ORIGINAL ARTICLE

Facial Nerve Injuries Revisited

O. Nuri Özgirgin MD, Levent N. Özlüoğlu MD

From Başkent University Hospital, Otolaryngology Department, Bahçelievler, Ankara, Turkey

Correspondence
O. Nuri Özgirgin MD
Başkent University Faculty of Medicine, Otolaryngology Department
6. Cadde 72/2 Bahçelievler, 06490 Ankara, Turkey

Phone: 90 312 223 8534
Fax: 90 312 215 7597
E-mail:ozgirgin@politzersociety.org

Presented in 25th Politzersociety Meeting, Seoul, 5-9 October, 2005

Submitted: 01 June, 2006
Accepted: 11 July, 2006

Mediterr J Otol 2006; 3: 127-132

OBJECTIVE: We present data from a series of traumatic peripheral facial nerve paralysis cases and review treatment options.

METHOD: A retrospective study that focuses on facial nerve palsies occurred by either temporal bone trauma, direct or iatrogenic injuries.

PARTICIPANTS: A total of 28 patients with peripheral facial nerve paralysis due to trauma were studied. Cases with acute-onset paralysis were managed surgically. Patients with delayed onset of paralysis were followed by either the House and Brackman (HB) grading system or electroneuronography (ENoG). Decompression of the facial nerve was performed when electroneurography findings suggested excitability lower than 5% as compared with the contralateral side.

RESULTS: Among the 28 patients 20 had cranial trauma, one patient had a gunshot injury, 2 had extratemporal traumatic injury, and 5 had iatrogenic injuries. Among the patients with temporal bone fractures, 9 underwent facial nerve decompression. Two patients with extratemporal injuries, as well as the patient with the gunshot trauma, and 4 patients with iatrogenic injuries with total nerve injury also were treated surgically. The best result that could be achieved in cases of total transection of the nerve was HB grade 3, except for the patient with gunshot trauma, who demonstrated HB grade-4 paralysis. Facial nerves that have been partially injured showed improvement to either HB grade 1 or 2.

CONCLUSIONS: The onset of the paralysis in regard to the timing of the trauma and the degree of the paralysis are the most two important prognostic criteria in cases with facial injuries.. In cases with total nerve transection, the most favorable outcome will be no better than HB grade 3.

The frequency of head trauma has increased in parallel with the number of high performance vehicles on the road. The 1980s showed the highest frequency of accidents, and thereafter, the frequency of head traumas fortunately decreased as a result of the use of seatbelts. Temporal bone fractures are associated with intracranial injuries in 22% of all head trauma cases[1].

From 1966 until the present, much debate has occurred regarding how peripheral facial nerve paralysis should be evaluated and managed. Wallerian degeneration of the nerve presents a challenge for otologists, because it is difficult to objectively assess nerve status and plan appropriate treatment. Among traumatic cases of delayed paralysis after temporal bone trauma, the different types of facial paralysis are the most widely discussed in the literature.

The initial effect of trauma to the facial nerve is ischemia. This leads to neural edema, which increases pressure in the closed space of the fallopian canal. Decompression surgery is a preventive procedure designed to curtail progression of neural injury due to edema. Approximately 50% of patients who undergo facial nerve decompression surgery achieve excellent functional outcome[2]. The majority of these injuries occurs in the pregeniculate, labyrinthine, and meatal segments of the nerve. This explains why the entire facial nerve should be explored during decompression. The choice of approach is dictated by the patient's hearing status. Patients with normal hearing undergo middle fossa craniotomy. . In cases with with acute and severe labyrinthine loss, a translabyrinthine approach may be used instead of the middle fossa approach.

Iatrogenic facial nerve injury occurs more frequently with radical and modified radical mastoidectomy than it does with intact bony external auditory canal procedures and atresia surgery[3]. Dehiscence of the facial nerve bony canal and abnormal location of the facial nerve may predispose a patient to nerve damage during surgery. The incidence of iatrogenic facial paralysis associated with otologic surgical procedures has been estimated to be between 0.6% and 3.6%4.

The aim of this paper is to present the data from a series of cases and discuss our methods of evaluating and managing traumatic peripheral facial paralysis.

MATERIALS AND METHODS

The study included a retrospective chart review of 28 consecutive cases of traumatic facial nerve paralysis including iatrogenic cases. Twelve patients had undergone surgery to decompress the facial nerve. All cases were graded using the House and Brackman (HB) facial nerve grading system (which was approved by the Facial Nerve Disorders Committee of the American Academy of Otolaryngology) as well as by using electrophysiologic tests (electroneuronography and electromyography) in patients with complete paralysis5.

Follow-up examinations were performed weekly for the first month and monthly thereafter as the paralysis resolved. Changes in paralysis state were monitored with the HB system. Individuals who reached HB grades 1 or 2 were classified as having shown "good recovery." The status of "incomplete recovery" was established at the end of 9 months, and facial function at that stage was judged as the permanent outcome.

RESULTS

Of the 28 patients with facial nerve paralysis due to trauma, 18 had temporal bone fractures. Of these 18 patients, the onset of paralysis was immediate in 7 (35%), delayed in 7, and unknown in 4. Additionally, 2 patients had cranial trauma without temporal bone fracture. 2 patients had direct injury in the extratemporal portion of the nerve, and 1 had a gunshot injury. In 5 patients, the facial nerve was injured during middle ear or mastoid surgery. The facial nerve injuries due to the acoustic tumor surgery were not included in the study. The details and outcomes for the trauma cases are presented in Table 1.

Among patients with temporal bone fracture, the fracture line was transverse in 2; it was longitudinal and oblique in the others. Patients with transverse fractures had total hearing loss. In the other patients, conductive hearing loss was detected. Among these, the air-bone gap was more than 40 dB in 3 cases.

Concerning treatment, 9 of the 18 patients with temporal bone fracture (7 with acute onset, 1 with

Table 1. Onset of paralysis in cases with facial nerve injury

	Acute onset	Delayed	Unknown	Total
Temporal bone fracture	7	7	4	18
Cranial trauma without fracture		2		2
Extratemporal injury	2			2
Gunshot injury	1			1
Iatrogenic injury	5			5
Total	**15**	**9**	**4**	**28**

delayed paralysis, and 1 with unknown onset time) underwent facial nerve decompression (Table 2).

The timing for surgical intervention was closely related with neurosurgical problems and Glasgow Coma Scale (GCS). All patients had GCS values above 10 (1 to 15) when first hospitalized. The earliest date at which patients could be operated on was the 11th day. The latest was the 27th day.

A middle fossa approach was performed in 6 patients, a transmastoid-translabyrinthine total decompression was done in 1 case, and transmastoid decompression by removing the incus to include the geniculate ganglion into the decompression was performed in 2 cases.

The injury on the nerve demonstrated intraneural hematoma and edema in 5 cases. Total transection of the nerve was found in 1 case, which was a child, and partial loss of perineurium and nerve tissue caused by bony fragments was present in 3 cases. An end-to-end anastomosis was performed in the transected nerve. Decompression was thought to be sufficient for the cases with partial tissue loss, and edema was the dominant finding in these cases.

The 6 cases with delayed paralysis, and 3 of the 4 cases with unknown onset, were managed conservatively. Patients with traumatic injury without temporal bone fracture also developed delayed facial paralysis, and these 2 cases responded completely to corticosteroid treatment (Table 3).

In 1 of the 2 patients with extratemporal injury, the nerve had been severed near the level of the bifurcation, and in the other case the injury was found on the exit of the stylomastoid foramen. End-to-end anastomoses had been performed in the first case, and the nerve was

Table 2. Type of treatment used among the cases with temporal bone trauma

	Acute onset	Delayed	Unknown
Decompressed	7	1	1
Medical		8	3

Table 3. Outcome of facial paralysis among the cases treated medically

	HB1	HB2	HB3
Facial palsy with delayed onset (fractures)	5	1	
Facial palsy with delayed onset (no fracture line)	2		
Facial palsy with unknown onset (fractures)		2	1

repaired by using a cable graft in the other case. A fibrous tissue replaced the nerve fibers in this patient. So we decided to resect the nerve segmentally between the lower third of the vertical segment in the mastoid and the main trunk of the nerve in the extratemporal portion, before the bifurcation. The defect was repaired by a cable graft obtained from the sural nerve.

In the gunshot case, the bullet had severed the vertical segment of the nerve. The horizontal and vertical portions of the nerve were surgically decompressed, and the severed site was repaired using a graft from the greater auricular nerve.

The 5 iatrogenic cases required different approaches. In 1 case, the nerve had been severed totally near the second genu during radical mastoidectomy. Decompression was performed during the same session, and a graft from the greater auricular nerve was used to repair the damage. At 3 months postsurgery, this patient's outcome was HB grade 3.

In 3 cases, there had been partial injuries. The perineurium was interrupted in 1 of these cases, and the fibers were partially injured in the other 2. Among them, 1 patient was referred 50 days following the injury, and there was a mass of granulation tissue on the traumatic site. The remnant of the nerve was edematous. Drill injury had been the cause in these cases.

The nerve was injured with a needle while removing the tympanosclerotic plaques near the facial nerve. It was treated by corticosteroid administration.

Among the cases in which a middle fossa approach had been used, no cerebrospinal fluid leakage was observed, and there were no infections such as meningitis. We have observed no additional sensorineural hearing loss in any of the patients.

DISCUSSION

The onset of facial paralysis in trauma cases is so important that all management policies are based upon it. In cases with acute onset with complete paralysis immediate surgery should be considered. However, the neurologic status of the patient and other manifestations that develop as a result of trauma may not allow the surgeon to operate. In delayed paralysis, individuals who exhibit less than 90% degeneration within 2 weeks of the trauma are expected to make a good recovery without surgery. Some cases of traumatic facial nerve paralysis are overlooked during a patient's overall trauma work-up immediately following the trauma, and it may not be possible to know whether the onset was acute or delayed. In such cases, follow-up should be done in the same manner as for Bell's palsy.

The time of onset is important also in cases of iatrogenic facial paralysis. If it is immediate and the occurrence of nerve block due to infiltration of anesthetic has been ruled out, the ear must be re-explored as soon as possible. If there is any doubt as to the physical integrity of the facial nerve, it may be best to follow the patient with ENoG and perform nerve repair if the patient shows no or poor (HB grade 5-6) recovery. However, patients with delayed palsy must be monitored by ENoG, and the follow-up is similar to that of delayed traumatic cases[6].

In case of labyrinthine fracture and anacusis, a 3-segment decompression technique is performed through the transmastoid-translabyrinthine pathway. When bone conduction hearing is preserved, even partially, decompression is done using a double approach combining a subtemporal, extradural, middle fossa approach with a transmastoid one. It may not be wise to wait for the EMG in patients,with immediate onset and complete paralysis if the patient's general condition allows for surgery. Indeed, the EMG pattern generally correlates with the clinical demonstration in patients who are operated on less than 2 weeks after the trauma[7].

In a series reported by Darrouzet and colleagues, a fracture line could not be demonstrated in 7.6% of the patients, and the pathology affecting the facial nerve was thought to be inflammation and edema of the nerve. In our series, this figure was 11%.

The damaged section must be repaired; preferably by suturing the nerve ends together directly. However, cases of severe damage with tissue loss may require a graft either from the greater auricular nerve or from the sural nerve. Successful axonal regeneration and reinnervation are highly dependent on good anastomotic techniques. In general, direct end-to-end anastomoses yield superior results over interposition grafts. A tension-free anastomosis is essential to achieve good results with primary repair. However, if the repair (an end-to-end suture) is expected to be under significant tension, a cable graft provides a stronger repair

The usefulness of the nerve sheath opening is questionable and controversial; some recommend decompressing the nerve while opening the sheath, and others state that decompression is sufficient8. In all cases of neural hematoma, we incise the sheath regionally to relieve the intraneural pressure.

The axis of the fracture line closely affects the hearing, as transverse fractures cross the longitudinal axis of the temporal bone and the labyrinth. In this situation, sensorineural hearing loss is inevitable. The site of the injury in these cases is generally in the middle ear portion of the nerve[9]. The hearing levels of the patients will be an important factor when determining the type of approach to the facial nerve. The middle fossa approach for geniculate ganglion lesions is not used by all; a pure transmastoid approach by dislocating the incudomalleolar joint to expose the proximal facial nerve in an extralabyrinthine manner is preferred by some surgeons[10, 11].

The most proximal point of the nerve that can be accessed through the posterior tympanotomy window is the cochleariform process. Further access can be possible only by extracting the incus temporarily. This approach is recommended where the injury is limited below the ganglion, as was the case in 2 of our patients.

Ten of 23 cases with external trauma had an acute onset. Twelve of these cases with external trauma were operated on. Neuroraphy was performed in 4 cases, in which the facial nerves had been transected. The outcome was HB 3 with synkinesis in these cases except for the patient with the gunshot trauma which was HB IV. The recovery rate will not be better than grade 3, and synkinesis will usually accompany reinnervation for patients in whom the nerve has been transected[12,13]. Decompression of the facial nerve was applied in 8 cases with temporal bone trauma, and the results were between HB 1 and 3 (Table 4).

The prognosis of facial paralysis in gunshot traumas is poor. Gunshot injury commonly leads to a situation in which the temporal bone has multiple small fractures and bullet fragments remain. Since it is not always possible to remove all these fragments, postoperative ear infection frequently occurs. A canal wall-up technique is the method of choice in any temporal trauma. However, because of the extent of the fractures and number of bullet fragments typically seen in gunshot wounds, these cases often require the use of canal-down technique. A controversial issue is whether the cavity should be left open or closed. After obliteration of the mastoid cavity with fat tissue, closure of the external ear canal would be the best option for protecting the nerve graft1[4].. The output was HB 4 in our case with gunshot trauma, and during the surgery, there were many bony particles that were nearly completely removed, and a cable graft was used to repair the nerve.

Many patients with temporal bone trauma suffer multiple traumas. The workup for facial paralysis is generally deferred until the patients are medically and neuro-otologically stable. It is rarely possible to evaluate these patients early. Even if the nerve can be evaluated earlier because of the neurologic status of the

Table 4. Type of approach and results of surgical treatment

	HB1	HB2	HB3
Middle fossa + transmastoid	4	1	1
Transmastoid + translabyrinthine	1		
Transmastoid + ıncus removal + geniculate decompression		1	1

patient, it may not be possible to operate immediately. In our cases, the earliest time that we could operate was the 11th day and the latest was 27th. We detected no differences among our cases with regard to improved facial expression between earlier (11th day) and later (27th day) operations, as other factors (eg, type of the injury) had more pronounced effects.

The rate of immediate paralysis in our series was 53%. In Darruozet's series, this figure was 50.3%, and in Bebear's15 series it was 70%.

In Darrouzet's series, recovery was good or fairly good (HB 1-3) in 86.2 % of patients operated upon and poor (HB 5-6) in 6.2 % of patients. Among our cases, the HB 1 and 2 outcome rate was 74%.

The state of facial expressions at 2 weeks is predictive of prognosis. ENoG is a valuable prognostic tool for this evaluation. At this time, facial movements should be at least HB 4, or the ENoG must show less than 90% degeneration for a good outcome with conservative management. The remaining patients should be treated with total decompression of the facial nerve, during the fourth week, for a favorable outcome. The onset of the paralysis in regard to the timing of the trauma and the degree of the paralysis are the most two important prognostic criteria in cases with facial injuries. In complete paralysis with immediate onset, decompression and repair of the nerve should be established as soon as possible. In cases with total nerve transection, the most favorable outcome will not be better than HB grade 3.

REFERENCES

1. Harker LA, McCabe BF. Temporal bone fractures and facial nerve injury. Otolaryngol Clin North Am. 1974 Jun;7(2):425-31.
2. Chang CY, Cass SP. Management of facial nerve injury due to temporal bone trauma. Am J Otol 1999; 20:96-114.
3. Pulec JL. Iatrogenic facial palsy: the cost. Ear Nose Throat J 1996; 75:730-6.
4. Harner SG, Leonetti JP. Iatrogenic facial paralysis prevention. Ear Nose Throat J 1996; 75:718-9.
5. House JW, Brackmann DE. Facial nerve grading system. Otolaryngol Head Neck Surg. 1985 Apr;93(2):146-7.
6. Nilssen EL, Wormald PJ. Facial nerve palsy in mastoid surgery. J Laryngol Otol 1997; 111:113-6.
7. Darrouzet V, Duclos JY, Liguoro D, et al. Management of facial paralysis resulting from temporal bone fractures: Our experience in 115 cases. Otolaryngol Head Neck Surg. 2001 Jul;125(1):77-84.
8. Wayoff M, Cabri J, Gazel P. Et al. Etude clinique des indications de l'exploration chirurgicale du nerf facial intrapetroux. J. Fr. ORL. 1982;31:99-106.
9. Fisch U. Facial paralysis in fractures of the petrous bone. Laryngoscope. 1974 Dec; 84(12):2141-54.
10. Ulug T, Arif Ulubil S. Management of facial paralysis in temporal bone fractures: a prospective study analyzing 11 operated fractures. Am J Otolaryngol. 2005 Jul-Aug;26(4):230-8.
11. Ulug T, Arif Ulubil S. Management of facial paralysis in temporal bone fractures: a prospective study analyzing 11 operated fractures. Am J Otolaryngol. 2005 Jul-Aug;26(4):230-8.
12. Shindo M. Management of facial nerve paralysis. Otolaryngol Clin North Am 1999; 32: 945-64.
13. Coker NJ, Kendall KA, Jenkins HA, Alford BR. Traumatic intratemporal facial nerve injury: management rationale for preservation of function. Otolaryngol Head Neck Surg 1987; 97:262-9.
14. Bento RF, de Brito RV. Gunshot wounds to the facial nerve. Otol Neurotol. 2004 Nov;25(6):1009-13.
15. Bebear JP, Castillo LA, Gapany B, et al. Traumatic facial lesions of the base of the skull. In: Portmann M, ed. Proceedings of the Fifth International Symposium on the Facial Nerve. Paris, Masson Publisher: 1985 pp. 233-235.