IMPROVED PRESERVATION OF FACIAL NERVE IN TRANSTEMPORAL APPROACHES TO THE SKULL BASE

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ABSTRACT

Surgery of the skull base has evolved over the past 100 years. The importance of combined otorhinological and neurosurgical approach in the management of lesions of the skull base has been realised in recent years. Through this strategy, lesions which were once thought unresectable are being removed completely with reduction in mortality. However, the morbidity due to facial palsy in lateral skull base surgery is common. To avoid this, intraoperative facial nerve monitoring was introduced in the late 70's and has been refined to such a point that it is now possible to safely predict the recovery of the temporary facial paralysis after lateral skull base surgery. The present study which was carried out in the Armed Forces for the first time has evaluated this by comparing 5 patients who underwent this surgery without intraoperative facial nerve monitoring with 5 patients who were operated with intraoperative facial nerve monitoring. The results have proved the efficacy of this tool in reducing the severity and duration of facial palsy after this surgery.

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Introduction

Surgery of the skull base has evolved over the past 100 years. This anatomical area has been approached by neurosurgeons, otologists, maxillofacial surgeons and plastic surgeons from different angles. Presently, the combined skills of these surgeons are utilized in treating lesions of this area once considered a 'bony no man's land'. The temporal bone houses man's most highly tuned organs of special sense, those of hearing and balance. The capacity of the temporal bone to open the door to the skull base was first recognised by Sir Charles Balance who in 1894, successfully removed the first acoustic neuroma armed with only a hammer and gouge. William House and Ugo Fisch, firmly established the temporal bone as the logical highway to the lateral skull base and described various approaches depending on the size and extent of the lesion [1].

Although the infratemporal approaches described by Fisch [2] provide excellent exposure of the lateral skull base, and microsurgical techniques have resulted in precise dissection, yet the manipulation of the facial nerve during these procedures often results in temporary facial paralysis. Historically, intraoperative nerve monitoring using faradic stimulation was employed by neurosurgeons as early as 1898. But, nerve monitor-

ing, as we know it today, evolved in the late 1970's and has been refined to the point that multiple nerve monitoring systems are available today. The primary motor nerve monitoring modality is electromyography (EMG) which is the gold standard and has excellent sensitivity, detecting subtle sub threshold electrical information.

The present study which was carried out for the first time in the Armed Forces seeks to validate the importance and advantage of intraoperative facial nerve monitoring during skull base surgery in reducing morbidity of the patient.

Applied Anatomy

The first step in operating near the facial nerve is an understanding of its anatomy in both the normal and the pathological temporal bone. The neurologist, skull base surgeon encounters the intracanalicular and cerebello-pontine angle segments of the facial nerve. These segments lack epineurium, that firm protective fibrous sheath that is present in the more peripheral segments. When epineurium is absent, the surgeon has a particularly difficult task, dissecting tumor, inflammatory or scar tissue directly off the nerve fascicles. For example, in case of acoustic neuroma the nerve may be ventrally displaced, splayed, thinned, and attenuated. Often it may appear more like a small wisp

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of wet tissue paper than the cable structure which we are normally familiar with. Hence efforts have been made to develop adjunctive tools and refine surgical techniques to preserve the facial nerve [3].

Material and Methods

Ten patients underwent transtemporal skull base surgery over a 2 year period between Jun 95 to Jun 97 at Command Hospital (SC), Pune. These patients were part of the group of patients that were being evaluated for combined Otorhinological and Neurosurgical approach to lesions of the skull base under AFMRC project 2027/95 which has since been completed. A team consisting of Neurologist and Neurosurgeon jointly assessed them. In addition to the clinical assessment of the neurological status including cranial nerve function, imaging modalities such as CT, HRCT, MRI, Carotid Angiography and Digital Subtraction Angiography (DSA) were used in deciding the surgical approach. Pre and post-operative facial function was assessed in all cases according to the House Brackmann 6 point scale [4]. There were six male and four female patients, ranging in age from 22 years to 61 years (mean 37.6 years). Among these patients, the first five were operated without intraoperative facial nerve monitoring in the first year of the study, as the same was not available at that time. The other five were operated between Jun 1996 and Jun 1997 with intraoperative facial nerve monitoring using the Brackmann II facial nerve monitor (Fig-1).

Facial nerve EMG monitoring

After the induction of general anaesthesia, bipolar hook wire electrodes were placed intramuscularly into the ipsilateral orbicularis oculi and orbicularis oris muscles [5]. EMG signal were amplified and filtered. During periods of electrocautery, the acoustic signal was interrupted manually in a compulsory fashion. A hand held stimulation probe was used in a distant anode (monopolar) configuration [6]. The anode, a monopolar needle electrode was placed subcutaneously over the ipsilateral shoulder. Pulsed electrical stimuli of 0.1 msec duration were generated at a rate of 6 per second. Stimulus intensity levels were maintained at 0.2 mA throughout the procedure. The stimulus probe was available throughout the surgical procedure to be used at the surgeon's discretion [7].

Anaesthesia

General anaesthesia was induced by intravenous administration of thiopental. Peripheral muscle relaxation was achieved by intravenous administration of succinyl choline or pavulon. Further doses were used minimally and the surgeon was warned about the

insensitivity of the nerve during the time of action of the drug. The sensitivity was repeatedly checked by the anaesthesiologist with a hand held muscle reflex tester. General anaesthesia was maintained throughout the procedure with a major inhalational agent, isoflurane or enflurane, in a 2:1 mixture of nitrous oxide and oxygen. Intravenous morphine was added for supplemental analgesia in most cases.

Interpretation of evoked EMG activity

In this series, the evoked EMG activity observed during surgical exposure and rerouting of the facial nerve was exclusively of the burst pattern. Such activity occurred with various mechanical manipulations of the facial nerve and was interpreted as mere mechanical stimulation of the nerve. During the uncovering of the facial nerve with the diamond drill, this activity was taken as a signal that the facial nerve sheath has been reached. When such elicited activity persisted despite further uncovering of the nerve from the fallopian canal and stylomastoid foramen, it was interpreted as relative trauma to the nerve. Similar activity was also noted during dissection of acoustic tumour near the internal auditory meatus. At such times, attempts were made to minimise the production of EMG activity through alteration of surgical technique. Electrical stimulation was used intermittently to assess the status of the facial nerve conduction and at the end of the operation, before closure of the wound [8].

Results

Tumour type and size

The data from 5 monitored cases were compared with the data from 5 cases performed without intraoperative facial nerve monitoring. The histologic findings for each case are summarised in Table 1. The tumor sizes for monitored and unmonitored cases are compared in Table 2.

TABLE 1
Tumour type (n=10)

Histology	Unmonitored	Monitored
Glomus Jugulare	2	2
Vestibular schwannoma	3	1
Schwannoma IX nerve	—	1
Epidermoid cyst CP angle	—	1
Total	5	5

TABLE 2
Tumour size (n=10)

Size (cm)	Unmonitored	Monitored
0 - 3	2	1
3 - 6	3	3
>6	—	1
Total	5	5

Preoperative facial function

Facial nerve function was assessed preoperatively, in the immediate postoperative period and thereafter every 3 monthly upto 1 year. All patients in both groups had normal preoperative facial function. Two patients in the monitored group did complain of occasional facial twitching preoperatively, but had normal func-

Fig. 1 : Backmann II Facial Nerve Monitor

tion on testing.

Surgical management of the facial nerve

The surgical management of the facial nerve is summarised in Table 3. Short mobilisation of the nerve was performed in 3 cases, deroofting of the vertical segment of the nerve with identification and mobilisation of the nerve at the stylomastoid foramen was performed in 2 cases. Identification and isolation of the nerve in the internal acoustic meatus was done in 5 cases of acoustic neuroma which were excised through a retrosigmoid approach.

TABLE 3
Surgical management of facial nerve (n-10)

Management	Unmonitored	Monitored
Short mobilisation	2	2
Deroofing fallopian canal	1	1
Drill out of IAM*	2	2
Total	5	5

* Internal auditory meatus

Postoperative facial function

The early postoperative facial function as well as the function at 3,6,9 and 12 monthly follow up of the patients in both groups is summarised in Table 4. In the unmonitored group, 3 out of 5 patients had recovered to grade I/II facial function (1/2), while the other 2 had grade III function at 1 year follow up. In the monitored group, all had recovered to grade I/II function (4/1) at 1-year follow up (Table 4).

TABLE 4
Postoperative facial nerve function (n-10)

Grade	Immediate	At 3 months	At 6 months	At 9 months	At 1 year
Unmonitored group (n=5)					
I - II	1	1	1	2	3
III - IV	1	2	2	2	2
V - VI	3	2	2	1	0
Monitored group (n=5)					
I - II	1	2	3	3	5
III-IV	3	2	1	2	0
V-VI	1	1	1	0	0

Discussion

While modern diagnostic imaging gives an accurate diagnosis of the location and extent of tumor in the skull base and combined otoneurological surgical techniques have resulted in achieving total excision of tumor from this 'bony no man's land', the goal of cranial nerve preservation after this type of surgery is yet to be realised. All transtemporal approaches carry a significant risk to the facial nerve, which has to be managed competently to avoid permanent loss of facial function [9]. The mobilisation of the facial nerve as in the infratemporal approach, or identification of the facial nerve and dissection of the tumor from its sheath as in the translabyrinthine and retrosigmoid ap-

proaches causes varying degrees of trauma to the nerve. In order to minimise this trauma, intraoperative facial nerve monitoring has become a routine in these surgical procedures.

Intraoperative facial nerve monitoring can assist the surgeon in several ways during transtemporal dissection:

1. During the procedure to uncover the facial nerve, the production of bursts of EMG activity indicates when the nerve sheath has been reached before significant trauma occurs. Such feedback enables the surgeon to more safely uncover the facial nerve in the relatively blind areas, such as at the second genu along the medial aspect of the nerve. The area of the facial nerve along the second genu has been the most difficult to decompress because of the presence of the lateral semicircular canal. Before the availability of facial nerve monitoring, the nerve was most likely to be inadequately decompressed in this area, so that removal of the nerve from the fallopian canal was more difficult and possibly more traumatic.

2. During removal of the facial nerve from the fallopian canal, feedback concerning relative trauma to the facial nerve is continuously available to the surgeon. Such feedback has led to certain modifications in technique (for example, the use of sharper dissection than was used previously, especially along the descending portion of the facial nerve where the stapedius branch tethers the nerve in the fallopian canal).

3. Once the facial nerve is rerouted 'safely' out of the way, there is a tendency to forget that it is still in the surgical field. During tumour dissection, vigorous surgical maneuvers may cause direct mechanical stimulation and possible injury to the facial nerve. Elicitation of evoked EMG activity reminds the surgeon of the presence and whereabouts of the facial nerve, so that further surgical activity may be appropriately modified.

Various studies [10-12] in the developed countries have proved the advantages of intraoperative facial nerve monitoring in reducing the long term morbidity of this disability. In the present study, 4 of the 5 patients in the unmonitored group had severe degree of facial palsy in the immediate postoperative period necessitating tarsorrhaphy and later were left with a grade III palsy that causes considerable deformity in the long term. On the contrary, the patients in the monitored group, had comparatively milder degrees of facial palsy in the immediate postoperative period which resulted in the early and near normal recovery of facial

function. These results although are from a small group, compare favourably with those of other studies [10,11].

To conclude, meticulous facial nerve dissection and management during continuous acoustic facial EMG monitoring has resulted in improved preservation of facial nerve function after the transtemporal resection of skull base tumours. This study which was carried out in the Armed Forces for the first time, has proved that intraoperative facial nerve monitoring in skull base surgery is a valuable tool and an inescapable requirement for the benefit of the patient and also the surgeon who will be spared of unnecessary litigation. Nowadays, in developed countries it is mandatory to carry out intraoperative facial nerve monitoring during any lateral skull base procedure [13].

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