

**RELATIONSHIP BETWEEN SITE OF FACIAL NERVE INJURY
AND PERCENTAGE OF DENERVATION IN
ELECTRONEURONOGRAPHY:
A RETROSPECTIVE STUDY**

DR TAMIL SELVI A/P RAJOO

**DISSERTATION SUBMITTED IN PARTIAL FULLFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF MASTER OF
MEDICINE (OTORHINOLARYNGOLOGY-HEAD
AND NECK SURGERY)**



**SCHOOL OF MEDICAL SCIENCES
UNIVERSITI SAINS MALAYSIA**

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I would like to express my deepest gratitude and thanks to my supervisor, Professor Dr. Khairi Md Daud, Consultant Otorhinolaryngology, Department of Otorhinolaryngology-Head and Neck Surgery (ORL-HNS), School of Medical Science, Universiti Sains Malaysia, for initiating the idea of this study, as well as for his kind guidance and continuous support throughout the course of completing this dissertation despite his very busy schedule and endless commitments. It is a great honor to work under his supervision.

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ABSTRAK

Objektif Kecelakaan saraf facial akibat trauma memberi kesan teruk pada fungsi dan penampilan seseorang pesakit itu. Ia amat mustahak untuk seorang pakar Otorinolaringogi sentiasa peka dalam mengesan dan merawat kecederaan itu secepat mungkin. Dengan itu, kami mengkaji kesan klinikal pada pesakit yang mengalami keretakan/kepatahan tulang temporal dan kecederaan saraf facial akibat trauma itu. Kami juga mengkaji hubungan antara lokasi kecederaan saraf facial dan peratusan kemerosotan saraf dalam ujian elektroneurografi (ENOG).

Metodologi Ini merupakan satu kajian retrospektif yang telah dijalankan di sebuah hospital universiti dari 1hb Januari 2010 sehingga 31hb Januari 2020. Seramai 82 pesakit keretakan/kepatahan tulang temporal dan kecederaan saraf muka yang memenuhi kriteria telah menyertai kajian ini. Kriteria penyertaan adalah semua pesakit di atas yang mempunyai maklumat lengkap tentang fungsi saraf muka, skala kecederaan House Brackmann, ENOG dan imbasan CT beresolusi tinggi tulang temporal. Data demografi, penemuan klinikal, Audiometri Tona Asli, skala kecederaan House Brackmann, ENOG dan imbasan CT beresolusi tinggi semuanya dikumpulkan dan dianalisa.

Keputusan Min umur pesakit yang terlibat dengan trauma kajian adalah 27.5 tahun. Kemalangan kenderaan bermotor menyumbang 92.7% daripada penyebab trauma. Kebanyakan penunggang motosikal yang terlibat tidak memakai topi keledar (83.3%). Didapati 87.8% adalah kes kelemahan saraf muka jenis bukan serta merta. Separuh daripada pesakit (50%) mengalami kelumpuhan saraf muka gred 4 pada skala kecederaan House Brackmann. Didapati hilang pendengaran jenis konduktif yang paling kerap terjadi. Keretakan/kepatahan tulang temporal jenis longitudinal adalah tertinggi (60.5%).

Jika mengikut sistem klasifikasi keretakan/kepatahan tulang temporal yang terbaru, majoriti kes adalah jenis kapsul otik terselamat (84.4%). Berdasarkan sistem klasifikasi lama, kami dapati bahawa segmen timpanik saraf muka adalah lokasi yang paling kerap tercedera (28%) dan diikuti oleh segmen genu pertama (24.4%). Tiada perbezaan signifikan antara peratusan kemerosotan saraf pada ujian ENOG dengan lokasi kecederaan saraf muka (nilai $p < 0.075$).

Kesimpulan Tiada hubungan antara lokasi kecederaan saraf muka dan keputusan ujian ENOG. Justeru, pemilihan pesakit untuk pembedahan tidaklah hanya berpandukan pada imbasan CT beresolusi tinggi, tetapi juga gred klinikal (waktu kelumpuhan) dan ujian ENOG bersiri.

RELATIONSHIP BETWEEN SITE OF FACIAL NERVE INJURY AND PERCENTAGE OF DENERVATION IN ELECTRONEURONOGRAPHY: A RETROSPECTIVE STUDY

ABSTRACT

Objective Traumatic facial nerve injury is very devastating functionally and aesthetically for a patient. It is crucial for an Otorhinolaryngology surgeon to be vigilant in diagnosing facial nerve injury and intervene at a right time . Hence, we aimed to study the clinical outcome of patients with temporal bone fracture (TBF) and traumatic facial nerve injury. In addition, the association between site of facial nerve injury and percentage of denervation in electroneuronography(ENOG) was studied.

Methodology This a retrospective study (observational) which done in tertiary university hospital between 1st January 2010 to 31st January 2020. A total 82 patients who had TBF and traumatic facial nerve injury who fulfilled inclusion and exclusion criteria have been recruited. The inclusion criteria are all the patients who involved with trauma with complete documentation of facial nerve function with House Brackmann (HB) grading, Electroneuronography (ENOG) result and post trauma High Resolution Computer Tomography (HRCT) of Temporal bone. The data on demography of patients, clinical findings, Pure Tone Audiometry, HB grading, ENOG and HRCT Temporal result were collected and analysed.

Results The mean age of patients involved in trauma were 27.5 years old. Motor Vehicle Accidents (MVA) constituted 92.7% of the cause for trauma. Most of the motorcyclists who involved were without helmet (83.3%). Delayed facial paralysis was found in 87.8% cases. Half of the patients with facial nerve injury had severity of HB grade IV (50%). The conductive hearing loss was commonly seen among our patients. The prevalence of

patients with longitudinal TBF were the highest (60.5%). Based on the new classification of TBF, majority of our cases were otic capsule sparing (84.4%). Based on the old classification, we found the tympanic segment of facial nerve (28%) commonly injured followed by the first genu (24.4%). There was no significant difference between the percentage of denervation (ENOG) and the sites of facial canal fracture (p value<0.075).

Conclusion There is no association between sites of facial nerve injury and ENOG result. The selection of patients for surgery should not solely rely on HRCT but also clinical grading (time of onset) and serial ENOG monitoring.

CHAPTER 1:

INTRODUCTION

1.1 INTRODUCTION

Facial nerve injury can be a very devastating consequence of a blunt or penetrating trauma to the head and the neck. The commonest cause of facial nerve injury is by blunt trauma from a fracture of the temporal bone¹. A study by Coker et al. reported that 18 of the 29 patients with traumatic facial nerve injury handled had TBF². The blunt force trauma of TBF causes either direct fallopian canal involvement and nerve injury or indirect injury via post concussive injury and oedema³. A local study conducted in the Tengku Ampuan Afzan Hospital in 2008 revealed that traumatic facial injury was seen in 24 out of 46 patients who sustained TBF⁴. These injuries typically are caused by falls from height, motor vehicle accidents, assaults, and penetrating trauma like gunshot wound^{5,6}. Little S and Kesser B found in their study that the causes of TBF were mainly motor vehicle crash (n = 14[47%]), followed by falls (n = 10 [33%]) and assault (n = 4 [10%])⁷.

The facial nerve is more vulnerable to injury than any other cranial nerve following head trauma due to several reasons, most notably its length and course. A thorough knowledge of the facial nerve courses is pertinent in diagnosing the sites of the facial nerve injury. It can be classified as intracranial, intra-temporal and extratemporal. The intra cranial course is from its origin at the pontomedullary junction of the brain stem to the apex of the Internal Auditory Canal (IAC). The intra temporal course is within the IAC to the stylomastoid foramen. It can be subdivided further into meatal, labyrinthine, tympanic, and mastoid segments^{1,5}. The understanding the extent of the facial nerve damage is also crucial for surgeons to predict the prognosis and make decisions on the treatment.

Facial nerve injury can be grossly described as a simple traction injury of the structurally intact nerve, crush injury or full transection, and loss of a segment of nerve^{1,8}. In 1943,

Seddon et al. classified nerve damage into three types which are neuropraxia, axonotmesis and neurotmesis^{9,10}. Neuropraxia occurs when compression or stretch induces an anoxic, physiological block of both axoplasmic transport and ion channel functions along damaged axons: loss of function is usually temporary and removal of the compressive agent typically brings about a rapid and complete restoration of function as well as pain relief^{8,10}. Neurotmesis occurs when a nerve is either completely divided or severely damaged by injury that recovery without some form of surgical intervention is impossible^{8,10}. Axonotmesis happens when a blunt trauma to a nerve results in Wallerian degeneration distal to the injury, but the connective tissue layers (epi-, peri- and endoneurium) remain intact. Conduction stops throughout the distal extent of the nerve within a few days of injury^{8,10}.

Subsequently in 1951, Sir Sydney Sunderland expanded Seddon's classification of axonotmesis to characterise progressively more invasive levels of injury to the endoneurial contents, perineurium and epineurium respectively, correlating these additional levels to more precise outcomes in axonotmesis injuries^{10,11}. The Sunderland's grade 1 and 2 injuries, which correspond to neuropraxia and axonal degeneration with intact endoneurium, normally recover fully; the grade 3 injuries recover partially; the grades 4 and 5 which correspond to neurotmesis, often require surgical intervention⁸⁻¹⁰.

A standard clinical grading of the facial nerve function is the HB scale. Based on a clinical evaluation of the patient's facial presentation, HB gives an approximation of the patient's amount of voluntary mobility¹². However, it can be subjective due to variations among observers^{13,14}. The use of modern diagnostic tools such as HRCT Temporal and ENOG has made the diagnosis and treatment of facial nerve injury more accurate¹⁵.

The HRCT of the Temporal bone is the best method to demonstrate the temporal fracture line in relation to the fallopian canal¹⁶. Traditionally, radiographic imaging of TBF is classified into longitudinal, transverse, or mixed types, based on their orientation in relation to the petrous ridge^{7,17}. In the new system, TBF is classified into otic capsule sparing and otic capsule violating, based on the integrity of the otic capsule bone⁷.

A study of the HRCT Temporal in patients with facial paralysis in TBF showed that the most frequently affected site was the geniculate ganglion (80.6%), followed by the tympanic segment (48.3%), labyrinthine segment (16.1%), pyramids (6.4%) and the mastoid segment (3.2%)¹⁶. Multiple studies concluded that the incidence of longitudinal fracture is higher than transverse fracture in the temporal bone^{3,7,18-20}. However, the traumatic facial nerve injury is more common in transverse fracture.

For patients with facial palsy, determining the extent of facial nerve injury and assessing the prognosis are crucial. In 1973, Esslen developed the prognostic procedure known as ENOG, which is still frequently used today^{21,22}. It is an objective test that measures the evoked compound muscle action potentials (CAMP) by the electrical stimulation of electrodes that are placed as near as feasible to the stylomastoid foramen, to stimulate the main trunk of the facial nerve^{5,21,22}. The percentage of facial nerve degeneration on the paralysed side is shown by the ENOG value, which is the ratio of the CAMP on the paralysed side to that on the healthy side, multiplied by 100^{5,21,22}.

The percentage of denervation in ENOG represent the percentage of neural fibres that are no longer responding. Any ENOG response greater than 10% (or conversely, a 90%

denervation) is consistent with a spontaneous recovery and may allow the ‘wait and watch’ response by the treating physician²³. However, a response of less than 10% can direct to surgical exploration and facial nerve decompression^{14,23}. It is crucial to wait at least 3 days post facial palsy for reliable ENOG value because Wallerian degeneration of nerve from the point of injury to distal of stylomastoid foramen takes roughly 72 hours to complete.^{14,21,22,24}.

Multiple studies have been conducted to evaluate the accuracy of the HRCT temporal in diagnosing type TBF and the site of the traumatic facial nerve injury. There are also studies on the reliability of ENOG to determine the severity of traumatic facial nerve injury. Despite all these literatures, no study has evaluated the association between the types of temporal bone fracture and the sites of facial nerve injury with the severity of facial nerve injury using ENOG. The aim of this study was to evaluate the association between sites of facial nerve injury and ENOG. This study will broaden the knowledge of surgeons in understanding the nature and management of the traumatized facial nerve in the future.

CHAPTER 2:

OBJECTIVES OF THE STUDY

2.0 OBJECTIVES OF THE STUDY

2.1 General Objective

To study on patients with traumatic facial nerve injury with the use of House Brackmann(HB) scale , percentage of denervation in ENOG and radiological evidence of temporal bone fracture.

2.2 Specific Objectives

1. To identify the site of the facial nerve injury based on the HRCT Temporal (with a Bone window algorithm).
2. To correlate the severity of facial nerve injury based on HB with percentage of denervation in ENOG.
3. To determine the association between the sites of facial nerve injury with the severity of the facial nerve injury based on ENOG.
4. To evaluate the agreement between old and new classification of Temporal bone fractures

CHAPTER 3:

MANUSCRIPT

3.1 TITLE PAGE

Relationship Between Site of Facial Nerve Injury and Percentage of Degeneration in Electroneuronography

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3.2 ABSTRACT

Objective: We aimed to study the clinical outcome of patients with temporal bone fracture (TBF) and traumatic facial nerve injury. In addition, the association between site of facial nerve injury and percentage of denervation in electroneuronography(ENOG) was studied.

Study design: This was a retrospective study (observational) done from 1st January 2010 to 31st January 2020.

Setting: Tertiary university hospital

Patients : A total of 82 patients who had TBF and traumatic facial nerve injury who fulfilled inclusion and exclusion criteria were recruited. Inclusion criteria included post-trauma patients with complete documentation of facial nerve function with House Brackmann (HB) grading. ENOG result and post trauma High Resolution Computer Tomography (HRCT) of Temporal bone. The data on demography of patients, clinical findings, Pure Tone Audiometry, HB grading of facial nerve, ENOG and HRCT Temporal result were collected and analysed.

Results: The mean age of patients involved in trauma were 27.5 years old. Motor Vehicle Accidents (MVA) constituted 92.7% of the cause for trauma. Most of the motorcyclists involved were without helmet (83.3%). Delayed facial paralysis was found in 87.8% of cases. Half of the patients with facial nerve injury had severity of HB grade IV (50%). Conductive hearing loss was commonly seen among our patients. The prevalence of patients with longitudinal TBF were the highest (60.5%). Based on the new classification of TBF, majority of our cases were otic capsule sparing (84.4%). Based on the old classification, we found the tympanic segment of facial nerve (28%) was commonly

injured followed by the first genu (24.4%). There was no significant difference between the percentage of denervation (ENOG) and the sites of facial canal fracture (p value<0.075).

Conclusion There is no association between sites of facial nerve injury and ENOG result. The selection of patients for surgery should not solely rely on HRCT but also on clinical grading of facial nerve palsy (at time of onset) and serial ENOG monitoring.

3.3 INTRODUCTION

Facial nerve injury can be a very devastating consequence of a blunt or penetrating trauma to the head and the neck. The commonest cause of facial nerve injury is by blunt trauma from a fracture of the temporal bone¹. A study by Coker et al. reported that 18 of the 29 patients with traumatic facial nerve injury handled had TBF². The blunt force trauma of TBF causes either direct fallopian canal involvement and nerve injury or indirect injury via post concussive injury and oedema³. A local study conducted in the Tengku Ampuan Afzan Hospital in 2008 revealed that traumatic facial injury was seen in 24 out of 46 patients who sustained TBF⁴. These injuries typically are caused by falls from height, motor vehicle accidents, assaults, and penetrating trauma like gunshot wound^{5,6}. Little S and Kesser B found in their study that the causes of TBF were mainly motor vehicle crash (n = 14[47%]), followed by falls (n = 10 [33%]) and assault (n = 4 [10%])⁷.

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Subsequently in 1951, Sir Sydney Sunderland expanded Seddon's classification of axonotmesis to characterise progressively more invasive levels of injury to the endoneurial contents, perineurium and epineurium respectively, correlating these additional levels to more precise outcomes in axonotmesis injuries^{10,11}. The Sunderland's grade 1 and 2 injuries, which correspond to neuropraxia and axonal degeneration with intact endoneurium, normally recover fully; the grade 3 injuries recover partially; the grades 4 and 5 which correspond to neurotmesis, often require surgical intervention⁸⁻¹⁰.

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The HRCT of the Temporal bone is the best method to demonstrate the temporal fracture line in relation to the fallopian canal¹⁶. Traditionally, radiographic imaging of TBF is classified into longitudinal, transverse, or mixed types, based on their orientation in relation to the petrous ridge^{7,17}. In the new system, TBF is classified into otic capsule sparing and otic capsule violating, based on the integrity of the otic capsule bone⁷.

A study of the HRCT Temporal in patients with facial paralysis in TBF showed that the most frequently affected site was the geniculate ganglion (80.6%), followed by the tympanic segment (48.3%), labyrinthine segment (16.1%), pyramids (6.4%) and the mastoid segment (3.2%)¹⁶. Multiple studies concluded that the incidence of longitudinal fracture is higher than transverse fracture in the temporal bone^{3,7,18-20}. However, the traumatic facial nerve injury is more common in transverse fracture.

For patients with facial palsy, determining the extent of facial nerve injury and assessing the prognosis are crucial. In 1973, Esslen developed the prognostic procedure known as ENOG, which is still frequently used today^{21,22}. It is an objective test that measures the evoked compound muscle action potentials (CAMP) by the electrical stimulation of electrodes that are placed as near as feasible to the stylomastoid foramen, to stimulate the main trunk of the facial nerve^{5,21,22}. The percentage of facial nerve degeneration on the paralysed side is shown by the ENOG value, which is the ratio of the CAMP on the paralysed side to that on the healthy side, multiplied by 100^{5,21,22}.

The percentage of denervation in ENOG represent the percentage of neural fibres that are no longer responding. Any ENOG response greater than 10% (or conversely, a 90%

denervation) is consistent with a spontaneous recovery and may allow the ‘wait and watch’ response by the treating physician²³. However, a response of less than 10% can direct to surgical exploration and facial nerve decompression^{14,23}. It is crucial to wait at least 3 days post facial palsy for reliable ENOG value because Wallerian degeneration of nerve from the point of injury to distal of stylomastoid foramen takes roughly 72 hours to complete.^{14,21,22,24}.

Multiple studies have been conducted to evaluate the accuracy of the HRCT temporal in diagnosing type TBF and the site of the traumatic facial nerve injury. There are also studies on the reliability of ENOG to determine the severity of traumatic facial nerve injury. Despite all these literature, no study has evaluated the association between the types of temporal bone fracture and the sites of facial nerve injury with the severity of facial nerve injury using ENOG. The aim of this study was to evaluate the association between sites of facial nerve injury and ENOG. This study will broaden the knowledge of surgeons in understanding the nature and management of the traumatized facial nerve in the future.

3.4 MATERIALS AND METHODS

This was a retrospective observational study done in Hospital Universiti Sains Malaysia, Kubang Kerian, Kelantan. This study was approved by our university Human Research Ethics Committee with code number USM/JEPeM/21050379. The study was performed according to Helsinki Declaration.

The data was collected from the medical record department, clinic of ORL-HNS and PACS online (Picture Achieve Communication System). We collected data between 1st January 2010 and 31st January 2020. A total of 82 patients who had TBF with traumatic facial nerve paralysis were recruited (strictly based on inclusion and exclusion criteria). The inclusion criteria were post-trauma patients with complete documentation of facial nerve function with HB grading, ENOG result and post trauma HRCT of Temporal bone. Patients with bilateral facial nerve injury, pre-existing facial nerve palsy prior to trauma due to other causes, comatose and uncooperative patients or patients on any form of muscle relaxants were excluded from the study.

Variables recorded for each participants included demography, date of trauma, mode of injury, side of facial palsy, date of onset of facial palsy, other associated symptoms and signs post trauma. The severity of facial nerve palsy was graded clinically based on HB grading (Table 1)². We have documented the pure tone audiometry (PTA), ENOG results, HRCT temporal post trauma findings for each patient.

The PTA results were interpreted based on The World Health Organization (WHO) hearing loss classification which categorised based on the disease's severity or degree. Mild hearing loss was defined as between 26 and 40 dB, moderate as between 41 and 55

dB, moderately severe as between 56 and 70 dB, severe as between 71 and 90 dB, and profound as above 91 dB^{25,26}. For sensorineural hearing loss (SNHL), the audiogram showed similar abnormal bone conduction and air conduction threshold levels (higher than 25 dB)^{26,27}.

For conductive hearing loss (CHL), the audiogram showed normal bone conduction (0–25 dB) and abnormal air conduction threshold levels (higher than 25 dB)^{26,27}. According to the American Speech-Language-Hearing Association, CHL is diagnosed when there is a significant air–bone gap (greater than 10dB)²⁶. Mixed hearing loss has both conductive and sensorineural impairment where both an air–bone gap larger than 10 dB and an elevated bone conduction threshold are observed²⁶.

The percentage of facial nerve degeneration in ENOG of the paralysed side was calculated with the ratio of the CAMP on the paralysed side to that on the healthy side, multiplied by 100^{5,21,22}. The percentage of denervation in ENOG represented the percentage of neural fibres that were no longer responding. Any ENOG response greater than 10% (or conversely, 90% denervation) had good prognosis with a chance of spontaneous recovery²³. A response of less than 10% (greater than 90% degradation) was regarded as significant value because there was a 50% possibility of an unfavourable recovery and a much lower likelihood that facial nerve function would return²⁸.

The HRCT of Temporal bone reports and scans were examined for fracture of the temporal bone and site facial nerve (fallopian canal) injury. Traditional classification schemes (longitudinal, transverse, or mixed) and new classification schemes (otic capsule sparing or otic capsule involvement) were used to categorise the TBF. Longitudinal

fractures were defined as fractures running parallel to the petrous pyramid. Transverse fractures were defined as fractures running perpendicular to the petrous pyramid. Mixed fractures were defined as a combination of both longitudinal and transverse fractures. The new classification for TBF labelled fractures simply based on the integrity of the otic capsule bone^{18,28}. The site of facial nerve injury was categorized into meatal segment, labyrinth segment, first genu, tympanic segment, second genu and mastoid segment.

The IBM Statistical Package for Social Sciences was used to analyse the data (SPSS version 27.0). In order to summarise categorical data, frequency and percentage were used. The Spearman correlation test was used to determine the correlation between severity facial nerve injury based HB grading and percentage of denervation in ENOG . The Kruskal-Wallis Rank Sum test was used to compare the percentage of denervation in (ENOG) in relation to the different sites of facial nerve injury. The Cohen Kappa test was used to assess agreement between old and new classification of Temporal bone fracture. A p-values <0.05 were deemed to be statistically significant.

3.5 RESULTS

Demographic

Eighty-two patients with traumatic facial nerve injury cases were included in the analysis. The demography of the cases was summarised in (Table 2). The mean age of the participants was 27.5 years old. Among the participants, 67 (81.7%) were males and 15 (18.3%) were females, with a male-female ratio of 7: 2. Largely, 80 (97.6%) Malay participants seen in the study followed by Chinese 1 (1.2%) and other 1 (1.2%).

The major cause of trauma is MVA (n=76; 92.7%). Among the seventy-six MVA cases, highest was involving motorcycle (n=65; 83.3%), followed by car (n=6; 7.7%), bicycle (n=3; 3.8%), pedestrian (n=2; 2.6%) and lorry and truck (n=2; 2.6%). Among the 65 motorcyclists, more than half of them (n=41; 63%), were not wearing protective gear like helmet at time of trauma.

Clinical findings among patients with Traumatic facial nerve palsy

There were about forty-eight patients (58.5%) with ear bleed post trauma which was the major presenting complaint. Other post trauma symptoms reported were tinnitus (n=17; 20.7%), vertigo (n=13; 15.9%), ear fullness (n=10; 12.2%), headache (n=8; 9.8%) and hearing loss (n=43; 52.4%). The otology examination in emergency department revealed most patients had blood clot in external meatus (n=60; 73.2%), followed by hemotympanum (n=23; 28.0%), tympanic perforation (n=14; 17.1%), pinna laceration (n=11; 13.4%) and Battle's sign (n=4; 4.9%).

As PTA is a standardized and sensitive equipment for hearing assessment, it was used to diagnose types and severity of hearing loss in this study. PTA of 82 participants revealed

(n=76; 92.7%) of them had hearing loss and the rest (n=6; 7.3%) of them had normal hearing post trauma. Majority of the hearing loss were moderate in severity (n=36; 43.9%), followed by mild (n=19; 23.3%), profound (n=12; 14.6%) and severe (n=9; 11.0%). About half of hearing loss were CHL (n=43; 52.4%) while one third were mixed (n=21; 25.6%) and (n=12; 14.6%) of cases were in SNHL category.

Clinical assessment of Traumatic facial nerve palsy

There were (n=10; 12.2%) patients who had acute, and (n=72; 87.8%) patients had delayed facial palsy. On average, the onset of facial palsy occurred at day 5 post trauma. About (n=48; 58.5%) of them had facial palsy on the right side and (n=34; 41.5%) on left side. The clinical evaluation of facial nerve dysfunction using HB in these patients revealed that half of them (n=41; 50.0%) were Grade IV (moderate to severe dysfunction). This was followed by Grade II injury (mild dysfunction) (n=17; 20.7%), Grade V injury (severe dysfunction) (n=14; 17.1%), Grade III injury (moderate dysfunction) (n=9; 11.0%) and Grade VI injury (total dysfunction) (n=1; 1.2%).

HRCT temporal findings in traumatic facial nerve palsy

The HRCT in 82 patients revealed TBF in (n=76; 92.6%) of cases, leaving (n=6; 7.3%) of them without evidence of fracture line (Table 3). We observed that all the six patients without fracture line had delayed onset facial nerve palsy, around day 4 to day 5 of post trauma. The old classification of TBF based on fracture line in respect to the long axis of petrous ridge revealed that 46/76 (60.5%) were longitudinal fractures, 14/76 (18.4%) were transverse fractures and 16/76 (21.2%) were mixed fractures (Table 3). On new classification of TBF which is based on otic capsule involvement, we found 64 had otic

capsule sparing fractures and 12 had otic capsule violation fracture (Table 3). We found that 26 (31.7%) cases had ossicular involvement and 49 (59.8%) cases had fluid collection in the middle ear post trauma (Table 3).

Interestingly, we found that 22 (26.8%) patients with traumatic facial nerve palsy had intact facial canal on HRCT Temporal. Almost all of these intact facial canal (21/22 cases) had delayed onset of facial palsy. Additionally, there were cases of facial canal fractures at multiple sites (n=12; 14.6%) (Table 3). Of these 12 cases with multiple segments of facial canal fracture, the commonest combination was tympanic and first genu segments (50%) (Table 3). In term of sites of facial canal fracture, the tympanic segment (28.0%) was the commonest, followed by first genu (24.4%), mastoid (19.5%), labyrinthine (8.5%) and second genu (6.1%) (Table 3).

Electroneuronography findings in traumatic facial nerve palsy

The percentage of denervation of injured nerve were summarised in (Table 4) and the distribution is visualized in (Figure 1). In our study, all our first ENOG assessment were done between day 5 to day 14 post trauma (median of 7.5). The percentage of facial nerve denervation recorded by ENOG was between 47.7% to 94.2% (median of 82.0%). About 31 (37.8%) of our patients had denervation more than 90% at first ENOG reading.

Correlation between HB grading and denervation percentage in ENOG

Spearman correlation show that there is insignificant and low correlation between the clinical assessment using HB grading and percentage of denervation of injured nerve of first ENOG, as summarised in Table 5 and visualized in (Figure 2).

Comparison of percentage denervation (ENOG) at facial nerve fractures site.

There was no significant difference of percentage denervation between the facial canal segments fracture sites, as shown in Table 6. Hence, there were no association between sites of facial nerve injury and electroneuronography (p value <0.075). We observed that tympanic and multiple segments fracture showed more 90% denervation of facial nerve (Table 6). This means the injured facial nerve in those tympanic segments and multiple segments fracture sites will have poor chance of recovery.

Agreement between Old Classification of Temporal Fracture and Otic Capsule Violation

Among those with longitudinal fracture in HRCT, only 10 (16.1%) had otic capsule violation. Similarly, among those with transverse fracture, only 6 (20.0%) had otic capsule violation (Table 7). In terms of agreement between old and new classification, neither longitudinal fracture (P value < 0.459) nor transverse fracture (P value < 0.320) had agreement with otic capsule violation as shown in (Table 7). Nevertheless, the incidence otic capsule violation seen higher in transverse fracture (20.0%) in comparison to longitudinal fracture (16.1%), as seen in (Table 7).

3.6 DISCUSSION

There are many aetiologies for facial paralysis but the commonest cause is trauma. These injuries usually occur due to falls, MVA, assault and penetrating trauma like gunshot wounds. The facial nerve is injured in 7-10 % of temporal bone fractures^{5,29}. Traumatic facial nerve palsy result in devastating outcomes like ocular complications, impaired speech, feeding difficulties, and inability to convey emotion through facial expression in a patient. Hence, it has a life debilitating effect causing emotional stress and increase risk of post-traumatic stress disorder like depression or anxiety. Multiple studies in literature have concluded that facial palsy was significantly linked to lower Quality of Life and higher depression levels³⁰⁻³². The timing of treatment can significantly affect a patient's level of recovery, so it is essential for otorhinolaryngologists to have a thorough understanding of the principles of facial nerve trauma.

Multiple studies in literature concluded that MVA is a number one cause of trauma, similar to our finding^{1,16,33}. The average age of patients in our study is 27.5 years old, similar to the literature^{16,33}. Most patients were males which is consistent with other studies^{16,19}. This is because the majority of motorcyclist are males, hence their exposure to accident is higher. Young adults are prone to make impulsive decision and negligent in their driving habits which contribute to MVA. Among the key risk factors of MVA were failure to wear safety gear like helmet, excessive speeding, alcohol consumption, bad traffic condition, poor road surfaces and roadside hazards.

The race recruitment of patients in our study showed significant Malay preponderance. This was likely due to location of study which is situated at Malaysia's east coast with