CT appears to play an important role and adjuvant radiation therapy has been associated with improved survival for high-grade and locally advanced tumors.[18] All our patients received post-operative RT, which is the standard in the management of these advanced stage tumors, so we cannot establish difference in recovery period. Until date, post-operative RT appears not to have a negative impact on facial recovery after nerve cable grafting or direct primary repair.[19] In our series, adjuvant RT had no impact on achieving good facial function after facial nerve grafting. All the patients experienced some degree of recovery of facial function at 6 months post-operatively, one patient had an H-B Grade III score at 2 years post-operatively and another had Grade IV at 11 months post-operatively, results considered to be good according to the literature.[12,20]

A combined multidisciplinary approach to advanced parotid gland tumors is mandatory to achieve beneficial oncological and functional outcomes. The clearest indication is the presence of invasion of the intrapetrous portion of the facial nerve. Additional indications are based on the need to obtain oncological margins, in cases of malignant parotid tumors abutting the stylomastoid foramen, allowing identification and preservation of a proximal functional facial nerve to facilitate reconstruction with a nerve graft. Where possible, dynamic reconstruction with cable nerve grafting is indicated in advanced cases of parotid tumors, obtaining good functional results within the first 2 years of follow-up.

Declaration of patient consent

The authors certify that they have obtained all appropriate

patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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