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# ANOMALOUS INTRATYMPANIC FACIAL NERVE ENCOUNTERED DURING STAPES SURGERY AND ITS SURGICAL IMPLICATIONS

## ABSTRACT

**Aims and Objectives**:Identifying the facial nerve in any middle ear surgery is of utmost importance. This study aimed to find the frequency of intratympanic facial nerve anomalies encountered during stapes surgery and note any modifications made in the surgical procedure.

**Methods**: The study was conducted in the department of ENT-Head and Neck Surgery in a tertiary referral hospital in Nepal. A retrospective review of medical records of stapes surgery performed between January 2020 and December 2024 was conducted.

**Results**: A total of 121 stapes surgeries were performed in 121 patients (51 males and 70 females). The age ranged from 18 to 65 (mean 34.7 ± 9.2) years. Anomalous facial nerves were found in 10 (8.3%) cases. Partial prolapse of intact fallopian canal and dehiscent facial nerve without prolapse were observed in four (3.3%) cases each. Total prolapse of the facial nerve over the stapes footplate was noted in two (1.6%) cases. Almost all patients underwent standard stapes surgery. However, in the two cases with total prolapse, fenestration was created in the promontory in one, while the procedure had to be abandoned in the other. The facial nerve function was normal post-operatively in all the cases.

**Conclusion**: Anomalous intratympanic facial nerves encountered during stapes surgeries are not uncommon. Being vigilant about the possibilities of anomalous facial nerve and tailoring the surgical technique accordingly is crucial for ensuring a safe and successful outcome.

**Keywords**: Facial nerve, stapes surgery, Stapes

## INTRODUCTION

Stapes surgery, either stapedotomy or stapedectomy, is commonly done for otosclerosis. However, certain anatomical findings in the middle ear can complicate these procedures, potentially leading to complications like sensorineural hearing loss and facial nerve (FN) palsy. FN palsy is a rare complication of stapes surgery, occurring in approximately 1% of cases, and is considered a serious and distressing event for both the patient and the surgeon.[1]

As the tympanic segment of FN runs close to the stapes footplate area, anomalies along the FN course are of significant concern in the stapes surgery, which may eventually affect the success of the procedure. Certain anomalies of FN during stapes surgery have been described in the literature, namely dehiscent or prolapsed tympanic segment of FN overlying the stapes footplate, FN coursing over the promontory, and rare instances of FN duplication or triplication.[2-6] Some extent of dehiscence of the tympanic segment of the FN without prolapse over the stapes footplate is commonly observed during middle ear surgery, particularly stapes surgery. This typically is not a major surgical concern. Surgery can be accomplished in most of the cases, where the stapes footplate is partially obliterated by the prolapsed FN. However, a prolapsed FN obliterating the whole footplate area creates challenges for the surgeon to complete the surgery and increases the risk of inadvertent FN injury. Most cases with complete obliteration of the stapes footplate need to be abandoned.[7]

Awareness of such anomalies and tailoring the surgical techniques accordingly is crucial to ensure a safe and successful outcome following stapes surgery. However, there is a lack of literature related to such anomalies in the Nepalese context. This study thus aims to find the frequency of anomalous FN encountered during stapes surgery. The findings of this study will help estimate the magnitude of such anomalies in the Nepalese.

## METHODS

It was a retrospective study conducted at the Department of ENT-Head and Neck Surgery, Tribhuvan University Teaching Hospital, Kathmandu, Nepal. Ethical approval was obtained from the Institutional Review Committee of the Institute of Medicine, Kathmandu, Nepal {Ref.:- 395(6-11)E2081/082}. A thorough review of clinical records of 121 stapes surgeries performed between 1st January 2020 to 31st December 2024 was done to identify any FN anomalies and their impact on surgical manoeuvre.

All surgical procedures were performed by senior surgeons using a microscope under local anaesthesia via a transcanal approach. Tympanomeatal flap was elevated down to the tympanic sulcus and fibrous annular ligament of the tympanic membrane, which was then elevated to enter the middle ear. Around 2 to 3mm posterior-superior bony rim was either curetted or drilled to expose the horizontal segment of FN, incudostapedial joint, pyramidal process, stapedial tendon, stapes suprastructure and footplate. The stapes fixation was confirmed with careful mobilization of each ossicle using a blunt tip instrument. Otosclerotic focus, along with concomitant middle ear anomalies, if present, were also noted. The dehiscent fallopian canal was carefully inspected under high magnification (2.5X). A blunt-tipped instrument was used to confirm the dehiscence of the fallopian canal.

The sequential standard surgical steps that followed were incudostapedial joint dislocation, cutting the stapedial tendon with micro-scissors, creating a one millimeter microhole in the footplate using a manual perforator, placing the Teflon-piston prosthesis, and finally crimping it to the long process of the incus. The diameter of the Teflon-piston ranged from 0.4 to 0.5 mm, while the length ranged from 3.75 to 5.25 mm based on the distance between the stapes footplate and the under surface of the long process of the incus. FN dehiscence was defined as a bony defect of the fallopian canal with partially or entirely uncovered FN, while prolapse referred to the nerve displaced inferiorly and anteriorly to cover the oval window partially or totally with or without dehiscence of the fallopian canal.

Some modifications in the surgical procedure included creating the microhole before the removal of the stapes suprastructure. In case of FN prolapse, the procedure was completed as long as the stapes footplate was visualised adequately to make a microhole.

The data was entered into MS EXCEL. Descriptive data were estimated using measures of central tendency (i.e., mean and median) and measures of dispersion (i.e., standard deviation [SD]).

## RESULTS

A total of 121 stapes surgeries were performed in 121 patients during the study period, of which 51 were males and 70 females (male to female ratio 1:1.4). The age ranged from 18 to 65 years, with the mean age being 34.7(± 9.2) years. All patients except two had intraoperative evidence of otosclerotic foci. The two patients had stapes footplate fixation without evidence of otosclerotic foci and thus were diagnosed as having congenital stapes fixation.

Hundred and nine (90.1%) patients underwent stapedotomy, whilst 10(8.3%) patients underwent stapedectomy, and one had promontory fenestration.

Anomalous facial nerves were found in 10 (8.3%) cases. Partial prolapse of intact fallopian canal and dehiscent FN without prolapse were observed in four (3.3%) cases each. Total prolapse of the facial nerve over the stapes footplate was noted in two (1.3%) cases, with one of them having prolapsed FN extending even over the promontory (Table 1, Figure 1).

In two cases with total prolapse, the fenestration was created in the promontory. The procedure was completed in one case, while it had to be abandoned in the other. Post-operatively, the facial nerve function was normal in all patients irrespective of variations in the surgical procedure (Table 1).

**Table 1: Stapes surgeries based on intraoperative facial nerve status (N=121).**

| Intraoperative facial nerve status | Number (%) | Type of surgery performed | Number (%) |
|---|---|---|---|
| **Normal** | 111 (91.7%) | Stapedotomy | 101 (83.5%) |
| | | Stapedectomy | 10 (8.3%) |
| **Anomalous FN** | 10(8.3%) | | |
| Partial prolapse of intact fallopian canal | 4 (3.3%) | Stapedotomy | 8 (6.6%) |
| Dehiscent FN without prolapse | 4 (3.3%) | | |
| Total prolapse | 2 (1.3%) | Promontory fenestration | 1 (0.8%) |
| | | Procedure abandoned | 1 (0.8%) |

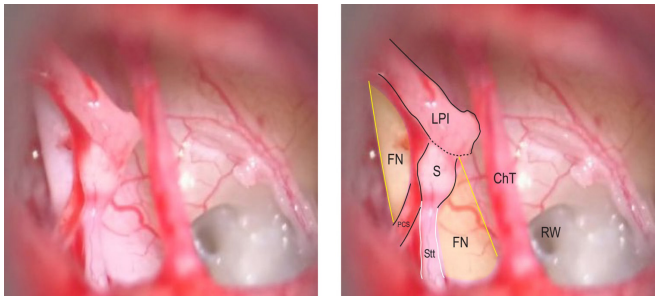


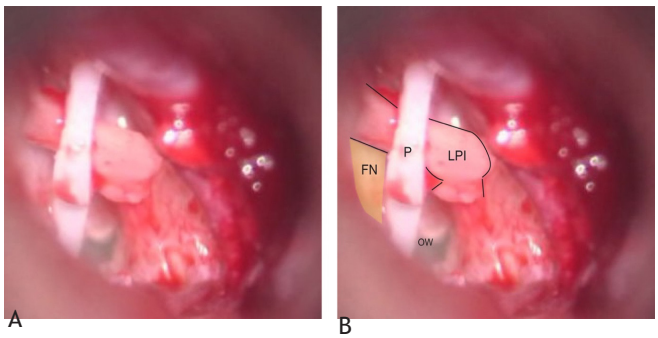

**Figure 1. Facial nerve completely obliterating the stapes footplate area.**

*(FN- Facial nerve, LPI- Long process of incus, S- Stapes head, RW- Round window, Stt- Stapedial tendon, PCS- Posterior crus of stapes, ChT- Chorda tympani nerve)*

Middle ear abnormalities were observed during three stapes surgeries. The procedure was completed in all without complications (Table 2, Figure 2).

**Table 2: Associated middle ear anomaly encountered during stapes surgery.**

| Diagnosis | Number | Facial nerve status | Associated Middle Ear Anomaly |
|---|---|---|---|
| Otosclerosis | 1 | Totally prolapsed | Absent anterior crus and rudimentary posterior crus of stapes |
| Congenital stapes fixation | 2 | Normal | Underdeveloped long and lenticular process of incus<br>Absent stapes suprastructure<br>Anomalously located round window and oval window |
| | | Normal | Absent stapedial tendon |




A B

**Figure 2. Facial nerve partially prolapsing over the stapes footplate area.**

A.Pre-operative B. Post-stapedotomy

*(FN-Facial nerve, LPI-Long process of incus, S-Stapes head, Stt-Stapedial tendon, O-Oval window, Pe-Pyramidal eminence)*

## DISCUSSION

Anomalous intra-tympanic course of FN, although rare, it is always good to be well-versed with the detailed anatomy of the FN and its possible variations to prevent inadvertent facial nerve injury during middle ear surgery, like stapes surgery.

An anomalous course of FN during stapes surgery has been reported between 2.6 to 11.4% in the literature (Table 3).[6-21] A dehiscence of the fallopian canal, with FN epineurium exposed at the tympanic segment, was noted amongst 3.27% in 427 stapes surgeries as reported by Tange et al.[10] Li et al.[8] reported a slightly higher dehiscence rate of 11.4% in 1,465 stapes surgeries. Interestingly, the frequency was found to be as high as 25-57% in cadavers, probably owing to the inability to recognize micro-dehiscence and search for all segments of the FN during surgery.[4,17,22-24]

FN dehiscence may be present with or without various degrees of facial nerve prolapse over the stapes footplate area. Stapes surgery becomes challenging in the presence of a narrow oval window niche, particularly when the FN is overhanging the footplate. In such situations, the procedure may need to be abandoned. Alternatively, modification in the surgical technique, such as displacing an overhanging FN superiorly and using an angled shaft piston, or drilling the promontory to improve footplate visualization, has been advocated.[9,25] The procedures have been abandoned very infrequently (0.2–0.3%), even when the prolapsed FN was found to be covering the oval window in 0.2-2% of stapes surgery.[8,9] Neff et al.[9] reported 2.6% cases of FN prolapse in 1,497 stapes surgeries, where 0.8% cases had partial prolapse covering less than 50% footplate area and 1.9% had prolapse more than 50% footplate area. In the later cases, the prolapsed FN was retracted for a few seconds to facilitate partial stapedectomy and vein graft placement. None of the cases had facial paresis in the immediate post-operative period. Similarly, in a study by Ballester et al.[11] among 595 stapedotomies, 5.3% (32 cases) had partial FN prolapse and 1.3% (8 cases) had total prolapse over the oval window. The surgical procedures were customised accordingly. In six out of seven cases with total FN prolapse, a prosthesis was placed over the promontory after making a burr hole just below the oval window. In one case of total prolapse, the prosthesis was placed above the oval window at the site where the facial nerve is usually located whereas in another case where the nerve was covering the oval window and the promontory, the prosthesis placement was withheld.

Some surgeons recommend creating the fenestration on the promontory when the stapes footplate is completely closed by the facial nerve.[7,9,21] As long as the footplate can be visualised, the FN can be retracted carefully, and a customised prosthesis (based on the anomalous anatomy) can be placed, avoiding nerve compression. Titanium-Teflon hybrid prostheses offer this advantage due to Teflon's flexibility.[7] In our study, almost all patients underwent the conventional technique except two. In two cases with total prolapse, the fenestration was created in the promontory.

Congenital middle ear malformations are usually associated with aberrant FN course.[5] An et al.[20] reported ossicular chain anomalies in 4% (7/175) ears undergoing stapes surgery, with stapes anomaly (aplasia or dysplasia) being encountered in all the cases. Similarly, incus was absent in two cases, incudostapedial joint (ISJ) was absent in one case and incudostapedial joint fibrous band was found in two cases. However, malleus being the least affected ossicle was found to be fixed and anteriorly displaced in one of the cases.[20] In the our study also, middle ear malformations such as absent anterior crus and rudimentary posterior crus of stapes, absence of stapes suprastructure and stapedial tendon,

underdeveloped long and lenticular process of incus and abnormally located round and oval window were noted.

Fortunately, none of the patients in our study developed iatrogenic FN paralysis, probably because all procedures were performed by experienced surgeons who were vigilant to the normal and abnormal anatomical variations. The identification of the fallopian canal and chorda tympani nerve has been considered a key landmark to ensure adequate exposure.[26,27] In addition, proper documentation of intraoperative FN status is crucial in case of nerve injury and will prove helpful in revision procedures.

In our study, the procedures were done purely using cold instruments. The addition of a laser in stapes surgery is not uncommon. It is used to facilitate the stapes footplate fenestration, the stapedial tendon, and the posterior crus division. However, delayed FN palsy has been reported in some cases post-stapedotomy, where the KTP laser was used.[28] Indirect thermal injury to the nerve has been implicated in this complication. A similar effect was noted in an in vitro study by Mills et al.[29]

Pre-operative radiological investigations play an important role in identifying the normal anatomy and anomalies. High-resolution computed tomography (HRCT) of the temporal bone can reveal anomalous courses of the intratympanic FN preoperatively.[30,31] Similarly, a recently developed ultra-high-resolution computed tomography (U-HRCT), with a spatial resolution of 0.1mm, may help detect the presence of dehiscence. Studies have demonstrated the capability of U-HRCT in delineating fine structures of the temporal bone, both in cadavers and patients with otologic disease.[32,33] In cases of uncertainty, intraoperative nerve monitoring is a valuable tool for identifying the nerve during surgery, especially in cases with anomalous course.[34,35]

Limitations of the present study include a small sample size, its retrospective study design, where some data could have been underreported in the chart. It is a single-centre study hence, the findings may not be generalisable. There could be potential interobserver bias as multiple surgeons were involved. A multicentric study following a standard criteria for the FN anomalies, involving a larger sample size is recommended. In addition, the use of pre-operative imaging can help identify the anomaly, which can be correlated intraoperatively.

**Table 3. Anomalies of the intratympanic facial nerve in different studies.**

| Authors | Study | Type of Surgery | Total Sample | Facial Nerve Findings |
|---|---|---|---|---|
| Li and Cao[8] | Retrospective | Microscopic stapedectomy/ stapedotomy | 1465 | Dehiscence: 11.4%<br>Dehiscence with protrusion: 6.96% |
| Tange and Bruijn[10] | Retrospective | Microscopic stapedotomy | 427 | Dehiscence: 3.27% |
| Ballester et al.[11] | Retrospective | Microscopic Stapedotomy | 595 | Total prolapse : 1.3%<br>Partial prolapse without dehiscence: 5.4%<br>Partial prolapse with dehiscence: 1%<br>FN duplication: 1case |
| Daniel et al.[16] | Retrospective | Microscopic stapedectomy | 3600 | Dehiscence: 2.8%<br>Overhang: 2.5% |
| Szymanski et al.[6] | Retrospective | Microscopic stapedectomy | 316 | Total overhang: 0.6%<br>Partial overhang: 6.3%<br>Dehiscence without protrusion: 0.6%<br>Duplication of FN: 1 case |
| Neff BA et al. [9] | Retrospective | Microscopic stapedectomy | 1497 | Prolapse >50% of footplate area: 1.9%<br>Prolapse <50% of footplate area: 0.8% |
| Di Martino et al.[17] | Prospective | Microscopic tympanoplasty/ stapedoplasty | 357 | Dehiscence: 6.4% |
| Vincent et al.[18] | Prospective | Microscopic laser stapedotomy | 3050 | Dehiscence: 5.7% |
| Gerard et al.[19] | Retrospective | Microscopic stapedotomy | 147 | Procident nerve: 18.37%<br>Dehiscence: 2.72%<br>Both: 7.48% |
| An YS et al.[20] | Retrospective | Microscopic stapedotomy for congenital stapes fixation | 62 | Anomalous facial nerve: 11.2% |
| Fernandez et al.[36] | Retrospective | Endoscopic stapedotomy | 205 | Dehiscence covering oval window: 0.9% |
| Senturk et al.[7] | Prospective | Microscopic stapedectomy | 28 | Dehiscence with prolapse<br><50% over footplate area : 6 cases<br>≥50% over footplate area : 5 cases |
| Soloperto et al.[12] | Retrospective | Endoscopic stapedectomy | 157 | Partial overhang<br>with dehiscence :6.4%<br>without dehiscence :1.3% |

## CONCLUSION

Anomalous facial nerves encountered during stapes surgeries are not uncommon. Being vigilant about the possibilities of anomalous facial nerve and tailoring the surgical technique accordingly is crucial for ensuring a safe and successful outcome.

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