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POINT OF FACIAL NERVE VULNERABILITY DURING MASTOIDECTOMY AMONG INDIAN PATIENTS: A CROSS-SECTIONAL STUDY.

*Rajarshi Datta[1], Sayantani Majumdar[2], Arpita Sarkar[1], Satabdi Sarkar[3]**
[1]Assistant Professor, Department of Anatomy, Jagannath Gupta Institute of Medical Sciences and Hospital, Kolkata, West Bengal, India.
[2]Associate Professor, Department of Anatomy, Jagannath Gupta Institute of Medical Sciences and Hospital, Kolkata, West Bengal, India.
[3]Associate Professor, Department of Anatomy, AIIMS, Kalyani, West Bengal, India

Abstract

Background

The petrous part of the temporal bone houses the major part of the intracranial courses of the facial nerve. The nerve might be injured during surgery involving the mastoid and tympanic region. The damage may cause facial asymmetry and impairment of facial muscle function. It may ruin a patient's face, affecting their mental and social health. This research seeks to identify the anatomical site most susceptible to facial nerve injury during surgical treatment of the mastoid and tympanic cavity.

Methods

A cross-sectional study of 198 mastoidectomies conducted by 10 surgeons was done. The number of mastoidectomies by each surgeon, the location of the injury, the grade of the nerve injury, and the number of recoveries were recorded. Statistical analysis was performed on the data obtained.

Results

Nine facial nerve injuries were reported among the 198 cases analyzed. The second genu was the most vulnerable site of nerve injury in our study. A Grade 3 injury was mostly found in the case of mastoidectomies. More than 70% of the cases recovered from the 'facial nerve' injury.

Conclusion

Injury of the nerve during mastoidectomy is the major complication faced by an otolaryngologist. Also, the injury paralyzes the facial muscles, having a significant impact on the patient's life. The injury can be best avoided by a thorough study of the anatomy of the nerve. In our study, it is found that the second genu is the prominent site of the injury. The otolaryngologist should be careful while performing the mastoidectomies and monitor the facial nerve *simultaneously.*

Recommendations

Future research should focus on developing targeted surgical training and incorporating intraoperative nerve monitoring to reduce facial nerve injuries during mastoidectomies, thereby improving patient outcomes.

Keywords: *mastoidectomy, facial nerve injury, second genu, Indian population*
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Corresponding Author: *Satabdi Sarkar**
Email: satabdi781@gmail.com
Associate Professor, Department of Anatomy, AIIMS, Kalyani, West Bengal, India

Introduction

Mastoidectomy is a surgical procedure of the squamopetromastoid part of the temporal bone that opens postauricular air cells by removing the thin bony partitions between the air cells [1]. Numerous indications are present for mastoid surgeries. Acute coalescent mastoiditis, chronic mastoiditis with its sequelae, and cholesteatoma are the most common indications for mastoid surgeries [1]. Canal wall up and canal wall down are two main types of mastoidectomy that are commonly performed [2]. The Posterior bony external auditory canal, which separates the ear canal from the mastoid cavity is left intact in Canal wall mastoidectomy. The surgery decision depends on multiple factors like severity of the disease, the inherent anatomy, the overall extent of the disease, management of impending surgical complications, and the patient's likelihood to follow up postoperatively [3]. Facial nerve injury is one of the most serious complications of ear surgery.[4] Some

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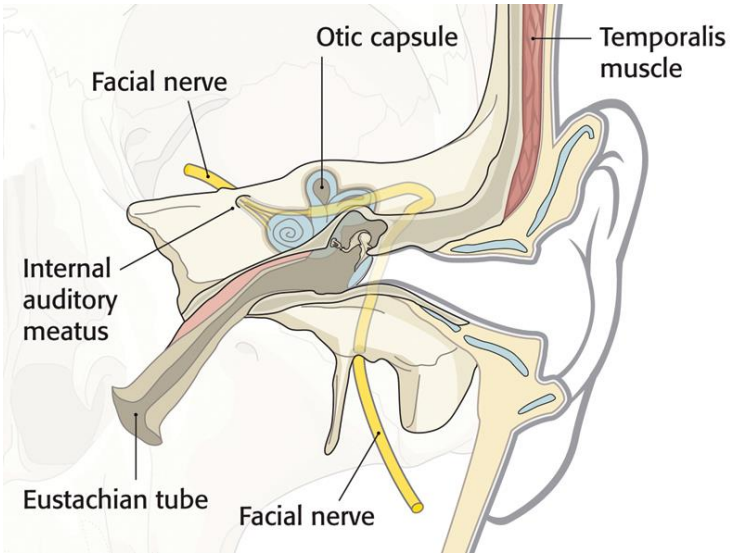
researchers mentioned the incidence of facial nerve injury in primary otologic procedures is between 1% and 4%. However, the incidence of injury has almost doubled (4 % to 10 %) in revised surgeries in comparison to primary surgery [5,6]. facial nerve paralysis can cause one's facial appearance or diminished facial expression, affecting the secretion of lacrimal, nasal, paranasal, and palatal glands. It also imposes a devastating effect on the social, psychological, and economic aspects of an affected person's life [4].

The anatomical course of the facial nerve can be divided based on its relation to the cranium and the temporal bone into intracranial, intratemporal, and extratemporal or extracranial parts. The commencement of the intratemporal part of the facial nerve occurs when it together with the intermediate nerve, passes through the internal auditory meatus of the temporal bone to enter the facial canal within the petrous part of the temporal bone[7]. The greater petrosal nerve, nerve to the stapedius, and chorda tympani nerve are the branches of the intratemporal part of the facial nerve. The greater petrosal nerve carries the visceromotor supply to the lacrimal glands and receives general afferent fibers from the nasal cavity, paranasal sinuses, and soft palate. The nerve to the stapedius supplies the stapedius muscle whereas the chorda tympani nerve carries the taste sensation from the tongue.

The labyrinthine segment extends from the internal auditory meatus to the geniculate ganglion is the narrowest segment of the intratemporal part of the facial nerve [8].



Picture 1 shows the intratemporal course of the facial nerve.
Source of the picture: https://images.app.goo.gl/ujDmrFvRZDVf1Xo37

While conducting mastoidectomies nerve injury as well as nerve rupture has been reported. The level of the injury can be graded as per the scale provided by House & Brackmann [9]. The anatomy of the facial bone and the placement of the facial nerves differs from race to race in humans [10]. However, there is literature available that reports the anatomy of the facial nerve that passes through the tympanic cavity [11, 12]. However, the exact point that is vulnerable to injury during mastoid surgery amongst the Indian population, especially from the eastern region has not been reported.

This study aims to determine the anatomical point that is the most vulnerable to injury during the surgical treatment of the chronic inflammation of the mastoid antrum and tympanic cavity in the Indian population and the proportion of nerve injury is recorded. This study is carried out at multiple centers to avoid bias in the sample population.

Methods

Study design

Cross-sectional study of the mastoidectomies conducted.

Study setting

The study was conducted at Jagannath Gupta Institute of Medical sciences and Hospital, West Bengal, India, from November 2020 to October 2023.

Participants

Patients undergoing mastoidectomies within the age range of 18-74 years were included for retrospective analysis. The patients undergoing mastoidectomies by the otolaryngologist with less than 10 years of experience were not included.

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Inclusion criteria

The study included participants undergoing mastoidectomies aged 18-74 years, focusing on surgeries performed by otolaryngologists with more than 10 years of experience.

Exclusion criteria

Exclusion criteria were surgeries conducted by otolaryngologists with less than 10 years of experience, aiming to ensure a high level of surgical expertise and potentially reduce the variability in facial nerve injury outcomes due to surgical experience.

Bias

There was a chance that bias would arise when the study first started, but it was avoided by giving all participants identical information and hiding the group allocation from the nurses who collected the data.

Study size

The sample size of 198 mastoidectomies conducted over three years at a tertiary care center in West Bengal, India, was determined through a retrospective analysis. This sample included patients aged 18-74 years who underwent surgery by otolaryngologists with more than 10 years of experience. The selection of experienced surgeons aimed to reduce variability in outcomes due to surgical expertise.

Data collection

Data on mastoidectomies performed by an otolaryngologist with more than 10 years of experience was obtained. The demographic data of the patients and the nerve injury data were collected. The site and extent of the injury of the facial nerve while performing mastoidectomy were measured using the CT of the temporal bone and House & Brackmann scale respectively [13]. Ten otolaryngologists were selected. they were interviewed by the data entry operator for each mastoidectomy performed by them with the help of a validated (by three external subject experts) mixed questionnaire.

Ethical consideration

This is a retrospective study where the name of the surgeons and the patients was not disclosed to the researchers. Data entry operators entered the data of the mastoidectomies and coded the names of the patients and the surgeons. Consents for the surgeries were checked by the assigned data entry operator.

Statistical analysis

The data obtained was arranged on the Microsoft Excel sheets and the data was then subjected to statistical analysis.

Results

The cases of mastoidectomies included in the study were of patients with ages ranging from 18 years to 74 years. In total 198 cases were performed by 10 experienced otolaryngologists in 3 years. 110 of them were males and 88 were females. There were cases of facial nerve rupture and 'facial nerve' injury. The percentage of injuries and ruptures in the case of each surgeon was calculated.

A surgeon reported rupture of the facial nerve in four cases among the total mastoidectomies performed by him, which was the highest compared to the other surgeons. Whereas four surgeons reported no cases of nerve rupture. Twelve cases of nerve rupture were reported among the 198 cases.

A surgeon reported 2 incidences of nerve injury among the total mastoidectomies performed by him, which was the maximum among all the 10 surgeons. In contrast, four surgeons reported no instances of 'facial nerve' injury. The total cases of facial nerve injuries were nine among the total 198 cases.

Among the 9 patients who had nerve injuries, 5 of them had grade 3 injuries as per the House & Brackmann scale. 2 of them had grade 2 injuries, 1 of them had grade 4 injuries, and 1 of them had an injury of grade 5. There were no grade 1 injuries found in this study.

The anatomical location of the injury was the second genu in the majority of the cases; 7 out of 9 injuries were in the second genu, 1 injury was in the horizontal portion, and one injury was in the vertical portion. Including the cases of nerve rupture and nerve injury, 70% of them recovered completely. Table No. 1 summarizes the findings of the study.

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Table no.1: Shows the details of the nerve damage during mastoidectomies

No. of otolaryngologist	No. of mastoidectomies	Incidences of nerve rupture	Incidences of nerve injury	Location of injury	Grading of the injury	No. of recoveries
1	18	4	2	Second genu	Grade 3 (2)	1
2	16	0	0	-	-	-
3	19	1	1	Horizontal portion	Grade 5(1)	1
4	20	3	3	Second genu	Grade3(1), Grade 2(2)	3
5	23	0	1	Second genu	Grade 3(1)	1
6	19	1	0	-	-	-
7	26	1	1	Second genu	Grade 3(1)	1
8	21	0	1	Vertical portion	Grade 4(1)	1
9	19	2	0	-	-	-
10	17	0	0	-	-	-

Discussion

The study's results highlight the risk of facial nerve injury during mastoidectomies, with a total of 21 cases of nerve damage (12 ruptures and 9 injuries) among 198 procedures. Notably, the highest incidence of nerve rupture was reported by one surgeon, indicating variability in surgical outcomes. The distribution of nerve injuries varied, with the majority (7 out of 9) located in the second genu, underscoring this site's vulnerability. In terms of severity, most injuries were classified as Grade 3 on the House & Brackmann scale, indicating moderate dysfunction.

Despite the risks, a significant proportion (70%) of patients experiencing nerve damage recovered fully, highlighting the potential for recovery post-injury. This outcome emphasizes the importance of skilled surgical techniques and post-operative care in managing and mitigating facial nerve damage risks during mastoidectomies.

The 7th cranial nerve is an important nerve that plays a significant role in facial expression. The course of the facial nerve is divided into three parts the intracranial part, the Intertemporal part, and the Extracranial part.

The total length of the intratemporal part of the facial nerve is around 3 cm. Within the bone, the nerve is divided into three segments-labyrinthine segments, genu, and tympanic segment. The prominent impression of the lateral semicircular canal plays an important landmark in identifying the parts of the facial nerve. The labyrinthine segment runs laterally from the fundus of the internal auditory canal to the geniculate ganglion. The geniculate ganglion is located just above the cochlea, beneath the middle fossa plate [4]. The tympanic portion of the facial nerve is located along the inferior margin of the lateral semicircular canal (LSCC) [14]. Around the posterior edge of the oval window and medial to the short process of the incus, the facial nerve follows a gentle curve in an inferior direction, which is called the second genu

The advances in technology and the well-versed knowledge of anatomy have decreased the number of 'facial nerve' injuries during mastoidectomies but they are still prevalent.

Studies conducted previously demonstrated that in the majority of the cases, the site of injury is second genu and the ratio of the injuries occurring in the horizontal and vertical proportion is 1:1 [4,14]. This is similar to the findings of our study. among the 9 cases of 'facial nerve' injury, 7 were in the second genu and the remaining 2 were in the horizontal and vertical portion respectively. A study concluded that the second genu is the area in which the maximum number of injuries were reported, and this was because of improper drilling during mastoidectomy [15].

A study found that the simultaneous monitoring of the facial nerve during the mastoidectomy decreased the probability of 'facial nerve' injury [16]. However, the surgeons in our study reported the anatomical study of the facial nerve helps in avoiding nerve injury. 9 cases of 'facial nerve' injury were reported among the 198 cases which accounts for 4.54 % of the total mastoidectomies. The range of facial injury cases varied from 0 to 7% in the other studies conducted in this domain [4,14,15]. Another study reported that the tympanic segment

of the facial nerve (50 %) was the most commonly injured surgery in canal wall-up and canal wall-down surgery [16]. Most of the facial nerve injuries were of grade 3 according to House & Brackmann grading. This was by the other studies which showed a grade 3 type of 'facial nerve' injury [17,18]. Grade 3 type of injury was diagnosed with paralysis in the facial muscles. A study conducted found that 77% of facial nerve injuries during mastoidectomies recovered over a certain period [19]. This was the finding of our study, 8 out of 9 patients recovered completely from the 'facial nerve' injury during mastoidectomy.

Conclusion

Injury of the nerve during mastoidectomy is the major complication faced by an otolaryngologist. The injury paralyses the facial muscle having a significant impact on the patient's life. It can be best avoided by a thorough study of the anatomy of the nerve. In our study, it is found that the second genu is the prominent site of the injury. CT of the temporal bone, which can show the anatomical details of facial nerve should be an important investigation for the surgeon to prevent the damage of facial nerve. Along with that the otolaryngologist should be careful in drilling during the mastoidectomies, identify the lateral semicircular canal correctly, and monitor the nerve simultaneously. Such studies are required on a large number of the Indian population to generate reliable literature for otolaryngologists. So that 'facial nerve' injury during mastoidectomy can be completely avoided.

Recommendations

Future studies should prioritize creating surgical training programs highlighting facial nerve anatomy, especially around the second genu, and integrating simulation-based training to enhance surgical precision. Additionally, adopting intraoperative nerve monitoring could reduce injury risks, improving patient outcomes. These strategies aim to lower facial nerve injury rates during mastoidectomies, preserving patients' facial functionality and quality of life.

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Conflict of interest

The authors have no competing interest to declare.

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