

Surgical Management of Peripheral Facial Paralysis due to Temporal Bone Fractures

Temporal Kemik Fraktürüne Bağlı Periferik Fasial Paralizinin Cerrahi Tedavisi

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ABSTRACT

Aim: The aim of this study is to report the results of our facial nerve decompression series and to define predictive factors on postoperative outcomes in temporal bone fractures.

Methods: Between May 2011 and July 2019, facial nerve decompression surgery was performed in 18 patients. Patients were operated by either transmastoid extralabyrinthine or transmastoid translabyrinthine route considering fracture location and hearing status. Audiologic evaluation was performed in all patients preoperatively and at the third month after operation.

Results: 15 males and 3 females were included in this study, whose ages ranged from 1 to 47 years (mean: 16.6 years). Twelve (66.6%) of the patients were operated within the first month. Three (16.7%) were operated later than 3 months. The most common cause of the temporal bone fracture was motor vehicle crash (9 patients, 50%), followed by television tipover (4 patients, 22.2%). Eleven (61.1%) of the fractures were violating the otic capsule. House-Brackmann (HB) grade 1 or 2 postoperative facial nerve functions were obtained in 14 (77.7%) patients. Patients who were operated within the first three months showed a significantly better progress in HB scores ($p=0.002$). There was a significant correlation between otic capsule involvement and the type of hearing loss ($p<0.001$).

Conclusion: Delayed surgical intervention for more than 3 months and involvement of labyrinthine portion of the facial nerve negatively affected the postoperative recovery of facial functions. Involvement of the otic capsule was significantly related with the type of hearing loss.

Key Words: traumatic facial paralysis, temporal bone fracture, facial nerve decompression

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ÖZET

Amaç: Bu çalışmanın amacı fasiyal sinir dekompresyonu serimizin sonuçlarını raporlamak ve temporal kemik kırıklarında postoperatif sonuçlara etkili faktörleri tanımlamaktır.

Material ve Metod: Mayıs 2011 ve Temmuz 2019 yılları arasında 18 hastaya fasiyal dekompresyon cerrahisi uygulandı. Hastalar, kırık lokalizasyonları ve işitme durumları göz önünde bulundurularak transmastoid ekstralabirentin ya da transmastoid translabirentin yolla opere edildi. Hastaların tümünde cerrahi öncesinde ve postoperatif 3. ayda işitme odyolojik olarak değerlendirildi.

Bulgular: Çalışmaya dahil edilen hastaların 15'i erkek, 3'ü kadındı. Hastaların yaşı 1 ila 47 arasında değişmekteydi (ortalama: 16.6). Hastalardan 12'si (%66.6) travma sonrası ilk ay içerisinde opere edildi. Hastaların 3'ünde (%16.7) cerrahi zamanı 3 aydan geçti. En sık karşılaşılan temporal kemik kırığı sebebi motorlu taşıt kazasıydı (9 hasta, %50), bunu üzerine televizyon devrilen hastalar izledi (4 hasta, %22.2). Kırıklardan 11'i (%61.1) otik kapsülden geçiyordu. Hastaların 14'ünde (%77.7) postoperatif House-Brackmann (HB) evre 1 ya da 2 fasiyal sinir fonksiyonu elde edildi. İlk 3 ay içerisinde opere edilen hastalarda postoperatif HB skorları anlamlı olarak daha iyi bulundu ($p=0.002$). Otik kapsül tutulumu ile işitme kaybının tipi arasında anlamlı bir ilişki vardı ($p<0.001$).

Sonuç: Postoperatif fasiyal fonksiyonlarının iyileşmesini olumsuz etkileyen faktörler; cerrahinin 3 aydan daha geç bir dönemde yapılması ve fasiyal sinirin labirentin segmentinin tutulu olması olarak belirlenmiştir. Otik kapsülün tutulumu ile işitme kaybının tipi arasında anlamlı bir ilişki olduğu saptanmıştır

Anahtar Sözcükler: travmatik fasiyal paralizi, temporal kemik kırıkları, fasiyal sinir dekompresyonu

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INTRODUCTION

Temporal bone fractures are common complications of head trauma. Skull base fractures occur in 4 to 30% of head traumas, and of these 18 to 40% have temporal bone involvement (1). Rate of peripheral facial paralysis (PFP) is about 7 to 10% in temporal bone fractures (2).

Conventionally, temporal bone fractures are classified as longitudinal or transverse according to the relationship of the fracture line and the long axis of the petrous pyramid (3). Longitudinal fractures are more common (90%), but occurrence of PFP is rare when compared with transverse fractures (20% and 50% respectively) (4). A more recent classification according to otic capsule involvement of the fracture line was found to be more predictive and favored against the conventional classification (5-7).

Immediate onset paralysis of the facial nerve is mostly related with a severe injury like transection of the nerve and often require a surgical intervention while delayed paralysis suggests compression of the nerve in the fallopian canal due to edema or hematoma, and an excellent outcome is expected with conservative treatment (5,6,8). In cases with unknown-onset PFP, electrophysiologic assessment is of great importance in order to make a decision on the necessity of a surgical intervention.

Decompression surgery is indicated in certain and complete immediate PFP (9) as well as 90% or greater denervation of the facial muscles found on electroneurography (ENoG) examination (10) or electromyography (EMG) findings coexisting with an obvious fracture line involving the facial canal at high-resolution computed tomography (HRCT) (5,8,9).

The aim of this study is to report the results of our facial nerve decompression series and to define predictive factors on postoperative outcomes in temporal bone fractures.

MATERIALS and METHODS

Between May 2011 and July 2019, facial nerve decompression surgery was performed in 18 patients who had traumatic facial paralysis due to temporal bone fractures. All patients were evaluated with High-resolution computed tomography (HRCT) preoperatively, and a clear-cut fracture line involving the fallopian canal was present in all cases. Fractures were classified as otic capsule sparing (OCS) or otic capsule violating (OCV) according to their involvement of otic capsule on HRCT images. Pre- and postoperative facial nerve functions were graded by the means of House-Brackmann (HB) scale (11). All patients had HB grade 6 PFP preoperatively. Except one, all patients were followed up at least 18 months. The remaining patient who was followed up for 6 months was also included in the study as the total recovery was obtained 2 months after surgery. Postoperative HB scores were grouped as good (HB 1-2), moderate (HB 3-4) and poor (HB 5-6).

Two of the patients had certain immediate PFP coexisting with a clear fracture line crossing the fallopian canal on HRCT and were operated at the fourth day after the trauma without performing an electrophysiologic test. Sixteen patients who had unknown-onset PFP underwent an EMG evaluation at least at the 14th day after trauma. The presence of fibrillation potentials and lack of synchronized evoked response after nerve stimulation indicated neurotmesis in all patients.

An audiologic evaluation was performed in all patients preoperatively. Six of the patients who were under the age of 6 were evaluated with Acoustic Brainstem Response (ABR) test adjunct to behavioral audiometry. Hearing was re-examined at least 3 months after the surgery in patients who had conductive or mixed type hearing loss.

Surgery was performed by either transmastoid extralabyrinthine or transmastoid translabyrinthine route considering fracture location and hearing status. Transmastoid extralabyrinthine technique was performed as described by Quaranta et al. (12). Incus was interposed over the stapes after decompression of the nerve in patients with preoperative serviceable hearing.

The SPSS 20.0 software program (IBM Corp., Armonk, NY, USA) was used for the statistical analyses. A Mann-Whitney U Test and a Chi-Squared Test were used to compare quantitative and ordinal variables, respectively. P-values less than 0.05 were considered statistically significant.

RESULTS

There was a male predominance among patients (15 (83.3%) to 3 (16.7%)). Ages of the individuals ranged from 1 to 47 years (mean: 16.6 years). PFP was on the right and left sides in 10 (55.6%) and 8 (44.4%) patients, respectively. Surgery time ranged between 4 days and 1 year (mean: 58 days) after the initial trauma. Twelve (66.6%) of the patients were operated within the first month. Six (33.3%) patients underwent a later surgery and of these only three (16.7%) were operated later than 3 months. Postoperative follow-up time ranged between 6 months and 8.5 years (mean: 5 years).

The most common cause of the temporal bone fracture was blunt trauma due to motor vehicle crash (9 patients, 50%), followed by television tipover (4 patients, 22.2%). Industrial accidents, falls and assault were encountered in the remaining patients.

Eleven (61.1%) of the fractures were violating the otic capsule and in the remaining 7 (38.9%) patients, an OCS temporal bone fracture was observed on the HRCT. All 7 of the OCS fractures and 3 out of 11 OCV fractures were operated by the transmastoid extralabyrinthine approach. Transmastoid translabyrinthine approach was performed in 8 of the OCV fractures. Surgical observations verified the HRCT findings in all patients. Isolated fractures of the tympanic and mastoid portions were encountered in 2 (11.1%) and 1 (5.5%) patients, respectively. Fifteen (83.3%) patients had a fracture involving the geniculate ganglion which was accompanied by the involvement of proximal tympanic or distal labyrinthine portions in 15 (83.3%) and 7 (38.8%) patients, respectively. Patient data is summarized in Table 1.

Sixteen (88.8%) of the 18 patients received a decompression surgery solely. Two patients received a facial nerve anastomosis during the same surgery. One of these patients was operated 1 year after the trauma due to an industrial accident. The fracture was in the perigeniculate area, but transmastoid translabyrinthine decompression of the fallopian canal revealed a severe fibrosis of the labyrinthine, geniculate and tympanic portions of the facial nerve which did not allow rerouting and side to side anastomosis or nerve transplantation. A hypoglossal-facial anastomosis was performed at the same surgery, and postoperative facial functions improved to HB 3. This patient was under follow-up for seven years. The remaining patient who was operated due to perigeniculate temporal bone fracture caused by a motor vehicle crash received transmastoid translabyrinthine decompression of the fallopian canal through tympanic, geniculate and labyrinthine portions six months after the initial trauma. The nerve was fibrotic in the distal labyrinthine portion and in geniculate ganglion region. Rerouting and side to side anastomosis were performed after the removal of the fibrotic nerve segment, but the outcome was poor postoperatively (HB 5). Although a hypoglossal-facial anastomosis was offered, the patient refused to receive another surgery and was under follow-up for about 2 years without further improvement.

Overall postoperative HB scores were significantly better compared to preoperative scores ($p < 0.001$). Good postoperative facial nerve functions were obtained in 14 (77.7%) patients, moderate and poor outcomes were encountered in the remaining 3 (16.6%) and 1 (5.5%) patients, respectively. Involvement of the labyrinthine portion was significantly related with worse postoperative HB scores ($p = 0.018$). This relationship was not significant for the other portions. Surgical technique significantly affected the postoperative facial recovery. Patients who received a transmastoid translabyrinthine approach had significantly worse postoperative HB scores ($p = 0.04$). Timing of the surgery was another significant prognostic factor for the improvement of postoperative facial nerve functions. Patients who were operated within the first three months showed a significantly better progress in HB scores when compared with the individuals who received later surgeries ($p = 0.002$). The difference was not statistically significant when the cutoff time was accepted as 1 month ($p = 0.052$). Violation of the otic capsule did not affect the postoperative HB scores significantly ($p = 0.195$).

Preoperative audiometric assessment revealed a total sensorineural hearing loss (SNHL) in 11 (61.1%) patients. Conductive hearing loss (CHL) or mixed type hearing loss (MHL) were diagnosed in 7 (38.8%) patients. SNHL was present in all otic capsule violating fractures. In contrast, otic capsule sparing fractures were always accompanied by either CHL or MHL. There was a significant correlation between otic capsule involvement and the type of hearing loss ($p < 0.001$). In one patient who had mild CHL preoperatively, average pure tone air conduction thresholds worsened from 15 dB to 25 dB postoperatively. Except this case, either preserved or improved thresholds were obtained in all patients with preoperative CHL or MHL.

Table 1: Patient data.

| Patient | Age (year) | Gender | Time of Surgery (day) | HRCT | Site | Approach | Postop. HB |
|---------|------------|--------|-----------------------|------|-----------|----------|------------|
| 1 | 2 | m | 30 | OCS | III | EL | 2 |
| 2 | 26 | m | 30 | OCS | gg, II | EL | 1 |
| 3 | 2 | m | 4 | OCV | II | EL | 1 |
| 4 | 10 | m | 25 | OCV | I, gg, II | TL | 1 |
| 5 | 47 | m | 365 | OCV | I, gg, II | TL | 6 |
| 6 | 22 | m | 45 | OCV | gg, II | TL | 2 |
| 7 | 6 | m | 21 | OCV | I, gg, II | TL | 1 |
| 8 | 13 | f | 50 | OCS | gg, II | EL | 1 |
| 9 | 2 | m | 24 | OCV | I, gg, II | TL | 3 |
| 10 | 1 | m | 20 | OCV | gg, II | EL | 2 |
| 11 | 4 | m | 30 | OCV | gg, II | EL | 1 |
| 12 | 38 | m | 30 | OCS | gg, II | EL | 1 |
| 13 | 24 | m | 14 | OCV | I, gg, II | TL | 1 |
| 14 | 5 | m | 100 | OCV | I, gg, II | TL | 4 |
| 15 | 35 | m | 180 | OCV | I, gg, II | TL | 6 |
| 16 | 36 | f | 4 | OCS | gg, II | EL | 2 |
| 17 | 8 | f | 21 | OCS | gg, II | EL | 1 |
| 18 | 18 | m | 60 | OCS | II | EL | 1 |

m= male; f= female; HRCT= High-Resolution Computed Tomography; OCS= otic capsule sparing; OCV= otic capsule violating; I= labyrinthine segment; gg= geniculate ganglion; II= tympanic segment; III= mastoid segment; EL= transmastoid extralabyrinthine; TL= transmastoid translabyrinthine; Postop. HB= postoperative House-Brackmann grade

DISCUSSION

The conventional classification of the temporal bone fractures which are named as longitudinal and transverse according to the relationship of the fracture line and the long axis of the petrous pyramid are based on cadaveric experiments (3). According to this classification, fractures of the temporal bone are mostly longitudinal (80-90%) and transverse fractures are less common (10-20%). As a result of the advancements in the temporal imaging methods, oblique and mixed type of temporal fractures were also described adjunct to the conventional classification (13). However, even this updated classification system failed to predict the major complications of temporal bone fractures like facial paralysis, hearing loss and CSF leak in some cases. A more recent classification based on otic capsule involvement was found to be superior to the conventional classification in prediction of the complications and outcomes (6,7). OCV fractures are rare compared to OCS fractures although they are related with a markedly high risk of major complications like SNHL, facial nerve paralysis and cerebrospinal fluid leak when compared with OCS fractures (5-7). In the present series 11 (61.1%) of 18 patients had OCV fractures. Since only the patients who underwent a decompression surgery were included in the study, it is not possible to comment on the incidence of OCV fractures in all temporal traumas, but this high rate among patients who required surgical treatment in our series supports the opinion that there is a high risk of developing facial paralysis in OCV fractures. Besides that, postoperative facial recovery rates were not found to be significantly related with the otic capsule involvement in the present series ($p=0.195$).

Perigeniculate region was the most affected portion of the facial nerve in our series. Fifteen (83.3%) patients had a fracture line crossing the fallopian canal at the perigeniculate area. This finding is compatible with the previous publications (8,14). Hato et al (2). predicted that the decompression surgery could be performed more easily in fractures that involve the peripheral portions of the facial nerve which should result in better postoperative recovery, but interestingly the outcomes were similar in all fracture locations in their series.

Contrary to their findings, involvement of the labyrinthine portion was a significant negative prognostic factor for the postoperative recovery of the facial functions ($p=0.018$) in our series. In accordance, these patients frequently required a translabyrinthine approach, and the patients who were operated through this route also showed a worse postoperative recovery as expected ($p=0.04$).

Time of the onset of paralysis is another considerable prognostic factor. Immediate onset paralysis of the facial nerve is mostly related with a severe injury like transection of the nerve and often require a surgical intervention while delayed paralysis suggests compression of the nerve in the fallopian canal due to edema or hematoma, and an excellent outcome is expected with conservative treatment in such cases (5,6,8). It is not always possible to identify the exact time of onset of facial paralysis in patients with head trauma due to loss of consciousness or delayed otolaryngologic examination while more vital problems are given priority in treatment. In such cases, electrophysiologic assessment is of great importance in order to make a decision on the necessity of a surgical intervention. In the present series, only 2 (11.1%) of the 18 patients had immediate onset paralysis. Due to loss of consciousness or delayed referral of the patients to our center after their initial trauma treatment, definite onset time of facial paralysis could not be determined in the majority of our patients.

According to the current literature, the indications for decompression surgery are; certain and complete immediate paralysis (5,9) as well as 90% or greater denervation of the facial muscles found on electroneurography (ENoG) examination (10) or electromyography (EMG) findings coexisting with an obvious fracture line involving the facial canal at high-resolution computed tomography (HRCT) (5,8,9). In patients with unknown-onset facial paralysis, clinical findings with the contribution of electrophysiological tests and fracture line demonstrated on HRCT have the greatest impact on decision making (15). Immediate onset paralysis was present in two of our patients. Depending on the clinical findings and HRCT images which confirmed a clear-cut fracture through the fallopian canal, both patients were operated on the 4th day without an electrophysiological assessment. In patients with unknown onset PFP, in addition to HRCT, an EMG was performed on the 14th day at the earliest, and these patients received a later surgery.

Electrophysiological tests are used to differentiate neuropraxia, which is treated always conservatively from neurotmesis often requiring a surgical intervention. ENoG and EMG are the most commonly used electrophysiologic tests in the assessment of the neural damage. Signs of Wallerian degeneration become apparent after 72 hours. ENoG is applicable as an early diagnostic test which can be conducted 3 days after the onset of peripheral facial paralysis. Fisch suggested that more than 90% degeneration found on ENoG within 6 days after onset of the facial paralysis indicates decompression surgery. Based on this criterion, he reported that only 7% of the patients were overtreated with an unnecessary surgery according to his observations (16). EMG is able to detect Wallerian degeneration signs after 10 to 12 days (8). On EMG, the presence of fibrillation potentials and lack of response after nerve stimulation indicate neurotmesis while lack of voluntary action potential but the existence of a synchronized evoked response through nerve stimulation state neuropraxia (8,17). There is a controversy in the literature about which electrophysiological test should be applied to decide whether a surgery is indicated or not, and also to predict the outcome. ENoG is favored because it allows an early assessment and prevents an undesirable delay for surgery. The criteria proposed by Fisch are widely accepted in the literature (2,10,12,14,15). In contrast many authors found EMG most reliable and discredited ENoG because of its questionable reproducibility and reliability (8,17-19). Adour et al. (18) reported the test-retest fluctuation of ENoG as high as 16% and favored maximal nerve excitability test as a more accurate indicator of the facial nerve status. Sittel et al. (19) performed bilateral ENoG on 20 healthy volunteers and found that the repeated measurements differed considerably and the amplitude ratio was not constant in every individual at the repeated measurements. Esslen (20) when he introduced ENoG, postulated a left-right difference less than 3% in healthy subjects, but the findings of Sittel did not support Esslen as the difference was found to be between 26% and 39%. Grosheva et al. (17) found EMG superior to ENoG in determination of the prognosis of PFP. In their series, ENoG predicted the prognosis correctly in 146 (73%) of 201 patients. This rate was 89% for the initial EMG which was performed on the first 14 days after trauma. Follow-up EMG was the best to predict the outcome (97%). Positive and negative predictive values of the EMG reached to 100% and 96%, respectively after a 15 days interval. Our experience with ENoG (unpublished data) is consistent with the suggestions of Adour and Sittel about the high test-retest fluctuation and inconsistency of the results in the repeated measurements. In the present series, ENoG was not performed in any of the individuals. Two of the patients who had immediate PFP were operated depending on the clinical findings and presence of the clear-cut fracture involving the fallopian canal on HRCT without an electrophysiological assessment, and the remaining patients were evaluated by EMG at least 14 days after the trauma.

Timing of the decompression surgery is a controversial issue especially in patients with a history of unknown-onset facial paralysis. There is a trend in the recent literature to perform the decompression surgery as early as possible to obtain better outcomes. Hato et al. (2) suggested that the ideal time for the decompression surgery was within the first two weeks after trauma, and it must be performed within two months at the latest. Liu et al. (21) reported postoperative HB grade 1 or 2 recovery in 95% of their 57 patients who were operated within the first month. They claimed that early surgery may decrease the neural edema, prevent intraneural fibrosis by decreasing the anabolic nerve degeneration and improve recovery. Quaranta et al. (12) obtained postoperative HB 1 or HB 2 facial recovery in 7 of 9 (78%) patients who were operated on 27 to 90 days after trauma. Interestingly, 2 patients who underwent surgery three months after trauma showed comparable and even better recovery compared to earlier surgeries. They favored to perform the surgery within the first two weeks, but also suggested that good recovery can be obtained even in delayed surgeries. In the present series, most of the patients (12 of 18, 66.6%) were operated within the first month after trauma. Of these 2 patients were operated on the 4th day. Ten of these patients had unknown onset PFP, and in these cases if the clinical findings and HRCT images were correlated, absence of the voluntary activity and presence of the fibrillation potentials recorded with the EMG at the third week (14 days in one case) after trauma were the main indicators for the decompression surgery. The patients who were referred to our clinic later were also evaluated with EMG. A good postoperative facial recovery (HB 1-2) was obtained in 11 of 12 (91.6%) patients who were operated within the first month. This rate was 100% in 3 patients who were operated between the first and the third months. Overall, a good recovery was achieved in 14 of 15 (93.3%) patients who were operated within three months. This rate is compatible with the rate

(95%) of Liu et al. (21) who reported better recovery rates in patients operated in the first month compared to the report of Quaranta et al. (12) which was for the patients who underwent surgery between the first and third months. In the present series, none of the patients who underwent a decompression surgery after 3 months recovered to HB 1 or 2. Although better scores were obtained in patients operated within the first month, the statistical analyses did not reveal a significant difference compared to later surgeries. This was because the patients who were operated between the first and third months had also achieved an excellent improvement in facial functions. Our findings support Quaranta et al. as the surgery performed within three months resulted in significantly better outcome when compared with earlier interventions in our series (p=0.002). We observed irreversible changes in the facial nerve in two patients who were operated after six months and one year after the initial trauma. Both patients had severe intraneural fibrosis. Such severe damage of the nerve was not observed in any of the patients who were operated within three months.

Hearing loss is common in temporal bone fractures. About 24% of the patients suffer from hearing loss (5). CHL at the early period may be due to hemotympanum and resolve spontaneously. In patients with persistent CHL, interruption of the ossicular chain must be suspected, and an exploration for ossicular chain reconstruction is indicated (1). CHL is common in nonpetrous fractures especially which involve the middle ear (22). Our findings supported the literature as all the CHL were related with OCS fractures. Risk of SNHL in OCV fractures is 7 to 25 times higher than in OCS fractures (6,7). In the present series, 11 out of 18 patients (61.1%) had preoperative severe SNHL, and an OCV fracture was present in all, which is compatible with the current literature (6,7). Type of the hearing loss plays a decisive role in choosing the surgical technique. Translabyrinthine route must be avoided in cases with serviceable hearing. In such cases transmastoid extralabyrinthine and middle cranial fossa approaches or a combination of both techniques may be used for hearing preservation (2,12,15). Patients with CHL due to temporal bone fractures highly benefit from ossiculoplasty (10). In our series, all CHL and MHL patients were operated by the transmastoid extralabyrinthine technique and hearing thresholds were improved or at worst preserved in all patients but one.

CONCLUSION

Factors that affect the postoperative recovery of facial functions were; delayed surgical intervention for more than 3 months and involvement of labyrinthine portion of the facial nerve. Violation of the otic capsule always resulted in SNHL while a CHL or MHL was present in otic capsule sparing fractures. Unlike its significance in predicting the type of hearing loss, otic capsule involvement was not significantly related with postoperative facial recovery rates in our series.

Conflict of interest

No conflict of interest was declared by the authors.

REFERENCES

1. Johnson F, Semaan MT, Megerian CA. Temporal bone fracture: evaluation and management in the modern era. *Otolaryngol Clin North Am* 2008;41:597-618
2. Hato N, Nota J, Hakuba N, Gyo K, Yanagihara N. Facial nerve decompression surgery in patients with temporal bone trauma: analysis of 66 cases. *J Trauma* 2011;71:1789-92; discussion 92-3.
3. Gurdjian ES, Lissner HR. Deformations of the skull in head injury studied by the stresscoat technique, quantitative determinations. *Surg Gynecol Obstet* 1946;83:219-33.
4. Lambert PR, Brackmann DE. Facial paralysis in longitudinal temporal bone fractures: a review of 26 cases. *Laryngos* 1984;94:1022-6.
5. Brodie HA, Thompson TC. Management of complications from 820 temporal bone fractures. *Am J Otol* 1997;18:188-97.
6. Dahiya R, Keller JD, Litofsky NS, Bankey PE, Bonassar LJ, Megerian CA. Temporal bone fractures: otic capsule sparing versus otic capsule violating clinical and radiographic considerations. *J Trauma* 1999;47:1079-83.
7. Little SC, Kesser BW. Radiographic classification of temporal bone fractures: clinical predictability using a new system. *Arch Otolaryngol Head Neck Surg* 2006;132:1300-4.
8. Darrouzet V, Duclos JY, Liguoro D, Truilhe Y, De Bonfils C, Bebear JP. Management of facial paralysis resulting from temporal bone fractures: Our experience in 115 cases. *Otolaryngol Head Neck Surg* 2001;125:77-84.

9.Cannon CR, Jahrsdoerfer RA. Temporal bone fractures. Review of 90 cases. Arch Otolaryngol 1983;109:285-8.

10.Nosan DK, Benecke JE, Jr., Murr AH. Current perspective on temporal bone trauma. Otolaryngol Head Neck Surg 1997;117:67-71.

11.House JW, Brackmann DE. Facial nerve grading system. Otolaryngol Head Neck Surg 1985;93:146-7.

12.Quaranta A, Campobasso G, Piazza F, Quaranta N, Salonna I. Facial nerve paralysis in temporal bone fractures: outcomes after late decompression surgery. Acta Otolaryngol 2001;121:652-5.

13.Ghorayeb BY, Yeakley JW. Temporal bone fractures: longitudinal or oblique? The case for oblique temporal bone fractures. Laryngoscope 1992;102:129-34.

14.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.

15.Ulug T, Arif Ulubil S. Management of facial paralysis in temporal bone fractures: a prospective study analyzing 11 operated fractures. Am J Otolaryngol 2005;26:230-8.

16.Fisch U. Facial paralysis in fractures of the petrous bone. Laryngoscope 1974;84:2141-54.

17.Grosheva M, Wittekindt C, Guntinas-Lichius O. Prognostic value of electroneurography and electromyography in facial palsy. Laryngoscope 2008;118:394-7.

18.Adour KK, Sheldon MI, Kahn ZM. Maximal nerve excitability testing versus neuromyography: prognostic value in patients with facial paralysis. Laryngoscope 1980;90:1540-7.

19.Sittel C, Guntinas-Lichius O, Streppel M, Stennert E. Variability of repeated facial nerve electroneurography in healthy subjects. Laryngoscope 1998;108:1177-80.

20.Esslen E. The Acute Facial Palsies: Investigations on the Localization and Pathogenesis of Meato-labyrinthine Facial Palsies: Springer, 1977.

21.Liu Y, Han J, Zhou X, Gao K, Luan D, Xie Fet al. Surgical management of facial paralysis resulting from temporal bone fractures. Acta Otolaryngol 2014;134:656-60.

22.Ishman SL, Friedland DR. Temporal bone fractures: traditional classification and clinical relevance. Laryngoscope 2004;114:1734-41.