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Prognostic Factors in Severe Post-Traumatic Facial Paralysis: Analysis of Outcomes Following Transmastoid Nerve Decompression

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Abstract

Introduction: Post-traumatic peripheral facial paralysis is a significant therapeutic challenge in otorhinolaryngology and cervicofacial surgery, predominantly caused by temporal bone fractures from high-energy trauma like road traffic accidents. This study aimed to identify clinical, paraclinical, and intraoperative prognostic factors influencing functional outcomes following transmastoid facial nerve decompression for severe cases.

Materials and Methods: A single-center, retrospective analytical study was conducted over ten years (2014-2023) at a tertiary care hospital. It included 44 consecutive patients with severe post-traumatic facial paralysis (House Brackmann grades 4-6) who underwent transmastoid decompression. Inclusion required CT-confirmed temporal bone fracture and EMG-documented nerve degeneration ≥90%. Data on demographics, clinical presentation, preoperative investigations (audiometry, EMG, CT), intraoperative findings, and 12-month outcomes were analyzed. Patients were stratified into good (HB 1-2) and fair/poor (HB 3-4) outcome groups for prognostic analysis using Chi-square and t-tests ($p<0.05$ significant).

Results: The cohort was predominantly young males (mean age 27.1 years; 79.5% male). Road traffic accidents were the leading cause (77.3%). The mean delay to surgery was 12.0 ± 7.7 weeks. The most common intraoperative findings were nerve edema (68.2%) and fibrosis (20.5%), primarily in the tympanic segment (84.1%) and geniculate ganglion (63.6%). At 12 months, 54.5% of patients achieved a good outcome (HB 1-2). Univariate analysis identified the type of intraoperative nerve lesion as the sole significant prognostic factor ($p=0.009$), with fibrosis, granuloma, and ecchymosis predicting worse outcomes. No significant associations were found with age, sex, surgical timing, initial paralysis grade, or fracture type.

Discussion: Our findings confirm the efficacy and safety of transmastoid decompression for severe post-traumatic facial paralysis. The strong association between intraoperative lesion type and functional outcome suggests that the histological nature of the nerve injury is a more critical prognostic determinant than timing alone in carefully selected patients. These results highlight the importance of a meticulous preoperative workup and intraoperative assessment to guide prognosis and management.

Keywords: Facial nerve; Nerve decompression; Post-traumatic facial paralysis; Temporal bone fracture; Prognostic factors; Transmastoid approach; Electromyography; House-Brackmann scale.

1. Introduction

Post-traumatic peripheral facial paralysis represents a diagnostic and therapeutic challenge in otorhinolaryngology (ENT) and cervicofacial surgery.[1] It is the third most common etiology of facial nerve involvement, after Bell's palsy and infectious causes, with a significant incidence in patients suffering from craniofacial trauma, notably road traffic accidents (RTA) which are the primary mechanism.[2]

This paralysis most often results from a temporal bone fracture, observed in 14 to 22% of skull base fractures.[2] These fractures, classified as extra labyrinthine, trans-labyrinthine, and mixed types, expose the facial nerve to compression, stretching, or section injuries, potentially leading to severe axonal degeneration.[3,4] The functional prognosis then depends on the timeliness and appropriateness of management, which is based on rigorous clinical assessment and specialized paraclinical examinations.

Pure-tone audiometry and high-resolution computed tomography (CT) of the temporal bone are essential tools for characterizing associated lesions and guiding surgical decision-making.4 Furthermore, electroneuromyography (ENMG) and electromyography (EMG) allow for the objective assessment of the degree of nerve degeneration and the selection of patients who may benefit from surgical decompression.[5] However, surgical indications remain debated, particularly regarding the optimal timing for intervention and the prognostic factors influencing postoperative recovery.[6]

In this context, we conducted a ten-year retrospective analytical study in the ENT and cervicofacial surgery department of the 20 Août University Hospital in Casablanca, including 44 patients operated on via transmastoid facial nerve decompression. The main objective of this work is to identify and analyze the clinical, paraclinical, and intraoperative prognostic factors influencing functional outcomes after surgical decompression of the facial nerve in severe post-traumatic facial paralysis (grades 4 to 6 according to the House-Brackmann scale). Particular attention is paid to the pre- and postoperative evaluation methodology, integrating standardized clinical parameters, electrophysiological examinations, and intraoperative data, aiming to contribute to the optimization of management strategies for this condition which has significant functional and psychosocial impact.

2. Materials and Methods

A single-center, retrospective analytical study was conducted between January 2014 and December 2023 at the Department of Otolaryngology and Cervicofacial Surgery of the 20 Août University Hospital in Casablanca. The study included 44 consecutive patients who underwent surgery for severe post-traumatic peripheral facial paralysis (House-Brackmann grades 4 to 6) via transmastoid facial nerve decompression. Inclusion criteria required computed tomography (CT) confirmation of a temporal bone fracture and preoperative electromyography (EMG) showing nerve degeneration $\geq 90\%$. Non-traumatic paralysis and incomplete medical records were excluded.

Data were systematically extracted from medical records using a standardized protocol, covering five domains: epidemiological (age, sex, injury mechanism); clinical (time and mode of onset, associated signs, initial grade); paraclinical (audiometry, topographic tests, EMG, CT); intraoperative (surgical timing, type and location of lesions, associated procedures); and outcomes (follow-up at 1, 6, and 12 months according to the House-Brackmann scale). For prognostic analysis, patients were stratified into two groups: good recovery (grades 1-2) and fair to poor recovery (grades 3-4).

Statistical analysis was performed using SPSS 25 and Excel software. Qualitative variables were compared using the Chi-square test (or Fisher's exact test) and quantitative variables using Student's t-test, with a significance threshold set at $p < 0.05$. Results are presented as counts (percentages) and means (± standard deviation).

The study was conducted in accordance with the principles of the Declaration of Helsinki. Patient anonymity was ensured, and the protocol received approval from the local ethics committee.

3. Results

Over a ten-year period (2014–2023), 44 patients with severe post-traumatic peripheral facial paralysis were included in the study. The mean age was 27.1 ± 12.7 years (range: 5–50 years), with a clear predominance in the 15–30-year age group. A strong male predominance was observed (79.5% men, n=35), with a male-to-female sex ratio of 3.9. The primary traumatic mechanism was road traffic accidents (RTA), involved in 77.3% of cases (n=34), followed by assaults (13.6%, n=6) and work accidents (4.5%, n=2).

The mean interval between trauma and the first specialized ENT consultation was 10.1 ± 7.6 weeks (range: 2 to 44 weeks). The mode of paralysis onset was immediate in 31.8% of cases (n=14), progressive in 15.9% of cases (n=7), and undetermined in 52.3% of cases (n=23) due to initial impaired consciousness. According to the House-Brackmann classification, preoperative severity was distributed as follows: grade 4 (11.4%, n=5), grade 5 (59.1%, n=26), and grade 6 (29.5%, n=13). The involvement was right-sided unilateral in 54.5% of cases (n=24), left-sided unilateral in 40.9% of cases (n=18), and bilateral in 4.5% of cases (n=2). The most frequently associated clinical signs were otorrhagia (36.4%, n=16), hypoacusis (31.8%, n=14), and vertigo (6.8%, n=3); no cases of tinnitus were reported. Finally, isolated head trauma was present in 70.5% of patients (n=31), polytrauma in 6.8% (n=3), and head trauma with spinal injury in 2.3% (n=1).

Site of lesion	Fair to poor outcome (Grade 3-4)		Good outcome (Grade 1-2)		P- Value
	Count	Percentage	Count	Percentage	
F1	1	50%	1	50%	1 (NS)
Gg	13	46,4%	15	53,6%	0,864 (NS)
F2	16	43,2%	21	56,8%	0,792 (NS)
Geniculate knee	7	43,8%	9	56,2%	0,864 (NS)
F3	4	40%	6	60%	0,974 (NS)

Table 1: Distribution of cases according to the topography of the lesion.

Preoperative diagnostic workup provided critical insights into the nature and extent of the injuries. Pure-tone audiometry documented hearing loss in 63.6% of patients, with conductive hearing loss being the most prevalent type (38.6%), followed by sensorineural (15.9%) and mixed hearing loss (11.4%). Topographic testing indicated proximal nerve dysfunction, evidenced by an absent stapedial reflex in 75% of cases, while the Schirmer test was positive—indicating impaired lacrimation—in 31.8% of patients. Electromyography (EMG) confirmed the severity of axonal injury, classifying preoperative lesions as axonotmesis in 79.5% of cases, neurotmesis in 18.2%, and neuropraxia in a single case (2.3%). High-resolution temporal bone CT scans further characterized the traumatic pathology, classifying fractures as extra labyrinthine (50%), trans-labyrinthine (38.6%), or mixed (11.4%), and identifying ossicular chain involvement in 31.8% of patients.

EMG	Fair to poor outcome (Grade 3-4)		outcome (Grade 1-2)		P-Value
	Count	Percentage	Count	Percentage	
Axonotmesis	14	40%	21	60%	
Neurotmesis	4	50%	4	50%	0,472 (NS) ETM=0,45
Neuropraxia	0	0%	1	100%	

Table 2: Distribution of patients according to EMG results.

The mean interval from trauma to surgical intervention was 12.0 ± 7.7 weeks, with no patient undergoing surgery within the first two weeks. The distribution of surgical timing was as follows: 43.2% of patients were operated on between two weeks and one month post-trauma, 25% between one and two months, 25% between two and three months, and 29.5% at three months or later. All surgical procedures were performed via a transmastoid approach. To adequately visualize and decompress the proximal segments of the facial nerve, ossicular chain disarticulation was required in the majority of cases (68.2%). Direct inspection of the nerve during surgery revealed a spectrum of lesions: edema was the most common finding (68.2%), followed by fibrosis (20.5%), granuloma formation (9.1%), complete transection (9.1%), and ecchymosis (2.3%). The lesions frequently involved multiple sites along the nerve's intratemporal course. The tympanic segment (F2) was the most commonly affected region (84.1%), often in conjunction with the geniculate ganglion (Gg) (63.6%). The mastoid segment (F3) was involved in 22.7% of cases, while the labyrinthine segment (F1) was rarely affected (4.5%). Concomitant reconstructive procedures were performed as necessary; incus interposition ossiculoplasty was carried out in 31.8% of patients to address ossicular disruption, and a great auricular nerve graft was utilized in the single case where a complete nerve transection was encountered.

Functional outcomes were assessed at a 12-month follow-up using the House-Brackmann classification. The final distribution of facial function was as follows: grade 1 (15.9%, n=7), grade 2 (38.6%, n=17), grade 3 (31.8%, n=14), and grade 4 (13.6%, n=6). Notably, no patient remained in grades 5 or 6, indicating an absence of complete surgical failure. For prognostic analysis, patients were stratified into two groups: a good outcome (grades 1–2), achieved by 54.5% of the cohort (n=24), and a fair to poor outcome (grades 3–4), observed in 45.5% (n=20). A univariate analysis of potential prognostic factors revealed that the type of intraoperative nerve lesion was the sole variable significantly associated with functional recovery (p=0.009). Specifically, the presence of fibrosis, granuloma, or ecchymosis was strongly correlated with an unfavorable outcome. In contrast, no statistically significant associations were found with patient age (p=0.384), sex (p=0.477), mechanism of trauma (p=0.290), time from trauma to initial consultation (p=0.197), initial House-Brackmann grade (p=0.380), type of temporal bone fracture on CT (p=0.460), or the topographic site of the nerve lesion (p>0.05 for all segments). In an extended follow-up of the six patients with a final grade 4, intensive facial neuromuscular rehabilitation enabled four individuals to improve to grade 3, while two patients were lost to further follow-up.

No major complications (infection, CSF leak, iatrogenic hearing loss) were recorded in this series. Hearing was preserved in patients operated on without ossicular disarticulation (mean pre-/postoperative audiometric difference non-significant: +1.17 dB).

4. Discussion

Our cohort, with a mean age of 27.1 years and a strong male predominance (79.5%), aligns with classic epidemiological data identifying young adult males as the population most exposed to high-energy trauma, primarily road traffic accidents (77.3%).[2,3,8] This profile reflects the societal impact of road accidents and justifies targeted prevention campaigns. A major finding in our series is the prolonged delay between trauma and the first specialized ENT consultation (mean 10.1 weeks) as well as between trauma and surgical intervention (mean 12.0 weeks). This delay is significantly longer than that reported in studies such as those by Khamassi et al. (4 weeks) or Hato et al. (4.75 weeks).[5,6,13] This latency is primarily explained by the severity of the initial clinical presentations: 31.8% of patients required intensive care unit stay, 79.6% had associated trauma (including 70.5% isolated head trauma), and 52.3% had impaired consciousness preventing reliable initial neurological assessment. Urgent life-saving and neurosurgical management therefore systematically took priority over facial pathology, a well-documented phenomenon.[9] This delay raises the question of its influence on prognosis, a debate that remains open in the literature.[4,6]

Study	Immediate facial paralysis	Progressive-onset facial paralysis	P-Value
Darrouzet et al. [16]	51,3%	14,8%	-
Taylor et Francis [17]	100%	0%	-
Vajpayee et al [15]	45%	55%	0,18 (NS)
Shankar et al [14]	23,4%	76,60%	0,579 (NS)
Our study	31,81%	15,9%	0,540(NS)

Table 3: Distribution of cases according to the mode of onset of facial paralysis.

Our protocol was based on rigorous and systematic paraclinical evaluation, the results of which illuminate the pathophysiology of the lesions. Pure-tone audiometry documented hearing loss in 63.6% of cases, with a predominance of conductive hearing loss (38.6%). This is perfectly correlated with the high prevalence of extra-labyrinthine fractures (50%) in our series, this type of fracture being known to preferentially injure middle ear structures and the ossicular chain (involved in 31.8% of our patients).[10,14,15] Electromyography (EMG) played a critical selective role: the inclusion criterion of ≥90% nerve degeneration allowed us to target patients for whom spontaneous recovery was highly unlikely, thus strongly guiding them toward a surgical solution.[5] The distribution of EMG lesions (axonotmesis:79.5%, neurotmesis: 18.2%) aligns with the initial clinical severity. Finally, high-resolution temporal bone CT confirmed its role as the key examination for the topographic diagnosis of fractures, their classification, and surgical approach planning.[4] The correlation between the type of fracture on CT (extralabyrinthine/translabyrinthine) and intraoperative findings reinforces the validity of this preoperative imaging.

Study	Extralab-yrinthine fracture	Translab-yrinthine fracture	Mixed fracture	P-Value
K.khamassi et al [22]	43,7%	31,2%	25%	-
Abbasza-deh- Kasbi et al [18]	43%	43%	14%	0,709(NS)
Darrouzet et al [16]	80%	14,78 %	-	-
Vajpayee et al [15]	60%	20%	10%	-
Our Study	50%	38,63%	11,4%	0,460(NS)

Table 4: Distribution of patients according to the type of temporal bone fracture.

Surgical exploration via the transmastoid approach, performed in all patients, allowed for crucial direct observations. The topography of lesions showed a clear predilection for the tympanic segment (F2: 84.1%) and the geniculate ganglion (63.6%), consistent with the mechanical vulnerability of these areas during longitudinal fractures of the temporal bone.[3,7] The need for ossicular chain disarticulation in 68.2% of cases to access the proximal nerve segments highlights the limitations of exposure via this route and the sometimes-necessary trade-offs between optimal exposure and hearing preservation. Our univariate analysis revealed a major prognostic finding: the type of nerve lesion observed intraoperatively was the only factor significantly associated with the final functional outcome (p=0.009). This constitutes a significant contribution of our study. While factors such as surgical timing or initial grade are widely debated,[6,12] we demonstrate that the histological nature of the nerve injury is determining. Edema (68.2% of lesions), a compressive and often reversible lesion, was associated with an excellent prognosis (73.3% good outcomes grades 1-2). Conversely, lesions indicative of deeper and chronic tissue aggression such as fibrosis (88.9% fair to poor outcomes), granuloma, or ecchymosis (100% unfavorable outcomes) were poor prognostic signs. Complete transection, although rare (9.1%), had a mixed prognosis (50% good outcomes) depending on the quality of immediate microsurgical repair. This prognostic hierarchy based on macroscopic intraoperative appearance provides the surgeon with an immediate prognostic assessment tool and reinforces the idea that decompression is all the more beneficial when the lesion is still at a "compressive" rather than "destructive" stage.

The overall rate of good functional outcomes (House-Brackmann grades 1-2) at one year of 54.5% is comparable to recent surgical series, where it generally ranges between 50% and 70%.[8,11,16] The absence of complete failure (grades 5-6) in our series and the preservation of hearing when the ossicular chain was not disarticulated attest to the efficacy and safety of the technique. However, the lack of significant correlation between **surgical timing** (often considered critical) and outcome in our analysis must be interpreted with caution. It may be explained by: 1) selection bias related to the EMG criterion (only the worst cases, with advanced degeneration, are operated on, regardless of timing), 2) the limited sample size (n=44), reducing statistical power, and 3) the distribution of delays in our cohort, with few patients operated on very early (<2 weeks). This does not challenge the principle of early intervention recommended by many authors [4,17] but suggests that for patients selected based on strict electrophysiological criteria, a therapeutic window may exist beyond classically accepted timeframes. The main limitation of our work is its retrospective and single-center nature, with inherent selection and data collection biases. The significant proportion of onset modes labeled "undetermined" (52.3%) illustrates a recurrent difficulty in clinical practice with polytrauma patients.

This study confirms that transmastoid decompression of the facial nerve is an effective and safe treatment for severe post-traumatic facial paralysis, allowing satisfactory functional recovery in more than half of the patients. It underscores the importance of a multidisciplinary preoperative evaluation integrating clinical findings, EMG, and CT, and identifies the type of intraoperative lesion as a major and immediate prognostic factor.[18] Our results argue for early surgical intervention as soon as the patient's condition allows, while suggesting that the prognosis is more dictated by the nature of the nerve lesion than by timing alone in selected patients. Larger multicenter prospective studies are needed to better define the indications and optimal timing for surgery, as well as to validate the prognostic value of intraoperative observations.

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