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Traumatic Intratemporal Facial Nerve Injury

Travmatik İntratemporal Fasial Sinir Yaralanmaları

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Özet

Travmatik fasial paraliziler genellikle temporal kemik kırıkları ve otolojik cerrahi sırasında ortaya çıkarlar. Fasial paralizi nedenleri arasında Bell paralizisinden sonra ikinci sırada yer alırlar. Paralizinin ciddiyetine göre medikal veya cerrahi olarak tedavi edilirler. Cerrahi eksplorasyon kararı ve zamanı elektrofizyolojik test sonuçlarına göre verilir. Cerrahi varış yolunun seçimi ise radyolojik bulgulara ve işitmenin durumuna bağlıdır. Bu çalışmada değişik nedenlere bağlı 98 travmatik fasial paralizili olgu değerlendirmeye alınmıştır. Paralizi başlangıcından itibaren ilk 10 gün içinde elektronörografide (ENoG) %90'dan fazla nöral denervasyon görülen olgularda cerrahi girişime karar verilmiştir. Geç başvuran, elektromyografide (EMG) aksiyon potansiyelleri görülmeyen yoğun denervasyon potansiyellerine sahip tam paralizili olgular da cerrahi olarak tedavi edilmiştir. Ameliyat edilen toplam 42 olguda cerrahi teknik olarak; longitudinal temporal fraktürlerde middle fossa ve / veya transmastoid, işitmenin olmadığı transvers temporal fraktürlerde ise translabirentin yollar kullanılmıştır. Geriye kalan 56 olgu ya medikal olarak tedavi edilmiş ya da hiçbir şey yapılmayıp izlenmiştir. Nöral dejenerasyonu %90'dan fazla olmayan medikal grupta sinir fonksiyonları birinci yıl sonunda House-Brackmann sınıflamasına göre grade I-II, cerrahi girişim yapılan grupta ise grade II-III idi. Greater auricular nerve ile interpozisyon kablo grefti uygulanan 7 olguda ve uç uca anastomoz yapılan 2 olguda sinir fonksiyonu grade III bulundu. Travmatik fasial sinir yaralanmalarına ait literatür gözden geçirilerek sonuçlar tartışıldı.

Anahtar Sözcükler: **Fasial paralizi, temporal kemik kırıkları.**

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Abstract

Traumatic facial paralysis occur as a result of temporal bone fractures or during otologic surgery. They take the second place after Bell's palsy in the etiology of facial paralysis. Its treatment is medical or surgical according to its severity. The decision and timing of surgical exploration is given according to electrophysiologic test results. Choice of the approach depends on radiographic and audiometric findings. In this study, 98 traumatic facial paralytic patients with different etiologies are evaluated. Surgical treatment was preferred for the patients who had more than 90% neural degeneration as proved by ENoG in the first 10 days of the paralysis. Late presented, complete paralytic patients who had no action potentials but had dense denervation potentials in EMG were also treated by surgery. 42 patients who fit these conditions were operated and as approach methods transmastoid and/or middle fossa routes - for longitudinal temporal bone fractures and translabyrinthine approach for transverse temporal bone fractures with total hearing loss were used. The remaining 56 patients were treated medically or only followed up. In the medical group with neural degeneration House-Brackmann classification. In surgically treated patient group, it was grade II-III. Nerve function was found to be grade III in 7 and in 2 patients with end to end anastomosis. The results were discussed as the references about traumatic facial nerve injury were reviewed.

Key Words: **Facial paralysis, temporal bone fractures.**

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Introduction

Traumatic facial nerve injuries occur as a result of temporal bone fractures, penetrating head and neck injuries, iatrogenic during otologic surgery and traumatic injuries during labour. Most of the facial nerve injuries are seen in the intratemporal

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course of the nerve and they are generally due to blunt trauma of the bone. Temporal fractures which are mostly seen after traffic accidents and falling down from high altitudes can be classified according to the long axis of the bone as longitudinal, transverse and mixed types. To make this classification high resolution temporal bone CT can be used. Facial nerve injury accompanies the more frequently seen longitudinal fractures in 10-20% of the cases. In such cases conductive type hearing loss is seen and the injury is mostly in perigeniculate region. In the transverse fractures of the temporal bone nerve injury is present in half of the cases and it is accompanied by inner ear damage. Making surgical exploration decision for the traumatic nerve injury leads to discussion mostly in the case of temporal fractures. Wheather the treatment is surgery or not and if surgery is the treatment modality which type of approach technique is to be used are all included in this discussion. In the case of penetrating injury and nerve injuries during otological procedures the answers to all of these questions can easily be given. The decision of surgical exploration and timing of the procedure are dependent on the results of electrophysiological tests. With these examinations the degree and the rate of axonal degeneration distal to the lesion are determined. Today surgical exploration decision is given on the basis of degeneration degree over %90 determined in electroneuronograhpy and no motor unit action potentials in electromyography. The timing of operation are still being discussed but early exploration procedure has lots of supporters. The choice of surgical approach for the exposition of injured neural segment depends on radiologic and audiometric findings. Here, the complicated cases are the cases in which the facial injury is seen in the longitudinal fractures of the temporal bone. In such fractures the injury is generally in the geniculate ganglion region and for the exposition of the nerve some authors prefer transmastoid approach but some authors believe that the best method to explore this region is from the middle cranial fossa. In the cases of transverse fractures in which the injury is accompanied by total hearing loss, the exploration of the nerve is by translabyrinthine aproach. In the temporal fractures the most common facial nerve pathologies are contusion, intraneural hematoma, injury due to bone fragments and interruption of the nerve. Other types of fractures are generally together with partial or total section of the nerve. In this article 98 traumatic facial nerve paralysis due to different origins are evaluated. We used surgical treatment to 42 of the cases and the remaining are given medical treatment. As a surgical technique we used middle cranial fossa, transmastoid and translabyrinthine approaches. Here the indication, technique and functional results of medical and surgical treatments are discussed and related literatures are looked over.

Material and Method

To our study group in İstanbul University Cerrahpaşa Medical Faculty, 98 traumatic facial nerve paralytic cases between 1989 and 1996 are included. In the evaluation of the patients, serial ENoG are used between 3rd and 10th days, if the patients presented early and EMG is used after 3 weeks. To evaluate the prognosis, trigeminofacial reflex is used for the evaluation of the proximal portion of the lesion. For the decision of the type of the surgical approach, we used high resolution computerised tomography and audiological examinations. We applied surgical treatment to those with neural degeneration over %90 in ENoG and no motor unit action potentials in EMG and medical treatment to the others.

Results

In our study 59 of the participated patients were male and 39 were female, mean age; 26.3. We operated 42 patients and in 18 cases with longitudinal temporal fractures, total facial decompression is made by using middle cranial fossa and transmastoid approach combination. In 8 cases the pathology is presented only by using transmastoid route. In 6 cases with transverse and mixed type temporal bone fractures with total hearing loss we used translabyrinthine total facial decompression. 9 cases with iatrogenic paralysis, transmastoid approach was used. A case with weapon injury, transmastoidal and extracranial approach methods were used together (Table 1). Most frequent nerve pathology seen in study was contusion and intraneural

Table 1. Etiology and treatment modalities of facial paralysis cases.

Etiology of the paralysis	No of cases	Surgical cases	Medical cases
Longitudinal fracture	76	18 c-TM/MF, 8 TM	50
Transverse/mixed fracture	8	6 TL	2
Iatrogenic paralysis	13	9 TM	4
Weapon injury	1	1 TM/EC	–
Total	98	42	56

C-TM/MF: Combined Transmastoid - Middle Fossa Approach
TM: Transmastoid Approach TL: Translabyrinthine Approach
TM/EC: Transmastoid - Extracranial Approach

hematoma with an %80 ratio. This is followed by bone impingement in %20 and nerve interruption in %7 (Table 2). In 7 cases with 6 iatrogenic paralysis, and one weapon injury we used greater auricular nerve for interposition-cable-graft. In 4 cases end to end anastomosis is made (Table 3). Nerve function is found to be grade III in grafted cases and grade II-II in other cases due to House-Brackmann classification. Medically treated patients as a result of low neural degeneration or patients who presented late but who had a tendency to recover clinically and had polyphasic reinnervation potentials in EMG, had grade I-II nerve function results (Table 4).

Table 2. Intraoperative nerve pathology.

Contusion / Intraneural hematoma	%80
Bone impingement	%20
Nerve interruption	%7

Table 3. Reparation of the facial nerve.

Iatrogenic paralysis	6 cases	Interposition cable graft with GAN
Weapon injury	1 cases	interposition cable graft with GAN
Iatrogenic paralysis	2 cases	End to end anastomosis
Tranverse fracture	2 cases	End to end anastomosis
Total	11 cases	

GAN: Greater Auricular Nerve

Table 4. Nerve function (After one year).

Medically treated group	Grade I-II
Surgically treated group	Grade II-III
Grafted / Anastomosed group	Grade III

According to House - Brackmann classification.

Discussion

When we revised the literature about facial paralysis, among all cases traumatic facial paralysis is the second most frequent etiologic factor of facial paralysis following Bell's Palsy ranging from 5%-20%.[1,2] The most frequent cause of traumatic facial paralysis is the fractures of the temporal bone. Fractures of the temporal bone are seen usually as a result of traffic accidents and falling down.[3] Among blunt head trauma cases that present to emergency services, temporal bone fractures are seen approximately 5%. Exploration of the facial nerve is necessary in only 10% of fractures. In their work Ghorayeb et al. studied 2888 patients who presented with blunt head trauma and they confirmed 123 temporal bone fractures. Only eleven of these patients were needed to be explored because of facial nerve paralysis.[4] In our country, it's not possible to final out exact statistical data about this subject. But in a retrospective study concerning patients with traumatic facial paralysis who were treated by surgical procedures, the etiologic cause was 70% traffic accident. Naturally these numbers include only a small percent of patients with blunt head trauma. In other words, there are thousands of patients with head trauma beyond the 42 patient that we operated.

The decision to explore the facial nerve in traumatic facial paralysis depends on the results of electrophysiologic studies.[5,6] The most reliable tests for such studies are Nerve Excitability Test (NET), Electroneuronography (ENoG) and Electromyography (EMG). NET can be applied after the third day of the paralysis and can be used in the first 3 weeks. More than 3.5 mA difference between normal and paralytic sides is a bad prognostic factor.[5,7]

With this test the excitability thresholds are low and so in 42% of Bell's palsy patients - in spite of normal test results, recovery is bad.[5] Maximal Stimulation Test (MST) is a modification of NET and

this test the magnitude of the stimulus is maximal or supramaximal (5mA and more). This test is of value in the 3rd-5th day of the paralysis and responses to electrical stimuli are evaluated visually. This is way, an objective method, ENoG, which is forwarded by Esslen, has much more supporter.

Different from EMG, in this test nerve is stimulated electrically and compound muscle action potentials, consisting of motor units contracting simultaneously are measured.[2,6] ENoG is valuable in the third-tenth day of the onset of the paralysis. With this method percentage of axonal degeneration distant to the lesion is calculated and decision of surgical treatment is given. Degeneration less than 90% can be improved.[10,11,12] In more than 90% axonal loss, surgical exploration is necessary. EMG can be used after 3rd week of the paralysis and voluntary and involuntary facial movements can be detected with needle electrodes when electrical stimuli of the nerve is not applied. Appearance of polyphasic reinnervation potentials after the 3rd week indicates good prognosis. Presence of intensive fibrillation potentials and positive spike waves are findings of complete degeneration and is an indication of the exploration of the facial nerve.[5,11] 1-2 years after the paralysis the data about the denervated muscle can be detected by EMG. If fibrillation potentials are lost and "bioelectrical silence" is found in EMG study, there's no chance to anastomose the facial nerve. When this is the case, to confirm the fibrosis of the muscle, muscle biopsy is suggested.[13] In our study group, we performed serial ENoG between days 3rd and 10,th and EMG after 3 weeks to the early presented cases. To the 42 patients with ENoG data showing neural degeneration more than 90% in days 7-10 and no MUAP in EMG, arranged surgical intervention.

Trigeminofacial Reflex Test (Blink Reflex Test) is the only test that can be used to evaluate paralysis from the proximal portion of the lesion and we applied this test to 44 patients in the first 3 weeks. 29 cases with R_1 & R_2 latencies that turned out to be normal, the prognosis was better. The patients in this group had low degree of neural degeneration and were treated medically. The fifteen patients in the other group had delay in latency that continued an average of 1.5 months and treated with surgery. These findings are compatable with literature.[14]

We used topognostic tests such as Lacrimation Test and Acoustic Reflex Test to evaluate facial nerve functions distal to the lesion. But we could not use the results of these tests to choose the approach method. Lacrimation Test which shows 30% difference in normal subjects, doesn't give exact results and it is unreliable.[9] Acoustic Reflex Test is not valuable in the evaluation of patients who have traumatic facial paralysis with conductive or sensorineural hearing loss. But these test are used to establish the surgical approach route in centers where CT and electrophysiologic tests can not be done.[15]

When surgical treatment decision is given with electrophysiologic test data, the approach method choice depends on radiographic, audiometric findings. Fractures of the temporal bone are rarely displaced and for this reason the fracture line can not be seen with conventional radiographic techniques as long as the line is perpendicular to the film plane. Evaluation of temporal bone fractures and nerve injury requires high resolution CT with "bone window enhancement and fine coronal & axial planes of 1.5-3 mm. Conventional Cranial Tomograpy which is used to scan CNS for trauma is not enough for evaluation of temporal fractures. MRI is valuable to evaluate brain stem, cerebellopontine angle segment of the facial doesn't give enough information about the bone detail of the fractures. MRI with gadolinium can present any soft tissue edema or inflammation in temporal bone, but unable to evaluate intratemporal facial nerve injury. In our work we only used high resolution CT. Patients who had head trauma with total denervation seen in ENoG we applied total facial decompression even if no fracture line was detectable in CT. Five patients with facial paralysis seen after blunt head trauma who had no fracture line in CT, we found fracture on temporal bone and facial nerve pathology during exploration.

During the evaluation procedure of the facial paralysis of the patients who are candidates of operation, the onset of the paralysis whether immediate or delayed is investigated. Careful history can be learned from emergency staff, family or if possible from the patient himself. Here the most important point is the determination of the facial movements. The complete recovery of sudden onset

facial paralysis is worse than delayed paralysis. If degeneration is not seen within the first 2 weeks of the onset complete recovery is expected.[18,19] The indication of facial nerve exploration for acute facial paralysis in the first 6 days after the temporal fracture is the axonal loss more than 90%.[7,10] For the acute facial paralysis with less than 90% axonal loss, there is no need for exploration. Delayed paralysis generally show better prognosis compared to immediate paralysis. But a delayed paralysis within the 6 days of the onset showing more than 90% indicates severe injury and surgical exploration is indicated.[10,19] Determination of development of denervation from the onset of the paralysis is important because delayed paralysis may have bad prognosis and immediate paralysis may have good prognosis. According to Fisch, progression of the degeneration in time can give idea about the severity of the nerve injury. Prognosis of degeneration with more than 90% in the fifth day is worse than that of in the 14th day. The follow up of this condition can be done with ENoG also the timing of surgery is important from trauma point of view. Early exploration is applied for delayed paralysis because most of the time, this condition is due to an intraneural hematoma which has to be drained immediately.[10] Also with time this hematoma can progress into a granulation tissue by organization and than a scar tissue occurs. This tissue avoids the progression of the regenerated axonal fibers to the distal portion - and recovery with severe sequela is seen.

Immediate paralysis is generally together with other injuries such as cranial, thoracal, abdominal and orthopedical and so late exploration is obligatory.[18] 3-4 weeks of latency for exploration after an early paralysis is suggested because evaluation of the anatomy of the operation field is more easier after the regression of edema and hematoma. Sometimes it's not possible to evaluate the patient early. For this reason, after the injury, progression of degeneration at the onset may be established late. In this case, if complete paralysis is seen, fracture line is proved by CT, and denervation potentials are present in EMG, surgical exploration of the nerve is indicated. If no fracture line is seen in CT and polyphasic reinnervation potentials are found in EMG, spontaneous recovery after 8-12 weeks is expected.[10,19] Discussions about the timing of the operation are still going on for the opinion of McCabe, the repair should be performed often 21 days of the injury because the maximal proteosynthetic activity of the motor neurons can be seen at the end of this period.[20] Contrast to this, recent studies indicate that when the interval after injury is according to patients situation, the surgical exploration should be performed as soon as possible[21].

When surgical treatment decision is given for posttraumatic facial paralysis, there appears some problems concerning the choice of approach for longitudinal temporal bone fractures. For the facial paralysis due to weapon injury or for iatrogenic cases, the injured segment of the nerve can be found easily and so a suitable surgical approach can be planned. For transverse temporal bone fractures which are accompanied by sensorineural hearing loss, facial decompression is performed by translabyrinthine approach. As the location of the lesion varies in longitudinal fractures different surgical techniques are suggested. In such fractures, the most frequent site of the nerve injury is the geniculate ganglion region.[21] Because the bone is the weakest at this point. Bone roof of the geniculate ganglion is very thin and in 7-15% of the cases, it may show dehissence.[22] So trauma can effect this region easily. Also with the displacement of bone fragments of longitudinal or transverse fractures in this region superficial petrosal nerve stretches the facial nerve. For this reason intraneural hematoma and tension in geniculate ganglion or vicinity, and facial paralysis is seen. In posterior longitudinal fractures, the location of the injury is in the second genu of the nerve and in the mastoid region, but it's rare.[18]

The best exposition geniculate ganglion region and labyrinthine segment is accomplished by "Middle Fossa Approach". In vertical or tympanic segment injuries which are rarely seen in longitudinal fractures, transmastoid approach is enough.[3,10,23,24,25] On the other hand some authors including M.May insist that it's possible to reach laby rinthine portion of the facial nerve by transmastoid - transattical route and say that there's no need to use middle fossa approach.[26] However transmastoid approach which was popular until a few years ago, does not permit the exposition of the labyrint-

hine segment in all case. Temporal bone studies showed that ampulla of the superior and horizontal semicircular canals prevent of the superior and horizontal semicircular canals prevent to reach to the labyrinthine portion of the nerve.[27,28] It can be used as an alternative technique where craniotomy could not be performed or epitympanum was well pneumatized.

We used combination of transmastoid & middle fossa approaches for the 18 facial paralytic cases due to longitudinal fractures. As suggested by Fisch we drilled the bony tissue between dura and labyrinth by middle fossa approach and so with minimal retraction of the temporal lobe, we were able to reach labyrinthine and geniculate segments of the nerve from the top. As we used transmastoid route in the first phase of the operation, the guiding point that we created on tegmen tympani facilitated the discovery of the upper portion of the nerve. We had no complication due to temporal lobe retraction because of minimal retraction that we performed. In the 8 cases where the nerve pathology was found to be only in tympanic and vertical portions of the nerve, we used transmastoid approach. For the 6 patients who had total hearing loss with transvers and/or mixed fractures, we performed total facial decompression by translabyrinthine approach. We established %80 of contusion and intraneural hematoma in patients that ve operated due to facial paralysis with temporal bone fracture. In 20% of the cases, bone fragments were found to be plunged into the nerve. Nerve discontinuity which was reported as 30% in Fisch's series was only %7 in our study.[29] In one case, displaced incus was found to be burried into tympanic segment of the nerve - 31 of the 42 patients that we performed surgical exploration due to posttraumatic paralysis, we applied facial nerve decompression and so bone fragments and intraneural hematoma were cleared off and nerve sheath was incised. As a result the pressure on the nerve decreased and expension of the nerve was established. We used interposition cable graft with greater auricular nerve in 7 cases of which 6 had different origins and one was due to weapon injury. Rerouting in the 2nd genu of the nerve gains only few milimeters. As the volume of the injured nerve was too much, that gain was not enough and so we used cable graft. Total of 4 cases with facial paralysis due to transverse fracture in 2 patients and iatrogenic in 2 patients, we performed end to end anastomosis. Two cases with iatrogenic origin that we constructed end to end transmastoid anastomosis, exploration of the nerve till the branching point in the parotis made the anastomosis possible.

The patients who had neural degeneration less than %90 or who had improvement tendency clinically due to EMG data, nerve functions in House - Brackmann classification were grade I-II of the end of the first year. In operation group, nerve function were 60% grade II and 40% grade III. In cases where nerve repair was performed by grafting, the nerve functions were found to be grade III of the end of the first year, which was similar in references.[30,31]

Conclusion

The choice of treatment in posttraumatic facial paralysis depends on the results of electrophysiologic tests and progress of degeneration. Today, the accepted concept is the exploration of the nerve if neural degeneration exceeds 90% in the first week. The discussed cases are mostly the facial paralysis due to temporal bone fractures after blunt head trauma. The common opinion about the approach in the cases with total hearing loss is the application of translasyrinthine approach. But in cases with longitudinal fractures with mixed or conductive type hearing loss there's no common concept. Discussions about the transmastoid or middle fossa approaches are still going on. In the studies of the last ten years, middle fossa aproach is seen to be preferred for the lesions near the geniculate ganglion. In the light of our experiences, we suggest the use of the combination of middle fossa and transmastoid approaches for the patients with paralysis due to longitudinal fractures and Bell's palsy. This combination is rather a functional and safe method.

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