The Journal of International Advanced Otology

J Int Adv Otol 2021; 17(4): 294-300 • DOI: 10.5152/iao.2021.8506

Original Article

Surgical Outcomes of Transmastoid Facial Nerve Decompression for Patients With Traumatic Facial Nerve Paralysis

Harun Gür[1], Kemal Görür[1], Onur İsmi[1], Yusuf Vayısoğlu[1], Kemal Koray Bal[2], Cengiz Özcan[1]

[1]Department of Otorhinolaryngology, Mersin University School of Medicine, Mersin, Turkey
[2]Department of Otorhinolaryngology, Adana Training and Research Hospital, Adana, Turkey

ORCID IDs of the authors: H.G. 0000-0001-6165-2350; K.G. 0000-0002-2147-4673; O.İ. 0000-0001-5061-8907; YY.V. 0000-0002-7132-1317; K.K. 0000-0002-2000-0601; C.Ö. 0000-0001-7409-2057

Cite this article as: Gür H, Görür K, İsmi O, Vayısoğlu Y, Koray Bal K, Özcan C. Surgical outcomes of transmastoid facial nerve decompression for patients with traumatic facial nerve paralysis. *J Int Adv Otol.* 2021; 17(4): 294-300.

OBJECTIVE: To evaluate the facial nerve function and audiological results of delayed (by at least one month after the insult) transmastoid facial nerve decompression (FND) in traumatic facial nerve paralysis (FNP).

METHODS: Medical records of 57 patients with traumatic FNP were reviewed and surgical results of 13 patients (mean age 28.0 ± 17.67, range 3-67) undergoing transmastoid FND were analyzed. Preoperative and postoperative mean hearing thresholds were compared using 0.5, 1, 2, and 3 kHz. Facial nerve function was graded according to the House–Brackmann scale (HB) before and after surgery. HB scale results of grade III or better were accepted as good results postoperatively.

RESULTS: Preoperative HB grades were V in 5 and VI in 8 patients. Twelve of 13 patients had good recovery of facial nerve function regardless of the operation timing. When mean preoperative and postoperative air–bone gap (ABG) values were compared (except the patients with total sensorineural hearing loss), the mean preoperative ABG was 33 ± 15.9 dB, and mean postoperative ABG was 17.2 ± 8.68 dB. There was a mean hearing gain of 15.8 dB after transmastoid facial nerve decompression surgery. Surgery and anesthesia-related complications were not seen in any patients.

CONCLUSION: The transmastoid route can be used safely and effectively with elimination of the risks of craniotomy and middle fossa surgery for patients with traumatic FNP. Hearing improvement can be achieved by performing ossicular chain reconstruction during decompression surgery for patients with conductive or mixed hearing loss (HL).

KEYWORDS: Facial nerve, decompression, facial paralysis

INTRODUCTION

Facial nerve paralysis (FNP) may develop from many causes, such as trauma, infections, and tumors. The most common causes of FNP are idiopathic (Bell's palsy), head, or temporal bone traumas.[1] Iatrogenic trauma to the facial nerve during the otologic surgery may also cause FNP. Surgical procedures for cerebellopontine angle lesions, congenital aural atresia, and chronic otitis media with or without cholesteatoma have a risk of facial nerve injury.[2] FNP can occur in 10% of all temporal bone fractures (TBF), and these fractures occur mostly due to vehicle accidents.[3] They are classified as otic capsule-violating and otic capsule-sparing fractures.[4] Another classification indicates linear, transverse, and mixed type, depending on the relation between the fracture line and the long axis of the petrous bone. Eighty percent of all TBFs are longitudinal; facial paralysis occurs in 20% of them. Transverse fractures comprise 20% of all TBFs; FNP occurs in 50% of them.[5] The remainder are the mixed type TBFs.

The aim of this study was to evaluate the facial nerve motor function and audiological results of the transmastoid facial nerve decompression (FND) surgery in the late period (delayed by at least one month after the traumatic insult) after traumatic FNP.

Corresponding author: Harun Gür, e-mail: hrngur@hotmail.com
Received: April 15, 2020 • **Accepted:** August 5, 2020
Available online at www.advancedotology.org

MATERIALS AND METHODS

Medical records of 57 patients with traumatic FNP were reviewed and 13 patients who underwent transmastoid FND between 2010 and 2017 were retrospectively analyzed.

Inclusion Criteria

We studied the records of patients who met the following criteria:

i. House–Brackman(HB) grade V and VI FNP one month after trauma;
ii. Patients with traumatic FNP who were administered systemic corticosteroid treatment, with no observable recovery;
iii. Patients with traumatic FNP who did not have any middle ear disease or cerebellopontine angle tumors;
iv. Patients with traumatic FNP undergoing transmastoid approach (TMA) for FND.

Exclusion Criteria

i. Patients recovering spontaneously or after medical treatment;
ii. Patients with HB grades I through IV;
iii. Patients who needed another advanced surgical approach other than FND.

This study was approved by the local institutional review board (No:2019/315). All traumatic FNP patients had been hospitalized in the intensive care unit (ICU) and had undergone mechanical ventilation. High-dose prednisolone or dexamethasone had been administered to the patients in the ICU. These patients had been referred to our department at least one month after the traumatic insult and after their recovery from the mechanical ventilation and unconscious state. Therefore, FNDs had been performed within 1 to 3 months after trauma (Table 1). Patients had undergone a delayed FND (at least 1 month after the insult)[6,7] depending on the delay in their admission.

Surgical Indications

i. Presence of fibrillation, spike potentials, and total axonal degeneration on EMG (electromyography);
ii. Absence of volunteer potentials and facial movement;
iii. Fracture line apparently the crossing fallopian canal as seen on high-resolution computerized tomography (HRCT);
iv. Severe facial nerve paralysis (H–B grade V-VI).

Electromyographical examinations were performed during the first examination. The HRCTs of temporal bone were obtained from all patients preoperatively. Fracture types and localizations were classified and noted. Audiometric evaluations were performed preoperatively and postoperatively in the 3rd and 12th months. Preoperative and postoperative hearing outcomes were compared with a 4-frequency pure-tone average (PTA) using 0.5, 1, 2, and 3 kHz.[8] Air–bone gap (ABG) values were calculated by subtracting bone PTA values from air PTA values. Hearing gains were calculated by subtracting the postoperative (first year after decompression) ABG values from the preoperative ones. Auditory brainstem response was tested in 1 patient who was a 3 year-old boy. Facial nerve function was graded according to the HB system both preoperatively and 12 months postoperatively. HB scale results of grade III or better were evaluated as good results.[9] Electroneuronography was not performed on any patient since all of them were admitted 4 weeks after trauma.

Surgical Technique

Facial Nerve Decompression

Under general anesthesia, a complete mastoidectomy was performed through a retroauricular incision. The facial nerve was found in the posterior edge of the posterior tympanotomy. For most cases where the main insult was at the perigeniculate region, if bony spurs could be eliminated effectively and the nerve could be decompressed, then the incus was not removed, especially in patients with a wide epitympanic region. However, the incudostapedial joint was separated and the incus was removed to access the perigeniculate region if the traumatized area could not be achieved. The facial nerve bony canal was examined and removed 180 degrees, from the labyrinthine segment and the geniculate ganglion to the stylomastoid foramen, under the operating microscope. Bony spicules embedding in the nerve were removed during surgery. In the case with bilateral FNP (Patient 12), there was complete nerve cutting on the left side. A cable graft was

Table 1. Patients' Demographic and Clinical Features

P. no	Age/Gender	Side	Etiology	Preop HB	Postop HB	Timing of Surgery*	EMG Findings
1	20/M	R	Motorbike accident	5	3	3 months	Total axonal degeneration
2	18/M	R	Motorbike accident	5	2	2 months	No voluntary MUP
3	37/M	R	Traffic accident	6	3	1 month	Total axonal degeneration
4	3/M	R	TV falling on head	5	2	3 months	Near-total axonal degeneration
5	67/M	L	Bicycle accident	5	1	1 month	Total axonal degeneration
6	19/M	R	Traffic accident	6	3	1 month	No voluntary MUP
7	22/M	R	Traffic accident	6	6	2 months	Total axonal degeneration
8	44/M	L	Traffic accident	6	3	1 month	Total axonal degeneration
9	18/M	R	Traffic accident	6	3	1 month	Total axonal degeneration
10	44/M	L	Traffic accident	5	2	3 months	Near-total axonal degeneration
11	10/M	L	Iatrogenic	6	3	2 months	Total axonal degeneration
12	43/M	R	Wood block falling on head	6	2	1 month	Total axonal degeneration
13	19/M	R	Traffic accident	6	2	1.5 months	Near-total axonal degeneration

P.no, Patient no; HB, House–Brackmann; EMG, electromyography; M, male; Preop, preoperative; Postop, postoperative; R, right; L, left; MUP, motor unit potential.
*Timing of facial nerve decompression after the traumatic insult.

harvested from the greater auricular nerve (GAN) to repair the nerve. Therefore, the left ear of this patient was excluded from the study. In the right ear of this patient, the incus was first removed in order to explore the geniculate ganglion, and the bone spur was then removed from the geniculate ganglion region. At the end of the operation, the incus was replaced in its original position so as to restore the hearing, by fixing with bone cement. In 1 patient (Patient 7), the facial nerve showed severe edema and damage in the mastoid segment near the stylomastoid foramen. Facial nerve decompression surgery was performed. However, functional recovery could not be achieved, and the patient had HB grade VI FNP after the first surgery. About 4 months after decompression, VII-XII anastomosis was performed with a sural nerve graft. The final HB grade of the patient after the latter operation was HB grade III. Nevertheless, the postoperative HB grade of the patient was regarded as grade VI, and the HB grade of the VII-XII anastomosis was not included. A 10-year-old boy (Patient 11) had undergone congenital aural atresia surgery in another hospital, had immediate FNP after surgery, but he had been treated with 1 mg/kg methylprednisolone. His family was admitted to our clinic 2 months after the first surgery. The boy was operated on after EMG and temporal bone HRCT evaluation. During surgery, traumatic injury near the stylomastoid foramen in the mastoid segment of the facial nerve was seen, and the mastoid segment of the facial nerve was decompressed, including the stylomastoid foramen.

RESULTS

The age of the 13 male patients ranged from 3 to 67 (mean age 28 ± 17.67). Patients' demographic features and trauma types are shown in Table 1. Nine patients had FNP on the right side and 4 patients on the left side. Tympanic membrane and middle ear could not be examined for the boy who had undergone surgery for aural atresia in another hospital. Neurologic examinations, except for the facial nerve, were unremarkable in the remaining patients.

EMG Findings

All patients had total or near-total axonal degeneration and no voluntary motor unit potential on EMG records preoperatively (Table 1).

Temporal Bone Computed Tomography Examination

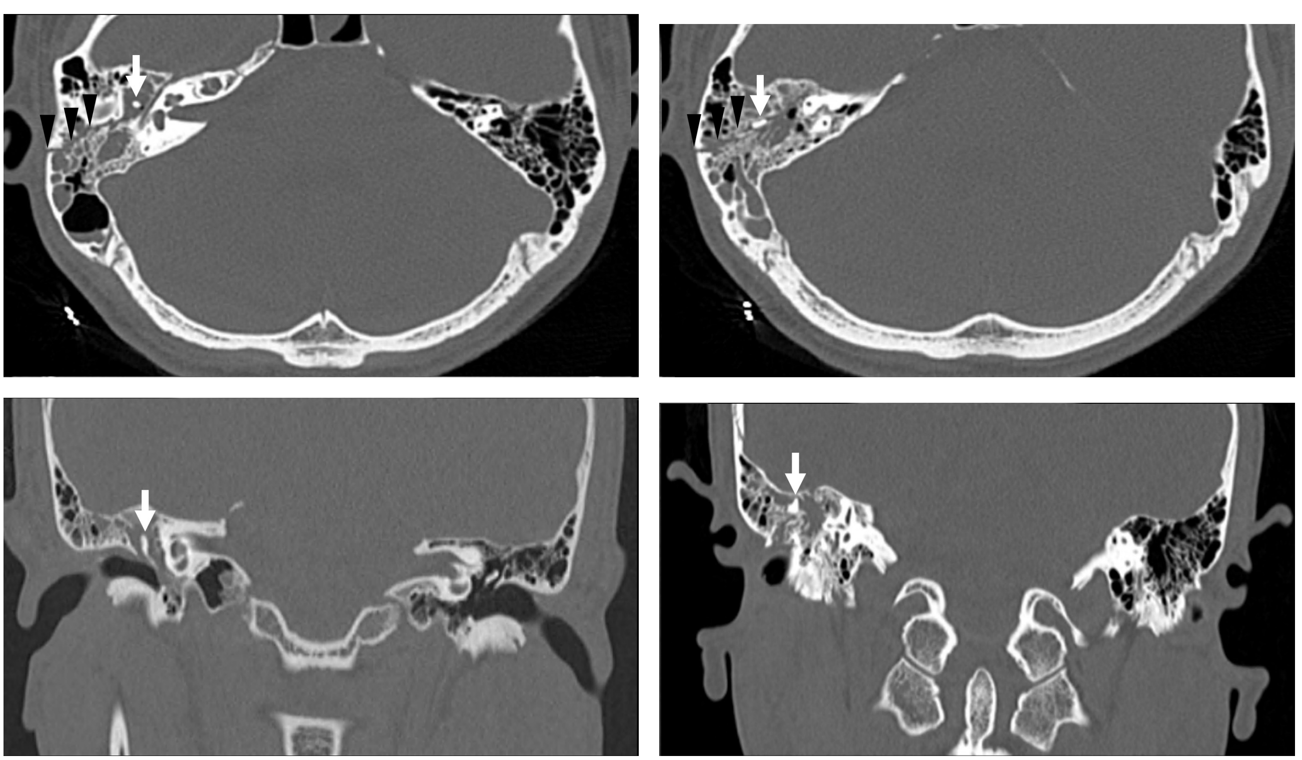
Five longitudinal, 1 transverse, and 6 mixed type fractures were observed on HRCT (Figures 1, 2, 3, and 4). These fracture lines were seen in the mastoid segment in 2 (17%), and in the perigeniculate region in 10 (83%) of the temporal bone HRCT scans. There were otic capsule-violating fractures in 4 temporal bones (33%) and otic capsule-sparing fractures in 8 temporal bones (67%). The otic capsule-violating fractures were transverse in 1 and mixed type in 3 patients (Table 2). In 1 patient who had undergone aural atresia surgery in another institution, there was a mastoid cavity, and the result of the temporal bone computed tomography (CT) examination showed no fracture line.

Facial Nerve Injury Sites

Injury of the facial nerve was seen at the geniculate region in 10 and at the mastoid segment in 3 patients who were related to 2 TBFs and one iatrogenic trauma.

Surgical Findings for Facial Nerve Paralysis

Small bone spicules in the fallopian canal were seen in 10 patients during FND. It was seen that there was edema in the affected nerve area of all patients. A totally transected facial nerve at tympanic segment of perigeniculate area was not encountered in any patient.



Figures 1, 2, 3 and 4. The views of a longitudinal fracture line on right side temporal bone on axial (1, 2) and coronal (3, 4) views of computed tomography. White arrows: malleus (1,3), displaced incus to attic (2,4). Black arrowheads: the longidutinal fracture line (Patient 3).

Table 2. Computed Tomography and Intraoperative Findings of the Patients

Ear No	Type of Fracture	Affected Region	Intraoperative Findings and Surgical Procedures
1	Mixed	Mastoid	Bone spur, GAN grafting
2	Mixed	GG	Bone spur, edema in nerve, intact ossicular chain
3	Longitudinal	GG	Bone spur, displacement of incus to attic, removed incus and interposed
4	Mixed	GG	Bone spur
5	Longitudinal	GG	Removed ossicles
6	Mixed	GG	Bone spur
7	Longitudinal	Mastoid	Severe edema and damage in mastoid segment, removed incus
8	Longitudinal	GG	Bone spur, edema in nerve, non-applicable fractured incus, removed incus, MSP
9	Mixed	GG	Bone spur, absent of long process of the incus, removed incus and interposed
10	Longitudinal	GG	Edema in nerve, fixed incus in its original place
11	İatrogenic	Mastoid	Fusion anomalies of malleus – incus, bone spur, granulation tissue, removed incus, MSP
12	Transverse	GG	Bone spur, separation at incudostapedial joint, fixed incus in its original place
13	Mixed	GG	Bone spur, displacement of incus to middle ear, removed incus and interposed

GG, geniculate ganglion; GAN, greater auricular nerve; MSP, malleo-stapediopexy.

Surgical findings of the patients are summarized in Table 2. No post-operative complications were seen.

Evaluation of the Facial Nerve Function

The HB grades were V in 5, and VI in 8 preoperative facial examinations. Since all patients had a history of being in ICU with mechanical ventilation, the time interval between the trauma and FNP and the initial FNP grade (complete or incomplete) after trauma could not be assessed. The mean preoperative HB grade score of patients was 5.61 ± 0.5; the scores were I in 1, II in 5, III in 6, and VI in 1, for facial examinations in the first-year postoperative control visits. The mean postoperative HB grade score of the patients was 2.7±1.2. Postoperative findings in 12 (92%) patients were referred to as good results, independent of the operation's timing (Table 1).

Audiometric Examination

Postoperative hearing thresholds and closure of ABG were assessed in the control visits in the 12th month after FND. The patients' audiometric results are summarized in Table 3.

Total sensorineural hearing loss was detected in 4 ears before surgery; thus, hearing-restoration surgery was not performed for these patients. Preoperatively, 8 ears had conductive hearing loss (CHL) or mixed hearing loss and one ear had normal hearing. Seven patients who had undergone hearing-restoration surgery had better PTA and ABG values compared to their preoperative hearing status, except for 1 patient (Patient 10, Figure 5). This patient had preoperative normal hearing and postoperative mild CHL. Mean ABG gain was 15.8dB for patients who had undergone hearing-restoration surgery (mean preoperative ABG: 33±15.9 dB, mean postoperative ABG: 17.2±8.68) (Table 3).

DISCUSSION

In the present study, we demonstrated that favorable facial nerve motor function could be maintained by transmastoid FND for patients with traumatic FNP even after 1-3 months of FNP. Decompression surgery between 1 and 3 months did not differ regarding facial nerve recovery according to the timing of the operation. Approximately 16 dB gain can be achieved by ossiculoplasty during transmastoid FND for patients with CHL or mixed HL. Ulug et al. presented a series of 11 patients with traumatic FNP; 63% of the patients had longitudinal type fracture, 37% had a mixed type,

Table 3. Patients' Hearing Thresholds and Types of Surgery

	Preoperative			Postoperative*			
Ear No	Air PTA (dB)	Bone PTA (dB)	ABG (dB)	Air PTA (dB)	Bone PTA (dB)	ABG (dB)	Hearing Surgery
10	20	13	7	35	15	20	Fixed incus in its original place
2	27	10	17	30	13	17	None
9	27	10	17	30	15	15	IRI
6	40	10	30	30	10	20	None
3	52	12	40	30	15	15	IRI
11	68	25	43	60	25	30	MSP
13	68	18	50	30	10	20	IRI
12	73	30	43	33	30	3	Fixed incus in its original place
8	75	25	50	35	25	10	MSP
1		TNSHL			TNSHL		None
4		TNSHL			TNSHL		None
5		TNSHL			TNSHL		None
7		TNSHL			TNSHL		None

PTA, pure-tone average; ABG, air–bone gap; TNSHL, total sensorineural hearing loss; IRI, incus removed and interposed; MSP, malleo-stapediopexy.
*Postoperative first year results.

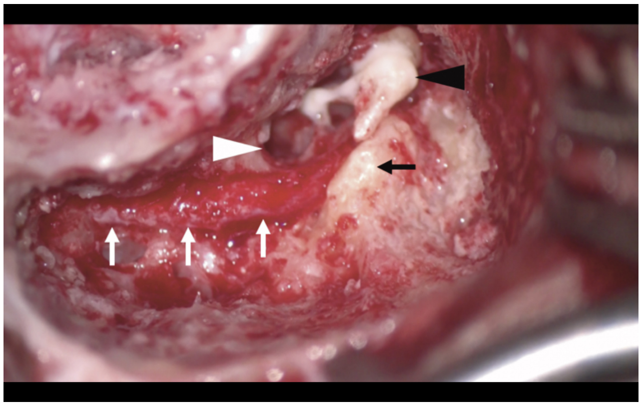


Figure 5. The view of the decompressed nerve and the reconstructed ossicular chain with incus via bone cement between malleus and stapes. White arrows: decompressed facial nerve, white arrowhead: posterior tympanotomy, black arrow: lateral semicircular canal, black arrowhead: incus fixed with bone cement in its original place (Left ear of patient 10).

and there was no patient with transverse type fracture.[10] In our study, we found that 50% of patients had mixed type, 42% had longitudinal, and 8% had transverse type fractures. We assessed only patients with traumatic FNP who had undergone FND. Therefore, the distribution of fracture types in our study was shown to differ from the ones in the literature. In our study, in most of the patients (83%), the affected part of the facial nerve was at the perigeniculate region, in concordance with the previous literature.[10-15] Patients with TBFs usually have multiple trauma and intracranial edema or bleeding, due to which these patients could be correctly evaluated by an otolaryngologist only when they were in generally stable health. Most of the patients may have had an extended stay in the ICU. Thus, evaluation of the facial nerve functions of these patients is delayed until the patient is awake and extubated from the mechanical ventilation.[16,17] In the late period, EMG records and HRCT findings can inform the surgeon about the decision of FND. In our study, the reason for delayed decompression for traumatic patients was also prolonged ICU stay. Patients' facial nerve functions could not be evaluated when they were in the ICU, since they were under general anesthesia and mechanical ventilation; thus FND could not be performed early. Observation and conservative treatment in cases of traumatic FNP may be useful for trauma-induced FNP. Systemic steroid treatment is an effective option for the delayed-onset and incomplete traumatic FNP.[15,18] Conservative treatment options can be effective for patients who have <90% facial nerve degeneration on ENoG within 3-14 days after trauma, absence of a distinct fracture line crossing the Fallopian canal on CT, and the presence of regeneration findings on EMG.[9] However, FND may be needed for patients with immediate-onset and HB grade V or VI traumatic FNP.[3] In our study, patients had HB grade V or VI FNP at first otolaryngologic examination, and they had a history of corticosteroid administration for brain injury during follow-up in the ICU. Additionally, their admission to our department was delayed by at least 1 month after the trauma. Therefore, these patients had already passed the observation and systemic corticosteroid treatment options when they admitted to our otorhinolaryngology clinic, and therefore, they underwent FND. There are many approaches for FND such as transmastoid, translabyrinthine, middle cranial fossa (MCF), and the combined approach, according to the area of the nerve injury and the hearing thresholds of the patients. If there is no serviceable hearing in the patient, the translabyrinthine approach may be an option for decompression. However, if there is favorable hearing, the transmastoid, MCF, or a combination of these 2 procedures can be employed in order to retain the hearing levels.[17] There is still no consensus regarding the gold standard in surgical approaches for FND for temporal bone fractures in the literature. MCF, MCF combined with TMA, and isolated TMA have all been demonstrated to exhibit satisfactory facial nerve function outcomes after decompression surgery.[10,11,12] Additionally, Ulug et al. emphasized that the labyrinth should be protected for cochlear implantation even if the patient has no serviceable hearing, so they offered that the MCF approach should be used instead of the translabyrinthine route for patients with total sensorineural hearing loss (TNSHL). The rationale of MCF approach for FND is that this technique promotes optimal access to the labyrinthine segment and the perigeniculate region.[1] Although MCF is an extradural subtemporal route, it has serious complications such as cerebrospinal fluid leak, meningitis, as well as aphasia and seizures because of craniotomy and retraction of the temporal lobe.[16,19] However, the mentioned complications are seen rarely with experienced surgeons, and permanent sequels are uncommon.[10,12,15,17,19,20] As seen in our study, extralabyrinthine TMA can also provide access to the perigeniculate region with incus removal and interposition or refixation to the original position at the end of the decompression, without deteriorating the hearing levels and protecting the patient from the complications of craniotomy. Except in cases with otic capsule-violating fractures, most patients with TBFs have conductive or mixed HL.[12] For these patients, TMA with wide anterior and posterior tympanotomy provides access to the middle ear during FND, and ossicular chain reconstruction for hearing improvement can be performed easily.[3] Liu et al. demonstrated an average 15 dB improvement in air conduction hearing levels by ossiculoplasty during TMA for patients with traumatic FNP.[14] Similarly in our study, we demonstrated a significant (average 15.8 dB) ABG closure for patients with preoperative conductive or mixed HL by the same surgical route. On the other hand, the isolated MCF approach cannot provide effective ABG closure and it needs a second look or combined surgery for hearing improvement for patients with conductive or mixed HL.[10,12] It is important to mention that in our study, we did not see any case of totally transected facial nerve at the perigeniculate region. By TMA, we could successfully explore the perigeniculate region, and edema of the nerve or bone spur trauma could be easily handled by this route. However, for cases with transected facial nerve at the proximal part of the geniculate ganglion, the MCF approach or translabyrinthine approach (in cases of TNSHL) are more suitable surgical routes.[11] The timing of FND for FNP is crucial to be able to achieve better postoperative results. Generally, early decompression is associated with better prognosis. Lee et al. had shown that early decompression decreases the risk of ischemia in the fallopian canal as well as the degree of Wallerian degeneration, thus late decompression is associated with poor prognosis.[21-23] Xu et al. demonstrated that FND for FNP before first month of the paralysis had significantly better functional results compared to the decompression after 3 months of the paralysis.[6] Xie et al. stated that intervention within 2 two months of the surgery had better results compared to the surgeries performed after 2 months of the insult, whereas they couldn't find any difference regarding postoperative facial nerve function for patients that underwent FND in the first 2 weeks or 2 months of the paralysis.[7] Sanus et al. performed decompression between 21 and 160 days after trauma.[24] They determined good outcomes (HB III or better) in 75% of the cases. Ulug et al.

suggested that FND performed within 3 months of the traumatic insult could obtain satisfactory facial nerve function outcomes irrespective of the timing of the surgery.[10] Our study results were similar, in that all patients were operated in 1 to 3 months of the paralysis, and all of them except for 1 patient recovered with favorable outcome regardless of the operation timing. Observation with conservative treatment options may also exhibit good recovery rates for most of the patients with delayed-onset traumatic FNP.[25] On the other hand, patients with immediate-onset FNP, having no motor unit potentials on EMG and bone fracture lines involving the Fallopian canal, are candidates for decompression surgery since these patients may exhibit unsatisfactory facial nerve recovery outcomes and may recover with synkinesis sequel by waiting for spontaneous recovery.[15,26,27] In our study, we could not classify the patients according to the delayed- or immediate-onset FNP, since they were under general anesthesia in the ICU and facial nerve functions could not be assessed immediately after the traumatic insult. Total or near-total axonal degeneration on EMG results, bone spurs or fracture lines crossing the fallopian canal on CT, and no spontaneous recovery despite at least 1 month's period were the primary findings that indicated FND surgery in our study. Therefore, all patients underwent FND surgery. In summary, for the patients who have the aforementioned FND indications and have good health conditions, decompression may be a better treatment option. However, favorable results can also be obtained with delayed transmastoid decompressions.

CONCLUSION

Surgical treatment of FNP due to TBF can be successfully performed by TMA. The transmastoid route can be used safely by eliminating the risks of craniotomy and middle cranial fossa approach, and postoperative hearing results can be preserved even in patients with incus removal and replacement. This surgical route allows the restoration of the ossicular chain for patients with conductive or mixed HL while performing effective decompression of the facial nerve. Although early decompression is advocated, late decompression delayed by a period within 1 to 3 months can also result in satisfactory facial nerve function outcomes, especially for patients who were treated in the ICU for a long time. The transmastoid approach to traumatic FNP is an effective method that enables ossicular chain reconstruction in cases of trauma-induced CHL.

Transmastoid FND prevents the risks of intracranial complications of the middle cranial fossa approach.

Delayed (between 1 and 3 months of the insult) FND can also lead to satisfactory facial nerve function outcomes.

Ethics Committee Approval: This study was approved by Mersin University review board(No:2019/315).

Informed Consent: Informed consent was obtained from all the patients themselves other than a male baby's parents.

Peer Review: Externally peer-reviewed.

Author Contributions: Concept – H.G., O.İ., K.G.; Design – K.K.B., Y.V., C.Ö.; Supervision – K.G., C.Ö., Y.V.; Resource – H.G., K.G., C.Ö.; Materials – K.G., Y.V., C.Ö.; Data Collection and/or Processing – K.K.B., H.G., O.İ.; Analysis and/or Interpretation – H.G., K.G., O.İ.; Literature Search – H.G., K.G., C.Ö.; Writing – H.G., O.İ., K.G.; Critical Reviews – H.G., O.İ., K.G.

Acknowledgment: This study was presented as an oral presentation at the 41st Turkish National Otolaryngology Head and Neck Surgery Congress, Antalya, Turkey, November 13-17, 2019.

Conflict of Interest: The authors declared that this study has received no financial support.

Financial Disclosure: The authors have no funding or financial support.

REFERENCES

1. Owusu JA, Stewart CM, Boahene K. Facial nerve paralysis. *Med Clin North Am*. 2018;102(6):1135-1143. [CrossRef]
2. Benecke JE Jr. Facial paralysis. *Otolaryngol Clin N Am*. 2002;35(2):357-365. [CrossRef]
3. Vajpayee D, Mallick A, Mishra AK. Post temporal bone fracture facial paralysis: strategies in decision making and analysis of efficacy of surgical treatment. *Indian J Otolaryngol Head Neck Surg*. 2018;70(4):566-571. [CrossRef]
4. Rafferty MA, Mc Conn Walsh R, Walsh MA. A comparison of temporal bone fracture classification systems. *Clin Otolaryngol*. 2006;31(4):287-291. [CrossRef]
5. Irugu DVK, Singh A, Ch S, Panuganti A, Acharya A, Varma H, et al. Comparison between early and delayed facial nerve decompression in traumatic facial nerve paralysis - A retrospective study. *Codas*. 2018;30:e20170063. doi:10.1590/2317-1782/20182017063.
6. Xu P, Jin A, Dai B, Li R, Li Y. Surgical timing for facial paralysis after temporal bone trauma. *Am J Otolaryngol*. 2017;38(3):269-271. [CrossRef]
7. Xie S, Wu X, Zhang Y et al. The timing of surgical treatment of traumatic facial paralysis: a systematic review. *Acta Otolaryngol*. 2016;136(12):1197-1200. [CrossRef]
8. Committee on Hearing and Equilibrium. Committee on Hearing and Equilibrium Guidelines for the Evaluation of Results of Treatment of Conductive Hearing Loss.*Otolaryngol Head Neck Surg*. 1995;113(3):186-187. [CrossRef]
9. Berania I, Awad M, Saliba I, Dufour JJ, Nader ME. Delayed facial nerve decompression for severe refractory cases of Bell's palsy: a 25-yearexperience. *J Otolaryngol Head Neck Surg*. 2018;47(1):1. [CrossRef]
10. Ulug T, Arif Ulubil S. Management of facial paralysis in temporal bone fractures: a prospective study analyzing 11operated fractures. *Am J Otolaryngol*. 2005;26(4):230-238. [CrossRef]
11. 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(5):652-655. [CrossRef]
12. Cannon RB, Thomson RS, Shelton C, Gurgel RK. Long-term outcomes after middle fossa approach for traumatic facial nerve paralysis. *Otol Neurotol*. 2016;37(6):799-804. [CrossRef]
13. Liu Y, Han J, Zhou X, et al. Surgical management of facial paralysis resulting from temporal bone fractures. *Acta Otolaryngol*. 2014;134(6):656-660. [CrossRef]
14. Liu Y, Liu S, Li J et al. Management of facial palsy after temporal bone fracture via the transmastoid approach. *Acta Otolaryngol*. 2015;135(3):307-311. [CrossRef]
15. 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;125(1):77-84. [CrossRef]
16. Bento RF, Pirana S, Sweet R, Castillo A, Brito Neto RVB. The role of the middle fossa approach in the management of traumatic facial paralysis. *Ear Nose Throat J*. 2004;83(12):817-823. [CrossRef]
17. Aslan H, Songu M, Eren E et al. Results of decompression with middle cranial fossa approach or traumatic intratemporal fascial nerve injury. *J Craniofac Surg*. 2014;25(4):1305-1308. [CrossRef]
18. Lee PH, Liang CC, Huang SF, Liao HT. The outcome analysis of traumatic facial nerve palsy treated with systemic steroid therapy. *J Craniofac Surg*. 2018;29(7):1842-1847. [CrossRef]

19. Sun DQ, Andresen NS, Gantz BJ. Surgical management of acute facial palsy.*Otolaryngol Clin North Am*. 2018;51(6):1077-1092. [CrossRef]
20. Zhu Y, Yang Y, Wang D, Dong M. Idiopathic recurrent facial palsy: facial nerve decompression via middle cranial fossa approach. *Am J Otolaryngol*. 2016;37(1):31-33. [CrossRef]
21. Lee SY, Seong J, Kim YH. Clinical implication of facial nerve decompression in complete Bell's palsy: A systematic review and meta-analysis. *Clin Exp Otorhinolaryngol*. 2019;12(4):348-359. [CrossRef]
22. Brown JS. Bell's palsy: A 5 year review of 174 consecutive cases: an attempted double-blind study. *Laryngoscope*. 1982;92(12):1369-1373. [CrossRef]
23. Jackson CG, von Doersten PG. The facial nerve: Current trends in diagnosis, treatment, and rehabilitation. *Med Clin North Am*. 1999;83(1):179-95, x. [CrossRef]
24. Sanuş GZ, Tanriöver N, Tanriverdi T, Uzan M, Akar Z. Late decompression in patients with acute facial nerve paralysis after temporal bone fracture. *Turk Neurosurg*. 2007;17(1):7-12.
25. Sanus GZ, Tanriverdi T, Tanriover N, Ulu MO, Uzan M. Hearing preserved traumatic delayed facial nerve paralysis without temporal bone fracture: Neurosurgical perspective and experience in the management of 25 cases. *Surg Neurol*. 2009;71(3):304-10. [CrossRef]
26. Fujiwara K, Furuta Y, Nakamaru Y, Fukuda S. Comparison of facial synkinesis at 6 and 12 months after the onset of peripheral facial nerve palsy. *Auris Nasus Larynx*. 2015;42(4):271-274. [CrossRef]
27. Bylund N, Jensson D, Enghag S et al. Synkinesis in Bell's palsy in a randomised controlled trial. *Clin Otolaryngol*. 2017;42(3):673-680. [CrossRef]