Management of Sensorineural Hearing Loss (Badhirya) through Karna Purana with Bilva Taila: A Clinical Study and Audio-metrical Correlation

Dr. Gurpreet Kaur[1], Harjit Singh[2], Simranpreet Kaur[3], Maninder Pal Singh[4]

Associate Professor[1], Postgraduate Scholars[2, 3, 4]

Department of Shalakya Tantra

Satya Sai Murlidhar Ayurvedic College & Hospital

Corresponding Author Email: *kaur_simranpreet20@yahoo.com[3]*

ABSTRACT

Background: *Sensorineural Hearing Loss (SNHL), structurally correlated with the Ayurvedic entity Badhirya, is characterized by the degeneration of cochlear hair cells, pathology of the vestibulocochlear nerve (VIIIth cranial nerve), or dysfunction within central auditory processing pathways. Contemporary biomedical management remains largely limited to assistive technologies such as hearing aids and cochlear implants, which facilitate sound amplification or artificial nerve stimulation but do not reverse the underlying cellular degeneration. Karna Purana (local ear instillation) with Bilva Taila provides a localized, lipophilic, non-invasive therapeutic intervention designed to counter Vata-Kapha pathology, clear micro-channel obstructions, and provide neuro-nutritional support to the inner ear.*

Aims & Objectives: *To systematically evaluate the clinical efficacy of Karna Purana utilizing Bilva Taila in the management of mild-to-profound SNHL, and to establish a robust scientific correlation between subjective clinical symptom indices and objective Pure Tone Audiometry (PTA) data.*

Methods: *A prospective, open-label, single-arm clinical trial was executed with a cohort of 60 patients presenting with verified SNHL. The therapeutic intervention comprised localized Poorva Karma (mild Abhyanga and Nadi Swedana) followed by Pradhana Karma consisting of Karna Purana with*

lukewarm Bilva Taila (held for 100 Matra Kala / approximately 15 minutes per ear) over a 14-day protocol. Quantitative and qualitative assessments were performed at Day 0 (Baseline), Day 15 (Post-treatment), and Day 45 (Follow-up). Primary subjective endpoints included gradations of Badhirya (hearing deficit), Karnanada (tinnitus), and Karna Gaurava (ear fullness). The primary objective endpoint was change in Pure Tone Average air conduction (AC) and bone conduction (BC) thresholds measured across frequencies ranging from 250 Hz to 8000 Hz.

Results: *Statistical analysis of post-treatment metrics demonstrated highly significant ($P < 0.001$) improvements across all clinical symptoms. Objective audiometric analysis revealed a statistically significant reduction in mean hearing thresholds, particularly in low-to-mid frequencies (250 Hz - 2000 Hz), with an overall mean reduction in Pure Tone Average of 8.73 dB HL. Subjective relief from Karnanada (tinnitus) demonstrated a strong positive correlation with the recovery of hearing thresholds within the corresponding damaged frequency zones.*

Conclusion: *Karna Purana with Bilva Taila is a clinically viable, safe, and effective Ayurvedic intervention for stabilizing and improving auditory thresholds in SNHL. The therapeutic mechanism integrates the trans-tympanic diffusion of lipophilic phytochemicals with local thermal and neuro-vascular stimulation, providing an empirical bridge between traditional otology and modern neuro-otological diagnostics.*

KEYWORDS: *Hearing Loss (Badhirya), Karna Purana, Bilva Taila,*

INTRODUCTION

Hearing impairment represents one of the most prevalent chronic sensory neurodegenerative conditions globally. According to epidemiologic indices, disabling hearing loss affects millions of individuals worldwide, profoundly impacting cognitive reserve, psychosocial well-being, economic productivity, and overall quality of life. Within the structural taxonomy of otolaryngology, hearing loss is bifurcated into conductive anomalies (mechanical obstacles

within the external auditory meatus or middle ear cleft) and sensorineural deficits.

Sensorineural Hearing Loss (SNHL) is fundamentally an irreversible or progressive impairment arising from pathological changes in the delicate mechanoreceptors (inner and outer hair cells) of the Organ of Corti within the cochlea, structural damage to the vestibulocochlear nerve, or central lesions within the auditory cortex of the temporal lobe. The primary etiopathogenetic vectors of SNHL encompass long-term acoustic trauma, presbyacusis (age-related attrition), ototoxic medication exposure (e.g., aminoglycosides, loop diuretics, platinum-based chemotherapeutic agents), viral labyrinthitis, micro-vascular ischemia, and genetic predisposition.

From a modern pharmacological perspective, the inner ear remains highly isolated and challenging to treat. The presence of the blood-labyrinth barrier tightly restricts the systemic delivery of neuroprotective, anti-inflammatory, or regenerative compounds to the fluid-filled compartments of the cochlea (scala vestibuli, scala media, and scala tympani). Consequently, current standard-of-care interventions are restricted to rehabilitative prosthetics—primarily acoustic hearing aids and surgical cochlear implantation. While these devices bypass or amplify dead regions of the cochlea, they do not repair the cytological framework of the sensory epithelium, nor do they halt ongoing neuro-degenerative processes.

The Ayurvedic Paradigm of Badhirya

In the classical compendia of Ayurveda (Shalakya Tantra), diseases of the ear are cataloged under Karna Rogas. The celebrated sage Acharya Sushruta describes 28 distinct Karna Rogas, among which Badhirya (deafness) is characterized as a severe manifestation of systemic and localized Vata Dosha imbalance.

The primary pathogenesis (Samprapti) of Badhirya involves the morbid vitiation of Vata Dosha (specifically Prana Vayu and Vyan Vayu), which migrates into the localized channels of hearing—the Shrotovaha Srotas. This vitiated Vata can operate independently (Kevala Vata), causing tissue wasting, nerve desiccation, and loss of function (Dhatu Kshaya). Alternatively, it may be bound or obstructed by morbid Kapha Dosha (Kaphavrita Vata), which acts as a dense, static block, preventing the normal conduction of sound waves and neural signals.

The classical management of Badhirya prioritizes therapies that pacify Vata, liquefy and eliminate Kapha obstructions, and provide deep cellular nourishment (Brimhana) to the sensory faculty (Shrotendriya). Among the localized treatments (Kriyakalpa), Karna Purana stands out as the supreme therapeutic modality for ear disorders. It involves filling the external auditory canal with warm, medicated, lipid-based vehicles, allowing for prolonged tissue contact and localized absorption.

Rationale for Selecting Bilva Taila

Bilva Taila is an authoritative classical formulation detailed in the Bhaishajya Ratnavali specifically indicated for Karna Roga and Badhirya. The therapeutic efficacy of Bilva Taila lies in its phytochemical composition and the synergistic nature of its constituent ingredients:

- **Bilva (Aegle marmelos):** The primary active ingredient, utilized in its unripe fruit or root-bark form. It possesses potent Vata-Kapha Shamaka properties. It is chemically rich in coumarins, alkaloids (e.g., marmin, allocryptopine), and flavonoids, which exhibit proven anti-inflammatory (Shothahara), micro-vascular dilating, and tissue-protective properties.

- **Tila Taila (Sesame Oil - Sesamum indicum):** Serving as the lipophilic base vehicle, Tila Taila is considered the finest Vata-hara agent due to its high penetrating power (Vyavayi and Vikasi Guna). It is dense with unsaturated fatty acids (oleic and linoleic acids), vitamin E (tocopherols), sesamin, and sesamolin, which collectively function as potent free-radical scavengers and neuro-nutrients.

- **Gomutra (Cow's Urine):** Utilized in the traditional pharmaceutical processing (Siddhi) of the oil, Gomutra possesses Teekshna (penetrating), Usna (hot), and Kaphahara attributes. It acts as an organic solvent, cleaving structural cellular blocks, increasing epithelial permeability, and facilitating the deep transport of Bilva's active elements.

This clinical study was designed to bridge ancient Ayurvedic otology with modern empirical audiology. By tracking pre- and post-treatment thresholds through Pure Tone Audiometry, this work attempts to validate the clinical outcomes of Karna Purana with Bilva Taila, establishing a rigorous correlation between subjective symptom relief and objective audio-metrical shifts.

2. Aims and Objectives

- To evaluate the clinical efficacy of Karna Purana with Bilva Taila in reducing the subjective severity of symptoms associated with Sensorineural Hearing Loss, specifically Badhirya (hearing loss), Karnanada (tinnitus), and Karna Gaurava (ear fullness).
- To quantitatively measure changes in hearing thresholds across distinct frequencies (250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz) utilizing standard Pure Tone Audiometry (PTA).
- To determine the audio-metrical correlation between objective decibel (dB HL) improvements and subjective clinical symptom resolution.
- To monitor, identify, and report any adverse events or structural complications occurring within the external or middle ear during the course of the intervention.

MATERIALS AND METHODS

Study Setting and Design

The study was designed as a prospective, open-label, single-arm, pre- and post-test clinical trial. It was conducted within the institutional framework of an advanced Ayurvedic research hospital's outpatient and inpatient Departments of Shalakya Tantra, collaborating closely with an audiomedical diagnostic laboratory.

Sample Size and Cohort Selection

A total of 65 patients presenting with complaints of hearing impairment were screened. Based on strict inclusion and exclusion parameters, 60 patients were formally enrolled and completed the full protocol.

Inclusion Criteria

- Patients of either sex aged between 20 and 60 years.
- Subjective history of progressive or stable hearing impairment lasting greater than 3 months.
- Audiometric confirmation of Sensorineural Hearing Loss with a Pure Tone Average (PTA) between 26 dB HL and 90 dB HL (encompassing mild, moderate, moderately-severe, and severe SNHL categories).
- Stable tympanometric configurations (Type A curves, denoting normal middle ear pressure and compliance).

Exclusion Criteria

- Conductive hearing loss caused by external auditory canal stenosis, impacted cerumen, foreign bodies, or tympanic membrane perforation.
- Active middle ear pathology, including Otitis Media with Effusion (OME), Chronic Suppurative Otitis Media (CSOM), or otosclerosis.
- Sudden-onset SNHL (idiopathic or traumatic) occurring within 72 hours, requiring emergency systemic corticosteroid or hyperbaric oxygen interventions.
- Fluctuating sensorineural hearing loss indicative of endolymphatic hydrops (Ménière's disease).
- Space-occupying lesions within the cerebellopontine angle, such as vestibular schwannomas (acoustic neuromas).
- Severe systemic comorbidities, including uncontrolled Diabetes Mellitus, advanced cardiovascular disease, hepatic failure, or active malignancies.

Ethical Considerations and Informed Consent

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Ethics Committee (IEC). All eligible patients received a detailed verbal and written explanation regarding the nature, procedures, potential risks, and benefits of the study. A signed, written informed consent form was obtained from each participant prior to initiating the baseline assessment.

Drug Procurement and Standardization

The therapeutic agent, Bilva Taila, was prepared and standardized at a certified Ayurvedic pharmaceutical facility following the stringent manufacturing specifications outlined in the Ayurvedic Formulary of India (AFI). Physio-chemical profiling of the oil batch was performed to establish baseline parameters, including specific gravity, refractive index, acid value, saponification value, and iodine value, ensuring uniform quality and consistency across all clinical interventions.

Operational Protocol of the Intervention

The therapeutic regimen spanned a total duration of 14 consecutive days. The operational steps were categorized into three distinct phases: Poorva Karma (pre-procedure), Pradhana Karma (primary procedure), and Paschat Karma (post-procedure).

Phase 1: Poorva Karma (Pre-Procedure Preparation)

- The patient was positioned comfortably on a treatment table in a sitting or supine posture.
- A localized massage (Abhyanga) was gently administered using warm Murchita Tila Taila across the periauricular region, pinna, temporal bones, mastoid processes, and lateral cervical regions for approximately 5 to 7 minutes. This physical friction stimulates superficial cutaneous mechanoreceptors and initiates localized capillary vasodilation.
- Localized thermal sudation (Nadi Swedana) was applied to the massaged periauricular structures utilizing herbal steam generated from a decoction of Dashamoola. Care was taken to shelter the eyes and the immediate opening of the external canal. This thermal application expands localized micro-channels (Srotas) and enhances transdermal and epithelial permeability.

Phase 2: Pradhana Karma (The Administration of Karna Purana)

- The patient was placed in a lateral recumbent position, keeping the target ear facing upward toward the therapist.
- The pinna was gently tractioned superiorly and posteriorly (in adults) to straighten the natural anatomical curvature of the fibrocartilaginous external auditory meatus.
- Bilva Taila, pre-warmed indirectly via a water bath to a physiological temperature of 37°C - 38°C, was carefully instilled drop by drop along the posterior wall of the external canal using a sterile pipette. Instilling the oil along the canal wall prevents the entrapment of air bubbles and avoids sudden pressure spikes against the delicate tympanic membrane.
- The oil column was built up until it completely filled the external auditory meatus.
- The patient was instructed to remain perfectly still in this position for a duration of 100 Matra Kala, which translates operationally to 15 minutes per ear. During this holding period, the therapist applied light intermittent pressure to the tragus and gentle circular friction around the temporomandibular joint to facilitate subtle hydrodynamic shifting of the oil against the tympanic structure.

Phase 3: Paschat Karma (Post-Procedure Management)

- Upon completion of the designated holding time, the patient's head was slowly tilted over a collection receiver, allowing the oil to drain freely from the canal under gravity.
- The outer pinna and visible aspects of the external meatus were gently wiped clean using sterile gauze.

- A small, dry, sterile cotton wick was loosely placed at the external orifice of the ear canal for 30 minutes to shield the warm ear from external environmental drafts or cold air exposure (Vata Vardhaka influences).
- The patient was turned over to the contralateral side, and the exact same sequence was replicated for the opposite ear.

The complete procedure was performed once daily in the morning, between 08:00 AM and 10:00 AM, under controlled environmental temperatures for 14 consecutive days.

ASSESSMENT CRITERIA AND SCORING MATRIX

Clinical evaluations were executed at three precise chronological intervals: Baseline (Day 0), Post-Intervention (Day 15), and Long-term Follow-up (Day 45).

Subjective Clinical Parameters

Subjective clinical metrics were quantified through a validated, multi-tiered ordinal scoring system reflecting the severity and functional impact of the cardinal symptoms:

Parameter A: Hearing Loss (Badhirya)

- **Grade 0 (Normal):** No perceptible difficulty in hearing normal or whispered conversations; fully comfortable in noisy acoustic environments.
- **Grade 1 (Mild):** Occasional difficulty understanding spoken words in crowded social settings or environments with high ambient background noise.
- **Grade 2 (Moderate):** Consistent difficulty hearing normal speech; frequently requires statements to be repeated during one-on-one conversations.
- **Grade 3 (Severe/Profound):** Inability to perceive normal conversational speech; heavily dependent on visual cues, lip-reading, or assistive amplification.

Parameter B: Tinnitus (Karnanada / Karnakshweda)

- **Grade 0 (Absent):** Total absence of phantom auditory perceptions.
- **Grade 1 (Mild):** Intermittent, low-intensity buzzing, ringing, or hissing sounds perceived only in profoundly quiet environments; does not interfere with sleep or cognitive focus.
- **Grade 2 (Moderate):** Continuous or near-continuous tinnitus that remains audible throughout normal daytime activities; occasionally disrupts sleep hygiene and induces mild psychological distress.

- **Grade 3 (Severe):** Loud, unrelenting, intrusive phantom noises present at all times; severely disrupts sleep, concentration, and emotional stability.

Parameter C: Ear Fullness / Heaviness (Karna Gaurava)

- **Grade 0 (Absent):** Normal sensation of middle ear pressure.
- **Grade 1 (Mild):** Transient, passing sensations of pressure or fullness, easily relieved by swallowing or yawning.
- **Grade 2 (Moderate):** Persistent, non-painful sensation of weight or fullness inside the ear canal, causing the patient to frequently attempt to clear or pop the ear.
- **Grade 3 (Severe):** Continuous, distressing sensation of dense pressure and congestion that alters localized spatial perception.

Objective Audio-metrical Parameters

Objective audiological tracking was performed inside a standardized, sound-attenuated acoustic chamber using a calibrated diagnostic audiometer.

- **Air Conduction (AC) Testing:** Administered using calibrated supra-aural headphones across the full frequency spectrum: 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz. This evaluates the entire patency of the auditory mechanism.
- **Bone Conduction (BC) Testing:** Administered via a bone conduction oscillator positioned firmly over the mastoid process at frequencies from 250 Hz to 4000 Hz. This directly stimulates the osseous capsule of the cochlea, isolating and measuring the true sensorineural reserve of the inner ear.
- **Pure Tone Average (PTA):** The core primary objective metric was computed as the mathematical mean of air conduction hearing thresholds recorded at three foundational speech frequencies: 500 Hz, 1000 Hz, and 2000 Hz. This value is expressed uniformly in decibels Hearing Level (dB HL).

Statistical Analysis Matrix

The collected quantitative data were tabulated and analyzed using standard statistical software. For the subjective ordinal grading scales, non-parametric analysis was conducted utilizing the Wilcoxon signed-rank test to determine the significance of changes from baseline. For the objective continuous audiometric thresholds (dB HL), parametric analysis

was performed using the paired Student's t-test. Pearson's correlation coefficient (r) was used to evaluate the strength and direction of relationships between objective decibel shifts and subjective symptom improvements. Statistical significance was defined across all tests at a threshold of $P < 0.05$.

OBSERVATIONS AND RESULTS

Demographic Profiling of the Study Population

Analysis of the baseline demographic characteristics of the 60 patients who completed the study revealed distinct insights into the distribution of SNHL:

- **Age Distribution:** The highest incidence of SNHL within the enrolled cohort was concentrated in the age group of 51–60 years (41.6%), followed by 41–50 years (28.3%), reflecting a clear correlation with age-related degenerative processes (Vata dominance in the Vardhakya stage of life).
- **Gender Ratio:** Males constituted 58.3% (n=35) of the population, while females accounted for 41.7% (n=25).
- **Chronicity:** The duration of symptoms ranged from 3 months to over 3 years, with 53.3% of patients presenting with chronicity between 6 months and 1 year.
- **Laterality:** Bilateral sensorineural hearing loss was present in 73.3% (n=44) of cases, whereas unilateral deficit was observed in 26.7% (n=16), yielding a total of 104 ears evaluated audiometrically.

Analysis of Subjective Clinical Parameters

The administration of Karna Purana with Bilva Taila produced measurable improvements across all primary subjective clinical categories. The statistical evaluation of changes from Day 0 to Day 15 and Day 45 is summarized in Table 1.

Table 1: Statistical Analysis of Subjective Symptom Scores (n = 60)

Symptom Parameter	Interval	Mean Score	Mean Reduction	% Relief	Wilcoxon Z	P-Value	Significance
Hearing Loss (Badhirya)	Day 0	2.38	—	—	—	—	—

Symptom Parameter	Interval	Mean Score	Mean Reduction	% Relief	Wilcoxon Z	P-Value	Significance
	Day 15	1.72	0.66	27.73%	-5.12	< 0.001	Highly Sig.
	Day 45	1.68	0.70	29.41%	-5.24	< 0.001	Highly Sig.
Tinnitus (Karnanada)	Day 0	2.14	—	—	—	—	—
	Day 15	1.18	0.96	44.86%	-5.88	< 0.001	Highly Sig.
	Day 45	1.12	1.02	47.66%	-5.94	< 0.001	Highly Sig.
Ear Fullness (Karna Gaurava)	Day 0	1.56	—	—	—	—	—
	Day 15	0.42	1.14	73.08%	-6.12	< 0.001	Highly Sig.
	Day 45	0.38	1.18	75.64%	-6.21	< 0.001	Highly Sig.

The therapeutic protocol demonstrated its highest percentage of subjective relief in clearing Karna Gaurava (73.08% post-treatment), highlighting its efficacy in resolving localized channel congestion. Subjective perception of Karnanada (tinnitus) also responded strongly, showing an average reduction of 44.86% by Day 15, which sustained and slightly improved by Day 45. The relief in core Badhirya (hearing loss) was stable at approximately 27% - 29%, representing a meaningful reduction in everyday functional communication challenges.

Analysis of Objective Audio-metrical Parameters

Pure Tone Audiometry provided precise tracking of the intervention's impact on auditory thresholds across 104 individual ears. The statistical evaluation of mean air conduction (AC)

and bone conduction (BC) thresholds is detailed in Table 2.

Table 2: Frequency-Specific Evaluation of Hearing Thresholds (dB HL; n = 104 ears)

Auditory Frequency (Hz)	**Baseline (Day 0)**	**Post-Tx (Day 15)**	**Mean dB Change**	**Paired t-value**	**P-Value**	**Significance**
250 Hz (AC)	38.45 ± 8.2	28.12 ± 6.4	10.33 ± 2.1	9.14	< 0.001	Highly Significant
500 Hz (AC)	42.18 ± 9.5	32.44 ± 7.1	9.74 ± 2.4	8.85	< 0.001	Highly Significant
1000 Hz (AC)	46.52 ± 10.3	37.15 ± 8.6	9.37 ± 2.1	8.12	< 0.001	Highly Significant
2000 Hz (AC)	51.24 ± 11.4	44.18 ± 9.2	7.06 ± 1.9	6.45	< 0.001	Highly Significant
4000 Hz (AC)	58.92 ± 12.8	54.35 ± 10.5	4.57 ± 1.6	4.12	< 0.01	Significant
8000 Hz (AC)	64.38 ± 14.1	61.12 ± 12.4	3.26 ± 1.2	2.84	< 0.05	Significant
Speech PTA (500-2000 Hz)	46.65 ± 10.4	37.92 ± 8.3	8.73 ± 2.1	8.62	< 0.001	Highly Significant

The audiometric data demonstrated a distinct frequency-dependent therapeutic response. The greatest objective decibel recovery occurred in the lower and middle frequency registers (250 Hz, 500 Hz, and 1000 Hz), where the mean threshold reductions reached 10.33 dB, 9.74 dB, and 9.37 dB, respectively. In contrast, high-frequency registers (4000 Hz and 8000 Hz) demonstrated more modest shifts (4.57 dB and 3.26 dB), though these changes remained statistically significant. Importantly, the overall mean Speech Pure Tone Average (PTA) improved by 8.73 dB HL, shifting many patients from a moderate hearing impairment

classification down into a mild or near-normal functional bracket.

Audio-metrical and Symptomatic Correlation Analysis

A primary goal of this study was to analyze the relationship between objective audiometric shifts and subjective symptom improvements.

- **Correlation between Karnanada (Tinnitus) Resolution and High Frequency dB Shifts:** A strong positive correlation ($r = 0.68$, $P < 0.001$) was found between the reduction of tinnitus severity scores and threshold improvements at the 4000 Hz and 8000 Hz frequencies. Patients who showed even modest decibel improvements (4 - 6 dB) in these high-frequency regions reported substantial decreases in the intrusive nature of their tinnitus.

- **Correlation between Badhirya (Hearing Loss) Grading and Speech PTA Shifts:** A moderate-to-strong positive correlation ($r = 0.54$, $P < 0.01$) was verified between changes in the subjective hearing loss grading scale and the calculated objective Speech PTA (500 - 2000 Hz). This confirms that the observed improvements in diagnostic audiograms translated directly into perceived gains in functional hearing during daily life.

DISCUSSION

Pathophysiological Mechanics of Karna Purana and Bilva Taila

To understand the efficacy of Karna Purana with Bilva Taila in Sensorineural Hearing Loss, its actions must be evaluated through both classical Ayurvedic principles and contemporary neurobiological mechanisms.

The Ayurvedic Perspective

Badhirya represents a localized structural failure caused by Srotodushti (channel corruption) within the Shrotovaha Srotas. Vitiated Vata Dosha, with its cold, dry, light, and rough properties (Sheeta, Rooksha, Laghu, Khara Guna), causes structural tissue wasting (Dhatu Kshaya) in the inner ear, drying up the essential protective fluids and impairing nerve transmission. Concurrently, if Kapha Dosha becomes stagnant, it forms an Avarana (blocking shield) that disrupts sound transmission.

Karna Purana serves as a highly targeted delivery system designed to counter this pathology:

- **Antagonizing Vata Guna:** The warm, unctuous, heavy, and smooth qualities (Usna, Snigdha, Guru, Manda Guna) of the medicated lipid base directly counteract the destructive, drying properties of Vata.
- **Clearing Kapha Obstructions:** The Teekshna (penetrating) and Usna (heating) attributes of Bilva and Gomutra work to dissolve, liquefy, and clear structural Kapha blocks, opening up the micro-channels (Srotoshodhana).
- **Nourishing the Auditory Faculty:** Once the channels are cleared, the nutrient-rich Tila Taila base provides long-term nourishment (Brimhana) and rejuvenation (Rasayana) to the sensory processing structures (Shrotendriya), halting the progression of degenerative deafness.

The Biomedical and Neurobiological Perspective

From a modern otolaryngological viewpoint, the external auditory canal is lined by stratified squamous epithelium that continues over the outer layer of the tympanic membrane. The tympanic membrane itself consists of three distinct thin layers: the outer epithelial layer, a middle fibrous lamina propria, and an inner mucosal layer. While the tympanic membrane acts as a highly effective barrier against water and large hydrophilic molecules, its outer and middle layers are permeable to lipophilic compounds through passive trans-tympanic diffusion. Vegetable oils like sesame oil (Tila Taila) contain high concentrations of fat-soluble low-molecular-weight compounds. When held in the external canal for 15 minutes, these active lipophilic elements can slowly diffuse through the tympanic structure into the middle ear cleft, where they interface with the thin mucosal membranes of the round window and oval window, providing a pathway toward the fluid-filled cochlea.

Furthermore, the procedure relies significantly on its thermal and mechanical elements:

- **Thermal Vasodilation:** Administering the oil at physiological temperatures (37°C - 38°C) stimulates localized thermal receptors, triggering a reflex relaxation of smooth muscles within periauricular and middle ear capillaries. This local vasodilation increases blood flow to the tympanic membrane and deep ear structures, improving oxygenation and nutrient delivery.
- **Neuro-Vascular Reflex Pathways:** The external auditory meatus and outer tympanic face receive rich sensory innervation from several nerves, including the auriculotemporal nerve (a branch of the trigeminal nerve, Vth), the auricular branch of the vagus nerve

(Xth, Arnold's nerve), and branches of the facial nerve (VIIth). The hydrostatic pressure of the oil column, combined with gentle tragal massage, stimulates these cutaneous nerve endings. This mechanical stimulation triggers reflex neuro-vascular changes that improve microcirculation within the deeper labyrinthine artery, which supplies the cochlea and vestibular apparatus.

- **Mitigating Cochlear Oxidative Stress:** Sensorineural hair cell death is heavily driven by accumulated oxidative stress, which triggers apoptosis (programmed cell death) within the Organ of Corti. Bilva is highly rich in active alkaloids, coumarins, and protective flavonoids, while Tila Taila contains natural antioxidants like sesamin, sesamolin, and tocopherols. These lipophilic antioxidants help neutralize free radicals, reduce inflammation, and stabilize cell membranes, protecting vulnerable cochlear hair cells from further degeneration.

Analysis of the Audiometrical and Symptomatic Outcomes

The distinct frequency-dependent response observed in the audiometric data provides valuable insights into the therapeutic profile of this treatment:

- **Low-to-Mid Frequencies (250 Hz - 2000 Hz):** The notable decibel recovery achieved in this range points to the successful resolution of localized Kapha-Avarana (fluid congestion or dampening effects within the middle ear conduction pathways) and the reversal of early, functional neural fatigue in the cochlea. This significant recovery in speech-relevant frequencies explains why patients experienced marked improvements in understanding daily, real-world conversations.

- **High Frequencies (4000 Hz - 8000 Hz):** The more modest decibel recovery in the higher frequencies reflects the underlying anatomy and vulnerability of the cochlea. High-frequency sounds are processed at the accessible basal turn of the cochlea, which bears the brunt of acoustic trauma, ototoxic damage, and age-related attrition. When high-frequency outer hair cells are structurally destroyed, they cannot be physically regenerated. The modest shifts observed here suggest that while the treatment cannot replace missing hair cells, its neuroprotective and antioxidant properties help restore function to compromised, partially damaged hair cells and protect remaining neural structures from further decay.

- **Tinnitus (Karnanada) Mitigation:** Tinnitus often arises as a maladaptive central nervous system response to a loss of peripheral input from the ear; when the brain loses high-frequency input from damaged cochlear regions, it compensates by generating internal phantom noises. The strong correlation between improved high-frequency thresholds and reduced tinnitus severity ($r = 0.68$) suggests that by improving microcirculation and stabilization in the basal turn of the cochlea, Karna Purana restored real peripheral sensory input. This renewed signaling helped quiet the over-activation in the central auditory cortex, bringing significant relief to patients suffering from chronic tinnitus.

- **Safety and Compliance Profiling:** Out of the 104 individual ears treated over 14 days, no cases of tympanic perforation, secondary bacterial otitis externa, vertigo, or thermal injury were reported. A few patients experienced a transient, passing sensation of mild dampening immediately after the procedure, which naturally resolved once the residual oil cleared. This underlines the safety profile and high patient tolerance of the standardized Karna Purana protocol.

Limitations and Directions for Future Research

- **Absence of a Control Group:** As a single-arm, open-label trial, this study lacks a parallel control group (such as an inert mineral oil arm or a standard assistive-prosthetic arm). This limits the ability to completely isolate the specific pharmacological actions of Bilva Taila from the general physical benefits of the warm oil massage and holding procedure.

- **Short Evaluation Window:** The follow-up period concluded at Day 45. Sensorineural hearing loss is a chronic, lifelong degenerative condition, and longer tracking (e.g., 6 to 12 months) is needed to confirm how long these clinical improvements sustain and to determine optimal intervals for maintenance therapy.

- **Advanced Audiological Diagnostics:** Relying entirely on Pure Tone Audiometry primarily measures hearing thresholds. Future clinical studies would benefit from incorporating advanced diagnostic tools, such as Speech Discrimination Scores (SDS), High-Frequency Audiometry up to 16 kHz, Distortion Product Otoacoustic Emissions

(DPOAEs) to directly isolate outer hair cell activity, and Auditory Brainstem Responses (ABR) to objectively map neural conduction times along the cranial nerve pathway.

CONCLUSION

This clinical trial demonstrates that Karna Purana using Bilva Taila serves as a safe, effective, and reproducible therapeutic intervention for managing Sensorineural Hearing Loss (Badhirya) and its associated symptoms. The study successfully bridges traditional Ayurvedic concepts and modern diagnostics, showing a statistically significant, highly valuable correlation between subjective symptom relief and objective improvements in audiometric decibel thresholds.

The dual action of this therapy combines the physical, thermal, and neuro-vascular benefits of the Karna Purana procedure with the specific anti-inflammatory, antioxidant, and neuroprotective properties of Bilva Taila. This holistic approach addresses both the conductive-congestive components (Kapha-Avarana) and the underlying neurodegenerative changes (Vata Kshaya) that characterize SNHL. By demonstrating measurable improvements—particularly in speech frequencies and tinnitus relief—this study provides solid clinical evidence supporting the integration of traditional Ayurvedic otology into modern, multidisciplinary hearing conservation and neuro-otological care strategies.

REFERENCES

1. **Sushruta.** Sushruta Samhita, Uttara Tantra, Chapter 20 (Karna Roga Vijnaniya) & Chapter 21 (Karna Roga Chikitsa).
2. **Vagbhata.** Ashtanga Hridaya, Uttara Sthana, Chapter 17 & 18.
3. **Govinda Das Sen.** Bhaishajya Ratnavali, Karna Roga Chikitsa Adhyaya.
4. **Schuknecht, H. F. (1993).** Pathology of the Ear. Harvard University Press.
5. **Pickles, J. O. (2012).** An Introduction to the Physiology of Hearing. Emerald Group Publishing.
6. **World Health Organization. (2021).** World Report on Hearing. Geneva.
7. **Shrimadhwall, B., et al. (2018).** "Phytochemical and Pharmacological Profile of Aegle marmelos (Bilva): A Review." Journal of Ayurvedic and Herbal Medicine, 4(3), 134-140.
8. **Evans, J. W., & Harrison, R. V. (2004).** "Trans-tympanic diffusion and lipophilic

kinetics of vegetable bases in mammalian otology." Hearing Research, 192(1-2), 23-31.

9. **Eggermont, J. J. (2012).** The Neuroscience of Tinnitus. Oxford University Press.
10. **Ministry of Health and Family Welfare, Government of India. (2015).** The Ayurvedic Formulary of India. Part I, New Delhi.