

## Hypoglossal-Facial Anastomosis after Facial Nerve Injury: Technique and Outcome

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### ABSTRACT

**Objectives:** Preservation of facial nerve functions represents a major challenge in skull base surgery. The goal of the present retrospective study is to analyze the result of hypoglossal-facial anastomosis in 12 consecutive patients. Also the extent of the functional outcome and the factors affecting recovery are evaluated. **Methods:** A retrospective study involved twelve patients suffered from permanent damage of the facial nerve after surgery for acoustic neuroma in seven patients, cerebellopontine angle meningiomas in two patients and following skull base fracture in three cases. All the patients were treated surgically by doing classic (end to end) hypoglossal-facial anastomosis. **Results:** The study included 6 men and 6 women with their age ranged from 15 to 60 years. The time elapsed between injury and anastomosis ranged from one month to 24 months. The follow up period after hypoglossal-facial anastomosis ranged from 2 to 72 months. Functional assessment of the facial nerve was evaluated by using House-Brackmann and Pitty-Tator scales. The mean time between operation and sign of improvement was 7.25 months, ranging from 2- 17 months. Good outcome was recorded in seven (58.3%) patients, fair in three (25%) patients and poor in two (16.7%) patients. All the twelve patients had disorders of speech and swallowing due to hemiglossal atrophy which was controlled within 2 to 3 months by appropriate speech therapy and rehabilitation. **Conclusions:** Hypoglossal-facial nerve anastomosis is an effective and reliable technique that gives consistent and satisfying results to reanimate the paralyzed facial nerve

**Key words:** Facial anastomosis; facial nerve Injuries; facial reanimation; Hypoglossal nerve.

### INTRODUCTION

Preservation of facial nerve function represents a major challenge to the surgeon involved in surgery of acoustic neuroma, and skull base lesions<sup>(19)</sup>. As early as 1901, the proximity of cortical nerve projection led Kort and Bernhard in Berlin to propose hypoglossal-facial anastomosis<sup>(10)</sup>. Since that time hypoglossal- facial anastomosis is a technique frequently performed to treat facial nerve palsy after removal of cerebellopontine angle tumors, skull base lesions and skull base fracture<sup>(1-4;7;10;11;13;19;24;25)</sup>. Basic morbidities of this technique are related to hypoglossal nerve section, producing

moderately severe swallowing and speech disorders. Over the past two decades, however, many variants of this procedure have been specifically developed to reduce morbidity after complete hypoglossal nerve section<sup>(1;4;7;16-18;22)</sup>. The goal of the present study of 12 cases of classic (direct end to end) hypoglossal-facial anastomosis, is to describe the technique, assess the extent of the functional outcome and the factors affecting recovery.

### PATIENTS & METHODS

#### Patient population:

This is a retrospective study done on 12 patients who were treated

surgically to reanimate the facial nerve by classic (end to end) hypoglossal-facial anastomosis in the Neurosurgical Department, Ain Shams University hospitals and Heliopolis hospital, in the period between June 1999 and November 2007. A detailed history was taken with complete general and neurological examination. The study included 6 men and 6 women with their age ranged from 15 to 60 years, with mean of 40.25 years. The causes of facial injury was postsurgical removal of acoustic neuroma in 7 patients, cerebellopontine angle meningioma in 2 patients and skull base fracture in 3 patients. All the patients were treated by classic (end to end) hypoglossal-facial anastomosis.

#### **Surgical Technique of Hypoglossal-Facial Nerve Anastomosis:**

Under general anesthesia, the patient is placed supine with the head turned away from the surgeon. A postauricular incision is made toward the mastoid tip and continued along the anterior edge of the sternocleidomastoid muscle to the hyoid bone Figure (1). This incision has the advantage of being partly hidden behind the auricle. With the dissecting microscope, the facial nerve was carefully exposed in the cranial base and dissected free to mobilize its distal portion in the parotid gland. Once the facial nerve, which was surrounded by thick connective tissue, was identified at the stylomastoid foramen, the soft tissue, including vessels in the facial canal and the nerve sheath, was left intact to preserve vascular supply to the facial nerve through the parotid gland. After obtaining a length of facial nerve sufficient to perform a tensionless anastomosis, the most proximal portion was sectioned. To expose nerve tissue for anastomosis, the distal stump of the

facial nerve was trimmed by cutting its thick nerve sheath of tough connective tissue. The hypoglossal nerve is easily located in the bicarotidian region and is dissected backward along the internal carotid artery as high as possible. The entire diameter of the hypoglossal nerve was used in all cases. The facial nerve is transected as proximal as possible to leave enough length for a suture. The hypoglossal nerve is sectioned microscopically as distal as possible to make suture at ease without any tension on the anastomosis. The epiperineurial nerve suture is performed microscopically by using four interrupted No.8 nylon sutures. Closure of the wound was done in layers. Figure (2- A,B).

#### **Postoperative care and physiotherapy:**

The intervention is followed by passive physiotherapy sessions until tonus is restored, which may take 8 to 10 months. In subsequent physiotherapy sessions, lingual-facial synergy is concentrated on active exercises, using dynamic tongue positioning. Once facial mobility is acquired, however, exercises are focused on restoring independent motion and lingual-facial dissociation.

#### **Evaluation of the facial nerve functions:**

Several classification have been employed to evaluate the degree of nerve recovery<sup>(14,19)</sup>. Pitty and Tator,<sup>(19)</sup> developed their classification to measure the postoperative both objective and subjective criteria of recovery Table (2). Pitty and Tator,<sup>(19)</sup> classification is recorded as good, fair, poor and failure based on the following information: 1) facial muscle contraction of the frontalis, periorbicularis oculi, and periorbicularis oris muscles and the presence of the nasolabial fold; 2)

swallowing, speech, and food manipulation in the mouth; 3) abnormal movements, including synkinesis, contractures, or hemifacial spasm; and 4) psychological and emotional aspects, evaluated by asking the patients to assess the degree of psychological benefit offered by the anastomosis on the basis of self-esteem and any limitations in social activity as

shown in Table (2). In addition, the assessment of the function of the tongue was also involved. The evaluation of the patient was done preoperatively by using House and Brackmann scale Table (1). But both House and Brackmann in addition to Pitty and Tator scales were used postoperatively.

**Table 1: House–Brackmann scale for grading facial nerve function<sup>(14)</sup>.**

| Degree of Function            | Grade | Definition   |
|-------------------------------|-------|--|
| Normal                        | I     | Normal & symmetrical function in all areas   |
| Mild dysfunction              | II    | Slight weakness noticeable only on close inspection; complete eye closure with minimal effort; slight asymmetry of smile with maximal effort; synkinesis barely noticeable; contracture or spasm absent                      |
| Moderate dysfunction          | III   | Obvious weakness, but not disfiguring; may not be able to lift eyebrow; complete eye closure & strong but asymmetrical mouth movement with maximal effort; obvious, but not disfiguring, synkinesis, mass movement, or spasm |
| Moderately severe dysfunction | IV    | Obvious disfiguring weakness; inability to lift eyebrow; incomplete eye closure & asymmetry of mouth with maximal effort; severe synkinesis, mass movement, & spasm  |
| Severe dysfunction            | V     | Motion barely perceptible; incomplete eye closure, slight movement in corner of mouth; synkinesis, contracture, & spasm usually absent   |
| Total paralysis               | VI    | No movement; loss of tone; no synkinesis, contracture, or spasm  |

**Table 2: Pitty and Tator classification of facial nerve function after hypoglossal-facial nerve anastomosis<sup>(19)</sup>.**

| Outcome | Description  |
|---------|--|
| Good    | Good facial symmetry at rest<br>Complete voluntary eye closure<br>Mild to moderate mouth movement<br>Minimal or absent synkinesis or mass movement<br>Minimal or absent dysfunction in eating, swallowing or<br>Speech, attributable to hypoglossal nerve section<br>Feeling of major benefit from the procedure |
| Fair    | Fair facial symmetry at rest<br>Unable to obtain satisfactory closure of the eye<br>Marked synkinesis or mass movement<br>Moderate dysfunction in eating, swallowing, or speech,<br>Attributable to hypoglossal nerve section<br>Feeling of limited benefit from the procedure                                   |
| Poor    | Gross facial asymmetry at rest<br>Total inability to close the eye<br>No mouth movement<br>Marked synkinesis or mass movement<br>Feeling of no benefit from the procedure  |
| Failure | No evidence of reinnervation   |

**Table 3: Characteristics and outcome of twelve patients treated with classic hypoglossal-facial anastomosis.**

| No | Gender | age | Cause of facial palsy | Time between injury and surgery (Months) | **Result of surgery | Duration of follow up (Months) |
|----|--------|-----|-----------------------|--|---------------------|--------------------------------|
| 1  | Male   | 45  | Acoustic neuroma      | 6  | Good                | 72                             |
| 2  | Female | 25  | Petrous bone fracture | 15                                       | Poor                | 50                             |
| 3  | Male   | 45  | Acoustic neuroma      | 12                                       | Fair                | 60                             |
| 4  | Male   | 35  | Petrous bone fracture | 18                                       | Fair                | 9                              |
| 5  | Female | 15  | Petrous bone fracture | 24                                       | Poor                | 36                             |
| 6  | Female | 25  | CPA meningioma        | 12                                       | Good                | 72                             |
| 7  | Male   | 49  | Acoustic neuroma      | 9  | Good                | 36                             |
| 8  | Male   | 55  | Acoustic neuroma      | 7  | Good                | 60                             |
| 9  | Male   | 60  | Acoustic neuroma      | 1  | Good                | 50                             |
| 10 | Female | 52  | CPA meningioma        | 9  | Good                | 28                             |
| 11 | Female | 50  | Acoustic neuroma      | 16                                       | Good                | 36                             |
| 12 | Female | 27  | Acoustic neuroma      | 12                                       | Fair                | 2                              |

\*\* According to the classification of facial nerve function after hypoglossal-facial anastomosis described by Pitty and Tator<sup>(19)</sup>.

## RESULTS

This is a retrospective study done on 12 patients 6 men and 6 women with age ranged from 15 to 60 years, with a mean of 40.25 years. The follow up period after hypoglossal-facial anastomosis ranged from 2 to 72 months, with a mean period of 42.58 months. The time elapsed between injury and anastomosis ranged from one month to 24 months with a mean of 11.75 months. The facial nerve was intact before surgical removal of acoustic neuroma in 3 patients and in the two patients of cerebellopontine meningioma. In 8 patients anastomosis was done within the first year of injury, the earliest anastomosis was done in the first month as the surgeon was sure that the facial nerve was cut during removal of the tumor Table (3), after discussion with the patient he agreed to do anastomosis. Four of other 7 patients, had of facial nerve injury during surgery, but the patients were reluctant to undergo early surgery, as they were not accepting the morbidity of hypoglossal nerve cut. In the last 3 patients the facial nerve was considered to be anatomically intact and therefore, the anastomosis was performed at 12 months following surgery as the expectation that facial nerve recovery would occur. Four patients were operated upon after one year of injury, 3 of them had skull base fracture and were treated conservatively to give them a full chance for spontaneous facial nerve recovery. The fourth patient had the anastomosis after 16 months from injury as she refused earlier surgery fearing of the morbidity of the operation. The mean time between operation and sign of improvement

was 7.25 months, ranging from 2- 17 months. The outcomes were measured after a mean follow up period of 42.92 months, with a range of 6 to 72 months.

Good outcome was recorded in seven (58.3%) patients, fair in three (25%) patients and poor in two (16.7%) patients. Six out of seven patients with good surgical outcome had their surgery done within 12 months of injury; fair results in three cases did not seem to be related to the time of surgery. Poor results were in two cases the first one did surgery after 15 months and the second after 24 months.

According to House–Brackmann scale for preoperative and postoperative evaluation, one patient improved from grade V preoperatively to grade III postoperatively, ten patients with grade VI preoperatively, improved to grade III in 6 patients, grade IV in three patients, grade V in one patient. The last patient grade VI preoperatively remained the same postoperatively.

The hypoglossal-facial anastomosis outcome was good in five cases Figure (3-A,B), and fair in two cases operated before for acoustic neuromas. Good outcome was observed in the two cases who were operated upon before for cerebellopontine angle meningiomas Figure (4-A,B). The fair and poor outcome was recorded in one and two cases respectively after skull base fracture.

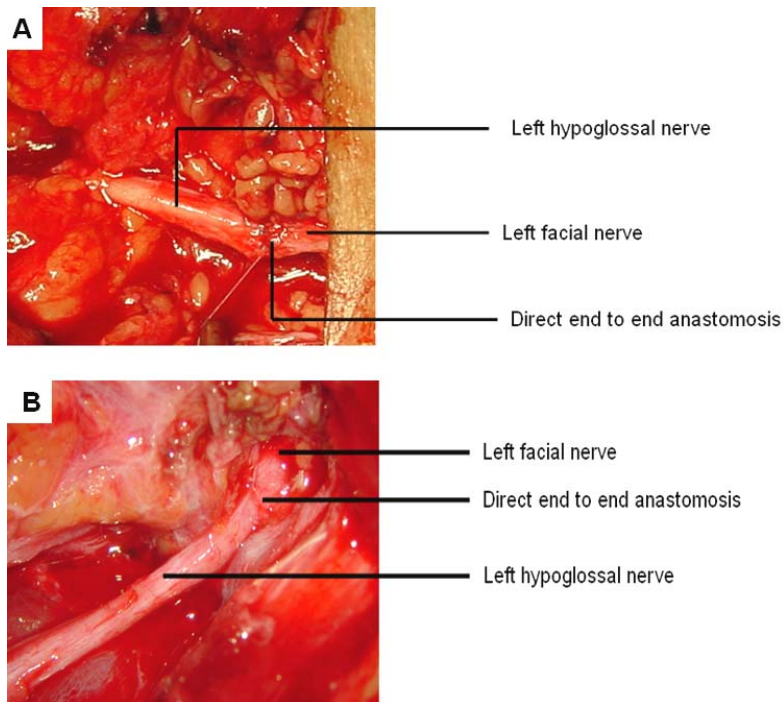
All the twelve patients had disorders of speech and swallowing produced by section of the hypoglossal nerve leading to hemiglossal atrophy Figure (3-C) and Figure (4-C). But with appropriate speech therapy rehabilitation, this situation could be

controlled in ten patients within 2 to 3 months and the remaining two patients lasted for one year. In addition, swallowing, especially food manipulation in the mouth was

affected in the immediate postoperative period; however, most of the patients got used to this and quickly learned to cope with the difficulty.



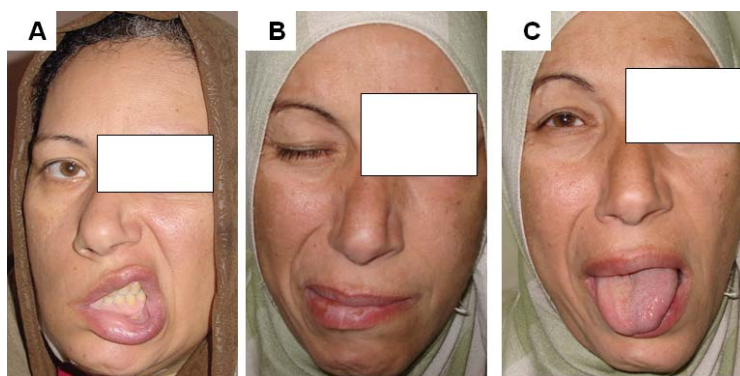
**Figure 1:** Intraoperative photographs showing Postauricular skin incision on the left side was made toward the mastoid tip and continued along the anterior edge of the sternocleidomastoid muscle toward the hyoid bone.



**Figure 2 (A,B):** Intraoperative photographs showing: A,B Exposure of facial nerve and mobilization of the hypoglossal nerve to make direct end to end anastomosis with the facial nerve.



**Figure 3(A,B,C):** [A] Complete left facial paralysis in a 45 year-old man after Left cystic acoustic neuroma resection. Six months after that surgery, a classical hypoglossal-facial nerve anastomosis was performed. [B] Eight months after the procedure facial muscle contraction of the periorbicularis oculi, and periorbicularis oris muscles and the presence of the nasolabial fold. [C] Postoperative left tongue hemiatrophy secondary to hypoglossal nerve section is observed.



**Figure 4 (A,B,C):** [A] A 50-year-old woman presented with a complete right facial nerve paralysis after excision of a huge right cerebellopontine meningioma. 16 months after that surgery, a classical hypoglossal-facial nerve anastomosis was done. [B] 24 months after the procedure facial muscle contraction of the frontalis, periorbicularis oculi, and periorbicularis oris muscles and the presence of the nasolabial fold. [C] Postoperative right tongue hemiatrophy is noted.

## DISCUSSION

Functional preservation of the facial nerve during removal of lesions along its course has been of considerable concern for surgeons approaching tumors at the base of the cranium. In spite of the striking development in surgical techniques and the remarkable improvement in

morbidity and mortality of many tumor excision procedures, facial paralysis is not an uncommon postoperative event<sup>(1,4,7,9,16,18,22)</sup>. The first surgical attempt to repair the facial nerve to treat facial paralysis was performed in 1879 by Drabnick, who anastomosed the spinal accessory nerve to the facial nerve; however, the first published report of this technique is attributed to

Sir Charles Ballance in 1895<sup>(18)</sup>. The first hypoglossal-facial nerve anastomosis was performed by Korte in Berlin in 1901; since then, there have been many reports of this surgical approach being used to treat facial paralysis secondary to surgery for cerebellopontine angle tumors and other lesions<sup>(19,21)</sup>. The discussion of which donor nerve to facial nerve crossover anastomosis would continue for years<sup>(7,23)</sup>. Ballance<sup>(19)</sup> suggested the cortical representation of the tongue and face are closer than those of the shoulder and face. The larger size of the cortical representation of the tongue may also account for the better results with hypoglossalfacial nerve anastomosis<sup>(7,19,23)</sup>. So, the most widely used to date being the classical hypoglossal-facial nerve anastomosis<sup>(7,21)</sup>. Basic morbidities of this technique are related to hypoglossal nerve section, producing moderately severe swallowing and speech disorders. However, many variants of this procedure have been specifically developed to reduce morbidity after complete hypoglossal nerve section<sup>(1,7,16,22)</sup>.

Many reports had no age limitation with the patients' ages ranged from 6 months to 75 years, although patients younger than 15 years were found in only two reports<sup>(5,8,19,27)</sup>. In this study the age of the patients ranged from 15 to 60 years. The time between facial paralysis due to the facial nerve lesion and anastomosis ranged from immediate surgery to 55 years;<sup>(5,8,27)</sup> comparing to this study the time elapsed between facial nerve injury and anastomosis ranged from one month to 24 months with a mean of 11.75 months. The delay in performing hypoglossal-facial anastomosis should be as short as possible as many authors mentioned<sup>(8;10;18)</sup>. The longer standing

the paralysis (>5 years), the greater the dilemma concerning treatment, because surgery involves sectioning a functional nerve<sup>(10)</sup>. Darrouzet, et al.<sup>(10)</sup> and Rosenwasser, et al.<sup>(20)</sup> believed that hemihypoglossal-facial nerve attachment circumvents the difficulty by avoiding the loss of lingual function in the name of hypothetical good recovery. Most procedures were performed within the first 1 to 2 years<sup>(5;8;18;19;27)</sup>, but in this study 67% of patients were operated upon within the first year and 33% were operated upon between the first and second year of facial nerve injury. The follow-up period ranged from 4 months to 16 years<sup>(5;8;19)</sup>. Follow up of the current patients ranged from 6 months to 72 months with mean 42.92 months.

Good results were achieved in approximately 65% of the patients, fair results in about 22%, and poor results (including total failures) in about 13%<sup>(5;8)</sup>. on the other hand Pitty and Tator<sup>(19)</sup> reported that 14 patient out of 22 patients (63.6%) had good results, three patients (13.6%) had fair and four patients (18.2%) had poor results. Good results in the present study were recorded in seven out 12 patients (58.3%), fair in three patients (25%) and poor in two patients (16.7%). However, Iansek, et al.<sup>(15)</sup> pointed out that the lack of a uniform classification of recovery of facial nerve function after hypoglossal-facial nerve anastomosis accounts for much of the difficulty in comparing the results of various series.

Pitty and Tator<sup>(19)</sup> had good achievement in their series in the form of restoration of facial muscle tone leading to the reappearance of the nasolabial fold and recovery of complete symmetry of the face at rest in 14 patients (63.6%). These patients considered that the benefit was

substantial and that their quality of social life was enhanced. In this series good results were recorded in seven patients (58.3%) and all of them were satisfied with the total results as regard facial symmetry at rest, nasolabial fold reformation, and closure of the eye, which sometimes required active tongue movement despite their hemiglossal atrophy. Patients were encouraged to train their tongues for better facial performance. Training in front of a mirror to achieve fine, discrete movement was probably useful. Some studies<sup>(6,19)</sup> reported improvement in selective motor control of facial muscles with behavioral training methods.

According to Pitty and Tator<sup>(19)</sup>, hemiatrophy of the tongue on the side ipsilateral to the anastomosis was present in all their 22 patients, although the severity varied considerably. In this series hemiatrophy of the tongue was present in all cases. But with appropriate rehabilitation, this situation can be improved within 2 to 3 months in ten patients and lasted for one year in two patients. In addition, swallowing, especially food manipulation in the mouth, was affected in the immediate postoperative period; however, most patients got used to this and quickly learn to cope with the difficulty. Modification of the anastomosis technique by using side to end anastomosis, seems to resolve this problem. Nevertheless, the effect of modified techniques on facial reanimation is still unclear, because the facial nerve function results were lacking in these reports<sup>(19,21,26)</sup>.

It was observed that the recovery of the frontalis branch of the facial nerve was very poor, which is similar to the findings in most other series<sup>(12,19,27)</sup>. The relatively small number of fibers

passing to the frontalis branch from the trunk of the postgeniculate portion of the facial nerve accounts for the poor reinnervation of the frontalis muscle<sup>(19)</sup>.

Mastoidectomy, as recommended by some authors<sup>(10,19)</sup>, was necessary in a minority of cases as it was very helpful in visualizing an atrophic facial nerve specially after a very long delay after injury. In this series mastoidectomy was never used to identify the facial nerve.

## CONCLUSION

Hypoglossal-facial anastomosis is a technique for rehabilitation of facial function following a proximal lesion of the facial nerve. In its classic form of anastomosis, synkineses and hemiatrophy of the tongue are the major drawbacks to this technique. The synkineses can be overcome by reeducation using biofeedback techniques. Hemiatrophy of the tongue can be reduced in the future by doing side to end hypoglossal-facial anastomosis. The use of uniform classifications and scales to evaluate the results of hypoglossal-facial anastomosis is needed to choose the best technique for the anastomosis.

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