Facial reanimation by hypoglossal-facial neurorrhaphy

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ABSTRACT

Objective: *Facial palsy may still occur after removal of large vestibular schwannomas. The aim of this paper is to describe the outcome of patients submitted to facial reanimation and make a concise revision about modern techniques available to reanimate a paralyzed face.* ***Methods:*** *A retrospective study of was performed about the surgical results of 12 patients submitted to hypoglossal-facial neurorrhaphy. These patients were submitted to radical removal of large vestibular schwannomas (> 3 cm) before and anatomic preservation of the facial nerve was not possible.* ***Results:*** *In 10 cases (83%) patients had a good outcome with House-Brackmann facial grading III. In two other cases the facial grading was IV and VI. All patients were follow-up for at least one year after the reanimation procedure.* ***Conclusion:*** *Hypoglossal-facial neurorrhaphy is a very useful technique to restore facial symmetry and minimize the sequela of a paralyzed face. Long last palsy seemed to be the main reason of poor outcome in two cases.*

KEYWORDS

Facial nerve, hypoglossal nerve, neuroma acoustic, nerve regeneration.

RESUMO

Reanimação facial por meio de neurorrafia hipoglosso-facial

Objetivo: *Paralisia facial pode ocorrer após remoção de schwannomas vestibulares volumosos. Neste artigo é descrito o resultado obtido em pacientes submetidos à reanimação facial, bem como é realizada uma revisão concisa das técnicas modernas disponíveis para reanimação de uma face paralisada.* ***Métodos:*** *Estudo retrospectivo do resultado cirúrgico de 12 pacientes submetidos à neurorrafia hipoglosso-facial. Todos esses pacientes foram operados anteriormente de schwannomas vestibulares volumosos (> 3 cm) e não foi possível a preservação anatômica ou funcional do nervo facial.* ***Resultados:*** *Em 10 casos (83%), observou-se boa recuperação da paralisia e gradação final III na escala de House-Brackmann. Em dois outros casos, um paciente evoluiu com grau IV e outro com grau VI. Todos os pacientes foram seguidos por pelo menos um ano após o procedimento.* ***Conclusão:*** *A neurorrafia hipoglossal-facial é uma técnica útil para restaurar a simetria facial e minimizar as sequelas de uma face paralisada. Paralisia de longa duração foi a causa de insucesso em dois casos nesta série.*

PALAVRAS-CHAVE

Nervo facial, nervo hipoglosso, neuroma acústico, regeneração nervosa.

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Introduction

Facial expression has its upmost feature in human beings, serving to interact them in their social environment and being an important way of conveying emotions as the face provides data on individual's sex, age and intentions.[1,2] Charles Darwin *apud* Waller *et al.*[3] wrote that facial expressions exist in all human population, representing an evolved biological behavior.

Paul Elkman *apud* Waller *et al.*[3] have described six facial expressions found in all cultures worldwide: fear, surprise, rage, disgust, happiness and sadness. The complexity of human expressions through face motion is impressive and loss of them may have profound impact on patients' daily life.

Even though facial nerve palsy is becoming uncommon following surgical removal of vestibular schwannomas,[4-6] it still may be a major problem, especially in large tumors radically removed. Despite successful tumor resection, patients are left disabled by their palsy with the well-known and well-described consequences of a facial palsy, added by social contact avoidance and other symptoms (Table 1).

Several techniques have been described to restore or keep facial function by dynamic or static reanimation and even camouflage techniques[7] may be used to disguise a paralyzed face. Hypoglossal-facial neurorrhaphy[8-13] is believed to be one of the best available techniques to restore dynamic facial expression and is probably the most used technique following total facial nerve disruption in the CPA (cerebellopontine angle), when facial nerve stumps to perform a facial nerve grafting in CPA, are not available.[14-16] More recently a variation of this technique (hemihypoglossal-facial neurorrhaphy) was described as having similar results, minimizing tongue atrophy and speech disturbance.[17-24] Some other techniques, using other donor nerves or interposed grafts have also been described.[25-29]

Table 1 – Common consequences of facial paralysis

Eyebrow drop
Lagophthalmos
Dry eye
Keratitis and blurred vision
Risk of blindness
Speak and swallow disturbances
Difficult on fluid and fluid intake
Lack/reduction of emotional expression
Poor social interaction and isolation
Depression

Patients and methods

Between 1998 and 2011, 60 patients harboring vestibular schwannomas were operated on at the Hospital das Clínicas da Universidade Estadual de Campinas and Hospital Municipal Mário Gatti in the city of Campinas, São Paulo, Brazil. The great majority of patients had preservation of the facial nerve and presented postoperative House-Brackmann (HB) grades II-III, with a follow-up of at least 18 months. In this series, 6 of them (10%) were submitted to hypoglossal-facial reanimation due to facial nerve disruption during the procedure (without available facial stumps within the CPA). One patient had already total facial palsy before the removal of the tumor. Additionally, six patients operated elsewhere on vestibular schwannomas were referred to our service for facial reanimation (Table 2). All patients had large tumors (> 3 cm).

The surgical skin incision used, the anatomy and surgical approach to this region were well-described elsewhere.[30-34] Basically the 2 nerves (facial and hypoglossal nerves) were found and cut. The two stumps were sutured with 10-0 (3 or 4 stitches) under microscopic magnification. No fibrin glue was used. Patients were discharged next day and the postoperative course was uneventful in all cases.

Results

During the follow-up period of at least one year, 10 patients had a good recovery of their palsy, 1 patient had partial recovery and 1 patient did not improve at all due to a very long lasting palsy (Table 2). The HB grading system was used to evaluate postoperatively the patients, even though other recovery grading systems have also been reported.[12,14,35] The patients in this series had few complaints about the donor nerve and 70% developed hemi-tongue atrophy.

Discussion

Facial paralysis is a major concern following surgical removal of tumors in the CPA. Frequently the nerve is directly or indirectly involved by the lesion and may be injured partially or permanently during tumor resection.

According to Conley and May[9] three basic operations can improve the stigmata of a facial paralysis: 1) facial nerve repair; 2) hypoglossal-facial nerve crossover; 3) muscle transposition. The time between nerve injury and repair dictates the best approach (Table 3).

Table 2 – Clinical summary and results of 12 patients treated by hypoglossal-facial neurorrhaphy

Case	Age, Sex	Duration of palsy (months)	Pre-op grade*	Post-op grade*
1	62, F	36	VI	III
2	65, F	12	VI	III
3	53, F	18	VI	III
4	45, F	30	VI	IV
5	51, F	3	VI	III
6	29, M	96	VI	VI
7	45, F	6	VI	III
8	46, M	8	VI	III
9	19, F	3	VI	III
10	59, F	3	VI	III
11	46, F	6	VI	III
12	55, F	3	VI	III

*Pre-operative and post-operative.

Table 3 – Recovery after a neurorrhaphy procedure in facial palsy

Elapsed denervation time	Functional recovery
1 year	Almost certain
1 to 2 years	Seemingly certain
2 to 3 years	Probable
3 to 5 years	Increasingly questionable
5 +	Not recommended

If the facial stumps are available, facial nerve repair with graft is chosen after the first months of injury. When the repair is performed between 1 and 2 years, the procedure of choice is hypoglossal-facial neurorrhaphy or its modifications. Between 2 and 4 years, a combination of hypoglossal-facial nerve crossover with muscle transposition is preferred. After 5 years, muscle transposition is recommended combined with camouflage techniques and upper eyelid golden weight implantation. According to our experience in patients with facial nerve palsy lasting more than 5 years an electromyography should be performed to evaluate the facial muscles. If muscle fibers are still functioning (contra-lateral inervation) a hypoglossal-facial anastomosis is still possible to be performed.

The most used procedure to dynamically restore a paralyzed face is the end-to-end hypoglossal-facial neurorrhaphy.[8-11,13,32] Time factor is very important and was recently reemphasized by Yetiser and Karapinar[13] in a meta-analytic study, demonstrating that early surgical intervention (less than one year) can yield the best results. The two nerves have some similarity and their cortical representation are closer than, for instance, the accessory nerve or any other cervical nerve, optimizing a better cosmetic result due to some 'learning' of the adjacent area.[18,36,37] Poor recovery of the frontal muscle is usually common due to the relatively low number of axons of the frontal branch of the facial nerve and browlift surgery is frequently necessary.[18]

In spite of the classic hypoglossal-facial being a standard procedure, some modifications of this technique have been describe to avoid the consequences of tongue atrophy and speech disturbance due to total disruption of the hypoglossal nerve. One technique to avoid completely cutting the hypoglossal nerve was described by May[38] and Flores[29] (interpositional jump graft). A side-to-end neurorrhaphy of the hypoglossal nerve to the facial nerve is used by adding a graft of the sural nerve or the greater auricular nerve. Perhaps the best graft donor is the sural nerve because its greater area[5,39,40] (Table 4). Nonetheless this technique implies two anastomoses to transverse, increasing the risk of mismatch (at each crossing less than 50% of axons reach the distal stump).[5]

A more recently modified hypoglossal-facial techniques are the side-to-end hemihypoglossal-facial nerve neurorrhaphy.[17-24] One of these techniques the facial nerve is rerouted by a transmastoid approach and brought down to be anastomosed to half-cut hypoglossal nerve. As long as the number of axons output in the hypoglossal nerve outnumbers[41] the facial nerve good results have been described, minimizing the risk of tongue atrophy or speech disturbances. Nevertheless Fernandez *et al.*[10] have pointed out that in rats, clas-

*Table 4 – Nerves cross-sectional area and mean axons number**

Nerve	Area (average, mm²)	Axons number (average)
Hypoglossal (high cervical)	1,54	9778
Facial (mastoid)	0,94	7228
Sural	1,17	5672
Greater auricular	0,82	Data not found

*Data varies from different sources and these figures were chosen by author's discretion.

sic facial-hypoglossal neurorrhaphy achieved 48% of motoneurons reinnervation compared to only 25% in hemihypoglossal-facial neurorrhaphy. Therefore this technique may have a chance of insufficient reinnervation and poorer outcome. Yetiser and Karapinar[13] have stated that, unfortunately, the collected data available at the time of their revision was not sufficient to compare the results of facial reanimation in patients with side-to-end versus end-to-end hypoglossal-facial neurorrhaphy.

Another dynamic facial reanimation is the cross-facial nerve graft with end-to-side neurorrhaphy.[42-44] This technique grafts one or two sural nerves from one side to the other, connecting buccal and temporozygomatic branches. It is reported by plastic surgeons to give patients a better "social smile". This is smile is said to be more natural in daily social life, giving to face a positive symmetrical effect (Viterbo, personal communication).

Regarding static reanimation several muscle transposition techniques (platisma, anterior belly of digastric, gracilis muscles) may be applied to restore face symmetry.[45,46] However none of these techniques provides dynamic movement of the face and should be reserved to patients with long lasting palsy.

Eyelid protection is also useful in the early or late stage of the palsy to prevent lagophthalmos, corneal exposure, bacterial infection and perforation.[47-49] Initial treatment includes the use of ocular lubricants, moisture chambers and taping of the lower eyelid. Gold weight upper lid implantation is an effective surgical treatment to protect corneal exposure[47] and can be combined with any of the above mentioned techniques.

Conclusion

Facial palsy is a disfiguring sequela following removal of vestibular schwannomas. Patients should be offered early dynamic facial reanimation if the facial nerve was not anatomically or functionally preserved during surgery to remove vestibular schwannomas or any other type of injury. If the facial nerve was anatomically preserved, close observation of at least one year should be done before performing any neurorrhaphy because late recovery is possible. Based on the current technique evolution we believe that the classic hypoglossal-facial neurorrhaphy seems to provide the best chance of good recovery in patients with more than one year of palsy. On the other hand side-to-end hemihypoglossal-facial neurorrhaphy should be used in case of less than one year of palsy to preserve tongue movement and avoid atrophy. Other techniques should be applied if the aforementioned ones fail to give good cosmetic results. Early gold weight upper lid implantation is advised before or even after the neurorrhaphy to protect the cornea. In this series a good House-Brackmann result was achieved in 83% of the cases and long lasting palsy was the main reason of poor outcome in two patients.

Competing interests

The authors declare no conflict of interest.

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