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ORIGINAL ARTICLE

POST-TRAUMATIC FACIAL PARALYSIS: OUTCOMES OF TRANSCANAL ENDOSCOPIC FACIAL NERVE DECOMPRESSION: A RETROSPECTIVE ANALYSIS

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Abstract:

Background: Microscopic or endoscopic techniques allow for facial nerve decompression (FND) in cases of traumatic facial palsy involving the denticulate ganglion and tympanic segment, offering an alternative to procedures requiring mastoidectomy.

Objective: Focusing on facial nerve (FN) function and hearing in lesions limited to the perigeniculate and tympanic segments, this study analyzes the outcomes of the Transcanal endoscopic approach (TEA) for FND.

Material and Methods: A review of post-traumatic facial nerve (FN) paralysis cases treated with the transcanal endoscopic approach (TEA) at KGN Teaching Hospital, Bannu-KP, from January 2018 to December 2022 was performed retrospectively. Twelve patients with immediate post-traumatic FN paralysis, no response to 14 days of systemic corticosteroids, a "House-Brackmann grade (HBG) of IV–VI", and lesions limited to the perigeniculate ganglion and tympanic segment of the FN were selected for surgical intervention. Postoperative changes in FN function and hearing following TEA for FND were then analyzed.

Results: The transcanal endoscopic approach (TEA) resulted in post-surgical enhancement of facial nerve (FN) function (HBG I/II) in 80.0% of patients within a 6-month follow-up.No significant further improvement in FN function was observed between the 6th and 10th months. Postoperative hearing improved in ten cases, while one patient with pre-existing sensor neural hearing loss showed no improvement.

Conclusion: In conclusion, the transcanal endoscopic approach (TEA) provides direct access for facial nerve decompression (FND) of lesions confined to the perigeniculate ganglion area and tympanic segment, avoiding the need to address the mastoid segment. TEA is characterized by minimal bone removal, good visualization, and precise surgical site evaluation. Importantly, our findings suggest that even patients presenting for surgery at a later stage may experience positive results.

Keywords: Facial Paralysis, Endoscopy, Geniculate Ganglion, Tympanic Membrane

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Introduction:

The impact of facial nerve (FN) paralysis extends beyond physical symptoms, affecting patients' psychological and emotional well-being, largely due to its visible cosmetic consequences. Bell's palsy, facial trauma, and tumours are typical underlying causes. In cases of traumatic facial paralysis, leading contributors include temporal bone fractures, gunshot wounds, and medical or surgical complications (iatrogenic injuries)[1]. In temporal bone fractures (TBFs), facial nerve (FN) damage may occur due to compression from bone fragments and swelling, the formation of intramural hematomas, or complete nerve transection. Based on the orientation of the fracture line relative to the petrous part of the temporal bone, TBFs are classified into longitudinal, transverse, and mixed types. Longitudinal fractures, accounting for 20% of TBFs, are linked to FN palsy in 50% of cases. Transverse fractures, which represent about 80% of TBFs, are

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associated with FN palsy in approximately 20% of cases[2].

In temporal bone fractures (TBF), injuries to the facial nerve (FN) most commonly occur at the perigeniculate ganglion and the transverse segment[3]. To accurately identify the site of nerve involvement, high-resolution computed tomography (HRCT) of the temporal bone is the preferred diagnostic tool. The onset characteristics and progression pattern of facial nerve (FN) palsy after trauma play a crucial role in predicting the likelihood of functional recovery[4].

The pattern of onset and the progression of traumatic facial nerve (FN) palsy are significant indicators in assessing the potential for functional recovery[5]. Facial nerve (FN) palsy severity is typically assessed using the House-Brackmann grading scale (HBG I–VI). The degree of nerve degeneration and regeneration can be assessed using electrophysiological studies, including electroneuronography (ENoG), electromyography (EMG), the maximum stimulation test, and the nerve excitability test.Among these, ENoG is most effective in the first 14 days after trauma for evaluating nerve deterioration. A finding of more than 90% degeneration on ENoG during this period is considered a key criterion for recommending facial nerve decompression (FND)[6]. Electromyography (EMG) is utilized to assess nerve regeneration and becomes particularly useful after the first two weeks post-injury. To determine the exact site of facial nerve damage, topodiagnostic tests such as the Schirmer's test and the stapedial reflex test are performed.

Complete and persistent facial palsy of immediate onset (HBG-VI), especially when accompanied by unfavourable findings on ENoG and EMG, is less likely to improve with conservative treatment. Despite this, the ideal timing and surgical technique for facial nerve recovery are still subjects of ongoing debate[7].

There is ongoing debate about the most effective surgical approach for addressing facial nerve (FN) injuries. The choice of surgical technique is primarily guided by the location of the nerve damage.

Depending on the location of the facial nerve injury, different surgical approaches can be used for facial nerve decompression (FND), including the middle cranial fossa, transmastoid, and transcanal routes. Notably, the middle cranial fossa approach allows access to the more proximal portions of the facial nerve, specifically the labyrinthine segment and geniculate ganglion, while preserving hearing.[8]. Although the middle cranial fossa approach provides access to the facial nerve, it requires craniotomy and retraction of the temporal lobe. Alternatively, the transmastoid approach is suitable when the facial nerve injury is localized to the mastoid, second genu, or distal tympanic segment. The established technique for facial nerve decompression, involving canal wall-up mastoidectomy, atticotomy, and an expanded facial recess, typically requires considerable bone drilling for adequate visualization. Conversely, the transcanal approach, whether endoscopic or microscopic, permits unmediated access from the geniculate ganglion to the second genu. A significant advantage of the endoscopic transcanal technique is its offering of superior surgical field view and its ability to negotiate difficult angles.[9-12].

The purpose of this study was to assess the results of facial nerve decompression surgery using the transcanal endoscopic approach (TEA), examining its pros and cons in cases of temporal bone fractures (TBF) associated with facial nerve palsy.

Material and Method:

Study design: Retrospective, observational study

Setting and duration: Department of ENT, KGN teaching hospital Bannu from January 2018 to December2022.

Inclusion criteria: The study included all patients presenting with immediate-onset traumatic facial nerve (FN) palsy (House-Brackmann grade of IV, V, or VI).

Exclusion criteria: Patients were excluded if their facial nerve (FN) palsy involved the mastoid segment or if their traumatic FN palsy showed improvement with systemic steroid treatment.

Data collection procedure: The patient's medical history was analyzed. All these patients underwent facial nerve decompression (FND) via the transcanal endoscopic approach (TEA). Patients were monitored for 10 months following surgery. The demographic details of the patients were collected, including their clinical history, mode of injury, speed of facial asymmetry onset, and any existing comorbidities or prior neurosurgical interventions. The time between the onset of facial asymmetry and the patient's consultation with an otologist was also noted. A comprehensive clinical examination was carried out, including otoscopic evaluation, tuning fork tests, and a neurological examination. Facial nerve function was graded both before and after surgery using the House-Brackmann grading system (HBG). All patients underwent preoperative and postoperative pure tone audiometry, and postoperative hearing was assessed by measuring the air-bone gap (ABG) at 0.5, 1, 2, and

4 KHz frequencies. Physiotherapy for facial muscles was provided to all patients after surgery.

High-resolution computed tomography (HRCT) of the temporal bone was performed on all patients to determine the site of injury and assess the condition of the ossicular chain. While electrophysiological tests are crucial for evaluating the extent of facial nerve (FN) functional loss, they were not performed due to their unavailability at our site.

Surgical Methods: Using an endoscope,the surgical procedure was carried out under general anesthesia. A transcanal approach involved an incision and subsequent elevation of the posterior tympanomeatal flap. To achieve a clear visualization of the middle ear, the entire malleus was meticulously skeleton zed, starting at the tympanic membrane. Posterior canalplasty was performed by removing the posterior bony canal wall to allow for better exposure and easier manipulation of instruments. Following disarticulation of the incudostapedial joint, the incus and malleus head were extracted. An atticotomy then exposed the anterior epitympanum and supralabyrinthine area. To locate the geniculate ganglion, key landmarks such as the cochlear form process and cog were identified and subsequently removed to improve visualization of the perigeniculate ganglion. The site of facial nerve injury was carefully accessed. In the supralabyrinthine area, bony fragments and granulations were removed using a diamond burr, pick, and curette to reveal the geniculate ganglion. Ultimately, sufficient exposure of the geniculate ganglion, greater superficial petrosal nerve, and tympanic segment of the facial nerve was obtained. (Figure 1).

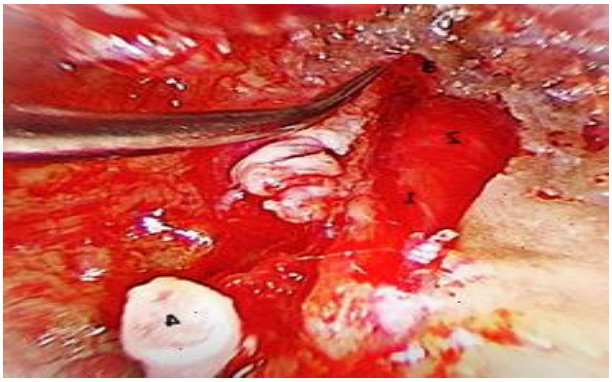

Figure 1: Endoscopic image taken during surgery (right ear) showing: a). Tympanic segment of the facial nerve, b). Geniculate ganglion, c). Greater superficial petrosal nerve, d). Head of the stapes

To decompress the facial nerve, the epineurium was incised with a tenotome. Partial ossicular reconstruction was accomplished using either an autograft of the incus or a titanium prosthesis. A tragal cartilage graft was employed for attic defect repair and to buttress the repositioned tympanomeatal flap. The external auditory canal was packed with gel foam soaked in normal saline.

Data analysis: Data was analyzed using SPSS version 24. Paired t-test was applied to compare pre- and postoperative HBG scores and ABG values. Chi-square test was applied for categorical variables (e.g., improvement in HBG vs. type of trauma

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Results:

The study cohort comprised nine patients who were enrolled between January 2022 and December 2023, all of whom met the necessary inclusion criteria. Following surgery, these individuals were monitored for a duration of 10 months. The patients' ages at the time of their operations ranged from 18 to 65 years, with a median age of 32.8 years. Analysis of temporal bone HRCT scans indicated fractures at the geniculate ganglion in most cases i.e. (58.33%, n=7), 25.5% (n=3) presented with mixed fractures involving both the geniculate ganglion and the tympanic segmentwhile 22.20% (n=2) exhibited fractures of the tympanic segment.As detailed in table 1, the interval between the traumatic event and surgical intervention varied from 30 to 60 days. Notably, three of the twelve patients underwent surgery more than 45 days post-injury due to delayed presentation. Common findings during the surgical procedures, also presented in table 1, included compression by granulation tissue, bony fragments, edema and fibrosis.

Table 1: Findings of Pre-Op and Post-Op FND

Gender	Injury's Site	Surgery time (days)	Intra-Op findings
Female	Geniculate ganglion + tympanic segment	52	Bony fragments fibrosis
Female	Geniculate ganglion	50	Bony fragments fibrosis
Female	Tympanic segment	30	Bony fragments fibrosis
Male	Geniculate ganglion + tympanic segment	32	Edema

Male	Geniculate ganglion + tympanic segment	53	Edema
Male	Geniculate ganglion	34	Edema granulation
Male	Tympanic segment	39	Edema granulation
Male	Geniculate ganglion	28	Edema granulation
Male	Geniculate ganglion	30	Granulation
Male	Geniculate ganglion	28	Granulation
Male	Geniculate ganglion	26	Hematoma edema
Male	Geniculate ganglion	32	Hematoma edema

At presentation, seven of the twelve patients exhibited House-Brackmann Grade (HBG) V facial palsy, while five presented with HBG IV. No patients presented with HBG VI. The average surgical time was 90 minutes. Seven days postoperatively, ten patients showed improvement to HBG III, and two improved to HBG IV. At the 6-month follow-up, two patients had recovered to HBG I, seven to HBG II, and three to HBG III. By the 12-month mark, five additional patients improved from HBG II to HBG I, as detailed in Table 2. The rate of functional facial nerve improvement (HBG I or II) was 80.0% at 6 months post-surgery. Notably, there was no substantial progress observed between the 6-month and 10-month follow-up periods. To achieve adequate surgical exposure, the head of the malleus and incus were removed in all twelve cases, necessitating subsequent ossiculoplasty in all patients. Intraoperative, ossicular chain dislocation was identified in five of the twelve cases.

Table 2:Outcomes After Facial Nerve Decompression: A Series of Twelve Cases (using the transcanal endoscopic approach)

HBG score				Avg. air bone gap	
Pre-Op	Post-Op			Pre-Op	Post-Op
	7 days	180 days	300 days		
Grade V	III	II	I	28	20
Grade V	III	II	I	28	20
Grade V	III	II	II	25	28
Grade V	III	II	II	30	24
Grade V	III	III	III	30	22
Grade V	IV	III	III	32	26
Grade V	IV	III	III	28	22
Grade IV	III	II	I	35	22
Grade IV	III	II	I	30	24
Grade IV	III	II	I	26	24
Grade IV	III	I	I	28	20
Grade IV	III	I	I	35	28

Table 3: Mean, Median and Range details

Metric	Pre-Op Air Bone Gap	Pre-Op Air Bone Gap
Mean	29.33	23.33
Median	28.5	23.0
Range	25-35	20-28

The study included twelve cases, with most of the cases exhibiting conductive hearing loss. Two cases presented with mixed hearing loss, and a single case involved pure sensorineural hearing loss. Postoperative assessment revealed hearing gains, quantified by the average closure of the air-bone gap (500, 1000, 2000, 4000 Hz). Encouragingly, eight patients demonstrated improved hearing after surgery; however, the one patient who already had sensorineural hearing loss did not experience any improvement.

Pe and post-op air bone gap by case & its trend is displayed in figure 2& figure 3.

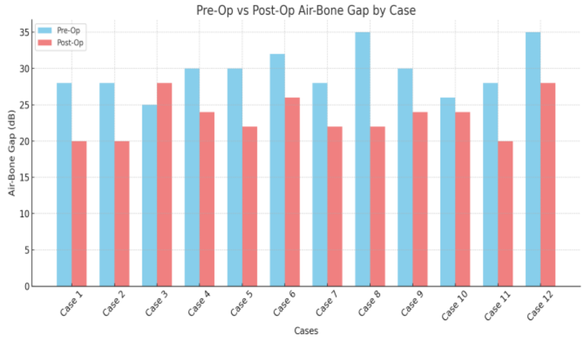

Figure 2: Pre and post-Op Air Bone Gap by Case

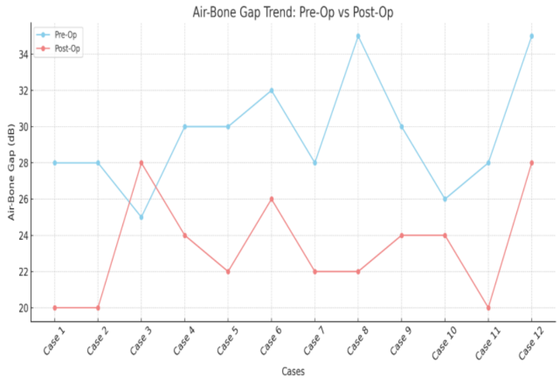

Figure 3: Trend in Pre & Post-Op Air Bone Gap

Discussion:

Standard surgical methods often struggle to access lesions located at the geniculate ganglion and the tympanic segment of the facial nerve (FN). The complexity of these cases is further compounded by traumatic injury to the FN. High-resolution computed tomography (HRCT) is crucial as it uniquely provides a precise identification of the nerve injury site, thereby guiding the selection of the appropriate surgical technique. Our study focused on lesions situated within the geniculate ganglion and the tympanic segment of the FN. While both the transmastoid and middle fossa approaches can reach lesions in the perigeniculate ganglion area and the tympanic segment of the FN, each has inherent drawbacks. In contrast, the transcanal approach offers direct access to these specific lesion locations.

Utilizing either a microscope or an endoscope, the transcanal approach can be employed. Specifically, the transcanal endoscopic approach (TEA) provides a significantly improved view of the facial nerve (FN) and its surrounding anatomy during surgery. This enhanced visualization aids the surgeon in a more precise evaluation of the injury location when contrasted with the microscopic transcanal method.[7] An endoscopic technique also presents the advantages of requiring less bone drilling and leading to shorter surgical procedures.

Liu et al. performed a retrospective analysis on 18 individuals who had post-traumatic facial nerve (FN) palsy and were treated with extended subtotal facial nerve decompression (FND) via the transmastoid route. Their results showed that 66.7% of these patients experienced a recovery of FN function to House-Brackmann Grade I or II.[13]

In another study, Cannon et al. observed that the middle cranial fossa approach resulted in improved facial nerve (FN) function (HBG I/II) in 72.7% with post-traumatic FN palsy.[14] Nevertheless, this approach was associated with postoperative vertigo in 16.7% of their patient cohort and wound infections in 5.5% of cases.

In a study of six patients, Alicandri-Ciufelli et al. found that the transcanal endoscopic approach (TEA) led to an 83.3% rate of improvement in FN function, reaching House-Brackmann Grade I or II. These results were recorded after a 6-month follow-up duration.[7]

Our research showed that 80.0% of the patients experienced an improvement in facial nerve (FN) function to House-Brackmann Grade I or II over a 180 days follow-up. Importantly, no further significant gains in FN function were observed between the 6-month and 10-months follow-up marks. Furthermore, our study recorded no instances of complications either during or after the surgical procedures.

A systematic review by Xie et al. in 2016, which analyzed six studies with a total of 119 patients, aimed to identify the best time frame for surgical treatment of traumatic facial palsy (TFP). The data indicated that surgical treatment performed within two weeks of the injury yielded the most favorable clinical outcomes. Furthermore, they indicated that surgical explorations done within the first two months also led to good outcomes.[15]

As noted by Hato et al., the transmastoid approach poses difficulties when attempting to decompress the tympanic segment of the facial nerve (FN)[16]. This challenge likely contributes to the poorer postoperative recovery seen in their study, where only 41.7% of patients reached House-Brackmann Grade I. The limited visibility of the tympanic segment, caused by the presence of the lateral semicircular canal and stapes, probably results in incomplete bone removal in this region.[17]

In a case report by Kahinga et al., two instances of facial nerve (FN) injury located in the tympanic segment were treated using the transcanal endoscopic approach (TEA). The outcomes at 6 months post-surgery for these two patients were a House-Brackmann Grade II and a House-Brackmann Grade III score, respectively.[18]

In our study, twelve patients with post-traumatic facial nerve (FN) palsy underwent treatment using a transcanal endoscopic approach (TEA). Their lesions were localized to the perigeniculate area, the tympanic segment of the FN, or both. At the six-month follow-up, one patient achieved a House-Brackmann Grade I recovery, five reached Grade II, and three recovered to Grade III. It is relevant to note that two of these nine patients presented for treatment over 60 days after sustaining their injury. In a related publication, Alicandri-Ciufelli et al. described six cases utilizing TEA for post-traumatic FN palsy involving the tympanic segment and/or the geniculate ganglion of FN7.

In situations where the facial nerve (FN) injury spans both the mastoid and tympanic segments, a combined surgical method, integrating transcanal and transmastoid routes, is considered more suitable for comprehensive exposure. Given that the malleus head and incus are removed to optimize the view during the transcanal endoscopic approach (TEA), ossiculoplasty is a necessary step in all TEA cases. Among our nine patients, eight exhibited better hearing, demonstrated by closure of the air-bone gap. One patient did not have improved hearing due to a pre-existing sensorineural hearing loss. Additionally, one must recognize that the endoscopic method does not offer any advantage over the microscopic approach in terms of preserving the ossicles.

Our experience with the transcanal endoscopic approach (TEA) in Bannu has yielded results that are comparable to those achieved with other surgical methods like the transmastoid and middle fossa approaches. Additionally, the outcomes of our study are consistent with findings from other centers using TEA.

Despite its effectiveness, TEA has certain drawbacks. A key limitation is the single-handed surgical technique often required, which can make managing bleeding challenging. Consequently, having a microscope on standby in the operating room is essential, enabling the surgeon to use both hands to control bleeding with suction if needed. The issue of bleeding can be mitigated through multiple techniques.[19,20]

In addition to the previously mentioned points regarding TEA, there's also a potential for the stapes to become displaced (subluxation) when removing bone from the upper-back part of the ear canal. Fogging of the endoscope lens is another common issue encountered during these procedures. Moreover, using an endoscope can be difficult in patients who have a small or narrow ear canal. It's also important to remember that the endoscopic approach cannot reach lesions situated in the mastoid portion of the facial nerve (FN).

Selecting the right patients for surgery is vital, as a significant number of individuals with facial paralysis due to trauma may recover with just systemic corticosteroid treatment. Consequently, a period of observation, typically around 14 days after the injury, is necessary. Furthermore, if the onset of facial weakness is delayed following the trauma and the recovery isn't complete, the likelihood of an excellent outcome without surgical intervention is usually high.[21]

Conclusion:

For traumatic facial palsy involving the perigeniculate ganglion and tympanic segment, transcanal endoscopic FND appears to be an effective strategy. The importance of accurately locating the facial nerve injury via temporal bone HRCT cannot be overstated, as it aids in excluding mastoid segment involvement. This endoscopic technique yields results on par with other surgical options like microscopic transcanal, middle cranial fossa, and transmastoid approaches. Minimally invasive, requiring less bone removal, and offering excellent surgical field visualization are key benefits of transcanal endoscopic facial nerve decompression (FND), allowing for accurate assessment of the facial nerve injury site..

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