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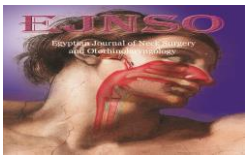

Accidental vs. Iatrogenic trauma and their surgical outcome of facial nerve surgery

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Abstract:

Introduction: Introduction: -The facial nerve (FN) is at risk for an injury through its course by accidental or surgical trauma. FN trauma management is a challenging as spontaneous recovery is unpredicted.

Patient and Methods: A prospective study was conducted on patients (22 cases) with posttraumatic LMN FN paralysis (accidental /iatrogenic etiology) who were candidates for surgical intervention.

Results: At final post intervention (1 year) follow-up, 7/22 patients (31.82%) had mild dysfunction (House–Brackmann (HB) grade II), 12/22 cases (54.55%) had a moderate dysfunction (HB grade III), 2/22 cases (9.09%) had moderately severe dysfunction (HB grade IV) and 1/22 case (4.55%) had total dysfunction (HB grade VI).

Conclusion: The outcome of the FN function following the surgical repair is significantly better in cases with accidental trauma compared to those with surgical trauma. This means that the insult of the surgeon on FN is much worse than accidents.

Key words: Facial nerve, Surgical, Accidental trauma , Outcome.

Introduction

Facial nerve trauma is the second cause of facial paralysis. The facial nerve (FN) is at risk of an injury along any of its segments by accidental or surgical trauma. FN trauma management is challenging as spontaneous recovery is unpredicted. Two important factors onset & degree of paralysis can predict recovery and potential intervention.[1]

The maximum amount of nerve degeneration is determined by electroneurography (ENoG) with serial examinations until reductions in amplitude on the paralyzed side cease. ENoG has a narrow clinical value after that point as electrical changes on an ENoG will be put off after the clinical improvement. Reduction in the amplitude of compound muscle action potential (CMAP) < 30% can predict a complete recovery. Although reductions in CMAP amplitude are 70- 90%, full recovery can occur through 8 months, and residual deficits can be expected. Once CMAP amplitude reduction with nerve degeneration > 90% a poor recovery is predicted with moderate to

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severe residual dysfunction and delayed maximum recovery up to 12 months.[2]

Electromyography (EMG) is an important tool in trying to prognosticate consequences for patients with complete FN palsy with ENoG finding more than 90% degeneration. In a few cases with ENoG recording, > 90% of degeneration can be because of dyssynchronous discharges of the neurapraxic fibers. This haphazard firing prevents summation of the myogenic action potential, ensuing in a drastically decreased or absent CMAP suggesting excessive nerve degeneration.[3]

This study was to assess the variable FN trauma (accidental & iatrogenic) and their correlation to the surgical outcome in patients with posttraumatic FN paralysis.

Patients and Methods

A prospective study was conducted on patients (22 cases) with posttraumatic lower motor neuron (LMN) FN paralysis (accidental /iatrogenic etiology) who were candidates for surgical intervention and admitted to the ENT department of Al Kasr Al Aini university hospital between January 2018 and January 2020.

The protocol of the study was submitted to the Ethical Committee of the Sohag Faculty of Medicine for approval. Before surgery, informed written consent was taken after a description of the surgical details, possible surgical complications, and the unpredictable prognosis.

Inclusion criteria:

1. Cases with posttraumatic LMN FN paralysis (accidental /iatrogenic etiology) who were candidates for surgical intervention.
2. Preoperative electroneurography [ENoG] testing showed total and/or >90% axonal degeneration (16 cases) with total denervation potentials on electromyography [EMG].
3. Intraoperative FN trauma that was repaired intraoperatively (6 cases).

Exclusion criteria:

1. Patients with upper motor neuron lesions (UMNL) & non-traumatic LMN facial nerve paralysis (inflammatory or neoplastic etiology) who were candidates or not for surgical intervention.
2. Patients with posttraumatic partial FN paralysis with House–Brackmann (HB) facial nerve grading systems showing partial FN paralysis.
3. Electroneurography [ENoG] testing showed < 90% axonal degeneration or EMG showed signs of regeneration.

The patient's evaluation included:

- A detailed ENT history, ENT examination, Clinical House–Brackmann (HB) grading scale assessment, otoneurological examination, and general examination.
- **The audiological evaluation** included pure tone audiogram, speech audiogram, and Stapedial reflex.
- ***Radiological evaluation*** in 22 cases using computed tomography (CT) of the temporal bone to assess the pathology of the ear preoperatively (iatrogenic cases) and fracture type concerning the FN (accidental cases). CT brain (9 cases) & MRI with gadolinium of the brain, cerebellopontine angle (CPA), and temporal bone (4 cases) for intracranial insult evaluation by a neurosurgeon.
- **Recent preoperative ENoG & EMG testing** (9 accidental cases and 7 iatrogenic cases) were performed within one week before surgery and compared to any previous data by

using Nihon Kohden neuropack device with the standard technique.

- ***The surgical intervention details*** were recorded including the time between the onset of trauma and the time of surgical intervention, the surgical technique that was used, the operative findings on facial nerve exploration, and the outcome of surgery.
- ***A postoperative electrophysiological study*** was done in the form of electroneurography (22 cases) & electromyography (22 cases). Clinical assessment was performed at 6 &12 months postoperatively by the House-Brackmann grading system with comparing of the results of ENoG and EMG Electrophysiologic testing. EMG and ENoG testing in iatrogenic cases, which had an intraoperative repair, were done postoperatively at 6 and 12 months with no preoperative electrophysiological study.
- ***Preoperative*** **and postoperative medical treatment** with antibiotics with steroids (1 mg/kg prednisolone for 3-4 weeks postoperatively)

Serial postoperative assessment of facial nerve function was carried out based on clinical evaluation (HB scoring) and electrophysiological evaluation over at least 6 months period following surgery.

Statistical analysis:

It was done with the IBM SPSS software package version 25 statistical program.

The statistical results between the surgical outcome and the type of trauma had a significant statistical significance relationship with (p-value < 0.05) and others hadn't a significant statistical relationship with (p-value> 0.05).

Results

Our study was conducted on 22 cases with posttraumatic complete LMN FN paralysis. There were 13 males (59.1 %) and 9 females (40.9 %) ranging in age from 11 to 63 years (mean =27.82). Different age group distribution that revealed the more incidence was in young males, especially in age groups (10-19) & (30-39) (Fig 1).

The etiology of the FN paralysis was iatrogenic in 13 cases (59.1 %) and accidental in 9 cases (40.9 %). The iatrogenic cases included 13 cases during middle ear and mastoid surgery; nine of them (40.91%) were during Middle ear (M.E) cholesteatoma surgery, three cases (13.64%) during glomus jugulare surgery, and one case (4.55%) during M.E squamous cell carcinoma surgery. The accidental cases included traffic accidents in 5 patients (22.73 %), falling from height in 2 cases (9.09%), and gunshots in 2 cases (9.09%) (Fig 2).

All patients (22 cases, 100%) underwent FN decompression at the site of trauma after visualization of the trauma effect on the course of FN and nerve integrity. Different sites of FN lesions were detected according to the type of trauma and its mechanism, where 11/22 cases (50%) had trauma at the mastoid segment, 8/22 cases (36.4%) at the 2nd genu, 1/22 cases (4.5%) at the tympanic segment, 1/22 case (4.5%) at the labyrinthine segment and 1/22 case (4.5%) at the tympanic segment & 2nd genu**.**

All cases with accidental etiology (9 cases) and only 7/13 cases of iatrogenic cases had evidence of neural degeneration preoperatively (>90% degeneration with ENoG). The other 6/13 iatrogenic cases underwent immediate intraoperative repair with no preoperative ENoG evaluation. With postoperative follow-up at 6 months, ENoG evaluation ranged between 55 and 92 nerve degeneration (mean=74.3) (Std.Deviation=11.03). At 12 months, ENoG evaluation ranged between 30

and 92 nerve degeneration (mean=54.04) (Std.Deviation=16.96). The degree of improvement in nerve degeneration postoperatively at 6 months ranged between (55-88%) where 21/22 cases showed ENoG improvement although 1/22 cases had nerve degeneration at 92%. At one year postoperatively the improvement in nerve degeneration ranged between (30-80%) where 21 cases showed improvement although one case still had nerve degeneration at 92% **.**

At the final post-intervention (1 year) follow-up, 7/22 patients (31.82%) had mild dysfunction (HB grade II), 12/22 cases (54.55%) had a moderate dysfunction (HB grade III), 2/22 cases (9.09%) had moderately severe dysfunction (HB grade IV) and 1/22 case (4.55%) had total dysfunction (HB grade VI).

For the etiology and mechanism of trauma to the FN, in 9 accidental cases, there were 5/9 cases had grade II HB (3/5 cases had a motor car accident, 1/5 cases had gunshot and 1/5 case had to fall from a height) and remaining 4/9 accidental cases had grade III HB (2/4 cases had a motor car accident, 1/4 had gunshot and 1/4 had falling from a height). In 13 iatrogenic cases, there were 2/13 cases had grade II HB, 8/13 cases had grade III HB, 2/13 cases had grade IV HB and 1/13 cases had grade VI HB. In nine cases with M.E cholesteatoma surgery, there were 1/9 cases had grade II HB, 7/9 cases had grade III HB and 1/9 cases had grade IV HB. In 3 cases with glomus jugulare surgery, there 1/3 case had grade II HB, 1/3 cases had grade III, and 1/3 case with grade VI HB. A single case of M.E neoplasm (Sq. C.C) who had grade IV HB. There was a statistically significant relation between the etiology & mechanism of trauma and the surgical outcome (Fig 3 A&B).

Figure (4 A, B&C) describes the relation of the site of FN injury according to the type of trauma and its surgical outcome. In accidental cases, all patients (9 cases) had good outcomes ranging between grades II-III HB. The mastoid segment was the commonest site (5/9 cases) where 3/5 cases had grade II HB, and 2/5 cases had grade III HB. This was followed by 2/9 cases at the 2nd genu, 1/2 case with grade II HB and 1/2 case with grade III HB. In the last 2/9 cases, 1/2 case at the labyrinthine segment had grade II HB, and 1/2 case at the tympanic segment had grade III HB). In iatrogenic cases (13 cases), the 2nd genu (7/13) & mastoid (6/13) segments were the commonest sites. In the mastoid segment, 2/6 cases had grade II HB, 3/6 cases had grade III HB and 1/6 cases had grade IV HB. In 2nd genu segment, 4/6 cases had grade III HB, 1/6 cases had grade IV HB and 1/6 case had grade VI HB. Lastly, 1/13 cases at the tympanic segment & 2nd genu had grade III HB**.**

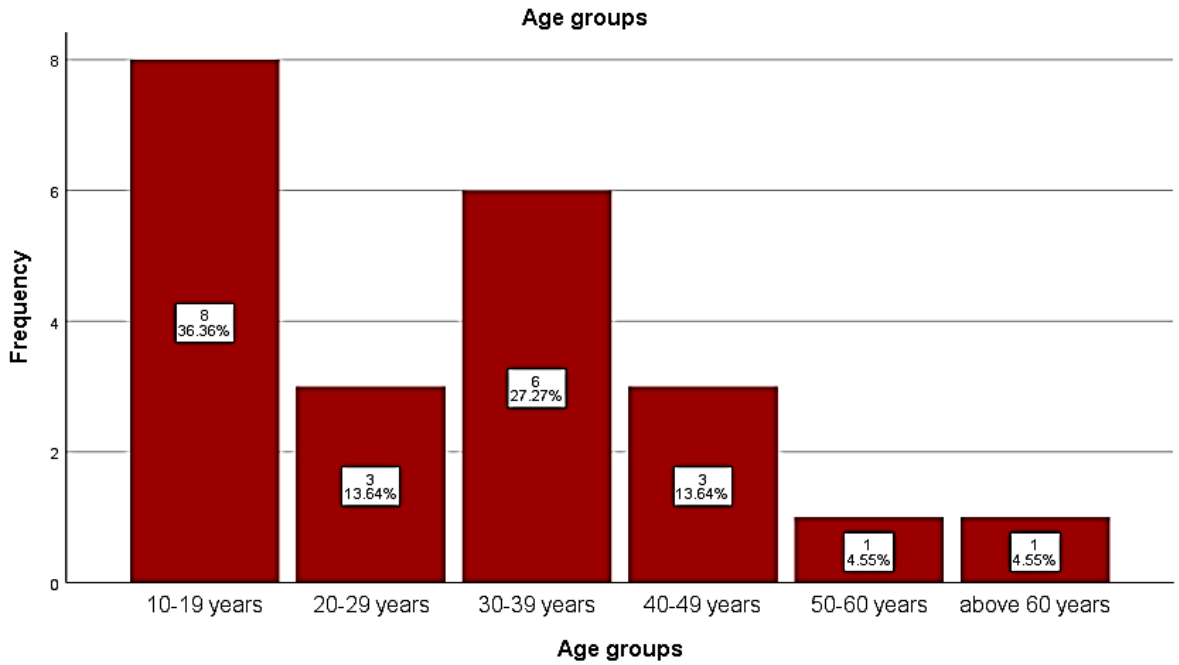

Figure (1) shows the age groups of the patients.

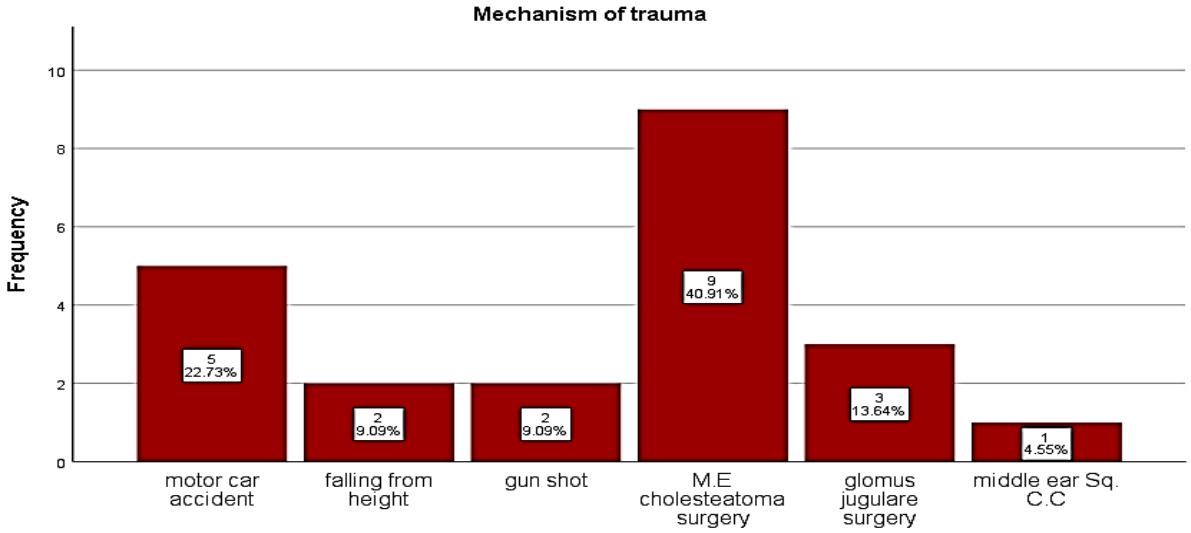

Figure (2) Show the etiology of FN paralysis.

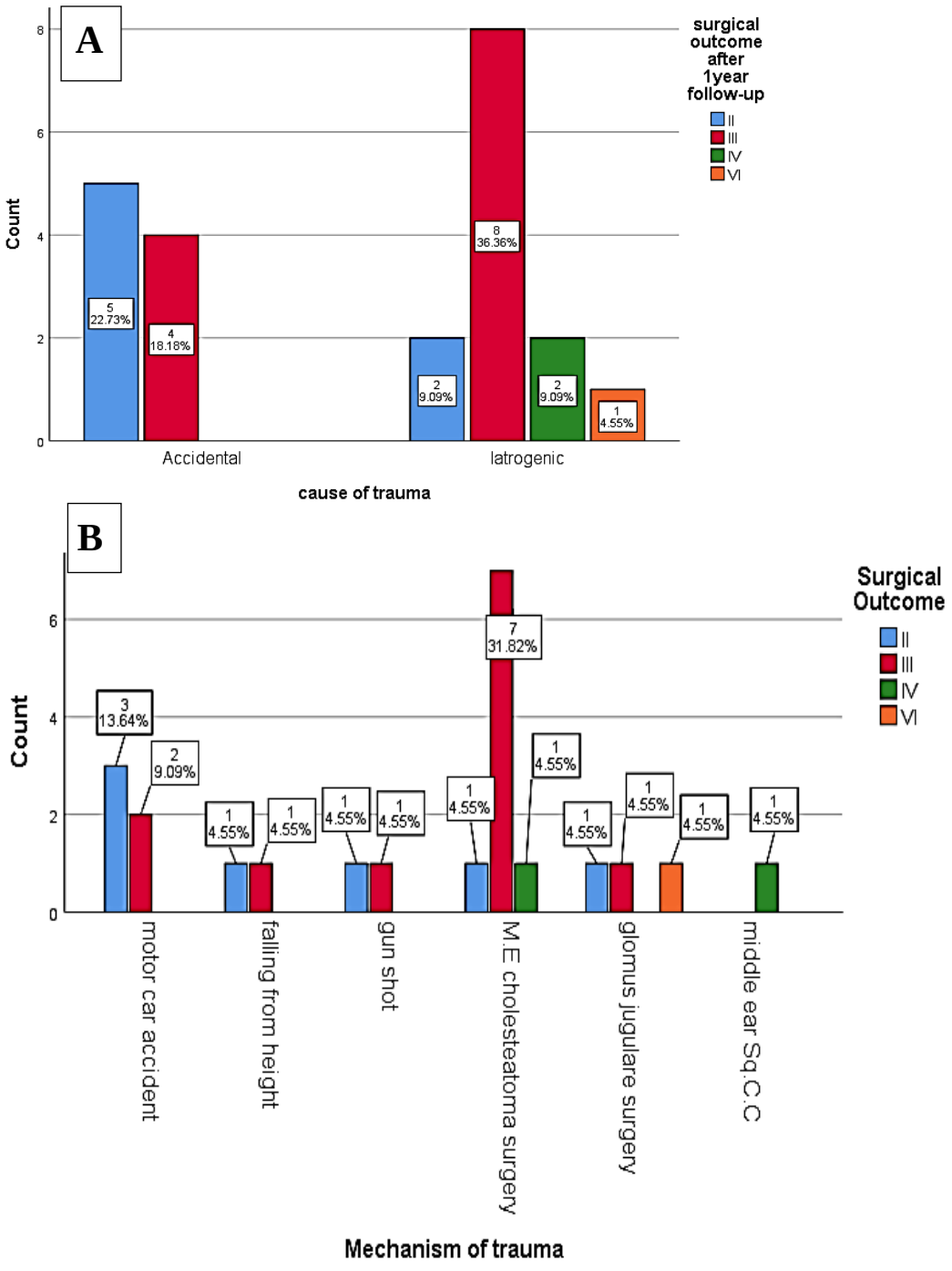

Figure (3 A&B) shows the relation between the etiological factors of FN paralysis and the surgical outcome at 1 year postoperatively.

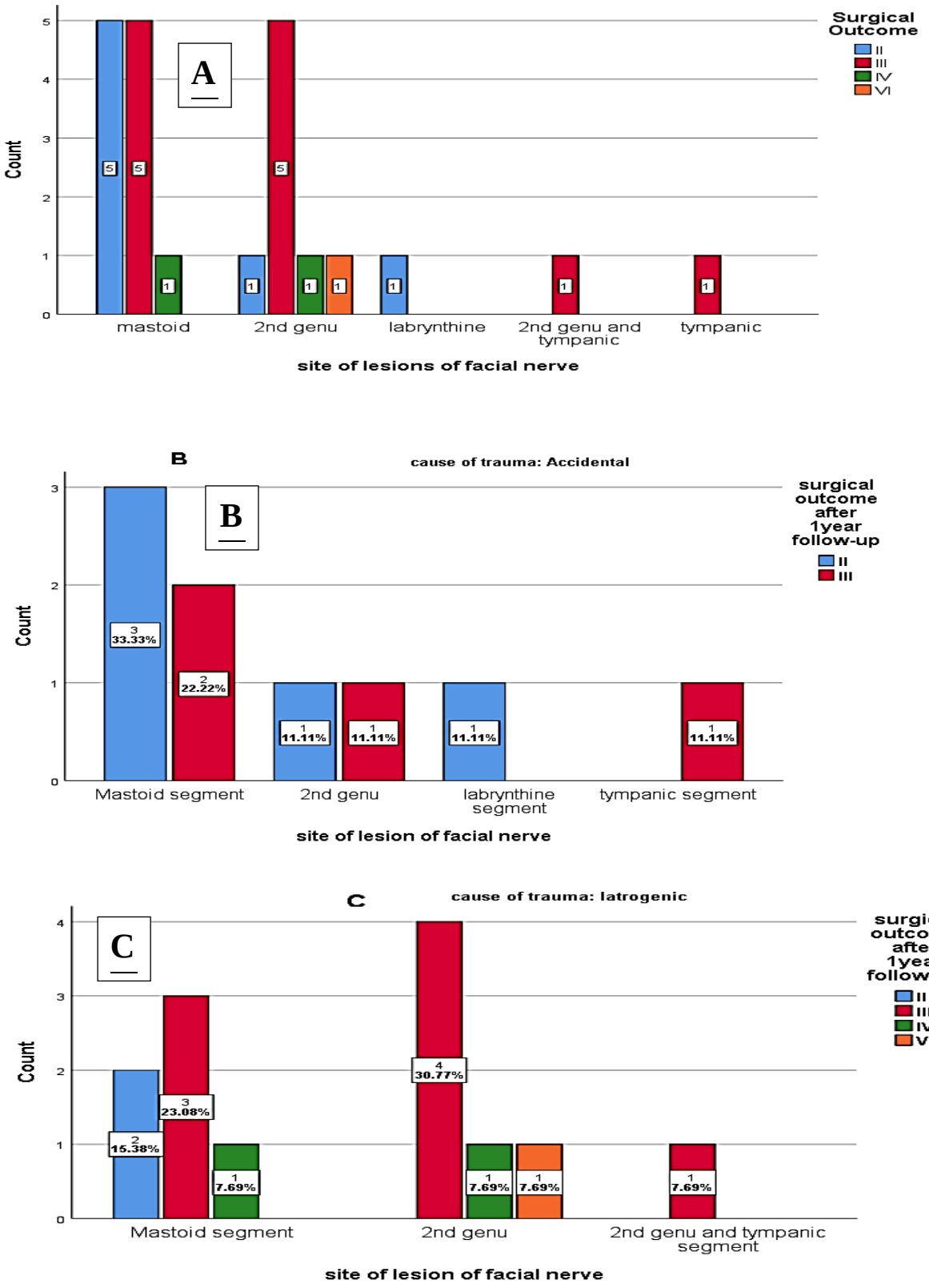

Figure (4 A, B&C) shows the relation between the site of FN lesions & type of trauma and the surgical outcome at 1 year postoperatively.

Discussion :

Traumatic FN injury can affect any part of the FN course. Injuries to distinctive parts of FN require distinctive management strategies. The choice of the best strategy for control and the consequences of reconstruction vary dramatically because of diverse elements. FN injury's site & extent are two of the most important factors for determining the strategy of repair.4

Different studies were conducted on factors influencing the prognosis of FN palsy showed a good prognosis was related to many factors that included younger age, initial paralysis lower than HB grade III, and normal responses on nerve excitability tests and stapedial reflex.4-9

The iatrogenic FN injury varied between 1% and 5% in ear surgery. in 1996, Harner SG 10 reported that FN paralysis incidence among surgical trainees was 2% and decrease to 1.3% among consultants. also In 1997, Nilssen and Wormald 11, reported that the overall incidence was 1.7%, while In our study the iatrogenic cause (59.1%) was more than accidental one (40.9%) where the iatrogenic cases included more in mastoid surgery mainly cholesteatoma surgery. In our study the FN injuries during the mastoid surgery were due to inappropriate drilling with cutting burrs or the removal of granulation tissue over exposed FN. The presence of inflammation, bleeding, sclerotic mastoids, or altered landmarks of FN could disorient the surgeon (especially junior surgeons) and might cause inju ry to the FN. In addition, the pathological conditions of the middle ear and mastoid made the identification of the FN difficult. The outcome of the FN function following the surgical repair is significantly better in cases with accidental trauma compared to those with surgical trauma. This means that the insult of the surgeon on FN is much worse than accidents. This raises the essential massage to otologic surgeons to do all the merit to avoid FN trauma. The threat of iatrogenic FN harm throughout COM surgical treatment is enormously low. Nevertheless, the decline in temporal bone specimens for education purposes and the overall fashion closer to minimally invasive keyhole surgical treatment underlines the want for correct surgical education. We warn surgeons now no longer to have a fake experience of satisfaction by omitting to refer difficult cases to a person higher qualified. The FN must stay the otologist’s friend.

We had 13/22 iatrogenic cases; one of them had an injury at the 2nd genu of the FN and the lateral SCC due to drilling more inferiorly than the actual location of the aditus. As the 2nd genu of the FN is located inferior and medial to the aditus, it is the more vulnerable site for injury (7/13 iatrogenic cases). Also at this site, the lateral SCC is liable to be injured. During surgery, a sclerotic mastoid and extensive granulation tissue may hinder the proper identification of the aditus. Furthermore, exposed FN at the region of 2nd genu by cholesteatoma & granulation tissue made FN more vulnerable to injury. Therefore, in atticotomy, it is advised to drill more superiorly and anteriorly towards the attic when encountering difficulty in identifying the aditus during middle ear & mastoid surgery.

Yeoh et al. (2004) 12 reported that for avoiding FN injury, it is should proper exposure to the attic a safer step to avoid FN injury in the second genu. Aiding of the superior part of the external auditory canal is a useful landmark in locating the attic region. Once the attic was reached further drilling postero-inferiorly was to identify the aditus, short process of incus, lateral SCC, and

the 2nd and mastoid segment of the facial nerve.

Sensorineural loss & vertigo could be occurred due to Injury of the labyrinth during drilling in mastoid surgery with the possibility of more serious suppurative and intracranial infections. So if fenestration of the lateral SCC occurs during the process of drilling or removal of disease, the fistula should be repaired immediately. The Fistula sign is an unreliable indication of the presence of a labyrinthine fistula. In a review by Kvestad et al. (2009)13, seven of 20 patients had a negative fistula sign, negative computed tomography scan, and no history of vertigo. High-resolution CT has a reported sensitivity of 80% to 97% and a false positive rate of less than 5%.14,15. By its anatomical location, the lateral semicircular canal is the portion of the labyrinth most often exposed to surgical trauma and erosion by cholesteatoma.16

Many authors advocate intraoperative monitoring and FN stimulation to avoid iatrogenic FN injury during mastoid surgery 17. Also Noss et al. (2001)18 reported that FN monitoring help in the surgical decision-making process and averted a potential injury to an abnormal course of FN, easy identification of the FN, with careful dissection of the Cholesteatoma matrix of the FN course. Thus, there is a greater margin of safety. 19-20

Conclusion:

Iatrogenic (surgeon-made) FN trauma is more common than accidental one. The mastoid segment of FN is the most vulnerable part to accidental trauma while the 2nd genu is the most vulnerable site in iatrogenic trauma. Variations in FN anatomy, either DE novo or due to the effect of the pathology are an important cause of iatrogenic FN trauma.

Otologic surgeons should look for the FN, and expect and identify its anatomic variations, and variations done by the pathology to minimize iatrogenic trauma that's more injurious to the nerve than accidental one. Trying to escape facial nerve facilitates FN injury or incomplete surgery. Making the FN your friend is safer than escaping it. Cholesteatoma surgery is the most common surgery associated with iatrogenic FN paralysis.

The outcome of the iatrogenic FN trauma is worse than the accidental one. Thus, otologic surgeons should be aware of the fact that they might be more injurious than motor car accidents.

Recommendations

Otologic surgeons should look for the FN, and expect and identify its anatomic variations, and variations done by the pathology to minimize iatrogenic trauma that's more injurious to the nerve than accidental one. Otologic surgery should be done under the supervision of senior surgeons after many courses of temporal bone dissection courses to decrease the incidence of facial nerve injury.

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