Recent advances in hypoglossofacial anastomosis for facial reanimation

Thesis

Submitted for fulfillment of M.Sc degree in General Surgery

By

Ahmed Ragab Morsi
M.B.B.CH

Under supervision of

Prof. Dr. Taher Ismail Ahmed
Professor of general and plastic surgery
Faculty of medicine – Cairo University

Prof. Dr. Maamon Ismail Maamon
Professor of general and plastic surgery
Faculty of medicine – Cairo University

Dr. Tarek Ahmed Amer
Assistant Professor of general and plastic surgery
Faculty of medicine – Cairo University

Faculty of Medicine,
Cairo University
2012

keywords

Facial reanimation – hypoglossofacial anastomosis – facial palsy – neurotization

Abstract

Best cosmetic and functional results obtained with earlier neurotization. Using part of hypoglossal nerve cause less tongue morbidity Splitting of the hypoglossal nerve and anastomosing it to the devisions of the facial nerve results in minimum synkinesis than anstomosis to the main trunk. The importance of training to coordinate the tongue and facial movements must be emphasized, more “natural” cosmetic results occurred in the patients who carefully followed a physiotherapy program.

Acknowledgment

First and for most …. I thank ALLAH who gave me everything.

I would like to express my sincere appreciation to Prof. Dr. Taher Ismail for his continuous support thorough my career.

I can't thank enough Prof. Dr. Maamoun Ismail for his fatherly support and encouragement.

My special thanks are dedicated to Prof. Dr. Tarek Amer who shared me the burden of completing this work, for his meticulous supervision all through this thesis and from who the ideas in this thesis were inspired, I owe him a lot.

I'm obliged to all my professors, my seniors, my colleagues and all my friends who contributed to this work.

List of abbreviations

- AICA → anterior inferior cerebellar artery
- CAMs → cell adhesion molecules
- CCA → common carotid artery
- CN → cranial nerve
- CPA → cerebello-pontine angle
- ECA → external carotid artery
- EDL → extensor digitorum longus muscle
- FN → facial nerve
- GDNFs → glial-cell-line-derived neurotrophic factors
- HFA → hypoglosso-facial anastomosis
- HHFA → hemi hypoglosso-facial anastomosis
- HN → hypoglossal nerve
- ICA → internal carotid artery
- IJV → internal jagular vein
- PBEF → prebifurcation extracranial facial nerve
- SMAS → superficial musculoaponeurotic system

Introduction

Facial nerve palsy is one of the most devastating nerve injuries with important functional and psychological impact on the patient's life.

A multitude of reconstructive techniques using muscle transfers, free muscle grafts, shortening or plication of weakened muscles, dermal transplants, fascial transplants, and the removal of redundant skin, have been described for reanimation of the paralyzed face. When the proximal facial nerve stump is not available, in the presence of viable facial muscles, the use of an intact donor nerve to neurotise the distal is the ideal choice. The most commonly used donor nerve is the hypoglossus, which is connected to the facial nerve at the level of the stylomastoid foramen. (***Rosenwasser et al., 1991)***

Hypoglossal-facial nerve anastomosis was often criticized because of the following postulated disadvantages:

1. Hemiparesis of the tongue leads to problems when talking and eating.
2. Facial movements are only possible through deliberate movements of the tongue.
3. These deliberate movements of the tongue lead to un-controlled grimacing.
4. Spontaneous emotional expression will never be regained.

There are diverse of techniques for hypoglosso-facial cross over apart from the classical hypoglosso-facial crossover there is HFA with longitudinal splitting of the hypoglossal nerve (HHFA), HHFA with jump interpositional nerve graft, HHFA with facial nerve transposition, End-to-side HFA, anastomosis of a descending branch of the hypoglossal nerve to the facial nerve, another technique is that after a classic hypoglossal-facial anastomosis, an anastomosis of a descending branch of the hypoglossal nerve to the distal stump of the same hypoglossal nerve and the "baby-sitter" procedure It involves two stages, with coaptation of ipsilateral 40 percent hypoglossal to facial nerve on the affected side, performed concomitantly with cross-facial nerve grafting and secondary microcoaptations 8 to15 months later.

Synkinesis is one of the most puzzling and difficult conditions to treat after incomplete recovery from facial nerve injury. Synkinesis is characterized by abnormal facial movements that occur during voluntary and spontaneous facial expression. Synkinesis is unpleasant sequelae in any patient after facial nerve surgery. Specific areas of synkinesis can be difficult to identify because it can result in what superficially appears to be no active facial movement at all. Any abnormal muscle action opposing the primary angle of movement can restrict motion to such an extent that no active movement occurs, even though muscle contraction may be obvious A “tug-of-war” results when one or more muscles contract out of the normal sequence. Facial mobility and the precision necessary for subtle cues are lost. Synkinesis varies in severity from mild to severe. In its worst form, mass action, it can result in uncontrollable activity of the facial muscles on the affected side during any attempted expression. Synkinesis can affect any of the facial muscles, in any pattern. **(Husseman and Metha, 2008)**

Aim of the work

Is to experience the newest methods of the hypoglosso-facial cross over techniques to achieve best results for facial reanimation with minimal synkinesis, and minimal hemiparesis of the tongue to produce satisfying aesthetic and functional outcomes.

Anatomy of facial nerve

The facial nerve has a motor and sensory root. The sensory root, the *nervus intermedius*, gains its name from its position between the facial and the vestibulocochlear nerves at the cerebellopontine angle. The two roots arise from the pons, lateral to the recess between the inferior olive and inferior cerebellar peduncle, and lie superior and slightly anterior to the vestibulocochlear nerve. The nervus intermedius usually cleaves at first to the vestibulocochlear rather than the facial nerve, passing to the latter as it approaches the internal acoustic meatus, often as more than one filament ***(Berry et al, 1995)***.

The facial nerve should perhaps be called the *intermediofacial nerve,* to emphasize that the nervus intermedius is classified as part of it. The name 'sensory root of facial nerve' often applied to the nervus intermedius is not entirely appropriate since the root contains visceral efferent fibers as well as afferents ***(McMinn, 1994)***.

The branchial motor fibers constitute the largest component of the facial nerve and provide efferent innervation to the stapedius, stylohyoid, and the posterior belly of the digastric and the muscles of the facial expression ***(Myckatyn and Mackinnon, 2003)***.

Supra nuclear anatomy:

Pyramidal (Corticonuclear) control:

Cells in layer V of the motor area, give rise to corticonuclear fibers - formerly called corticobulbar- pass through the corona radiata, and then run down through the genu of the internal capsule into the brain stem. Fibers collect in the most medial part of the central three fifth of the crus of the midbrain. From there they run downwards to reach the motor nucleus of the facial nerve ***(McMinn, 1994)***.

Extra-pyramidal control:

There are a number of additional cortical motor areas to the facial nucleus; some of these are the hypothalamus, the basal ganglia and midbrain tegmentum *(Crosby and De Jonge, 1983)***.**

This system provides for automatic associated movements and spontaneous, emotional, mimetic human facial language which accompanies the more precise voluntary responses ***(Crumley, 1989)***.

Thus emotional movements and automatic associated movements such as smiling at an amusing story, and unconsciously pursing the lips while concentrating on a problem, may persist in patients with a supra nuclear facial palsy involving direct corticonuclear pathway ***(Crosby and De Jonge, 1983)*****.**

Nuclei of the facial nerve:

Motor nucleus:

The nucleus from which most facial motor fibers are derived lies deep in the reticular formation of the caudal part of the pons, posterior to the dorsal trapezoid nucleus and ventromedial to the spinal tract and nucleus of the trigeminal nerve. It represents the branchial efferent column but lies deeper in the pons ***(Berry et al, 1995)***.

The facial motor nucleus is a complex consisting of lateral, intermediate and medial subnuclei. A further division of the medial nucleus into ventral, dorsal and intermediate groups has been described. These subsidiary group of neurons are arranged in columns.

There is general agreement that they innervate individual muscles or correspond to branches of the nerve, but observers disagree about details. The lateral subnucleus is said to innervate the buccal musculature, the intermediate sends axons into the temporal, orbital and zygomatic facial branches and the medial group into the posterior auricular and cervical rami and probably the stapedial nerve ***(Berry et al, 1995)***.

Efferent fibers that arise from the facial motor nucleus supply the striated muscles of the second pharyngeal arch. ***(Proctor, 1991)***.

Salivary nucleus (secretomotor nucleus):

The salivary nucleus is near the upper pole of the dorsal vagal nucleus, just above the pontomedullary junction and near the inferior pole of the facial nucleus. It is customarily divided into superior and inferior salivary nuclei, sending secretomotor fibers to the salivary and lacrimal glands via the facial and glossopharyngeal nerves ***(Berry et al, 1995)***.

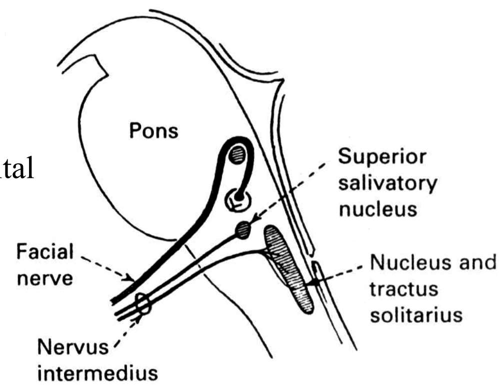


Fig. (1) A diagrammatic sagital section in the brain stem showing the VIIn nuclei. ***(Lindsay and Bone, 2004)***.

The visceral motor (secretomotor) nucleus of the nervus intermedius part is the superior salivary nucleus, part of the visceral efferent column and situated adjacent to the (branchial) facial nucleus. Neurons of the nucleus have been described as clustered along the intrapontine part of the nerve distal to its loop around the abducent nucleus ***(McMinn, 1994)***.

It represents the general visceral efferent column, and it sends its fibers preganglionic parasympathetic secretomotor, which leaves the brainstem in the nervus intermedius, but they are ultimately distributed through the chorda tympani to the sublingual and submandibular salivary gland and through the greater superficial petrosal nerve to the lacrimal glands and the glands of the nasal and palatine mucosa ***(Proctor, 1991)***.

The Nucleus Solitarius:

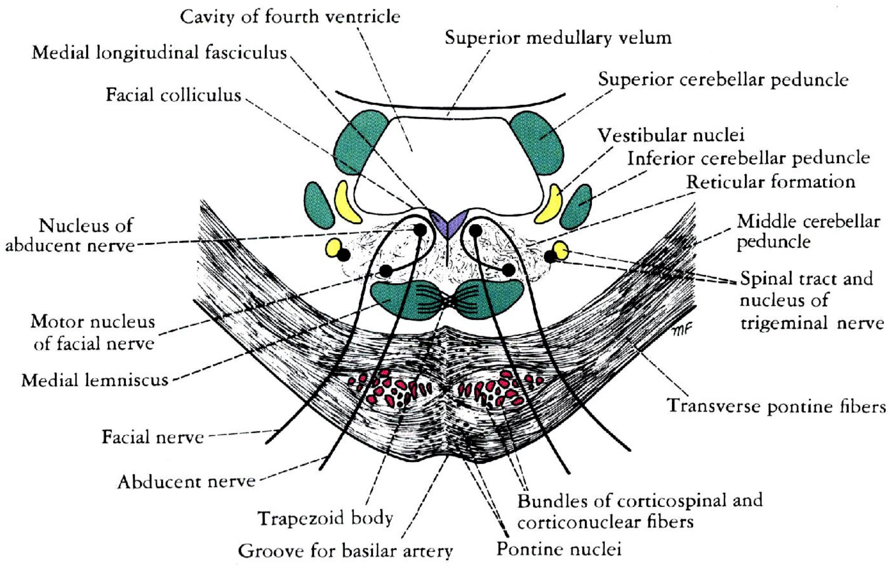
The sensory nucleus is the nucleus of the tractus solitarius which lies further laterally but mostly in the medulla. It receives the central processes of the taste cell bodies of the geniculate ganglion ***(McMinn, 1994)***.

The peripheral branches of these neurons run by way of chorda tympani nerve to the taste buds of the anterior two-thirds of the tongue and byway of the greater superficial petrosal nerve to the taste buds in the palate ***(May, 2000)***.

Infranuclear Anatomy:

Intrapontine:

Axons of the large motor nucleus at first incline dorsomedially towards the fourth ventricle, below the abducent nucleus and ascend medial to it near the medial longitudinal fasiculus, through which the facial may communicate with other cranial nerves. Fibers now curve antrolaterally around the upper pole of the abducent nucleus, as the facial colliculus, and descends antrolaterally through the reticular formation. Finally, they pass between their own nucleus medially and the spinal trigeminal nucleus laterally. Fibers then exits the brain stem between the olive and the inferior cerebellar peduncle. This unusual course provided apparent evidence of neurobiotaxis ***(Berry et al, 1995)***.



Cerebellopontine Angle:

The facial nerve emerges from the brainstem with a more slender nerve, the nervus intermedius between the facial nerve and the vestibulocochlear nerve. The nerves are void of epineurium, covered by pia mater and bathed in cerebrospinal fluid. The distance between the facial nerve and nervus intermedius exit from brainstem to their entrance into the internal auditory canal is approximately 23-24 mm. The facial nerve and the intermedius nerve are above and slightly anterior to the vestibulocochlear nerve ***(Kamerer and Tompson, 2001)***.

Here the motor root is in an antrosuperior groove on the vestibulocochlear nerve, with the sensory root between them. The facial nerve is in close and variable contact with the anterior inferior cerebellar artery (AICa) which usually lies in a ventral position between the nerve and the pontine surface. In 12.3% of people the AICa loops within the internal auditory canal ***(Berry et al, 1995)***.

Intratemporal portion of facial nerve:

Internal auditory canal:

The facial nerve, along with the nervus intermedius and the vestibulocochlear nerve, passes through the internal auditory canal which is 5 to 12 mms in length ***(Proctor, 1991)***.

The labyrinthine segment of the nerve runs across the axis of the petrous pyramid to the geniculum about 5mm from IAC, here the nerve presents a reddish asymmetrical swelling, the **geniculate ganglion**, which lies just medial to the tip of the cochleariform process. It then turns 130 degrees and forms the horizontal or **tympanic segment** which is 10-12 mm long and passes lateral to the vestibule, above the oval window, and below the lateral semicircular canal. It rarely lies lateral to the lateral semicircular canal. In the medial wall of the middle ear it slopes down from anterior to posterior forming an angle of approximately 10 degrees with the lateral semicircular canal. It lies medial to the malleus head anteriorly, the incudo-malleolar joint, incus and attic posteriorly. **The pyramidal part** connects the horizontal and mastoid segment at an angle between 95-125 degrees and here it gives off the nerve to the stapedius muscle. **The mastoid segment** then descends 10-14 mm to the stylomastoid foramen and gives off the chorda tympani nerve approximately 5 mm proximal to it, although the exact position varies and in 2% lies distal to the foramen ***(Berry et al, 1995)***.

The extra cranial facial nerve:

After shedding all the hitch-hiking nervus intermedius fibers, the nerve emerges from the stylomastoid foramen, now a purely branchial nerve ***(McMinn, 1994)***.

At the stylomastoid foramen the nerve is about 2cm deep to the middle of the anterior border of the mastoid processes. Emerging from the stylomastoid foramen, the nerve runs forward in the parotid gland, lateral to the styloid process, retromandibular vein and external carotid artery ***(Berry et al, 1995)***.

The trunk of the facial nerve passes through the parotid gland, where it branches to form the parotid plexus. The most common branching pattern is a bifurcation of the trunk. The upper branch gives rise to the temporal and zygomatic branches; the buccal, marginal mandibular and cervical branches originate from the lower branch. Beyond this point, diversity is considerable because of the formation of interconnections between the branches. The most frequent interconnections are between the zygomatic and buccal branches ***(Gardetto et al., 2002)***.

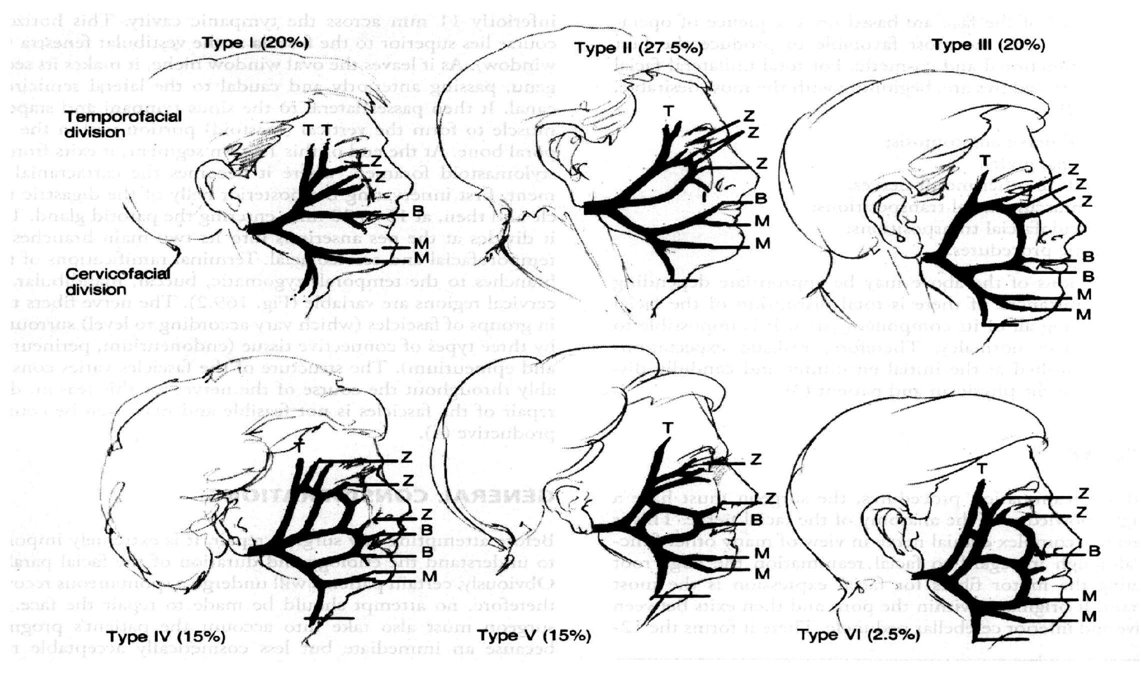


Fig.(2): The variability of the terminal branches of the Facial nerve. B:buccal; M:mandibular; T:temporal; Z:zygomatic ***(Gardetto et al., 2002).***

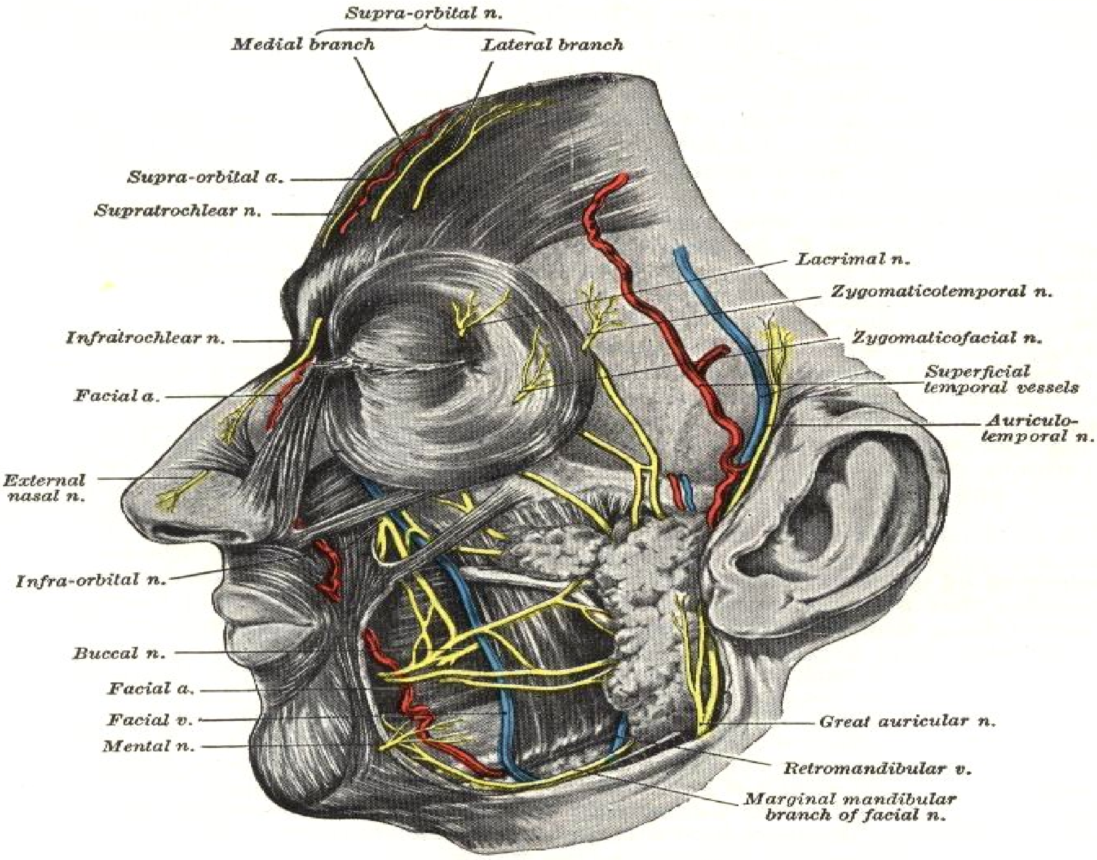


Fig.(3): Terminal branches of the Facial nerve ***(Berry et al., 1995)***.

The presence of the facial nerve within the parotid gland gives rise to the so-called superficial and deep parts of the gland. The superficial part lies lateral to the facial nerve, extending anteriorly to the border of the masseter muscle. The deep portion, which makes up about 20% of the gland, lies medial to the facial nerve and in the retromandibular fossa. However, others believe that the gland is bilobar, with an isthmus connecting the deep and superficial lobes. The isthmus lies between the two main branches of the facial nerve. The deep part gives rise to the parotid duct, which crosses the masseteric muscle and pierces the buccinator muscle to enter the oral vestibule ***(Gardetto et al., 2002)***.