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Point of Vulnerability of Facial Nerve during Mastoid Surgery in Indian Patients

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Abstract

Aims and objectives: This study aims at finding out the area of highest vulnerability for iatrogenic facial nerve injury during mastoid exploration done for chronic suppurative otitis media in Indian patients. *Study Design:* Multi-centric, retrospective survey. *Material and Methods:* A questionnaire was sent to 60 different otologists in India, out of which data provided by 20 surgeons with at least 10 years of experience was recorded and analysed statistically after blinding of the surgeon's names. *Results:* Out of the 3962 mastoid surgeries analysed mean incidence of nerve dehiscence was 3.1 ± 0.98 %. Mean incidence of iatrogenic nerve injury was 2.4 ± 0.79 %. Majority (57.6%, *n*=53) of the patients reportedly had maximum House-Brackmann clinical grade III facial paralysis at diagnosis. Majority, 85.87% (*n*=79) were reported to have occurred at second genu, 9.78% (*n*=9) at vertical portion and 4.34% (*n*=4) at horizontal portion. Most of injuries (77.17%, *n*=71) recovered completely. *Conclusion:* Despite of the interpersonal and inter-racial variations reported in the literature, and the commonest site of nerve dehiscence being horizontal portion in the intra-tympanic course, the region of the second genu is the most vulnerable point of injury and should be dealt with extra caution.

Keywords: Facial Nerve; Temporal Bone; Otitis Media.

Introduction

Chronic suppurative otitis media (CSOM) is the commonest diseases presenting to ear, nose and throat surgeons. CSOM has been divided into two clinico-pathological varieties: Mucosal and Squamous type. Surgical treatment of squamous type commonly involves open cavity tympanomastoid exploration in which the posterior wall of external auditory canal wall frequently needs to be lowered, though in some canal wall up technique is fallowed [1].

Facial nerve traverses the petrous part of the temporal bone from the internal auditory meatus to the stylomastoid foramen displaying variations and anomalies in its course. It provides a great challenge to the otologic surgeons in spite of the major and minor anatomical landmarks for facial nerve available in the literature [2].

Facial nerve injury not only affects facial symmetry, but also imposes a devastating effect on the social, psychological, and economic aspects of an affected person's life [3,4].

The tympanic segment of facial nerve is most important as it traverses the middle ear and may get inadvertently injured in the otologic surgery if one is not well conversant with its surgical anatomy and congenital variations. Authors have reported segments of facial nerve that most likely to be injured during open cavity mastoidectomies in different populations [5,6,7].

It is well established that there are minute inter-racial differences in the anatomy of skull bones and that the facial nerve is at variance in Indians as compared to the Japanese and Americans [8].

However, what portion of the nerve is at the greatest risk of injury and why, has not been reported in relation to Indian patients. The purpose of the present

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study was to find out the anatomical portion of facial nerve that is most vulnerable during mastoid exploration being performed on Indian patients for the treatment of chronic otitis media. The authors have attempted to do a multi-centric collection of data of large number of patients to reduce the bias in the study.

Materials and Methods

A questionnaire designed by the authors (Table 1) was sent to 60 different otologists in India selected randomly from the directory of otologists provided by Indian Society of Otology. Thirty surgeons responded to the queries. Out of these, data provided by 20 most experienced surgeons (with minimum of 10 years of experience in mastoid surgeries) was analyzed for this study. The respondent surgeons were asked to provide information from the records of mastoidectomies performed in last 10 years of Indian patients only. They were also asked to provide clinical grading of nerve injury as provided by House & Brackmann [9]. The data was consolidated in a table and analysed with the help of Microsoft Excel 2016 version. All data sheets received from surgeons were given numbers i.e. names of surgeons were excluded from data sheet by data entry operators to eliminate bias. Therefore the authors who finally analyzed the records were unaware of the names of the respondents whose identity was not disclosed to them. Pertinent patient demographics were also collected.

Results

A total of 3962 cases with patients with age range of 4 to 74 years were analysed, of which 2231 were males and 1731 were females. Out of the 3962 mastoid surgeries analyzed highest reported individual incidence of facial nerve dehiscence was 6.42% and the lowest was 2.17%. Mean incidence of nerve dehiscence was 3.1 ± 0.98 %. At the same time the highest incidence of facial nerve injury reported was 3.85% and the lowest was 1.67%. Mean incidence of iatrogenic nerve injury was 2.4 ± 0.79%. Majority (57.6%, *n*=53) of the patients reportedly had maximum House-Brackmann clinical grade III facial paralysis at diagnosis, while 18.47% (*n*=17) had grade II, 8.7% (*n*=8) had grade IV and 15.21% (*n*=14) grade V-VI injuries (Figure 1). Maximum number of grade V-VI injury reported by any surgeon was 2, and no grade I injury was reported. Out of all injuries, 85.87% (*n*=79) were reported to have occurred at second genu, 9.78% (*n*=9) at vertical

Table 1: Questionnaire

Serial Number	Questions
1.	Name of the surgeon
2.	Institute / Centre
3.	Number of mastoid surgeries performed in last 10 years in Indian patients
4.	No. of cases in which facial nerve was found dehiscent
5.	No. of cases in which facial nerve was injured during surgery
6.	Site of injury
7.	House-Brackman grade of injury judged during post-operative period clinically
8.	No of patients recovered
•	The confidentiality of information will be maintained at all levels of study.

Table 2: Descriptive data of Postoperative facial nerve injury with site and grade of injury

Surgeon No.	No. of surgeries	No. of nerves found dehiscent	No. of nerve injuries in 5 years	Site of injury	Grade* in two post operative days	Recovery
1	250	10	5	II G (5)	II (2), IV (2), V / VI(1)	2
2	200	6	6	II G (4), HP (2)	III (4), V / VI (2)	4
3	156	4	6	II G (4), VP (2)	III (4), V / VI (2)	6
4	170	7	3	II G (3)	III (3)	3
5	230	5	5	II G (4), VP (1)	III (3), IV (1), V / VI (1)	3
6	240	8	4	II G (4)	III (3), IV (1)	2
7	190	5	4	II G (3), VP (1)	III (4)	3
8	260	7	5	III G (5)	II (5)	5
9	165	4	6	II G (6)	III (3), II (3)	5
10	175	5	3	II G (3)	III (2), V / VI (1)	3
11	140	9	3	II G (2), VP (1)	III (3)	3
12	200	6	6	II G (4), HP (2)	III (4), V / VI (2)	4
13	156	4	6	II G (4), VP (2)	II (4), IV (2)	3
14	170	7	3	II G (3)	III (3)	3

15	230	5	5	II G (4), VP (1)	III (4), V / VI (1)	3
16	240	8	4	II G (4)	III (3), V / VI (1)	2
17	190	5	4	II G (3), VP (1)	III (3), V / VI (1)	3
18	260	7	5	III G (5)	II (4), V / VI (1)	4
19	165	4	6	II G (6)	II (4), III (2)	5
20	175	5	3	II G (3)	III (2), V / VI (1)	2
Total	3962	121	92	II G(79), VP(9), HP(4)	II(18), III(53), IV (8) V / VI(15)	71

II G= IInd Genu, HP= Horizontal portion, VP= Vertical portion, * House-Brackmann Grades

Table 3: Summary of Facial Nerve Involvement in Otologic Surgeries

No: of Surgeons	No: of Surgeries in last 5 years	Facial Nerve dehiscence found during operation	No: of facial nerve injuries incurred
20	3962	3.1±0.97% (*n*=121)	2.4±0.78% (*n*=92)

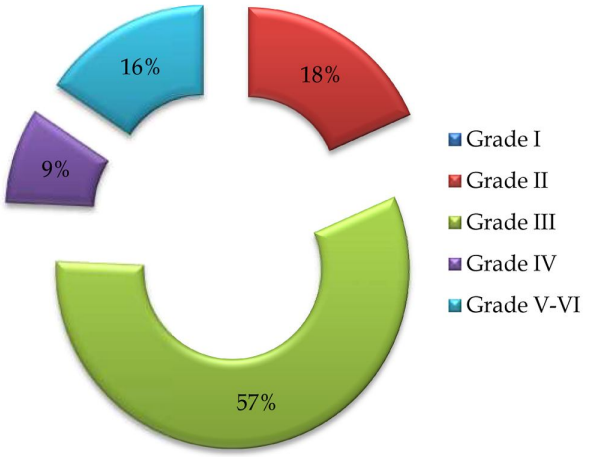

Fig. 1: Facial nerve recovery percentage based on House-Brackman Grading on 2nd post-operative day

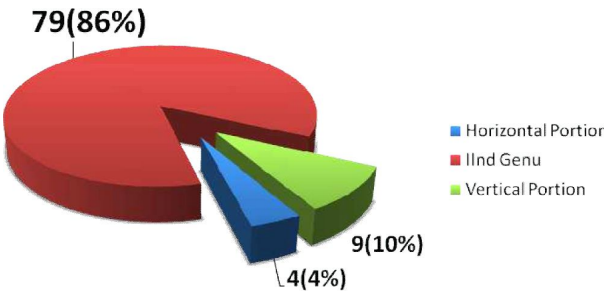

Fig. 2: Portion of facial nerve damaged in its intra-tympanic course

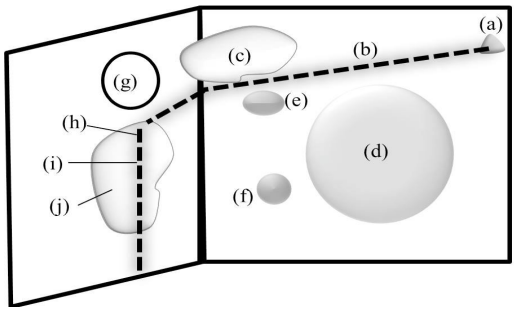

Fig. 3: Matchbox diagram of middle ear showing intra-tympanic course of facial nerve as dotted line: (a) Choclearifrom process, (b) Horizontal portion, (c) Bulge of lateral semicircular canal, (d) Promontory, (e) Oval window, (f) Round window, (g) Aditus, (h) IInd Genu, (i) verticle portion, (j) Pyramid

portion and 4.34% (*n*=4) at horizontal portion (Figure 2). Maximum injuries sustained by an individual surgeon were 6 and minimum were 2. It is notable that majority of injuries (77.17%, *n*=71) recovered completely (Table 2, 3).

Discussion

The facial nerve, or VIIth cranial nerve, is the nerve of facial expression. It is the only cranial nerve with longest course in a bony canal which passes through middle ear cavity that may be frequently affected by inflammatory disease CSOM. Therefore the knowledge of the key intratympanic landmarks is essential for safe accurate physical diagnosis, safe and effective surgical intervention for the treatment of CSOM. The tympanic segment extends from the geniculate ganglion (which lies behind the cochleariform process) to the horizontal semicircular canal and is 8-11mm in length. The nerve lies against the medial wall of the tympanic cavity, above and posterior to the oval window. The wall can be very thin or dehiscent in this area, and the middle ear mucosa may lay in direct contact with the facial nerve sheath. The facial canal has been reported to be dehiscent in the area of the oval window in 25-55% of postmortem specimens. The vertical portion of the facial nerve emerges from the middle ear between the posterior wall of the middle ear and the horizontal semicircular canal. This is just behind pyramidal eminence, where the facial nerve makes a second turn (marking the second genu) coursing vertically downwards to emerge from stylomastoid foramen. (Figure 3).

The most important landmarks for identifying the facial nerve in the mastoid are the cochleariform process, horizontal semicircular canal, the fossa incudis, pyrimidal process, chorda tympani, and the digastric ridge. The second genu of the facial nerve

runs infero-lateral to the lateral semicircular canal. This is a relatively constant relationship [8, 10].

After years of technological advances, in the operating microscope and micro-surgical drill, and the availability of pre-operating imaging, the risk of iatrogenic facial nerve paralysis though has declined, but has not ended. Hohman, et al. (2014) reported that otologic surgery resulted in 17% of all postoperative facial nerve palsy [11].

It has further been reported that, 82% of all otologic facial nerve injuries were caused by mastoid surgery. Ryu and Kim (2016) reported most common sites for the facial nerve injury during ear surgery as the tympanic segment in 43% cases, IInd genu with tympanic segment (horizontal portion) in 28.5% and mastoid segment (vertical portion) in 28.5% [12].

Asma et.al. (2009) concluded that mistakes that most likely occurred during mastoid surgery are drilling towards the antrum, causing injury to the facial nerve at the second genu [13].

Green and Shelton (1994) reported the most common area of iatrogenic injury to the facial nerve in mastoidectomy is in the tympanic segment. Though the use of the intraoperative facial nerve monitoring may help the surgeon identify the facial nerve by a simultaneous warning signal of the injury, it cannot be substituted for thorough anatomical knowledge of the temporal bone [12,14].

It is well evident in the literature that facial nerve shows several interpersonal and racial variations. Some of the variations in temporal bone dissections in Indian set up have been described by Yadav et.al. in 2006 [9].

However whether these differences affect the point or area at risk in course of facial nerve during mastoid surgery in Indian patients has yet not been documented. Our study not only pools in multi-centric data, but also encompasses large number of patients. Published reports place the incidence of facial nerve dehiscence anywhere from 0.5% to 74%, our study finds it at 3% [15-17].

In this study the incidence of iatrogenic facial nerve injury was found to be 2.4%, however individual reports in literature have quoted incidence of facial nerve injury from 0.6% to 10%. It is also notable that majority of the patients had grade III paralysis and more than 77% of the patients recovered totally. It is interesting to note that most injuries occurred at IInd Genu which may be due to a necessity to perform canal wall down surgery in many patients which report their disease late or in advanced stage. This is also contrary to the belief that nerve dehiscence is an important factor in per-operative injury, because nerve dehiscence is not common at IInd Genu [16-17].

Conclusion

Iatrogenic facial nerve injury is regarded as one of the most devastating complications of otologic surgery which not only results in asymmetry of the face but also causes psychological and social trauma to the patients. Surgeons should be well versed with the major and minor anatomical landmarks for facial nerve in literature and anomalies of the facial nerve. Despite of the variations reported in the literature, and the commonest site of nerve dehiscence being horizontal portion in the intra-tympanic course, the region of the second genu is the most vulnerable point of injury and should be dealt with extra caution. With careful dissection, the avoidance of nerve injury would be possible in most cases.

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