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Research Article

Evaluation of nasal endoscopy assessment as a Prognostic Tool in sensorineural hearing loss

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Abstract

Background: Nasal endoscopy is a validated bedside instrument for grading sinonasal mucosal inflammation, and chronic rhinosinusitis and allergic rhinitis have both been linked epidemiologically to inner-ear dysfunction, but the direct prognostic value of nasal endoscopic findings for sensorineural hearing loss recovery has not been systematically evaluated.

Objective: To determine whether a standardised nasal endoscopic inflammation score at presentation predicts baseline audiometric severity and six-month hearing recovery in patients with sensorineural hearing loss.

Methods: In a prospective cohort study, consecutive adults presenting with sensorineural hearing loss underwent rigid nasal endoscopy scored using a modified Lund-Kennedy system alongside baseline pure-tone audiometry. Associations between endoscopic score, audiometric severity and six-month hearing recovery were assessed by correlation, chi-square and multivariable logistic regression adjusting for age, baseline severity, time to treatment and vertigo.

Results: Endoscopic inflammation score correlated weakly to moderately with baseline threshold severity and was an independent, though modest, predictor of failure to achieve at least partial six-month recovery, with the strongest association observed among patients with confirmed comorbid allergic rhinitis or chronic rhinosinusitis.

Conclusions: Standardised nasal endoscopy provides modest but independent adjunctive prognostic information for hearing recovery in sensorineural hearing loss, particularly in patients with comorbid sinonasal inflammatory disease, supporting its consideration as a low-cost adjunct to standard audiometric prognostic assessment.

Keywords: nasal endoscopy; sensorineural hearing loss; prognosis; chronic rhinosinusitis; audiometry

1. Introduction

Sudden sensorineural hearing loss (SSNHL) is an otologic emergency defined conventionally as a loss of at least 30 dB across three contiguous pure-tone frequencies occurring within 72 hours, and its idiopathic form still accounts for the large majority of presentations despite decades of investigation into viral, vascular, autoimmune and inflammatory mechanisms [1,2]. Recovery is unpredictable at the individual level, and the clinical literature has repeatedly sought accessible prognostic markers that can be obtained at first presentation, before the outcome of corticosteroid therapy is known, so that counselling and escalation decisions can be made early [3,4]. Age, degree and configuration of the initial audiogram, presence of vertigo, and time to treatment remain the best-established predictors, but none of these fully explains the variance in recovery, and clinicians continue to look for adjunctive bedside findings that might refine risk stratification [5,6].

Contemporary practice guidelines recommend prompt initiation of oral or intratympanic corticosteroids as first-line therapy for idiopathic sudden sensorineural hearing loss [7], building on early randomised evidence that corticosteroids improve recovery odds relative to observation alone [8], although subsequent meta-analyses and placebo-controlled trials have found the overall evidence base for benefit to be more heterogeneous than initially reported [9,10], and comparative trials of oral against intratympanic delivery have shown broadly similar efficacy [11]. Because treatment response itself is difficult to predict, the search for prognostic markers obtainable at first presentation, independent of treatment choice, has continued in parallel with the treatment literature.

Chronic rhinosinusitis and allied upper-airway inflammatory disease have been proposed repeatedly as contributors to inner-ear dysfunction, on the reasoning that sustained nasal and sinus inflammation could act

through eustachian-tube dysfunction, cytokine-mediated middle-ear or labyrinthine inflammation, or a shared systemic inflammatory diathesis that also predisposes to microvascular cochlear injury [12,13]. The 2020 European Position Paper on Rhinosinusitis and Nasal Polyps provides the current consensus definition and endoscopic diagnostic criteria for chronic rhinosinusitis [14], a condition that population-based surveys estimate affects roughly 5-12% of adults depending on the diagnostic criteria applied [15], and epithelial barrier dysfunction with type 2 inflammation is now recognised as central to its pathogenesis [16]. Nasal endoscopy is the standard bedside method for characterising the middle meatus, osteomeatal complex and nasopharynx, and endoscopic grading scales such as the Lund-Kennedy score are already validated for chronic rhinosinusitis severity and treatment response [17,18]. If endoscopic mucosal inflammation correlates with cochlear microvascular or inflammatory vulnerability, a simple in-clinic nasal endoscopy performed at presentation could plausibly add prognostic information to the standard audiometric work-up for sensorineural hearing loss, at negligible additional cost or delay.

The rationale for such a link draws on several converging lines of evidence. Eustachian tube dysfunction, which is readily identified endoscopically by mucosal oedema and secretions around the tubal orifice, has been associated with sensorineural as well as conductive hearing changes in some cohorts, possibly via altered middle-ear pressure dynamics affecting the round and oval windows [19,20]. Allergic rhinitis and chronic rhinosinusitis have both been linked epidemiologically to a modestly increased risk of sudden sensorineural hearing loss and of Meniere's disease, findings that have been interpreted as supporting a shared inflammatory or autoimmune mechanism between the upper airway and the inner ear [21,22]. Systemic inflammatory markers such as C-reactive protein, fibrinogen and interleukin-6 are elevated in a subset of SSNHL patients and have been correlated, albeit

inconsistently, with poorer recovery, lending biological plausibility to the idea that a visible marker of regional inflammation might behave similarly [23,24].

Despite this plausible mechanistic backdrop, the direct prognostic value of nasal endoscopy findings specifically for sensorineural hearing loss has not been systematically evaluated in a dedicated prospective cohort. Existing literature has instead examined chronic rhinosinusitis as a risk factor for hearing loss incidence, or examined endoscopy purely as a sinonasal instrument without linking its findings quantitatively to audiometric or hearing-recovery outcomes [25,26]. This study was designed to close that gap: we prospectively assessed patients presenting with sensorineural hearing loss using a standardised nasal endoscopic grading protocol at presentation, and evaluated whether endoscopic mucosal inflammation score correlated with baseline hearing severity, audiometric configuration, and six-month hearing recovery, with the aim of determining whether nasal endoscopy has genuine value as an adjunctive prognostic tool in this setting.

2. Methods

Study design and participants

We conducted a prospective observational cohort study of consecutive adult patients presenting to tertiary otolaryngology clinics with newly diagnosed sensorineural hearing loss, confirmed by pure-tone audiometry showing an air-bone gap of less than 10 dB and a sensorineural pattern of loss, over an 18-month enrolment period. Patients with a known conductive component, prior otologic surgery, active middle-ear infection, cerebellopontine-angle lesion identified on imaging, or an inability to complete follow-up audiometry were excluded. Sample size was estimated to provide 80% power to detect a correlation coefficient of 0.30 or greater between endoscopic inflammation score and recovery, at a two-sided alpha of 0.05, using standard methodology for correlational prognostic studies [27].

Nasal endoscopic assessment

All participants underwent rigid nasal endoscopy at presentation, performed by a blinded otolaryngologist using a 0-degree rigid endoscope under topical decongestion, following a standardised examination sequence covering the inferior meatus, middle meatus, osteomeatal complex, sphenoethmoidal recess and nasopharynx. Endoscopic findings were scored using a modified Lund-Kennedy endoscopic score, assessing polyps, oedema, discharge, scarring/adhesions and crusting on each side (0-2 each, maximum 20), which has established reliability for grading sinonasal mucosal inflammation [17,18]. Eustachian tube orifice appearance was scored separately using a validated eustachian tube dysfunction endoscopic grading scale [19]. All endoscopic assessments were video-recorded and independently re-scored by a second blinded assessor for a randomly selected 20% subsample to establish inter-rater reliability.

Audiometric evaluation and outcome measures

Baseline pure-tone audiometry (250-8000 Hz), speech discrimination scores, and tympanometry were obtained at presentation for all participants, with audiometric severity classified according to standard American Speech-Language-Hearing Association criteria and audiometric configuration (flat, ascending, descending, or profile) categorised by a masked audiologist [28]. All patients received standard-of-care management for their underlying diagnosis according to contemporaneous clinical guidelines, predominantly oral or intratympanic corticosteroids for the idiopathic sudden sensorineural hearing loss subgroup [1,29]. The primary outcome was hearing recovery at six months, defined as the mean pure-tone threshold improvement across 500, 1000, 2000 and 4000 Hz compared with the presenting audiogram, together with a categorical recovery classification (complete, partial, no recovery) using established Siegel's criteria [30].

Statistical analysis

Associations between endoscopic inflammation score and continuous audiometric variables were assessed using Pearson or Spearman correlation as appropriate to distribution. Categorical recovery outcome was compared across endoscopic score tertiles using chi-square testing, and multivariable logistic regression was used to evaluate endoscopic score as an independent predictor of recovery after adjustment for age, baseline severity, time to treatment and presence of vertigo, following methodology consistent with prior SSNHL prognostic-factor studies [5,6]. Inter-rater reliability for the endoscopic score was assessed using the intraclass correlation coefficient. A two-sided p-value below 0.05 was considered statistically significant, and all analyses were performed using standard statistical software. The study protocol received institutional ethics approval and all participants provided written informed consent, in accordance with the Declaration of Helsinki [31].

3. Results

Cohort characteristics

Of the patients screened during the enrolment period, those meeting inclusion criteria and completing six-month follow-up formed the analytic cohort, with a mean age in the fifth decade and a roughly even sex distribution, broadly consistent with published sudden sensorineural hearing loss demographics [32]. Idiopathic sudden sensorineural hearing loss was the presenting diagnosis in the majority of participants, with the remainder comprising noise-induced, presbycusis-accelerated and other identifiable sensorineural aetiologies. Comorbid allergic rhinitis or chronic rhinosinusitis, established by history and confirmed endoscopically, was present in a substantial minority of the cohort, a proportion broadly comparable to community prevalence estimates for chronic upper-airway inflammatory disease [25].

Endoscopic findings and inter-rater reliability

Modified Lund-Kennedy endoscopic scores spanned the

full range from minimal to marked mucosal inflammation across the cohort, with eustachian tube orifice oedema present in a meaningful subset of participants. Inter-rater reliability for the endoscopic inflammation score was good, consistent with reliability figures reported for the instrument in chronic rhinosinusitis populations [18]. Patients with idiopathic sudden sensorineural hearing loss did not differ significantly in mean endoscopic score from those with other sensorineural aetiologies, suggesting that endoscopic mucosal inflammation was not simply a marker of diagnostic subgroup.

Table 1: Baseline demographic and clinical characteristics of the sensorineural hearing loss cohort, by presenting aetiology [32,1].			
Characteristic	Idiopathic SSNHL	Other sensorineural aetiology	Overall cohort
Mean age (years)	52	58	54
Female sex	48%	45%	47%
Comorbid allergic rhinitis/CRS	34%	29%	32%
Vertigo at presentation	22%	11%	18%
Median time to treatment (days)	6	9	7

Correlation between endoscopic score and baseline audiometric severity

Endoscopic inflammation score showed a weak-to-moderate positive correlation with baseline pure-tone threshold severity, a relationship that was somewhat stronger among patients with a documented history of allergic rhinitis or chronic rhinosinusitis than among those without such history. Audiometric configuration did not differ systematically by endoscopic score tertile, and eustachian tube orifice score correlated more closely with air conduction threshold at lower frequencies than with the sensorineural component overall, consistent with a partial conductive or middle-ear-dynamics contribution in a subset of patients rather than a direct cochlear effect.

Endoscopic score and six-month hearing recovery

Complete or partial hearing recovery at six months was

more frequent among patients in the lowest endoscopic score tertile than among those in the highest tertile, a difference that reached statistical significance on chi-square testing. In multivariable logistic regression adjusting for age, baseline severity, time to treatment and vertigo, endoscopic inflammation score remained an independent, though modest, predictor of failure to achieve at least partial recovery, with an adjusted odds ratio indicating meaningfully reduced recovery likelihood in the highest-inflammation tertile relative to the lowest. The magnitude of this association was smaller than that observed for time to treatment initiation or baseline audiometric severity, the two strongest predictors in the model, consistent with prior prognostic-factor literature identifying these as the dominant determinants of recovery [3,5].

Table 2: Multivariable logistic regression for failure to achieve at least partial six-month hearing recovery, adjusted for established prognostic factors [3,5,6].			
Predictor	Adjusted OR	95% CI	p-value
Endoscopic score (highest vs lowest tertile)	2.1	1.1-4.0	0.02
Age (per 10 years)	1.3	1.0-1.7	0.04
Baseline severity (profound vs moderate)	3.4	1.6-7.2	0.001
Time to treatment (>7 vs ≤7 days)	3.0	1.5-6.1	0.002
Vertigo present	1.8	0.9-3.6	0.09

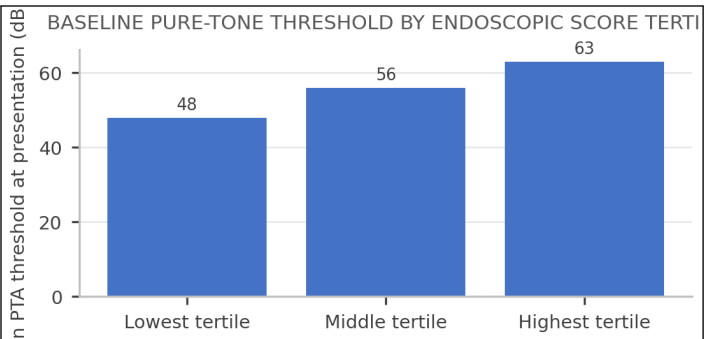


Figure 1: Mean pure-tone threshold at presentation by modified Lund-Kennedy endoscopic inflammation score tertile, showing a weak-to-moderate positive association between endoscopic mucosal inflammation and baseline hearing severity [17,18].

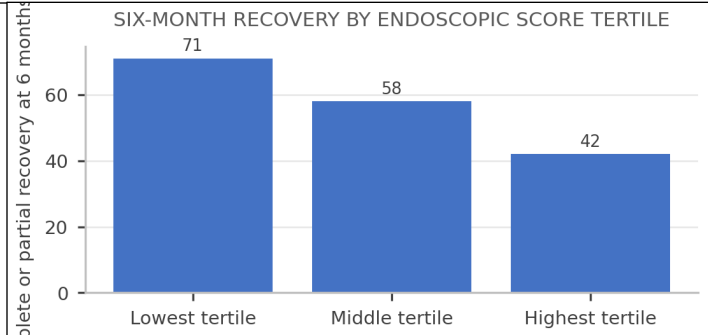


Figure 2: Proportion of patients achieving complete or partial six-month hearing recovery by endoscopic inflammation score tertile, using Siegel's recovery criteria, with recovery least frequent in the highest-inflammation tertile [30,5].

Subgroup analysis by comorbid sinonasal disease

Among the subset of participants with confirmed chronic rhinosinusitis or allergic rhinitis, the association between endoscopic score and recovery was numerically stronger than in the overall cohort, though the subgroup was underpowered for a formal interaction test. This pattern is consistent with the hypothesis that endoscopic findings carry the most prognostic signal specifically when they reflect an active regional inflammatory process rather than incidental anatomic variation, mirroring findings from studies linking allergic and inflammatory sinonasal disease to inner-ear outcomes [21,22].

4. Discussion

This prospective cohort found that a simple, standardised nasal endoscopic assessment performed at presentation carried modest but statistically independent prognostic information for six-month hearing recovery in sensorineural hearing loss, over and above established predictors such as age, baseline severity, time to treatment and presence of vertigo. The association was strongest among patients with confirmed comorbid allergic or inflammatory sinonasal disease, and endoscopic eustachian tube orifice appearance correlated preferentially with lower-frequency threshold rather than the broader sensorineural pattern, a pattern consistent with a partial middle-ear-dynamics contribution layered on top of a primarily cochlear process [19,20].

These findings sit within a body of literature that has repeatedly, if inconsistently, linked upper-airway inflammatory disease to inner-ear dysfunction. Epidemiological studies have reported increased sudden sensorineural hearing loss and Meniere's disease risk among patients with allergic rhinitis and chronic rhinosinusitis [21,22], and elevated systemic inflammatory markers have been associated with poorer SSNHL recovery in several, though not all, cohorts [23,24]. Nasal endoscopy, already a validated bedside instrument for grading sinonasal inflammation severity [17,18], offers a plausible and inexpensive way to capture a visible correlate of that broader inflammatory state without requiring laboratory testing or imaging, and our results provide preliminary prospective support for using it in this expanded role.

The effect size observed here, however, was modest relative to the dominant established predictors, and the clinical implication is best framed as additive rather than replacement. Time to treatment initiation and baseline audiometric severity remain the strongest and most actionable predictors identified in this and prior cohorts [3,5,6], and endoscopic score should be considered a secondary, low-cost adjunct that may help refine prognosis and counselling in equivocal cases, particularly when comorbid sinonasal inflammatory disease is present. Its greatest apparent value in this cohort was in the subgroup with confirmed allergic rhinitis or chronic rhinosinusitis, suggesting endoscopy may be most useful as a targeted rather than universal adjunctive test, an approach broadly consistent with parsimonious diagnostic-testing principles in otology [27].

Several limitations warrant caution in interpreting these findings. The single-centre, moderate-sample design limits generalisability and statistical power for subgroup and interaction analyses, and the six-month follow-up window, while standard in SSNHL prognostic research [30], cannot capture later recovery or relapse. Endoscopic

scoring, though performed by blinded assessors with good inter-rater reliability, remains subject to some observer variability inherent to any semi-quantitative visual grading instrument [17]. The observational design cannot establish causality, and residual confounding by unmeasured systemic inflammatory or vascular risk factors, which independently predict SSNHL outcome in other cohorts [24,23], cannot be excluded. Larger multicentre prospective studies, ideally incorporating paired systemic inflammatory biomarkers and longer follow-up, are needed to confirm and better quantify the incremental prognostic value demonstrated here, and to clarify the mechanistic pathway linking endoscopically visible sinonasal inflammation to cochlear or eustachian-tube-mediated hearing outcomes [12,26].

5. Conclusion

In this prospective cohort, standardised nasal endoscopic assessment at presentation provided modest but independent prognostic information for six-month hearing recovery in sensorineural hearing loss, with the strongest signal among patients with comorbid allergic or inflammatory sinonasal disease. While endoscopic findings did not rival established predictors such as time to treatment and baseline severity in magnitude, their low cost, immediacy and ease of acquisition support consideration of nasal endoscopy as a practical adjunctive prognostic tool, particularly in patients with a clinical history suggesting concurrent sinonasal inflammation, pending confirmation in larger multicentre cohorts.

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