Original Research

COMPARISON OF SYSTEMIC STEROIDS, INTRATYMPANIC STEROIDS, AND SYSTEMIC STEROIDS WITH ANTIOXIDANTS IN THE MANAGEMENT OF SUDDEN SENSORINEURAL HEARING LOSS: A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Background: Sudden sensorineural hearing loss (SSNHL) is a distressing otologic condition marked by rapid loss of auditory function, often developing without warning. Although corticosteroids are widely accepted as the primary treatment modality, uncertainty persists regarding the most effective route of administration. In routine clinical practice, antioxidants are also frequently prescribed as adjuncts, despite ongoing debate regarding their role.

Objectives: To compare hearing outcomes following systemic steroid therapy, intratympanic steroid therapy, and systemic steroid therapy combined with antioxidants in patients diagnosed with sudden sensorineural hearing loss.

Methods: This prospective comparative study included 30 patients with SSNHL allocated equally into three treatment groups. Group 1 received systemic steroids, Group 2 received intratympanic steroids, and Group 3 received systemic steroids with antioxidants supplementation. Hearing outcomes were evaluated using pure tone audiometry, and changes in pure tone average thresholds were analyzed over the follow-up period of 6 weeks.

Results: Improvement in hearing thresholds was observed across all treatment groups. Patients treated with systemic steroids combined with antioxidants demonstrated greater mean improvement in pure tone average thresholds when compared with systemic steroid therapy alone. Intratympanic steroid therapy also resulted in notable hearing recovery, with outcomes approaching those of combination therapy in several patients.

Conclusion: The study suggests that intratympanic steroid therapy and systemic steroids combined with antioxidants may offer advantages over systemic steroids alone in the management of sudden sensorineural hearing loss. Further studies with larger sample sizes are required to validate these findings.

Keywords: Sudden Sensorineural Hearing Loss, Systemic Steroids, Intratympanic Steroids, Antioxidants, Pure Tone Audiometry.

INTRODUCTION

Sudden sensorineural hearing loss [SSNHL] remains a challenging clinical entity, not because it is rare, but because it often arrives without warning symptoms. Patients typically report abrupt hearing reduction over hours or a day, sometimes accompanied by tinnitus or imbalance. For the clinician, the difficulty lies less in diagnosis and more in deciding how aggressively, and by which route, to intervene.

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By convention, SSNHL is defined as a rapid loss of 30 dB or more across at least three contiguous frequencies on an audiogram within a period of 72 hours. [1]. Despite this clear audiometric definition, the underlying cause is frequently elusive. Viral inflammation, vascular compromise, immune-mediated injury, and cochlear membrane disruption have all been proposed, yet most cases are ultimately labelled idiopathic in nature [2].

Steroids have remained the mainstay of treatment, largely on pragmatic grounds. Systemic corticosteroids are widely used as initial therapy, supported by biological plausibility and long-standing clinical experience [3]. At the same time, systemic administration is not ideal for every patient, particularly those with metabolic comorbidities or intolerance to high-dose steroids.

These limitations have kept interest alive in alternative routes of delivery.

Comparative evidence suggests that intratympanic steroids can be comparable to systemic steroids as initial therapy, and combined systemic and intratympanic regimens may offer additional benefit in selected cases [4, 5]. The appeal of intratympanic steroid delivery lies in its ability to achieve high local drug concentrations while largely avoiding systemic exposure. Even so, practice patterns remain variable, and there is no universal consensus on first-line choice.

The antioxidant question is less straightforward. Oxidative stress is mechanistically reasonable in inner ear injury pathways, and several antioxidant compounds have been explored with this rationale in mind [6,7]. However, formal guideline positions have historically been cautious, reflecting variability in study quality and inconsistency in observed clinical benefit [3]. In Indian practice, antioxidants are still frequently co-prescribed, often driven by a "low-harm, possible-benefit" approach and patient expectations rather than firm evidence.

Against this background, the present prospective comparative study was planned to compare three commonly used treatment strategies, systemic steroids, intratympanic steroids, and systemic steroids with antioxidants, using audiometric recovery as the primary outcome.

MATERIALS AND METHODS

Study design and setting

This prospective comparative study was conducted in the Department of ENT and Head & Neck Surgery at Farookh Academy of Medical Education Hospital and Research Institute, Mysuru and Dr. Manasa's Speciality Ent Centre, Bengaluru from January 2025 to January 2026. Patients presenting with sudden onset hearing loss were evaluated and managed according to a predefined treatment protocol during the study period. Scientific and ethical committee clearance was obtained.

Study population

A total of 30 patients diagnosed with sudden sensorineural hearing loss were included in the study after taking written informed consent. All patients underwent detailed clinical evaluation and baseline audiological assessment prior to initiation of treatment.

Inclusion criteria

Patients aged > 18 years presenting with unilateral sudden SNHL defined as more than or equal to 30dB loss over three consecutive frequencies within 72 hours were incuded.

Exclusion criteria

Patients with evidence of conductive or mixed hearing loss, history of those with identifiable etiologies, bilateral involvement, prior ear surgery on the affected side, prior hearing loss, delayed presentation, pregnant or lactating woman, contraindication to steroid therapy, patient lost to follow-up or with incomplete audiological data were excluded.

Group allocation and treatment protocol

Patients were allocated into three treatment groups, with 10 patients in each group.

- **Group 1 (Systemic steroids):** Patients received oral prednisolone at a dose of 1 mg/kg/day (maximum 60 mg/day) for 7 days, followed by gradual tapering over the subsequent 7 days, as per departmental protocol.
- **Group 2 (Intratympanic steroids):** Patients received intratympanic injections of dexamethasone (4 mg/mL), with 0.4–0.5 mL administered per injection. A total of three injections were given at 3-day intervals under local anesthesia using standard aseptic precautions.
- **Group 3 (Systemic steroids with antioxidants):** Patients received systemic corticosteroids similar to Group 1, along with oral antioxidant supplementation for a duration of 6 weeks.

The choice of antioxidant formulation reflected routine clinical use in the department during the study period.

Audiological assessment

Pure tone audiometry was performed at baseline prior to treatment initiation and repeated during follow-up visits. Air-conduction thresholds at 0.5, 1, 2, 4 kHz and 8 kHz were recorded, and the pure tone average was calculated for each patient. Follow-up audiometry was typically performed at approximately 2 weeks and 6 weeks after initiation of therapy.

Outcome measures

The primary outcome measure was improvement in pure tone average (PTA) from baseline to the final follow-up visit at 6 weeks. Secondary outcome measures included interim audiometric improvement at 2 weeks and categorical assessment of hearing recovery at the final follow-up. Hearing recovery was classified based on change in PTA from baseline as follows: **Complete recovery**, defined as improvement of ≥30 dB or return of hearing thresholds to within 10 dB of the unaffected ear; **Partial recovery**, defined as improvement of 10–29 dB and **No recovery**, defined as improvement of <10 dB. These categories were applied uniformly across all treatment groups.

Safety assessment

Patients were monitored for treatment-related adverse effects during follow-up visits. Systemic steroid–related symptoms such as gastrointestinal discomfort, sleep disturbance, and glycemic

fluctuations were documented. In the intratympanic group, procedure-related discomfort, vertigo, or local ear complications were specifically assessed.

Statistical analysis

Audiometric data were entered into a structured database and analyzed using standard statistical methods. Continuous variables were summarized using measures of central tendency and dispersion. Comparisons between treatment groups were performed using appropriate statistical tests based on data distribution. Categorical variables were analyzed using proportion-based comparisons. p-value of less than 0.05 was considered statistically significant.

RESULTS

Study population and baseline characteristics

A total of 30 patients diagnosed with sudden sensorineural hearing loss (SSNHL) were included in the analysis, with 10 patients allocated to each treatment group. All participants completed baseline and follow-up audiometric assessments, and no patient was excluded after allocation. The study population comprised adults aged between 22 and 58 years, with the majority of patients falling within the 31–50-year age group. Overall, males constituted 56.7% (17/30) of the study population, while females accounted for 43.3% (13/30), resulting in a male-to-female ratio of approximately 1.3:1. Baseline demographic and clinical characteristics, including age distribution, side of involvement, and baseline hearing severity, were broadly comparable across the three treatment groups (Table 1). The majority of patients presented within the first week of symptom onset, reflecting early clinical referral patterns.

Table 1: Baseline demographic and clinical characteristics of study participants

Parameter	Group 1 Systemic steroids (n=10)	Group 2 IT Steroids (n=10)	Group 3 Systemic steroids + Antioxidants (n=10)
Age (years), mean ± SD	41.6 ± 9.8	43.1 ± 10.5	40.9 ± 8.7
Left ear involvement, n	4	5	3
Right ear involvement, n	6	5	7
Time to presentation (days), median (IQR)	4 (3–6)	4 (2–6)	3 (2–5)
Baseline PTA (dB), mean ± SD	67.4 ± 10.6	69.1 ± 11.2	68.2 ± 9.7

Audiometric Outcomes and Hearing Improvement

All three treatment groups demonstrated improvement in pure tone average during follow-up. Mean PTA values showed progressive improvement from baseline to 2 weeks and further at 6 weeks in each group (Table 2).

The greatest mean PTA gain at final follow-up was observed in patients treated with systemic steroids combined with antioxidants, followed by the intratympanic steroid group. Patients treated with systemic steroids alone demonstrated improvement, though the magnitude of recovery was comparatively lower.

Table 2: Pure tone audiometry outcomes and hearing gain across groups

Audiometric parameter	Group 1 Systemic steroids	Group 2 IT Steroids	Group 3 Systemic steroids+ Antioxidants
Baseline PTA (dB), mean ± SD	67.4 ± 10.6	69.1 ± 11.2	68.2 ± 9.7
PTA at 2 weeks (dB), mean ± SD	55.6 ± 11.9	50.7 ± 12.5	49.2 ± 11.6
PTA at 6 weeks (dB), mean ± SD	49.1 ± 13.2	45.0 ± 12.9	42.1 ± 12.2
PTA gain at 6 weeks (dB), mean ± SD	18.3 ± 9.4	24.1 ± 10.2	26.1 ± 9.6

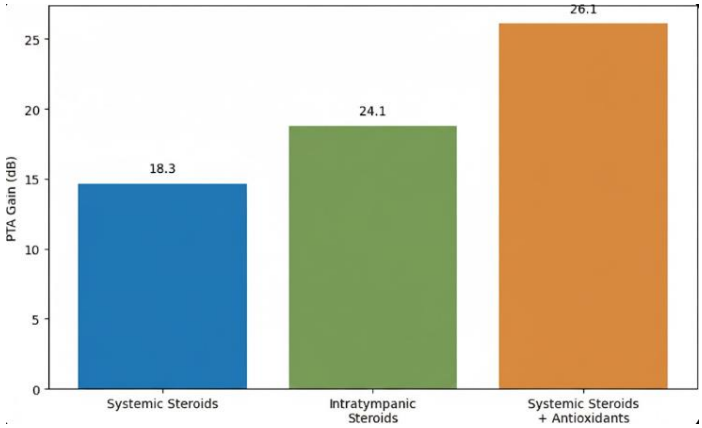

Figure 1: Mean Pure Tone Average Improvement (Db) At 6 Weeks across Treatment Groups

Bar chart with three differently colored bars representing each group; numerical PTA gain values at 6 weeks displayed above each bar.

Pattern of Hearing Recovery

When hearing recovery was categorized into complete, partial, and no recovery, distinct trends emerged across treatment groups (Table 3). Complete recovery was most frequently observed in the systemic steroids with antioxidants group, while the systemic steroid–only group showed the highest proportion of patients with no significant recovery. Partial recovery constituted the largest category across all three groups, indicating that while improvement was common, full normalization of hearing thresholds remained limited within the short follow-up period.

Table 3: Categorical hearing recovery at 6 weeks

Recovery category	Group 1 Systemic steroids	Group 2 IT Steroids	Group 3 Systemic steroids + Antioxidants
Complete recovery, n (%)	2 (20)	3 (30)	4 (40)
Partial recovery, n (%)	5 (50)	5 (50)	5 (50)
No recovery, n (%)	3 (30)	2 (20)	1 (10)

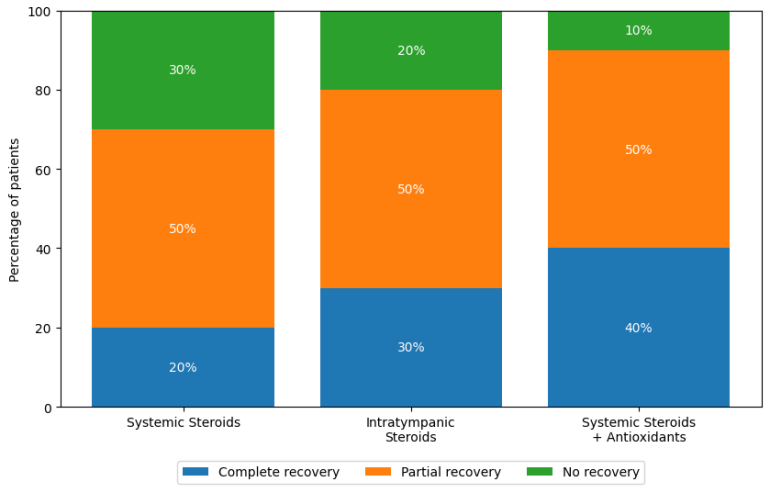

Figure 2: Distribution of hearing recovery categories by treatment group

Stacked bar chart with distinct colors representing complete, partial, and no recovery; percentage values shown within each bar segment.

Contribution of treatment modality to overall recovery

To visualize the relative contribution of each treatment strategy to overall recovery outcomes, proportional analyses were performed. The combination therapy group accounted for a larger share of complete recovery cases, while systemic steroid monotherapy contributed a higher proportion of non-responders.

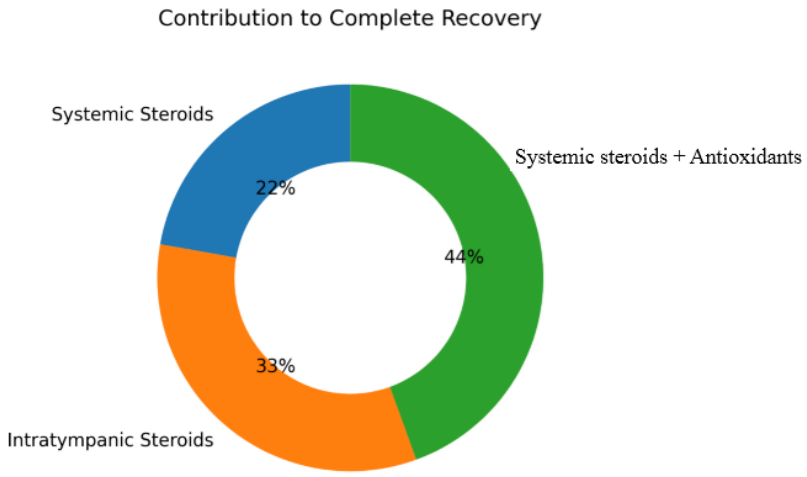

Figure 3: Proportion of Complete Recovery Cases across Treatment Groups

Donut chart with three segments representing each treatment group; percentage contribution labelled outside each segment.

Symptom Profile and Associated Findings

Tinnitus was the most frequently reported symptom at presentation. Tinnitus alone was observed in 50% (15/30) of patients, while both tinnitus and vertigo were present in 23.3% (7/30). No patients reported vertigo in isolation (0%). Neither symptom was reported by 26.7% (8/30) of patients (Figure 4).

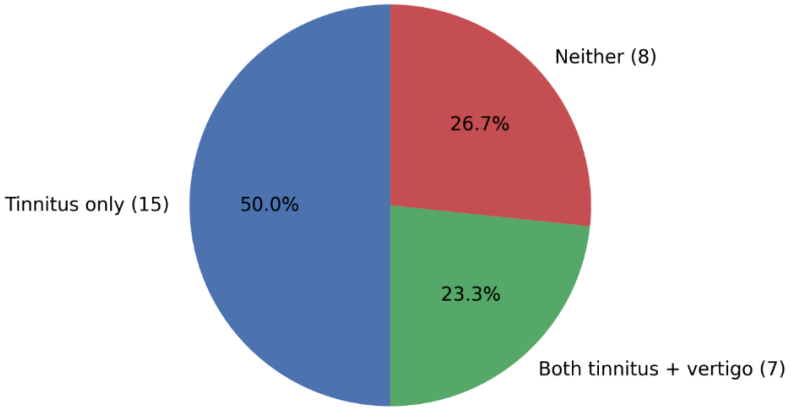

Figure 4: Symptom Distribution among Study Participants

Percentages are calculated out of 30 participants.
Pie chart showing tinnitus only (15/30), both tinnitus and vertigo (7/30), and neither symptom (8/30). No patients reported isolated vertigo (0/30).

Adverse Effects

Systemic steroid–related adverse effects were mild and self-limiting, consisting mainly of gastrointestinal discomfort and sleep disturbance. No patient required discontinuation of therapy. In the intratympanic steroid group, transient ear discomfort and brief vertigo were reported in a small number of patients, resolving without intervention. No serious local or systemic complications were observed during follow-up.

DISCUSSION

Sudden sensorineural hearing loss remains a condition in which treatment decisions are often made in the absence of definitive etiological clarity. Although diagnostic criteria are well established, response to therapy is variable, and recovery patterns differ between patients. In the present prospective comparative study, three treatment approaches commonly used in routine practice i.e., systemic steroids, intratympanic steroids, and systemic steroids combined with antioxidants, were evaluated with reference to short-term audiometric outcomes.

Improvement in hearing thresholds was observed across all three treatment groups during follow-up.

This finding indicates that recovery can occur following intervention, irrespective of the route or combination of therapy used. However, the degree of improvement varied between groups. Patients treated with systemic steroids alone demonstrated improvement, though the overall magnitude of recovery appeared lower when compared with the other treatment groups. Given the study design and sample size, this observation should be interpreted as a descriptive finding rather than evidence of inferiority [8].

Patients who received intratympanic steroid therapy showed greater audiometric improvement than those treated with systemic steroids alone. Intratympanic delivery is intended to provide higher local drug concentrations while limiting systemic exposure, and its use has expanded beyond salvage therapy in recent years [9]. In the present study, intratympanic therapy was associated with favorable hearing outcomes, although the data do not permit conclusions regarding its superiority over other treatment modalities.

The group treated with systemic steroids in combination with antioxidants demonstrated the highest mean improvement in hearing thresholds. While oxidative stress has been proposed as one of several mechanisms involved in cochlear injury [10], clinical evidence supporting routine antioxidant use in sudden sensorineural hearing loss remains variable [11]. In this study, the observed improvement in the combination group cannot be attributed specifically to antioxidant therapy, and the findings should be viewed as an association rather than a causal effect.

Prescribing patterns may also influence observed outcomes. In Indian clinical practice, antioxidants are frequently prescribed alongside steroids, often based on perceived safety and patient expectation rather than standardized evidence. The present findings reflect this practice pattern and highlight the difficulty in separating therapeutic effect from contextual factors in small comparative studies [12].

Several prognostic variables known to influence hearing recovery warrant consideration. Initial severity of hearing loss, presence of vertigo, and timing of treatment initiation have been associated with outcome in previous studies [13]. Although baseline characteristics were broadly comparable across groups, the limited sample size restricts adjustment for these variables and limits interpretation of subgroup effects.

Within these constraints, the study provides descriptive insight into hearing outcomes associated with three commonly used treatment strategies for sudden sensorineural hearing loss. The findings underscore the variability of recovery and support the need for individualized clinical decision-making. Larger studies with standardized protocols and longer follow-up are required to clarify the relative contribution of different therapeutic approaches.

LIMITATIONS

The study has certain limitations. The sample size was modest, which limits statistical power and generalizability of the findings. Follow-up was restricted to the early recovery period, and longer-term hearing outcomes could not be assessed. In addition, although treatment protocols were standardized within groups, the comparative design does not permit definitive conclusions regarding the relative efficacy of the treatment modalities.

CONCLUSION

In this prospective comparative study, improvement in hearing thresholds was observed across all treatment groups. Intratympanic steroid therapy and systemic steroids combined with antioxidants were associated with greater audiometric improvement than systemic steroids alone, although the findings should be interpreted descriptively. The results highlight variability in recovery patterns and support an individualized approach to the management of sudden sensorineural hearing loss. Further studies with larger sample sizes and longer follow-up are required to clarify treatment outcomes.

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