U.PORTO

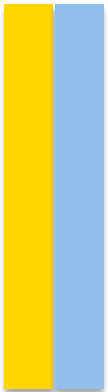
MESTRADO INTEGRADO EM MEDICINA
OTORRINOLARINGOLOGIA

Outcomes of Palatopharyngeal Surgery in Patients with Roncopathy: A Prospective Cohort Study

Arina Korableva

M

2026



Outcomes of Palatopharyngeal Surgery in Patients with Roncopathy: A Prospective Cohort Study

Dissertação de candidatura ao grau de Mestre em Medicina, submetida ao Instituto de Ciências Biomédicas Abel Salazar – Universidade do Porto

Autora: Arina Korableva

Aluna do 6º ano profissionalizante de Mestrado Integrado em Medicina

Afiliação: Instituto de Ciências Biomédicas Abel Salazar – Universidade do Porto

Endereço eletrónico: up202006659@edu.icbas.up.pt

Orientadora: Prof. Doutora Mariline Santos

Doutorada em Ciências Médicas pelo Instituto de Ciências Biomédicas Abel Salazar, Universidade do Porto

Professora Auxiliar Convidada do Instituto de Ciências Biomédicas Abel Salazar, Universidade do Porto

Assistente Hospitalar – Otorrinolaringologia – Unidade Local de Saúde de Santo António

Coorientador: Dr. Francisco Alves de Sousa

Universidade e Unidade Orgânica: Instituto de Ciências Biomédicas Abel Salazar (aluno de doutoramento em Ciências Médicas)

Assistente Hospitalar – Otorrinolaringologia – Unidade Local de Saúde de Santo António

Coorientador: Dr. Simão Pedro Cerqueira Queirós Bessa

Interno de Formação Específica – Otorrinolaringologia – Unidade Local de Saúde do Tâmega e Sousa

junho 2026

Outcomes of Palatopharyngeal Surgery in Patients with Roncopathy: A Prospective Cohort Study

Dissertação de candidatura ao grau de Mestre em Medicina, submetida ao Instituto de Ciências Biomédicas Abel Salazar – Universidade do Porto

Autora:

Arina Korableva

Orientadora:

Marilina Santos

Coorientador:

Francisco Sousa

Coorientador:

Jorge Braga

Porto, junho de 2026

Agradecimentos

Em primeiro lugar, gostaria de agradecer à Prof. Doutora Mariline pela sua disponibilidade, orientação e apoio ao longo de todo o percurso da realização desta dissertação. A sua dedicação, confiança e acompanhamento foram fundamentais para a realização deste trabalho.

Deixo também um agradecimento ao Dr. Francisco Sousa, pela disponibilidade e orientação neste trabalho. Ao Dr. Simão Bessa, agradeço pela sua disponibilidade e ajuda sempre que precisei.

À minha família, em especial aos meus pais, ao meu irmão e ao Tiago, por me acompanharem durante este percurso académico, por me encorajarem e por nunca deixarem de acreditar em mim. Sem eles, nada disto seria possível.

Por fim, deixo um agradecimento aos meus amigos que tornaram este percurso muito mais enriquecedor e inesquecível e me ajudaram a chegar ao fim desta jornada.

Abstract

Introduction
Roncopathy is a prevalent condition caused by vibration of the soft tissues of the upper airway during sleep, reflecting increased upper airway resistance and pharyngeal collapsibility. Beyond its social impact, it may impair quality of life and be associated with sleep-disordered breathing. Palatopharyngeal surgery includes a group of procedures with the aim of enlarging and stabilizing the upper airway and reducing tissue vibration contributing to roncopathy.

Aim
To evaluate the outcomes of palatopharyngeal surgery in patients with roncopathy through the analysis of subjective, objective and partner-reported outcomes before and after surgery.

Methods
A prospective cohort study including 15 adult patients with roncopathy undergoing palatopharyngeal surgery was conducted. Outcomes were assessed preoperatively and at 1- and 3-month follow-up using the Epworth Sleepiness Scale, the Berlin Questionnaire, partner-reported snoring outcomes (frequency, duration, and intensity), and, when available, objective assessment using SnoreLab. Postoperative pain was additionally assessed. Statistical analysis was performed using non-parametric methods.

Results
The study included 15 patients undergoing palatopharyngeal surgery, with 14 completing follow-up. The median baseline Epworth Sleepiness Scale score was 9 (IQR 5–13), with 80% (n=12) classified as high risk according to the Berlin Questionnaire. Partner-reported snoring outcomes showed baseline median scores of 3 for frequency, duration and intensity.
A significant reduction in Epworth Sleepiness Scale scores was observed at 3 months ($p=0.001$). Snoring frequency and duration significantly decreased over time ($p=0.002$ and $p<0.001$, respectively), with significant improvements between preoperative and both 1- and 3-month assessments. Snoring intensity also decreased significantly ($p=0.002$).
Objective SnoreLab assessment (n=9) demonstrated a reduction in snoring index values. Postoperative pain was reported as severe in 78.6% (n=11) of patients who completed follow-up.

Conclusion
Palatopharyngeal surgery in patients with roncopathy resulted in significant improvements in snoring frequency, duration and intensity, as well as daytime sleepiness. The greatest benefit was observed within the first postoperative month and sustained at 3 months.
However, postoperative pain was frequently severe, particularly in more extensive procedures. These findings suggest that while effective, palatopharyngeal surgery requires careful patient selection and consideration of postoperative morbidity.

Keywords: Snoring; Roncopathy; Palatoplasty; Pharyngoplasty; Palatopharyngeal Surgery; Palatal Surgery.

Resumo

Introdução
A roncopatia é uma condição prevalente causada pela vibração dos tecidos moles das vias aéreas superiores durante o sono, refletindo um aumento da resistência das vias aéreas e da colapsabilidade faríngea. Para além do impacto social, pode comprometer a qualidade de vida e estar associada a distúrbios respiratórios do sono. A cirurgia palatofaríngea engloba um conjunto de procedimentos com o objetivo de aumentar e estabilizar as vias aéreas superiores e reduzir a vibração tecidular responsável pela roncopatia.

Objetivo
Avaliar os resultados da cirurgia palatofaríngea em doentes com roncopatia, através da análise de outcomes subjetivos, objetivos e relatados pelo parceiro antes e após cirurgia.

Métodos
Foi realizado um estudo de coorte prospetivo que incluiu 15 doentes adultos com roncopatia submetidos a cirurgia palatofaríngea. Os outcomes foram avaliados no período pré-operatório e aos 1 e 3 meses do seguimento, utilizando a Escala de Sonolência de Epworth, o Questionário de Berlim, parâmetros de roncopatia reportados pelo parceiro (frequência, duração e intensidade) e, quando disponível, avaliação objetiva através da aplicação SnoreLab. A dor pós-operatória foi também avaliada. A análise estatística foi realizada com recurso a métodos não paramétricos.

Resultados
O estudo incluiu 15 doentes submetidos a cirurgia palatofaríngea, dos quais 14 completaram o follow-up. A mediana inicial da Escala de Sonolência de Epworth foi de 9 (IQR 5–13), sendo 80% (n=12) classificados como de alto risco de acordo com o Questionário de Berlim. Os outcomes da roncopatia reportados pelo parceiro apresentaram valores medianos iniciais de 3 para a frequência, duração e intensidade.
Observou-se uma redução estatisticamente significativa dos valores da Escala de Sonolência de Epworth aos 3 meses ($p=0,001$). Verificou-se igualmente uma diminuição significativa da frequência e duração da roncopatia ao longo do tempo ($p=0,002$ e $p<0,001$, respetivamente), com diferenças estatisticamente significativas entre o período pré-operatório e aos 1 e 3 meses. A intensidade apresentou também uma redução estatisticamente significativa ($p=0,002$). A avaliação objetiva com recurso à aplicação SnoreLab (n=9) evidenciou uma diminuição dos índices da roncopatia. A dor pós-operatória foi classificada como severa em 78,6% (n=11) dos doentes que completaram o seguimento.

Conclusão
A cirurgia palatofaríngea em doentes com roncopatia associou-se a melhorias estatisticamente significativas na frequência, duração e intensidade do ronco, bem como na sonolência diurna. O maior benefício foi observado no primeiro mês pós-operatório, mantendo-se aos 3 meses.
No entanto, a dor pós-operatória foi frequentemente severa, sobretudo em procedimentos mais extensos. Estes resultados sugerem que, apesar da sua eficácia, a cirurgia palatofaríngea requer uma seleção criteriosa dos doentes e uma adequada ponderação da morbilidade associada.

Palavras-chave
Ressonar; Roncopatia; Palatoplastia; Faringoplastia; Cirurgia Palatofaríngea; Cirurgia do Palato.

List of Abbreviations

AHI – Apnea–Hypopnea Index

AP – Anteroposterior

BMI – Body Mass Index

BQ – Berlin Questionnaire

BRP – Barbed Reposition Pharyngoplasty

CPAP – Continuous Positive Airway Pressure

DISE – Drug-Induced Sleep Endoscopy

ESS – Epworth Sleepiness Scale

ESP – Expansion Sphincter Pharyngoplasty

ICSD-3 – International Classification of Sleep Disorders, Third Edition

IQR – Interquartile Range

MAD – Mandibular Advancement Device

OSA – Obstructive Sleep Apnea

PSG – Polysomnography

PT – Positional Therapy

REM – Rapid eye movement

UPF – Uvulopalatal Flap

UPPP – Uvulopalatopharyngoplasty

VAS – Visual Analogue Scale

VOTE – Velum, Oropharynx, Tongue base, Epiglottis classification

Table of Contents

List of Tables

List of Figures

Background

Roncopathy, often perceived as a benign and primarily social condition, represents a highly prevalent and clinically relevant disorder with significant implications on the quality of life and potential associations with cardiovascular morbidity and Obstructive Sleep Apnea Syndrome. As highlighted in the literature, roncopathy affects a significant number of the adult population and may serve as an early indicator of upper airway dysfunction and increased collapsibility. Despite this, the management of primary snoring remains controversial, as treatment is frequently elective and guided by patient and partner distress, rather than by clear medical indication.

Among available treatment options, palatopharyngeal surgical techniques aim to reduce tissue vibration and improve airway stability. However, the evidence supporting their effectiveness remains heterogeneous, particularly due to variability in outcome measures and the limited integration of both subjective and objective assessment tools. Furthermore, the increasing availability of mobile health technologies, such as smartphone-based acoustic monitoring, offers new opportunities for more detailed and ecologically valid evaluation of snoring.

Therefore, this study was designed to evaluate the outcomes of palatopharyngeal surgery in patients with roncopathy by combining subjective and objective patient-reported outcomes, as well as partner-based evaluation. This study aims to evaluate the outcomes of palatopharyngeal surgery, with particular focus on its efficacy in reducing roncopathy and on the assessment of postoperative pain, thereby contributing to a clearer understanding of its risk-benefit profile and helping guide patient selection in the management of primary snoring.

Introduction

1 - Roncopathy

1.1 Definition

Snoring is a sound generated during sleep as a result of vibration of the soft tissues of the upper airway, particularly the soft palate and oropharynx. It is typically loud enough to be perceived by others and may persist over time. Although often considered a benign condition, frequent or disruptive snoring can negatively impact the quality of life of both the affected individual and their bed partner. In addition, habitual snoring may indicate the presence of underlying sleep-disordered breathing, such as Obstructive Sleep Apnea (OSA), which is associated with important health risks.[1]

According to the International Classification of Sleep Disorders (ICSD-3), snoring is categorized among isolated symptoms and normal variants. The diagnosis is based on reports of breathing-related sounds during sleep, usually inspiratory, without associated complaints of insomnia or excessive daytime sleepiness. Furthermore, diagnostic evaluation should not reveal evidence of other sleep-related respiratory disorders.[2]

Although often dismissed as a minor social disturbance, heavy snoring has been linked to a higher prevalence of cardiovascular disorders, including hypertension, stroke, and ischemic heart disease. Moreover, habitual snoring may represent an early manifestation of upper airway dysfunction and can precede the development of OSA. These associations highlight the clinical relevance of snoring and support the consideration of targeted therapeutic strategies in appropriately selected patients, particularly those with severe or persistent symptoms.[3]

1.2 Epidemiology and Prevalence

Snoring is a highly prevalent condition and represents one of the most common sleep-related complaints among adults. Epidemiological studies suggest that approximately 20–40% of adults experience habitual snoring, although reported prevalence varies considerably depending on the definition used and the method of assessment. Estimates range widely, from as low as 2% to as high as 86%, reflecting differences in diagnostic approaches such as polysomnography, self-reported data, or partner-based observations, as well as variability in the criteria used to classify snoring severity.[4–7]

Population-based studies have also identified consistent demographic trends. Snoring is more frequently reported in men than in women and tends to increase with age, peaking in middle-aged individuals before declining slightly in older populations. In a large telephone survey conducted in the United Kingdom, prevalence rose significantly with age, particularly among individuals between 45 and 54 years, before decreasing after the age of 65.[8]

In addition to age and sex, higher body mass index (BMI) has been consistently associated with increased snoring prevalence.[9,10] Although much of the epidemiological evidence originates from Western populations, similar patterns have been observed globally, suggesting that snoring constitutes a widespread public health concern.[8,10]

In Portugal, epidemiological data specifically addressing snoring prevalence are scarce, and most available information is derived from studies focusing on sleep-disordered breathing, particularly OSA. As a result, reliable population-based estimates of snoring prevalence in adults are currently lacking.

1.3 Mechanisms

Breathing is controlled by neurons in the brainstem that regulate oxygen and carbon dioxide levels and maintain upper airway patency during wakefulness. During sleep, breathing control becomes less stable and pharyngeal dilator muscle activity decreases, leading to narrowing of the upper airway and increased airflow resistance. While healthy individuals usually compensate through reflex mechanisms, inadequate compensation may result in airflow limitation or upper airway collapse, causing hypoxemia, hypercapnia, sleep fragmentation, and contributing to snoring and sleep-related breathing disorders. These mechanisms play a central role in the development of snoring and other sleep-related breathing disorders.[11-12]

Anatomical factors also contribute to snoring. Excess soft tissue in the soft palate or pharyngeal region can narrow the airway and generate tissue vibration during airflow. The soft palate is the most common source of snoring sounds, although other pharyngeal structures and, less commonly, the larynx may also be involved.[13,14]

Upper airway collapsibility, measured by critical closing pressure, is significantly greater in patients with OSA than in non-apneic individuals, supporting the concept that airway stability exists on a spectrum, with increased collapsibility associated with more severe sleep-disordered breathing.[14,15]

Roncopathy may also indicate underlying pharyngeal tissue vulnerability. Habitual snorers show reduced pharyngeal sensitivity to mechanical, thermal, and vibratory stimuli, which is even more pronounced in OSA patients. This sensory impairment may weaken protective reflexes

that maintain airway patency during sleep. In OSA, structural and functional abnormalities of pharyngeal tissues have also been described, including alterations in muscle fiber composition, neuromuscular control, and extracellular matrix organization. Although these changes are generally absent in primary snoring, chronic vibratory trauma from persistent snoring may promote progressive tissue remodeling and neural impairment, increasing airway collapsibility and potentially facilitating progression from primary snoring to OSA.[16]

1.4 Risk Factors

The pathophysiology of snoring is multifactorial, involving a combination of anatomical, functional, and lifestyle-related factors. In a large population-based study, Bloom and Kaltenborn (1988) identified male sex, middle age, obesity and cigarette smoking as independent risk factors for snoring. The authors also reported a dose-response relationship between smoking intensity and snoring prevalence, while alcohol consumption and the use of sedative medications were found to have a weaker but still notable association with increased snoring.[3]

Subsequent studies have reinforced the role of smoking as a significant contributor to habitual snoring. Both active and passive exposure to tobacco smoke have been associated with increased snoring frequency, likely due to airway inflammation and mucosal irritation. Importantly, this association appears to be independent of other variables such as age, sex and body mass index, and shows a clear dose-dependent pattern.[9]

In addition to these demographic and lifestyle factors, anatomical characteristics of the upper airway also play a critical role. Structural features such as an enlarged soft palate, hypertrophy of the tonsillar pillars, elongation of the uvula and impaired nasal patency can contribute to airway narrowing and increased airflow resistance during sleep, thereby promoting tissue vibration and snoring.[17]

These findings highlight that snoring results from the interaction of multiple factors, including individual characteristics, environmental exposures and anatomical predisposition.

1.5 Clinical Impact

Self-reported snoring has been consistently associated with impairments in both sleep quality and sleep quantity. Individuals who habitually snore often report shorter total sleep duration, difficulty achieving restorative sleep and increased daytime sleepiness, including unintentional episodes of dozing. These findings suggest a disruption in normal sleep regulation. Beyond its impact on sleep, habitual snoring has also been linked to broader health consequences, including a higher prevalence of coronary artery disease and depressive symptoms. Collectively, this evidence indicates that snoring should not be regarded solely as a benign or socially disruptive condition, but rather as a potential contributor to overall morbidity.[18,19]

Longitudinal studies have further demonstrated a relationship between sleep-disordered breathing and the development of cardiovascular risk factors. In particular, increasing severity of breathing disturbances during sleep has been associated with a higher risk of developing hypertension, even after adjusting for confounding variables such as age and body mass index.[20] In addition, snoring has been identified as an independent predictor of cardiovascular disease, especially in women, where it has been associated with both hypertension and a modest increase in cardiovascular risk, regardless of other metabolic factors.[21]

Furthermore, habitual snoring is strongly associated with OSA. Although not all individuals who snore will develop OSA, frequent and loud snoring often reflects increased upper airway collapsibility, which may progress to apneas or hypopneas during sleep. Epidemiological evidence shows that the risk of OSA is higher among habitual snorers, particularly in men, older individuals, and those with elevated body mass index.[1,22,23] For this reason, habitual snoring should be considered a relevant clinical marker that requires further evaluation for underlying sleep-disordered breathing.

1.6 Diagnosis

The diagnostic approach to roncopathy is primarily based on a differential diagnosis, with the main objective being the exclusion of obstructive sleep-disordered breathing. Although characterizing the acoustic features of snoring is important, the clinician’s aim is to distinguish primary snoring from OSA. For this reason, roncopathy should be considered a diagnosis of exclusion. This distinction can be challenging due to the significant pathophysiological overlap between conditions, as snoring often reflects increased upper airway resistance and may coexist with OSA. Consequently, the diagnostic evaluation must include an assessment of the

anatomical and functional characteristics of the upper airway, as structural abnormalities may contribute to tissue vibration either independently or in association with airway obstruction.[24]

A detailed clinical history, ideally including input in form of questionnaires from the bed partner, is essential to characterize the severity and impact of snoring. The assessment should address several key domains: the acoustic characteristics of snoring (including duration, frequency and intensity), the presence of nocturnal symptoms such as gasping, choking or restless sleep (which may suggest OSA), and daytime consequences such as excessive sleepiness, cognitive fatigue or morning headaches. In addition, predisposing factors should be evaluated, including body mass index, alcohol consumption, smoking habits and nasal obstruction. The presence of relevant comorbidities, such as cardiovascular disease, hypertension, obesity and diabetes, should also be considered, as these may influence both the severity of symptoms and the overall clinical risk profile.[24]

To establish an accurate diagnosis, the evaluation of roncopathy should integrate both subjective and objective methods, combining clinical history with targeted physical examination and, when indicated, further diagnostic testing.

1.6.1 Subjective Assessment

Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS) is a widely used self-administered questionnaire designed to assess an individual's general level of daytime sleepiness. It evaluates the likelihood of dozing in eight common sedentary situations, such as sitting and reading, watching television, or traveling as a passenger in a car. Each situation is scored on a 4-point scale ranging from 0 (no chance of dozing) to 3 (high chance of dozing), resulting in a total score between 0 and 24.[25]

In clinical practice, ESS scores between 0 and 10 are considered within normal limits, whereas values above 10 suggest excessive daytime sleepiness and justify further investigation.[25] Because the ESS reflects a habitual tendency rather than momentary fatigue on a specific day, it provides a relatively stable measure of sleep propensity, making it particularly useful in the assessment of sleep-related disorders.[25]

Originally introduced as a standardized psychometric tool, the ESS was designed to quantify subjective sleepiness as a trait, minimizing the influence of short-term fluctuations such as time of day or temporary sleep deprivation.[25] Its reliability has been well established, demonstrating high internal consistency (Cronbach's $\alpha \approx 0.88$) and the ability to distinguish between healthy

individuals and patients with sleep disorders.[25] Subsequent analyses have confirmed that the scale largely measures a single dimension of daytime sleepiness, supporting its validity as a reliable assessment tool.[26]

Within the evaluation of roncopathy, the ESS plays an important role in distinguishing primary snoring from conditions associated with pathological daytime sleepiness, particularly OSA. Although elevated ESS scores are more frequently observed in patients with OSA due to sleep fragmentation, habitual snoring itself may also be associated with increased daytime sleepiness, independent of apnea severity.[27] This indicates that snoring should not be considered a purely benign condition, as it may contribute to fatigue even in the absence of significant obstructive events. Nevertheless, some individuals may exhibit significant snoring without elevated ESS scores, reflecting the heterogeneous clinical presentation of roncopathy. Furthermore, although snoring intensity tends to increase with the severity of obstructive sleep apnea, it cannot be used as a reliable standalone predictor of OSA severity.[28]

Taken together, these findings highlight the value of the ESS as an adjunctive tool in the diagnostic pathway of roncopathy, enabling clinicians to identify patients who may require further investigation for underlying sleep-disordered breathing. In this context, a normal ESS score may support the absence of significant daytime sleepiness; however, it does not exclude the presence of underlying sleep-disordered breathing. Therefore, the ESS should be interpreted as an adjunctive tool within the diagnostic process rather than a definitive criterion for the diagnosis of primary roncopathy.

Berlin Questionnaire

The Berlin Questionnaire (BQ) is a widely used screening tool designed to identify individuals at increased risk for OSA. It complements other assessment instruments by focusing on clinical features and risk factors associated with sleep-disordered breathing, rather than solely on its consequences. In contrast to the ESS, which evaluates daytime sleepiness, the BQ assesses the presence of key phenotypic indicators of OSA through a structured set of questions.[29] The questionnaire consists of ten items grouped into three categories. Category 1 evaluates snoring characteristics, including frequency, intensity and associated social impact. Category 2 focuses on daytime symptoms, particularly fatigue and sleepiness, including episodes occurring during activities such as driving. Category 3 assesses established risk factors, namely obesity (body mass index ≥30 kg/m²) and a history of hypertension. Based on these categories, individuals are classified as being at “high risk” for OSA if two or more categories are positive, while those with fewer positive categories are considered “low risk”.[29]

This classification system is particularly relevant in the evaluation of roncopathy, as it allows differentiation between individuals with isolated snoring and those with a higher probability of underlying sleep-disordered breathing. Patients who are positive only in the snoring-related domain (Category 1) may represent cases of primary roncopathy, whereas those with additional symptoms or risk factors require further investigation.

The diagnostic performance of the Berlin Questionnaire has been validated in multiple studies, demonstrating that the BQ has good sensitivity and specificity for identifying patients at risk of OSA.[30] In clinical practice, the BQ may be used alongside other assessment tools, such as the ESS, to support the evaluation of patients with suspected sleep-disordered breathing and roncopathy.[24] While the ESS provides information on the presence of daytime sleepiness, the BQ contributes to risk stratification for OSA. Together, these instruments support a more accurate assessment, enabling clinicians to identify patients who require further diagnostic evaluation, such as polysomnography (PSG), while helping to characterize those with primary roncopathy.

1.6.2 Objective Assessment

SnoreLab App

While questionnaires provide essential screening for sleep-related symptoms and respiratory risk, the objective assessment of roncopathy requires quantitative analysis of snoring intensity and duration. Acoustic monitoring enables a more complete, longitudinal evaluation of snoring patterns through multiple nights, offering insight into the variability and real-life impact of the condition. Smartphone-based snoring applications utilize built-in microphones and digital signal processing techniques to identify snoring events based on characteristic acoustic patterns.[31]

One example of such applications is SnoreLab (Reviva Softworks Ltd), which provides continuous nocturnal acoustic monitoring. The primary output of these applications is a composite metric (e.g., “Snore Score”), which integrates sound intensity (in decibels) with total snoring duration, providing an estimate of overall nocturnal noise burden, a more representative measure than isolated peak sound measurements.

The clinical utility of smartphone-based monitoring has been explored in validation studies. Nakano et al. reported a strong correlation (r = 0.93) between smartphone-recorded snoring

time and measurements obtained from a portable monitor in a home setting, suggesting that smartphone-based systems may provide a useful estimate of snoring duration.[32]

Additional validation against PSG, the gold standard for sleep assessment, has also been reported. Smartphone-based snore detection has shown high sensitivity and specificity, indicating that it can reliably identify snoring events compared with other diagnostic techniques.[33] Furthermore, independent validation studies have demonstrated that smartphone applications can achieve high accuracy in detecting snoring, particularly for higher-intensity snoring, although they are not capable of identifying obstructive respiratory events.[34] Measurements obtained using different smartphones demonstrate strong overall correlation, supporting the consistency of smartphone-based monitoring across devices, despite minor variations in snoring intensity classification.[35] These findings suggest that smartphone-based monitoring may be a useful adjunct for the assessment of snoring, although it does not replace formal diagnostic methods.

Despite their practicality and accessibility, smartphone-based snoring monitoring systems present several limitations. Environmental factors and recording conditions may influence acoustic measurements, particularly in home settings where monitoring is performed under natural sleep conditions.[32] In addition, the absence of standardized protocols for device placement represents a potential source of variability. Although smartphones are typically positioned close to the patient's head, placement is not strictly controlled and may vary between users, which can affect signal capture and measurement consistency.[33]

Furthermore, while smartphone-based applications have demonstrated promising performance, their accuracy may depend on recording conditions and algorithm characteristics. The effectiveness may also be reduced in older populations due to limited access to technology and lower digital literacy. Consequently, these tools should be considered as supportive instruments for the assessment of snoring rather than definitive diagnostic methods.

Polysomnography

PSG is a detailed, multi-channel recording of physiological parameters during sleep and is considered the gold standard for the diagnosis of sleep-related breathing disorders, including OSA, central sleep apnea, and sleep-related hypoventilation.[36]

In addition to respiratory disorders, PSG allows the evaluation of sleep architecture and supports the assessment of other sleep-related conditions, such as periodic limb movement disorder and REM sleep behavior disorder.

A standard PSG study includes the simultaneous recording of multiple physiological signals, including electroencephalography, electro-oculography and electromyography, which are essential for sleep staging, as well as electrocardiography and pulse oximetry for cardiovascular and respiratory monitoring.[36] Respiratory parameters are assessed using airflow sensors (oronasal thermal sensors and nasal pressure transducers) and thoracoabdominal movement belts, enabling the detection of apneas and hypopneas.

The primary diagnostic metric derived from PSG is the Apnea–Hypopnea Index (AHI), which quantifies the number of respiratory events per hour of sleep. In clinical practice, an AHI < 5 is generally considered within the normal range, whereas higher values are used to define obstructive sleep apnea according to established diagnostic criteria.[37]

Although in-laboratory PSG (Type I) remains the reference standard, alternative diagnostic approaches such as portable monitoring (Type II and Type III studies) have been introduced. These home sleep apnea tests are recommended for selected patients with a high pre-test probability of OSA and without significant comorbidities.[37] However, full PSG remains necessary in more complex cases or when initial testing is inconclusive.

Clinical guidelines emphasize that objective sleep testing should be performed when a sleep-related breathing disorder is suspected, particularly in the presence of symptoms, comorbidities, or when therapeutic intervention is considered. If initial evaluation and testing are inconclusive, further investigation with PSG is recommended.[24]

Compared with smartphone-based acoustic monitoring, polysomnography has the advantage of providing detailed, multi-parametric physiological data, allowing precise identification of respiratory events and sleep architecture. However, PSG is typically performed over a single night, either in a laboratory or home setting, which may not fully capture night-to-night variability in snoring patterns. Nevertheless, while longitudinal acoustic monitoring offers practical advantages for assessing snoring patterns, it does not provide information on respiratory events, arousals or sleep stages, and therefore cannot replace PSG in the diagnosis of sleep-related breathing disorders.

Drug-induced sleep endoscopy

Drug-induced sleep endoscopy (DISE) is a dynamic diagnostic procedure used to evaluate the upper airway in patients with snoring and OSA. Unlike awake examinations, DISE is performed under controlled sedation, allowing direct visualization of airway behavior during a sleep-like state. This enables clinicians to observe the site and pattern of airway collapse in real time.

Earlier diagnostic methods, such as Müller's maneuver and imaging techniques, were limited because they assessed the airway in awake conditions and could not reproduce the dynamic nature of sleep-related obstruction. The introduction of DISE by Croft and Pringle represented a major advance, shifting assessment from static anatomical evaluation to functional, patient-specific analysis.

The reliability of DISE depends on achieving an appropriate depth of sedation that closely mimics natural sleep. Current recommendations support the use of propofol-based sedation with careful monitoring, often using the Bispectral Index, to maintain a level consistent with light-to-moderate sleep.[38,39] Several studies have shown that propofol sedation can reproduce upper airway behavior comparable to natural sleep conditions.[40,41]

During DISE, airway collapse is typically assessed using standardized systems such as the VOTE classification, which evaluates four key anatomical sites: the velum, oropharynx, tongue base, and epiglottis, as shown in *Table 1*.[42] For each structure, the degree of obstruction is categorized as no obstruction (<50% collapse), partial obstruction (50–75% collapse, or complete obstruction (>75% collapse), with an additional category when assessment is not possible. In addition, the configuration of collapse is described as anteroposterior, lateral or concentric. By combining these parameters, the VOTE classification provides a structured and reproducible method for documenting both the severity and pattern of airway collapse, thereby supporting more accurate diagnosis and guiding individualized treatment planning in patients with snoring and sleep-disordered breathing.

The primary clinical value of DISE lies in its ability to guide treatment decisions. It is particularly useful in patients with snoring or OSA who are candidates for surgical or non-CPAP therapies. By identifying the specific pattern of airway collapse, DISE supports a more individualized approach to treatment selection.[38]

In patients with roncopathy, DISE helps distinguish between different mechanisms of snoring, such as palatal flutter or multi-level obstruction. This is important for selecting appropriate interventions. For example, patients with predominant lateral pharyngeal wall

collapse may benefit from procedures such as expansion sphincter pharyngoplasty, while those with isolated palatal vibration may be better suited for more limited palatal procedures.[43]

Overall, DISE has become an important tool in the evaluation of snoring and sleep-disordered breathing, enabling a shift toward more targeted and individualized management based on functional airway assessment.

1.7 Treatment

Within current clinical frameworks, snoring alone is not generally considered a mandatory indication for treatment. Although it may be associated with an increased risk of cardiovascular disease and progression to OSA, the evidence supporting preventive benefits of early intervention remains limited. As a result, management is often guided by patient-reported burden, particularly in terms of social impact and quality of life.

Consequently, treatment decisions should be individualized, with careful consideration of potential risks and benefits. When intervention is indicated, it is recommended to prioritize conservative measures and minimally invasive techniques where appropriate. Clinical management should follow established guidelines to ensure the use of standardized and evidence-based treatment.[24]

This way, the following sections will review the main conservative and surgical treatment options for roncopathy, with a focus on choosing treatment based on each patient's individual anatomy and symptoms.

1.7.1 Conservative Management

Lifestyle modifications

Weight reduction is widely considered one of the most effective long-term conservative strategies for reducing the severity of roncopathy. Evidence from longitudinal studies of sleep-disordered breathing has demonstrated a clear relationship between changes in body weight and respiratory disturbances during sleep.[44] Although much of this evidence is derived from studies OSA, similar mechanisms are relevant in primary snoring.

From a pathophysiological perspective, obesity contributes to roncopathy through the accumulation of adipose tissue in the parapharyngeal region, which increases external pressure on the upper airway and reduces its diameter. This narrowing causes turbulent airflow and facilitates vibration of the soft tissues, particularly the soft palate and the uvula.[45] In addition,

central obesity may reduce lung volumes, such as functional residual capacity, which can increase upper airway collapsibility during sleep. Consequently, for patients with elevated body mass index (BMI), weight reduction should be considered a primary therapeutic objective to improve airway patency and reduce snoring severity.

In addition to weight management, modification of **alcohol consumption** represents an important lifestyle intervention. Alcohol has a depressant effect on the central nervous system and reduces the tone of upper airway dilator muscles, thereby increasing airway collapsibility during sleep.[46] This reduction in muscle tone can lead to increased airway resistance and promote snoring, even in individuals without baseline symptoms. Therefore, patients should be advised to avoid alcohol consumption, particularly in the hours preceding sleep, as part of a conservative approach to reducing snoring.

Smoking cessation is an important conservative intervention in the management of roncopathy, as cigarette smoke acts as an irritant to the upper airway. Evidence suggests that smoking is associated with structural and functional changes in the pharynx, including airway narrowing and increased severity of sleep-disordered breathing.[47] These effects are thought to result from chronic inflammation, leading to mucosal edema and increased mucus production in the upper airway. Such changes may reduce airway diameter and promote turbulent airflow, increasing soft tissue vibration and snoring. In addition, chronic irritation from tobacco smoke may contribute to increased upper airway collapsibility.

Therefore, smoking cessation should be recommended as part of a conservative treatment approach, as it may help reduce snoring and improve overall upper airway function.[48]

Upper airway musculature strengthening

Growing evidence suggests that strengthening the muscles of the upper airway and the floor of the mouth may help reduce the severity of roncopathy. Oropharyngeal exercises, also known as myofunctional therapy, have been investigated as a conservative approach for habitual snoring. Alternative approaches that involve similar muscle training, such as didgeridoo playing and targeted singing exercises, have also demonstrated potential benefits. These interventions are thought to enhance the function of upper airway muscles, including the tongue and soft palate, thereby reducing tissue collapsibility during sleep.[49,50]

However, the effectiveness of other forms of respiratory muscle training, such as playing wind or brass instruments, remains uncertain, with some studies showing no significant association with reduced snoring or daytime symptoms.[51]

In addition to active exercises, passive approaches such as intraoral electrical stimulation of tongue muscles have been explored. Although this method is not generally recommended for the treatment of OSA, it has shown beneficial effects in reducing roncopathy.[52]

Overall, these neuromuscular strategies represent a non-invasive approach to managing snoring, either as a standalone intervention or in combination with other treatments.

Positional therapy

Positional therapy (PT) is a conservative treatment option for patients whose roncopathy is position-dependent, typically occurring or worsening in the supine position. The underlying principle is to prevent airway narrowing caused by posterior displacement of the tongue and soft palate during sleep, which can increase airflow resistance and promote snoring.

Evidence suggests that a large proportion of patients with snoring or sleep-disordered breathing exhibit position-dependent patterns. In a review by Ravesloot et al. (2013), positional therapy was highlighted as an effective but often underutilized treatment approach for these patients.[53] Traditional methods, such as the "tennis ball technique," have largely been replaced by modern devices, including sleep position trainers, which use gentle vibration to discourage supine sleeping.

Clinical studies have demonstrated that Sleep Position Trainers using biofeedback (vibration) to discourage supine positioning can significantly reduce time spent in the supine position and improve sleep-related outcomes. For example, van Maanen et al. (2013) reported a marked reduction in supine sleep time and improvements in sleep quality following the use of a position trainer.[54] In addition, these devices have shown high patient compliance, likely due to improved comfort compared with older mechanical methods.

Comparative studies indicate that positional therapy may offer similar effectiveness to other conservative treatments, such as mandibular advancement devices (MADs), in selected patients with position-dependent sleep-disordered breathing.[55] Furthermore, combination approaches may provide additional benefit in patients with residual symptoms. Dieltjens et al. (2014) demonstrated that the combined use of positional therapy and MADs resulted in greater improvement in respiratory parameters compared with either treatment alone.[56] Overall, positional therapy represents a non-invasive and well-tolerated treatment option for patients with position-dependent roncopathy, particularly when appropriately selected based on sleep study findings.

Mandibular Advancement Devices

MADs are one of the most used conservative treatments for roncopathy. Their effect is based on the forward positioning of the mandible, which leads to anterior displacement of the tongue and associated soft tissues. This mechanical change increases the upper airway space and reduces collapsability during sleep, thereby decreasing roncopathy.

Although MADs are widely studied in the context of OSA, similar mechanisms are relevant for primary snoring. Clinical studies have shown that MADs can be an effective alternative to CPAP in patients with mild to moderate OSA, supporting their role in reducing upper airway obstruction.[57]

1.7.2 Surgical Management

Septoplasty and Inferior Turbinate Surgery

Surgical management of roncopathy often begins with correction of nasal obstruction, most commonly through septoplasty, reducing nasal resistance and improving airflow. From a physiological perspective, the upper airway behaves as a collapsible structure during sleep, and increased nasal resistance may contribute to greater negative inspiratory pressure and downstream airway narrowing. [58] By improving nasal patency, septoplasty may reduce airflow turbulence and, consequently, the vibration of oropharyngeal soft tissues associated with roncopathy.

In addition, optimizing nasal airflow is important for the success of other treatments, including palatal surgery and CPAP, as it improves airflow stability and patient tolerance.[59,60] Therefore, septoplasty should be considered not only as a local anatomical correction but also as part of a strategy to improve upper airway function. Some evidence indicates that combining septoplasty with inferior turbinate reduction may lead to greater improvements compared with septoplasty alone.[59]

Overall, the primary role of nasal surgery in roncopathy is to reduce nasal resistance, improve subjective symptoms such as snoring and nasal obstruction and improve the effectiveness of other treatments when needed.

Palatopharyngeal Surgery

Uvulopalatopharyngoplasty

Uvulopalatopharyngoplasty (UPPP) is a surgical procedure designed to enlarge the oropharyngeal airway by removing or reshaping soft tissue structures of the soft palate. Originally described by Fujita et al. (1981), the procedure typically involves resection of the uvula, trimming of the soft palate, and, in many cases, removal of the tonsils, with the aim of reducing airway obstruction and tissue vibration associated with snoring.[61]

The surgical management of OSA and roncopathy has evolved significantly since the introduction of UPPP, moving away from aggressive tissue excision towards more conservative and reconstructive approaches. Evidence from a meta-analysis by Sher et al. (1996) demonstrated variable success rates and highlighted the potential for postoperative complications, including velopharyngeal insufficiency, nasopharyngeal stenosis and persistent functional impairment.[62] These limitations contributed to development of new techniques, focusing on anatomical remodeling rather than tissue removal.

Overall, the role of traditional UPPP has become more limited, and current surgical strategies emphasize individualized, function-preserving approaches that better address the underlying mechanisms of airway collapse in patients with snoring and sleep-disordered breathing.

Uvulopalatal Flap

The uvulopalatal flap (UPF) was introduced by Powell et al. in 1996 as a reconstructive alternative to traditional excisional procedures for the treatment of snoring and OSA.[63] Unlike UPPP, which involves tissue resection, UPF preserves the uvula by repositioning it anteriorly onto the soft palate. This modification shortens and stiffens the soft palate while maintaining its functional integrity, with the aim of reducing airway obstruction and palatal vibration.

Clinical studies have demonstrated that UPF can be effective in improving symptoms related to upper airway obstruction. Neruntarat (2003) reported favorable short-term outcomes, although long-term results showed a reduction in effectiveness over time, suggesting that patient selection is important, particularly in cases where obstruction is not limited to the palatal level.[64]

In addition, UPF has been associated with a lower risk of complications compared with more aggressive excisional procedures. By preserving palatal structures, the technique reduces the

likelihood of adverse effects such as velopharyngeal insufficiency and nasopharyngeal stenosis. Later studies, have supported the role of UPF as a function-preserving surgical option within the broader shift toward reconstructive approaches in sleep surgery.[65]

Overall, UPF represents a less invasive alternative to traditional UPPP, particularly in patients with predominantly palatal obstruction, although its long-term effectiveness may be limited in cases of multilevel airway collapse.

Anterior Palatoplasty (Pang technique):

Anterior palatoplasty, also known as the Pang technique, is a reconstructive surgical procedure used in the management of primary snoring and mild-to-moderate OSA. Unlike traditional excisional techniques, anterior palatoplasty is based on soft palate remodeling and tissue stiffening. The procedure involves removal of a limited strip of mucosa from the anterior surface of the soft palate, followed by closure of the defect, resulting in shortening and stiffening of the palate.[66] This reduces palatal vibration and improves airway stability during sleep.

Objective studies have demonstrated structural changes following this technique, specifically, increases in upper airway dimensions on computed tomography after surgery, including enlargement of the retropalatal space.[67] These findings support the mechanism by which anterior palatoplasty improves airflow and reduces snoring.

Clinical outcomes have also been favorable. A systematic review and meta-analysis by Binar and Karakoc (2018) showed significant improvements in sleep-related parameters following the procedure, particularly in appropriately selected patients.[68] Similarly, it has been emphasized that better outcomes are observed in patients with mild-to-moderate disease and predominantly palatal obstruction.[69]

Anterior palatoplasty is associated with a favorable safety profile compared with more aggressive palatal procedures. Reported complications are generally mild and may include transient throat discomfort, globus sensation or dryness.[70] Major complications such as velopharyngeal insufficiency or significant voice changes are uncommon, due to preservation of palatal musculature.

In current practice, this technique is often used as part of a multilevel surgical approach. It may be combined with procedures targeting other sites of obstruction, such as expansion sphincter pharyngoplasty, to address both anteroposterior and lateral airway collapse.[71] This combined approach is particularly relevant in patients with complex or multilevel obstruction.

Partial uvulectomy (reductive uvulotomy) is a conservative refinement in palatal surgery aimed at reducing the vibratory component of the soft palate. It is often performed alongside

anterior palatoplasty to address residual distal tissue that may continue to contribute to snoring. An elongated uvula can oscillate during airflow and contact the tongue base, particularly during sleep, thereby increasing snoring intensity. Selective reduction of the distal uvula decreases its length and mass, reducing vibration while preserving the base of the uvula and its musculature. This preservation is important to maintain velopharyngeal function and minimize complications such as nasal regurgitation or changes in speech.[66]

Within a multilevel approach, partial uvulectomy complements procedures such as anterior palatoplasty by addressing residual soft tissue vibration and improving overall airway patency.

Expansion Sphincter Pharyngoplasty

Expansion sphincter pharyngoplasty (ESP) is a reconstructive surgical technique designed to address upper airway obstruction by targeting the lateral pharyngeal walls. Unlike traditional ablative procedures, ESP focuses on anatomical remodeling rather than tissue resection. The technique involves repositioning the palatopharyngeus muscle in a superolateral direction, resulting in widening and stabilization of the oropharyngeal airway during sleep.[72]

Clinical evidence supports the effectiveness of ESP, particularly in patients with lateral pharyngeal wall collapse. Systematic reviews and meta-analyses have demonstrated significant improvements in sleep-related parameters following ESP, supporting its role in modern reconstructive sleep surgery.[43]

In addition, ESP is associated with a favorable safety profile. By preserving key anatomical structures and avoiding extensive tissue excision, the procedure reduces the risk of complications commonly associated with traditional techniques.

Overall, ESP represents an important development in the surgical management of sleep-disordered breathing and is frequently incorporated into multilevel approaches to reduce snoring.

Relocation Pharyngoplasty

Relocation pharyngoplasty is a reconstructive palatal surgical technique designed to enlarge the retropalatal airway and improve lateral pharyngeal wall stability without extensive tissue resection. The procedure involves advancement of the soft palate and repositioning of the lateral pharyngeal structures, thereby increasing airway space and reducing collapse during sleep.[73]

This technique is particularly indicated in patients with retropalatal circumferential narrowing associated with lateral pharyngeal wall collapse, contributing to increased airway resistance and reduced effectiveness of traditional resective procedures.[74]

Clinical studies have demonstrated improvements in AHI, oxygenation, roncopathy and daytime symptoms following relocation pharyngoplasty. Favorable outcomes have been reported especially in selected patients with moderate disease, tonsillar hypertrophy and less severe patterns of circumferential collapse.[74] Compared with traditional UPPP, which primarily targets anteroposterior airway narrowing, relocation pharyngoplasty more directly addresses lateral and circumferential collapse, contributing to improved airway stability.[61,75]

In comparison with ESP, relocation pharyngoplasty is generally less invasive and preserves key muscular structures, including the superior pharyngeal constrictor. Although it may provide less lateral wall tension in more severe cases, it is associated with a favorable safety profile, with most reported complications being mild and transient.[74,75]

Barbed Reposition Pharyngoplasty

Barbed reposition pharyngoplasty (BRP) is a reconstructive palatal technique that represents a shift from traditional excisional surgery toward tissue-preserving airway remodeling. The method uses bidirectional, knotless barbed sutures to reposition and stabilize the soft palate and lateral pharyngeal walls. By anchoring the sutures to stable anatomical structures, the palatopharyngeus muscle is advanced and suspended, resulting in enlargement of the retropalatal airway and improved lateral wall stability.[76] Barbed pharyngoplasty is frequently performed in conjunction with tonsillectomy, particularly in patients with tonsillar hypertrophy, as this facilitates exposure and enhances lateral wall expansion. However, tonsillectomy is not an essential component of the procedure and may be omitted in patients with small or absent tonsils.

In addition to mechanical repositioning, the passage of barbed sutures through the soft palate induces localized fibrosis, which increases tissue stiffness and reduces the vibratory component responsible for roncopathy. This dual mechanism (structural repositioning and palatal stiffening) makes BRP particularly suitable for patients with palatal and lateral wall collapse.

Clinical evidence supports the effectiveness of BRP in the management of snoring and mild-to-moderate OSA. Systematic reviews have reported significant improvements in snoring severity and sleep-related parameters following treatment, particularly in appropriately selected patients.[77]

The advantages of BRP are largely related to its minimally invasive nature. Because the technique avoids extensive tissue resection and does not require knot tying, it is associated with reduced postoperative pain, faster recovery, and earlier return to normal diet compared with more traditional palatal procedures. Comparative studies have also suggested improved postoperative comfort and reduced analgesic requirements with barbed techniques.[78]

Complications are generally mild and transient. The most reported issue is partial suture extrusion, which is typically asymptomatic and easily managed during follow-up. Other potential effects include temporary dysphagia or a foreign body sensation. Serious complications such as persistent velopharyngeal insufficiency or significant hemorrhage are uncommon, contributing to a favorable safety profile.[77]

Barbed technology has also been applied to less invasive procedures, such as **Elevoplasty**, an office-based technique for primary roncopathy that uses barbed sutures to achieve palatal stiffening and shortening. Clinical studies have demonstrated improvements in subjective sleep quality and snoring outcomes with this approach.[79]

In addition, **barbed anterior palatoplasty** represents a modification of traditional anterior palatoplasty, using knotless sutures to achieve similar palatal advancement and stiffening while improving tension distribution and reducing the risk of suture-related complications.[80]

Overall, barbed pharyngoplasty techniques offer an effective and well-tolerated alternative to traditional palatal surgeries, combining reduced morbidity with significant improvements in airway patency and roncopathy.

Tonsillectomy

Tonsillectomy plays an important adjunctive role in the surgical management of roncopathy and sleep-disordered breathing, particularly when combined with palatal procedures aimed at enlarging and stabilizing the retropalatal airway. In patients with tonsillar hypertrophy, enlarged tonsils contribute to oropharyngeal narrowing, increased airway resistance, and lateral pharyngeal wall crowding, which may reduce the effectiveness of isolated palatal interventions.[61,81]

For this reason, tonsillectomy is frequently performed in conjunction with reconstructive palatal techniques. Removal of tonsillar tissue increases airway space, facilitates surgical exposure, and enhances the effectiveness of procedures that rely on lateral wall remodeling, such as ESP and relocation pharyngoplasty.[72,73]

This combined approach is particularly relevant in patients with lateral or circumferential patterns of airway collapse, where reduction of soft tissue can improve pharyngeal lumen dimensions and surgical access for reconstructive maneuvers.

Thus, rather than being considered an isolated intervention, tonsillectomy should be viewed as a complementary component of multilevel surgical strategies in appropriately selected patients with roncopathy and upper airway obstruction.

1.7.3 Surgical Management Summary Table

A summary of the surgical management approaches discussed is provided in *Table II* at the end of the manuscript.

2. Objectives

2.1 Primary Objectives:

To evaluate the effectiveness of palatopharyngeal surgery in patients with roncopathy by assessing postoperative changes over time (preoperative, 1-month, and 3-month follow-up) in:

- Self-assessment outcomes: Daytime sleepiness, measured by the Epworth Sleepiness Scale;
- Partner-reported snoring outcomes: frequency, duration, and intensity.

2.2 Secondary Objectives:

Secondary objectives included:

- To assess changes in the risk profile for sleep-disordered breathing using the Berlin Questionnaire;
- To evaluate snoring severity through objective assessment using SnoreLab metrics, when available;
- To assess postoperative morbidity through evaluation of pain intensity and to perform an exploratory, descriptive analysis of its relationship with the type and extent of surgical intervention.

3 Materials and Methods

Study approved by the Ethics Committee under number 2025.234 (192-CAC-CE)

3.1 Study Population

This study was designed as a prospective cohort study evaluating the effectiveness of palatopharyngeal surgery in adult patients with roncopathy. Patients undergoing surgical treatment at the Department of Otorhinolaryngology of Unidade Local de Saúde de Santo António were followed longitudinally, with outcomes assessed preoperatively and at 1- and 3-month postoperative follow-up. The study aimed to evaluate changes in subjective, partner-reported, and objective measures of roncopathy severity, as well as postoperative morbidity.

DISE was performed to assess the site and pattern of upper airway collapse during sleep. The VOTE classification system was used to characterize the level and configuration of obstruction. Within this classification, “AP” denotes anteroposterior collapse.

3.2 Inclusion and Exclusion Criteria

Inclusion criteria:

- Age ≥18 years
- Clinical diagnosis of disruptive roncopathy
- Patients undergoing palatopharyngeal surgery after DISE
- Availability for postoperative follow-up at 1 and 3 months

Exclusion criteria:

- BMI ≥30 kg/m²
- Previous palatal surgery
- Dependence on sleep medication
- Inability to complete questionnaires or provide reliable postoperative data

3.3 Data Collection

Data were collected at three time points:

- Preoperative assessment
- 1 month postoperative
- 3 months postoperative

At each assessment, subjective and partner-reported outcome measures were recorded. Objective SnoreLab data were collected when available.

3.4 Assessment Tools

3.4.1 Subjective Assessment

Epworth Sleepiness Scale

ESS was used to assess subjective daytime sleepiness. The questionnaire consists of 8 items scored from 0 to 3, with a total score ranging from 0 to 24, where higher scores indicate greater daytime sleepiness.

Berlin Questionnaire

The Berlin Questionnaire was used to assess risk for sleep-disordered breathing. Responses were analyzed according to its three domains, including snoring-related symptoms, daytime somnolence, and cardiovascular/metabolic risk factors.

Partner-reported snoring questionnaire evaluating:

Partner-reported snoring outcomes included assessment of snoring frequency, snoring duration, and perceived snoring intensity. Although responses were initially collected through open questions, they were subsequently standardized into an ordinal 1–4 scoring system to facilitate statistical analysis, with higher scores corresponding to greater symptom severity.

Scoring was defined as follows:

Snoring frequency

1 – Snoring very rarely/never

2 – Snoring on some nights (<50% of nights)

3 – Snoring on most nights (>50% of nights)

4 – Snoring every night

Snoring duration

1 – Almost no snoring/no snoring

2 – Snoring for some part of the night (<50% of the night)

3 – Snoring for most of the night (>50% of the night)

4 – Snoring throughout the entire night

Snoring intensity

1 – Snoring not audible

2 – Snoring audible only within the bedroom

3 – Snoring audible in the adjacent room with the bedroom door closed

4 – Snoring audible elsewhere in the apartment/floor or louder, with the bedroom door closed

These variables were analyzed as ordinal measures and included in repeated postoperative comparisons.

3.4.2 Objective Assessment

SnoreLab

Snoring severity was objectively assessed using the SnoreLab application. The primary metric used was the Snore Score, a proprietary index integrating snoring intensity and duration. Where available, snoring duration expressed as percentage of total sleep time was also recorded. SnoreLab data were collected preoperatively and at 1-month follow-up in a subset of patients (n=9). Given incomplete availability, SnoreLab data were analyzed as an exploratory objective outcome in this subgroup.

Postoperative Morbidity

Postoperative pain was assessed using a numeric rating scale from 0 to 10, where 0 represented no pain and 10 represented worst imaginable pain. Pain scores were recorded at postoperative follow-up and analyzed as a subjective measure of postoperative morbidity.

3.4.3 Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 30 (IBM SPSS Statistics).

Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were described using median and interquartile range, while categorical variables were presented as frequencies and percentages.

Given the small sample size (n = 14), repeated paired measurements, and the ordinal nature of several study variables, non-parametric tests were used.

- Wilcoxon signed-rank test for pairwise comparisons between time points (Pre vs 1 month; Pre vs 3 months)
- Friedman test for repeated measures comparison across all three time points (Pre, 1 month, 3 months)

A p-value <0.05 was considered statistically significant.

3.4.4 Flowchart of patient inclusion

A flowchart summarizing patient inclusion is provided in *Figure 1* at the end of the manuscript.

4. Results

4.1 Demographics

A total of 15 patients were included in the study. One patient did not complete the follow-up questionnaire and was therefore excluded from repeated-measures analyses of subjective outcomes, leaving 14 patients for these analyses. However, objective SnoreLab data were available for 9 patients.

The median age was 50 years (IQR 29–57), with a range of 25-66 years. *(Figure 2)* Of 15 patients, 14 were male (93.3%) and 1 was female (6.7%). *(Figure 3)*

4.2 Baseline Clinical Characteristics

The median baseline Epworth Sleepiness Scale score was 9 (IQR 5–13). According to the Berlin Questionnaire, 12 patients (80.0%) were classified as being at high risk for sleep-disordered breathing.

In addition, based on questionnaires completed by the patient's partner, the median snoring frequency, duration and intensity were assessed.

- The median snoring frequency score was 3 (2–4), corresponding to snoring on most nights.
- The median snoring duration score was 3 (2–3), indicating snoring during most of the night.
- The median snoring intensity score was 3 (2–3), corresponding to snoring audible in the adjacent room with the bedroom door closed.

Objective acoustic assessment with the SnoreLab application showed a median baseline SnoreLab score of 88 (48–113), indicating a considerable preoperative acoustic burden.

Baseline demographic and clinical characteristics are summarized in *Table III.*

4.3 Surgery Selection

Surgical planning was guided by DISE findings, and procedures were selected and tailored according to the predominant site and pattern of airway collapse. In patients presenting with isolated anteroposterior collapse at the velopharyngeal level, anterior palatoplasty or uvulopalatal flap procedures were performed. In patients with other patterns of velopharyngeal collapse or additional oropharyngeal obstruction, expansion pharyngoplasty was carried out.

Furthermore, septoplasty combined with inferior turbinate reduction was performed during the same surgical session when clinically indicated.

Table IV summarizes the VOTE classification in supine position, main obstructive component on DISE and surgical procedure for each patient.

4.4 Primary Outcomes

4.4.1 Epworth Sleepiness Scale

A Friedman test was conducted to evaluate changes in Epworth Sleepiness Scale scores across the three time points (preoperative, 1 month and 3 months). The results demonstrated a statistically significant difference (χ^2 (2) = 10.720, p = 0.005), indicating that at least one time point differed from the others. *(Table V)*

Post-hoc pairwise comparisons were performed using the Wilcoxon signed-rank test. A Bonferroni correction was applied to adjust for multiple comparisons, setting the level of statistical significance at $p < 0.0167$. After correction, a statistically significant reduction in ESS scores was observed between the preoperative and 3-month assessments (p = 0.001). No statistically significant differences were found between the preoperative and 1-month assessments (p = 0.027) or between the 1-month and 3-month assessments (p = 0.282).

These findings suggest that daytime sleepiness improved following surgery, with the most robust and statistically significant improvement observed at 3 months, while changes at earlier time points did not reach significance after correction for multiple comparisons. *(Table VI)*

4.4.2 Partner-reported snoring outcomes

Partner-reported snoring outcomes were evaluated using ordinal scales for frequency, duration and intensity, described previously in the methodology section. Due to the ordinal nature of these variables and the absence of normality assumptions, non-parametric tests were applied.

A Friedman test demonstrated statistically significant differences across time for snoring frequency (χ^2 (2) = 12.235, p = 0.002) and snoring duration (χ^2 (2) = 18.865, p < 0.001), indicating changes in these variables over the study period. For snoring intensity, the Friedman test also showed a statistically significant difference (χ^2 (2) = 7.280, p = 0.026), although this did not meet the adjusted significance threshold when considering multiple comparisons. (*Table VII)*

Post-hoc pairwise comparisons were performed using the Wilcoxon signed-rank test with Bonferroni correction (adjusted significance level p < 0.0167).

For **snoring frequency**, significant reductions were observed between the preoperative and 1-month (p = 0.013) and preoperative and 3-month assessments (p = 0.010), with no significant difference between 1 and 3 months (p = 0.096).

For **snoring duration**, significant reductions were observed between the preoperative and 1-month (p = 0.007) and preoperative and 3-month assessments (p = 0.001), both remaining statistically significant after correction. Although a reduction was observed between 1 and 3 months (p = 0.034), this did not reach statistical significance after Bonferroni correction.

Similarly, for **snoring intensity**, significant reductions were observed between the preoperative and 1-month (p = 0.008) and preoperative and 3-month assessments (p = 0.002), both remaining statistically significant after correction, while no significant difference was found between 1 and 3 months (p = 0.096). *(Table VIII)*

Mean partner-reported snoring outcomes are illustrated in *Figure 6*. A progressive reduction in all three parameters-frequency, duration, and intensity was observed over time. For each variable, the highest mean values were recorded preoperatively, followed by a marked decrease at 1 month and a further, more modest reduction at 3 months. The most pronounced improvement occurred between the preoperative and 1-month assessments, while changes between 1 and 3 months were smaller, indicating stabilization of outcomes. Among the three parameters, snoring frequency showed the highest baseline values, although all variables followed a similar downward trend. These findings visually support the results of the statistical analysis, demonstrating consistent improvement in partner-reported snoring severity after surgery.

4.5 Secondary Outcomes

4.5.1 Berlin Questionnaire

In this study, Berlin Questionnaire Categories 1 and 2 were analyzed using their ordinal scores rather than dichotomized classifications, to preserve data granularity and improve sensitivity in detecting longitudinal changes.

For Category 1 (snoring-related symptoms), a Friedman test demonstrated a statistically significant difference across the three time points (χ^2 (2) = 23.405, $p < 0.001$), indicating a change in scores over time. (*Table IX)* Post-hoc pairwise comparisons using the Wilcoxon signed-rank test with Bonferroni correction (adjusted significance level $p < 0.0167$) showed significant reductions between the preoperative and 1-month assessments ($p = 0.002$) and between the preoperative and 3-month assessments ($p = 0.002$), while no significant difference was observed between 1 and 3 months ($p = 0.317$). *(Table X)* These findings indicate a marked and sustained improvement in snoring-related symptoms, with most of the benefit occurring early after surgery and remaining stable over time.

In contrast, for Category 2 (daytime fatigue and sleepiness), the Friedman test did not demonstrate a statistically significant difference across time points (χ^2 (2) = 5.429, $p = 0.066$). (*Table IX)* Pairwise comparisons similarly showed no statistically significant differences after Bonferroni correction (pre vs 1 month: $p = 0.194$; 1 month vs 3 months: $p = 0.102$; pre vs 3 months: $p = 0.046$). *(Table X) These* results suggest that surgical intervention had limited impact on daytime fatigue and functional symptoms.

4.5.2 SnoreLab

SnoreLab scores were analyzed in a subgroup of 9 patients who provided complete recordings. Due to the small sample size and the absence of normality assumptions, comparisons between time points were performed using the Wilcoxon signed-rank test.

A significant reduction in SnoreLab scores was observed at 1 month postoperatively compared with preoperative values ($Z = -2.547$, $p = 0.011$), indicating an objective improvement in snoring severity. *(Table XI)* Most patients demonstrated decreased scores following surgery.

Despite the limited sample size, the consistency of improvement across patients reinforces the reliability of these findings.

4.5.3 Pain

Firstly, postoperative pain intensity was analyzed at the individual patient level using Visual Analogue Scale scores. The distribution demonstrated that most patients experienced high levels of pain, with the majority reporting scores in the upper range of the scale. Only a small number of patients reported low pain scores, while moderate values were relatively uncommon. (*Figure 4)*

An exploratory analysis was performed to assess whether postoperative pain varied according to the type of surgical procedure performed. No clear or consistent association between a specific surgical technique and higher pain scores was identified, likely due to the small sample size and the heterogeneity of procedures.

However, a trend toward higher pain levels was observed in patients undergoing more extensive or combined procedures, particularly those including tonsillectomy, which is known to be associated with increased postoperative discomfort. In contrast, procedures limited to anterior palatal remodeling demonstrated greater variability in pain intensity.

Overall, postoperative pain appeared to be influenced more by the extent of surgical manipulation and the number of anatomical sites treated rather than by a single specific technique.

Subsequently, postoperative pain was categorized as mild (0–3), moderate (4–6), and severe (7–10). Among the 14 patients, the majority experienced severe pain, accounting for 78.6% (n = 11). Mild pain was reported by 14.3% (n = 2) of patients, while only 7.1% (n = 1) reported moderate pain. (*Figure 5)*

5. Discussion

5.1 Primary Outcomes

The primary outcomes of this study included subjective daytime sleepiness and partner-reported snoring characteristics, providing complementary perspectives on both functional and perceptual aspects of treatment effectiveness.

Changes in daytime sleepiness were evaluated using the ESS to assess the functional impact of surgery on patients' daily life. In the present study, a statistically significant reduction in Epworth scores was observed over time, with the most pronounced improvement occurring at 3 months postoperatively. This delayed improvement suggests that the benefits of surgical intervention on daytime symptoms may not be immediate and may instead reflect a gradual adaptation of sleep quality and upper airway function over time.

Unlike roncopathy-related parameters, which improved early after surgery, changes in daytime sleepiness appear to evolve more slowly, likely reflecting the complex and multifactorial nature of this symptom. Daytime sleepiness is influenced not only by upper airway obstruction, but also by sleep architecture, behavioral patterns, psychological factors and other comorbidities. Furthermore, baseline Epworth scores in this cohort were not markedly elevated, which may have limited the magnitude of measurable improvement and reduced the sensitivity to detect clinically meaningful change.

Taken together, these findings suggest that while palatopharyngeal surgery may contribute to improvements in daytime function, its primary impact remains on the mechanical aspects of upper airway obstruction, with secondary and more gradual effects on broader functional outcomes.

Partner-reported outcomes were used to provide an external assessment of snoring severity, including frequency, duration and intensity. These measures are particularly valuable, as they reduce reliance on patient self-perception and provide a more objective reflection of real-world snoring burden.

In the present study, all three parameters demonstrated significant improvement following surgery, with reductions observed as early as 1 month postoperatively and maintained at 3 months. Among these variables, snoring duration showed the most consistent improvement across all time points, while frequency and intensity demonstrated significant reductions primarily when compared with preoperative values. The absence of significant differences

between 1 and 3 months for some parameters suggests that the majority of the therapeutic effect occurs early after surgery, followed by stabilization.

Overall, the agreement between partner-reported outcomes and other measures used in this study reinforces the internal consistency of the findings and highlights the clinical relevance of the observed improvements. These results indicate that palatopharyngeal surgery is effective in reducing both the perceptual and functional burden of snoring, with early benefits that remain stable over time.

5.2 Secondary Outcomes

Secondary outcomes included objective snoring assessment using SnoreLab, postoperative pain, and evaluation through the Berlin Questionnaire, providing additional insight into both physiological and patient-reported dimensions of treatment response.

Objective assessment of snoring was performed using the SnoreLab application in a subset of patients (n=9), providing an additional and complementary measure of treatment effectiveness. In the present study, a statistically significant reduction in SnoreLab scores was observed at 1 month postoperatively compared with preoperative values.

Although limited by the small sample size, these findings provide objective confirmation of the improvements observed in subjective and partner-reported outcomes. The consistency across different types of assessment strengthens the overall interpretation of treatment effectiveness and supports the reliability of the observed changes.

SnoreLab, as a smartphone-based acoustic monitoring tool, offers a practical method for longitudinal assessment of snoring in real-world conditions. While not a gold-standard diagnostic tool, its use in this study reflects an increasing trend toward accessible, patient-centered monitoring strategies. Overall, the reduction in SnoreLab scores supports the conclusion that surgical intervention effectively reduces the acoustic burden of snoring.

In addition to improvements in snoring-related outcomes, changes in the Berlin Questionnaire were evaluated to explore the impact of surgery on risk factors associated with sleep-disordered breathing.

For Category 1, which reflects snoring characteristics, a statistically significant reduction was observed between preoperative and postoperative assessments, consistent with the improvements seen in partner-reported outcomes. This concordance further reinforces the

internal validity of the results, as different instruments capture similar dimensions of snoring severity.

In contrast, Category 2, which evaluates daytime symptoms such as fatigue and sleepiness, did not demonstrate statistically significant changes across time points. This finding aligns with the results observed for the ESS and further supports the interpretation that daytime symptoms are influenced by multiple factors beyond upper airway obstruction alone.

In addition, the Berlin Questionnaire is primarily designed as a screening tool for OSA and incorporates factors beyond snoring. As such, it may be less sensitive to changes limited to snoring alone, which could partly explain the absence of significant improvement in Category 2 observed in this study. This further supports the distinction between improvements in local airway mechanics and the more limited impact of surgery on broader, multifactorial aspects of sleep-disordered breathing. Additionally, the relatively low baseline symptom burden may have limited the potential for measurable improvement.

Importantly, the Friedman test confirmed a significant overall effect for Category 1 but not for Category 2, further supporting the distinction between snoring-related and daytime-related outcomes.

Postoperative pain was evaluated using a visual analogue scale and further categorized to describe its clinical distribution. In the present study, most patients reported high levels of pain in the early postoperative period, with the majority falling within the severe pain category, while only a small number reported mild or moderate pain.

This distribution reflects the known postoperative profile of palatopharyngeal surgery, which involves manipulation of highly innervated oropharyngeal structures. Despite the high pain levels observed, no clear association was identified between a specific surgical technique and pain intensity.

However, a tendency toward higher pain scores was observed in patients undergoing more extensive or combined procedures, particularly those including tonsillar surgery. This suggests that postoperative discomfort may be more closely related to the overall extent of surgical manipulation rather than to a single technique. This should be considered when counselling patients and planning postoperative pain management.

5.3 Comparison with existing literature

The findings of the present study are consistent with the existing literature on the surgical management of roncopathy, which supports the effectiveness of modern palatopharyngeal techniques in reducing snoring severity and improving upper airway stability. Over time, surgical approaches have evolved from traditional ablative procedures, such as UPPP, which have reported success rates of approximately 40–50%, toward more conservative, reconstructive techniques focused on anatomical remodeling and preservation of function.[61]

The significant improvements observed in partner-reported snoring outcomes in this study align with previously reported results for anterior palatoplasty and its modifications. Previous studies have demonstrated sustained improvements in snoring and mild-to-moderate obstructive sleep apnea in appropriately selected patients.[66,68] Similarly, the reduction in snoring intensity and duration observed in this cohort is consistent with findings showing that palatal stiffening procedures effectively reduce the vibratory component of the upper airway.

In addition, the present results are comparable to those reported for palatal and lateral pharyngeal wall procedures. These techniques aim to reduce upper airway collapsibility by increasing palatal and/or lateral pharyngeal wall tension, particularly in patients with retropalatal, concentric or lateral collapse patterns identified on DISE.[72,73] The inclusion of these procedures in the present study likely contributed to the overall improvement observed, especially in patients with multilevel obstruction.

Barbed pharyngoplasty techniques, which were frequently employed in this cohort, have been increasingly described as effective and minimally invasive approaches for the treatment of snoring and mild-to-moderate OSA. Their mechanism combines tissue repositioning with palatal stiffening, resulting in both structural and functional improvement of the airway.[76,77] The outcomes observed in this study are consistent with these reported benefits, particularly with regard to the early improvement in snoring parameters.

An important aspect of the present study is the use of DISE to guide surgical decision-making. This approach is supported in the literature, as it allows identification of the specific site and pattern of airway collapse, enabling tailored, patient-specific treatment, in accordance with the principles of multilevel surgical approaches described in the literature.[38,39,72,73] The favorable outcomes observed in this study further support the role of DISE in optimizing surgical planning and improving treatment effectiveness.

Finally, the pattern of early postoperative improvement followed by stabilization observed in this study suggests that the primary effect of surgery occurs shortly after intervention, with subsequent maintenance of results. This observation is consistent with findings from studies

evaluating palatal and reconstructive surgical techniques, which demonstrate sustained postoperative improvement over time.[66]

Taken together, these findings place the results of the present study within the broader context of contemporary palatopharyngeal surgery, supporting the effectiveness of reconstructive, function-preserving techniques guided by individualized assessment. The consistency between the present results and the existing literature reinforces the role of tailored, multilevel approaches in achieving clinically meaningful improvements in snoring-related outcomes.

5.4 Clinical Implications

The findings of the present study have several important clinical implications for the management of patients with roncopathy, particularly in the context of individualized, function-preserving surgical approaches.

First, the significant improvements observed in partner-reported snoring outcomes reinforce the role of palatopharyngeal surgery as an effective therapeutic option in appropriately selected patients. Given that the indication for treatment in primary roncopathy is often driven by social burden and impact on quality of life, the consistent reduction in snoring frequency, duration and intensity supports the clinical relevance of surgical intervention. These findings suggest that, when conservative measures are insufficient or poorly tolerated, surgical treatment can provide meaningful symptomatic relief for both patients and their partners.

Second, the use of DISE to guide surgical decision-making represents a key aspect of modern clinical practice. By enabling direct visualization of the site and pattern of upper airway collapse, DISE allows for a more precise characterization of the underlying pathophysiology. The results of this study support the value of this approach, as individualized, multilevel surgical strategies were associated with consistent improvement across several outcome measures. This reinforces the concept that successful management of roncopathy depends on personalized treatment planning rather than the application of a single standardized procedure.

In addition, the observed differences between outcome domains provide important insights for patient selection. While snoring-related parameters and Berlin Questionnaire Category 1 demonstrated significant improvement, changes in daytime symptoms, as assessed by the Epworth Sleepiness Scale and Berlin Questionnaire Category 2, were less pronounced. This suggests that palatopharyngeal surgery primarily addresses the mechanical and vibratory components of upper airway dysfunction, with a more limited effect on multifactorial symptoms

such as fatigue and daytime sleepiness. From a clinical perspective, this highlights the importance of careful patient selection and expectation management, particularly in individuals without significant baseline daytime sleepiness impairment.

The incorporation of objective acoustic monitoring through the SnoreLab application also has relevant clinical implications. Although limited to a subset of patients, the observed reduction in objective snoring metrics supports the use of smartphone-based technologies as complementary tools in the assessment of roncopathy. In routine clinical practice, these tools may facilitate longitudinal monitoring in natural sleep environments, enhance patient engagement, and provide additional objective data to support treatment evaluation, particularly when access to formal sleep studies is limited.

Postoperative morbidity, particularly pain, represents an important factor in the overall evaluation of surgical treatment. The high prevalence of severe pain observed in this cohort highlights the need for appropriate perioperative counseling and optimized analgesic strategies. Although no clear association with a specific surgical technique was identified, the tendency for higher pain levels in more extensive or combined procedures suggests that morbidity is likely related to the overall extent of surgical manipulation and the number of anatomical sites treated. This should be considered when selecting surgical approaches, especially in patients with less severe symptoms or lower pain tolerance.

Furthermore, the temporal pattern of improvement observed in this study, characterized by early postoperative changes followed by stabilization, has practical implications for clinical follow-up. The findings suggest that the majority of symptomatic benefit is achieved within the first postoperative month, with subsequent maintenance of results. This may allow clinicians to use early follow-up assessments as a reliable indicator of medium-term outcomes, facilitating more efficient postoperative management and patient counseling.

Finally, the overall results of this study support the combined use of subjective, partner-reported and objective measures in the evaluation and management of roncopathy. This approach provides a more complete understanding of treatment outcomes, reflecting both patient perception and real-world functional impact. It may also improve patient selection and contribute to more personalized care.

In summary, the present findings reinforce the role of individualized, DISE-guided, multilevel surgical strategies in the management of roncopathy, while highlighting the importance of patient selection, expectation management and consideration of postoperative morbidity, to improve clinical outcomes.

5.5 Limitations

The present study has several limitations that should be considered when interpreting the results.

First, the relatively small sample size represents an important limitation. Although consistent trends were observed across multiple outcome measures, the limited number of patients reduces statistical power and may increase the risk of type II error, particularly in analyses where no statistically significant differences were detected. In addition, the small sample size limits the generalizability of the findings to broader populations and prevents reliable comparison between different subgroups of patients, such as those undergoing different surgical techniques or presenting different patterns of airway collapse identified on DISE. Future studies including larger and more balanced populations are necessary to allow meaningful subgroup analyses. Such studies would enable comparison between different surgical techniques and provide a more detailed evaluation of outcomes according to specific patterns of airway collapse identified on DISE, contributing to further improvement of individualized treatment strategies.

Second, the study population was markedly unbalanced in terms of sex distribution, with only one female patient included. This significantly limits the applicability of the findings to female populations. Sex-related differences in upper airway anatomy, fat distribution, hormonal influences and neuromuscular control have been described and may influence both the pathophysiology of roncopathy and the response to surgical intervention. Women may present with different collapse patterns and symptom profiles, potentially affecting both surgical planning and outcomes. Furthermore, the predominance of male patients in this cohort may reflect underlying epidemiological trends or referral patterns; however, this imbalance prevents meaningful comparison between sexes and limits the ability to assess whether similar outcomes would be observed in female patients. Future studies including more balanced populations are therefore necessary to better characterize potential sex-specific differences.

Third, the heterogeneity of surgical procedures performed is another relevant limitation. As this study reflects real-world clinical practice, different combinations of palatopharyngeal and adjunctive procedures were performed based on individualized DISE findings. While this approach enhances external validity and reflects contemporary personalized surgical strategies, it limits internal validity by preventing direct comparison between techniques. Consequently, it is not possible to determine the relative contribution of each individual procedure to the overall outcomes observed.

The relatively short follow-up period of 3 months restricts the evaluation of long-term outcomes. Although significant improvements were observed early and maintained at 3 months, longer follow-up is necessary to assess the durability of surgical effects and the risk of symptomatic recurrence over time. Given that scar maturation and functional adaptation of the upper airway may continue after the early postoperative period, longer-term studies would provide a clearer understanding of treatment effectiveness and stability.

Another limitation relates to the reliance on subjective and partner-reported outcome measures. While these are clinically meaningful and reflect the real-life impact of roncopathy, they are inherently influenced by individual perception, reporting bias and interpersonal dynamics. Although the inclusion of partner-reported outcomes strengthens the evaluation by providing an external perspective, these measures remain subjective and may be affected by expectations or placebo effects.

Objective assessment using the SnoreLab application was included as a complementary measure; however, it was available only in a subset of patients, further limiting the reliability of objective outcome evaluation. In addition, the use of a smartphone-based application introduces variability related to environmental conditions, device positioning, background noise and patient compliance. Although such tools offer practical advantages and reflect real-world conditions, they do not replace gold-standard objective assessments such as PSG.

Finally, the absence of a control group represents an additional limitation. Without a comparison group, it is not possible to definitively attribute the observed improvements exclusively to the surgical intervention. Factors such as placebo effects, behavioral changes or natural variability in symptoms cannot be entirely excluded. A controlled study design would be necessary to more rigorously evaluate the causal relationship between surgical intervention and clinical outcomes.

Despite these limitations, the study provides a structured evaluation of surgical outcomes by combining subjective, partner-reported and objective measures. The findings offer clinically relevant insights into the effectiveness of individualized, DISE-guided surgical strategies in the management of roncopathy and contribute to the growing body of evidence supporting patient-adapted multilevel surgery.

6. Conclusion

The present study demonstrates that palatopharyngeal surgery is an effective therapeutic option for the management of roncopathy, resulting in significant improvements in snoring-related outcomes. Reductions in snoring frequency, duration and intensity were consistently observed, supported by both partner-reported assessments and objective measurements in a subset of patients. These findings highlight the clinical relevance of surgical intervention in addressing the mechanical and vibratory components of upper airway obstruction.

In addition, improvements in daytime sleepiness, as measured by the ESS, were observed over time, although to a lesser extent than snoring-related outcomes. This reinforces the concept that palatopharyngeal surgery primarily targets the structural aspects of airway collapse, with more variable effects on multifactorial symptoms such as fatigue and daytime somnolence.

The use of DISE as part of the preoperative evaluation played a key role in guiding surgical decision-making, allowing for individualized approaches adapted to the specific pattern of airway collapse. The favorable outcomes observed in this study support the importance of DISE-guided surgical planning in optimizing treatment effectiveness.

Furthermore, the pattern of early postoperative improvement followed by stabilization suggests that the majority of clinical benefit is achieved shortly after intervention and maintained over time. This has practical implications for postoperative follow-up and patient counseling.

Despite the presence of postoperative pain in the early period, the overall benefits observed in terms of symptom reduction support a favorable risk-benefit profile for surgical intervention in appropriately selected patients.

However, the findings of this study should be interpreted considering its limitations, including the small sample size, heterogeneity of surgical techniques, short follow-up period and limited objective assessment. Future studies with larger and more balanced populations, longer follow-up and the inclusion of additional standardized objective outcome measures, such as PSG, are needed to further evaluate long-term effectiveness and to better define the role of specific surgical techniques according to DISE-defined patterns of airway collapse.

In conclusion, palatopharyngeal surgery, when guided by careful patient selection and DISE-based evaluation, represents an effective and clinically relevant approach for the treatment of roncopathy. These results support adapting surgery to each patient’s obstruction pattern, especially in cases of multilevel collapse. This approach may improve airway patency while preserving function and reducing the impact of snoring on patients and their partners.

7. References

1. Young T, Palta M, Dempsey J, et al. The occurrence of sleep-disordered breathing among middle-aged adults. N Engl J Med. 1993;328(17):1230–5.

2. Sateia MJ. International classification of sleep disorders-third edition. Chest. 2014;146(5):1387–94.

3. Bloom JW, Kaltenborn WT, Quan SF. Risk factors in a general population for snoring. Chest. 1988;93(4):678–83.

4. Lechat B, Naik G, Appleton S, et al. Regular snoring is associated with uncontrolled hypertension. Npj Digit Med. 2024;7(1):38.

5. De Benedetto M, Cuda D, Leante M, et al. [Snoring: an epidemiological study on 1146 adult subjects]. Acta Otorhinolaryngol Ital Organo Uff Della Soc Ital Otorinolaringol E Chir Cerv-facc. 1990;10(6):523–8.

6. Wali SO, Abaalkhail BA. Prevalence and predictors of habitual snoring in a sample of saudi middle-aged adults. Saudi Med J. 2015;36(8):920–7.

7. Kara CO, Zencir M, Topuz B, et al. [The prevalence of snoring in adult population]. Kulak Burun Bogaz Ihtis Derg KBB J Ear Nose Throat. 2005;14(1–2):18–24.

8. Ohayon MM, Guilleminault C, Priest RG, et al. Snoring and breathing pauses during sleep: telephone interview survey of a united kingdom population sample. BMJ. 1997;314(7084):860.

9. Franklin KA, Gíslason T, Omenaas E, et al. The influence of active and passive smoking on habitual snoring. Am J Respir Crit Care Med. 2004;170(7):799–803.

10. Hoffstein V. Snoring and upper airway resistance. In: Principles and Practice of Sleep Medicine [Internet]. Elsevier; 2005 [cited 2026]. p. 1001–12. Available from: https://linkinghub.elsevier.com/retrieve/pii/B0721607977500902

11. Horner RL. Pathophysiology of obstructive sleep apnea. J Cardiopulm Rehabil Prev. 2008;28(5):289–98.

12. Schäfer T. Respiratory pathophysiology: sleep-related breathing disorders. GMS Curr Top Otorhinolaryngol Head Neck Surg. 2006;5:Doc01.

13. Steinhart H, Kuhn-Lohmann J, Gewalt K, et al. Upper airway collapsibility in habitual snorers and sleep apneics: evaluation with drug-induced sleep endoscopy. Acta Otolaryngol (Stockh). 2000;120(8):990–4.

14. Gleadhill IC, Schwartz AR, Schubert N, et al. Upper airway collapsibility in snorers and in patients with obstructive hypopnea and apnea. Am Rev Respir Dis. 1991;143(6):1300–3.

15. Malhotra A, Pillar G, Fogel R, et al. Upper-airway collapsibility: measurements and sleep effects. Chest. 2001;120(1):156–61.

16. Heiser C, Zimmermann I, Sommer JU, et al. Pharyngeal chemosensitivity in patients with obstructive sleep apnea and healthy subjects. Chem Senses. 2013;38(7):595–603.

17. Teculescu D, Hannhart B, Cornette A, et al. Prevalence of habitual snoring in a sample of french males. Respiration. 2001;68(4):365–70.

18. Lindberg E, Janson C, Svardsudd K, et al. Increased mortality among sleepy snorers: a prospective population based study. Thorax. 1998;53(8):631–7.

19. Bhattacharyya N. Sleep and health implications of snoring: a populational analysis. The Laryngoscope. 2015;125(10):2413–6.

20. Hu FB, Willett WC, Colditz GA, et al. Prospective study of snoring and risk of hypertension in women. Am J Epidemiol. 1999;150(8):806–16.

21. Hu FB, Willett WC, Manson JE, et al. Snoring and risk of cardiovascular disease in women. J Am Coll Cardiol. 2000;35(2):308–13.

22. Stradling JR, Crosby JH. Predictors and prevalence of obstructive sleep apnoea and snoring in 1001 middle aged men. Thorax. 1991;46(2):85–90.

23. Punjabi NM. The epidemiology of adult obstructive sleep apnea. Proc Am Thorac Soc. 2008;5(2):136–43.

24. Stuck BA, Dreher A, Heiser C, et al. Diagnosis and treatment of snoring in adults–s2k guideline of the german society of otorhinolaryngology, head and neck surgery. Sleep Breath. 2015;19(1):135–48.

25. Johns MW. Reliability and factor analysis of the epworth sleepiness scale. Sleep. 1992;15(4):376–81.

26. Smith SS, Oei TPS, Douglas JA, et al. Confirmatory factor analysis of the epworth sleepiness scale (ess) in patients with obstructive sleep apnoea. Sleep Med. 2008;9(7):739–44.

27. Svensson M, Franklin KA, Theorell-Haglöw J, et al. Daytime sleepiness relates to snoring independent of the apnea-hypopnea index in women from the general population. Chest. 2008;134(5):919–24.

28. Maimon N, Hanly PJ. Does snoring intensity correlate with the severity of obstructive sleep apnea? J Clin Sleep Med JCSM Off Publ Am Acad Sleep Med. 2010;6(5):475–8.

29. Netzer NC, Stoohs RA, Netzer CM, et al. Using the berlin questionnaire to identify patients at risk for the sleep apnea syndrome. Ann Intern Med. 1999;131(7):485–91.

30. Kang K, Park KS, Kim JE, et al. Usefulness of the berlin questionnaire to identify patients at high risk for obstructive sleep apnea: a population-based door-to-door study. Sleep Breath. 2013;17(2):803–10.

31. Brown J, Mitchell Z, Jiang YA, et al. Accuracy of smartphone-mediated snore detection in a simulated real-world setting: algorithm development and validation. JMIR Form Res. 2025;9:e67861.

32. Nakano H, Hirayama K, Sadamitsu Y, et al. Monitoring sound to quantify snoring and sleep apnea severity using a smartphone: proof of concept. J Clin Sleep Med. 2014;10(1):73–8.

33. Chiang JK, Lin YC, Lin CW, et al. Validation of snoring detection using a smartphone app. Sleep Breath Schlaf Atm. 2022;26(1):81–7.

34. Klaus K, Stummer AL, Ruf S. Accuracy of a smartphone application measuring snoring in adults-how smart is it actually? Int J Environ Res Public Health. 2021;18(14):7326.

35. Figueras-Alvarez O, Cantó-Navés O, Cabratosa-Termes J, et al. Snoring intensity assessment with three different smartphones using the snorelab application in one participant. J Clin Sleep Med. 2020;16(11):1971–4.

36. Ralph Downey 3rd JVR. Polysomnography. In: Handbook of Clinical Neurology [Internet]. Elsevier; 2019 [cited 2026]. p. 381–92. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780444640321000254

37. Kapur VK, Auckley DH, Chowdhuri S, et al. Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: an american academy of sleep medicine clinical practice guideline. J Clin Sleep Med. 2017;13(3):479–504.

38. Carrasco-Llatas M, Matarredona-Quiles S, De Vito A, et al. Drug-induced sleep endoscopy: technique, indications, tips and pitfalls. Healthcare. 2019;7(3):93.

39. Awad M, Okland TS, Nekhendzy V. Drug-induced sleep endoscopy. Atlas Oral Maxillofac Surg Clin. 2019;27(1):7–10.

40. Rabelo FAW, Küpper DS, Sander HH, et al. Polysomnographic evaluation of propofol-induced sleep in patients with respiratory sleep disorders and controls. The Laryngoscope. 2013;123(9):2300–5.

41. Hillman DR, Walsh JH, Maddison KJ, et al. Evolution of changes in upper airway collapsibility during slow induction of anesthesia with propofol. Anesthesiology. 2009;111(1):63–71.

42. Kezirian EJ, Hohenhorst W, De Vries N. Drug-induced sleep endoscopy: the vote classification. Eur Arch Otorhinolaryngol. 2011;268(8):1233–6.

43. Pang KP, Pang EB, Win MTM, et al. Expansion sphincter pharyngoplasty for the treatment of osa: a systemic review and meta-analysis. Eur Arch Otorhinolaryngol. 2016;273(9):2329–33.

44. Peppard PE. Longitudinal study of moderate weight change and sleep-disordered breathing. JAMA. 2000;284(23):3015.

45. Marjorie V. Launico SCN. Anatomy, airway. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025. Available from: https://www.ncbi.nlm.nih.gov/books/NBK459258/

46. Issa FG, Sullivan CE. Alcohol, snoring and sleep apnea. J Neurol Neurosurg Psychiatry. 1982;45(4):353–9.

47. Kim KS, Kim JH, Park SY, et al. Smoking induces oropharyngeal narrowing and increases the severity of obstructive sleep apnea syndrome. J Clin Sleep Med. 2012;8(4):367–74.

48. Trenchea M, Deleanu O, Suţa M, et al. Smoking, snoring and obstructive sleep apnea. Pneumologia. 2013;62(1):52–5.

49. Puhan MA, Suarez A, Cascio CL, et al. Didgeridoo playing as alternative treatment for obstructive sleep apnoea syndrome: randomised controlled trial. BMJ. 2006;332(7536):266–70.

50. Ojay A, Ernst E. Can singing exercises reduce snoring? a pilot study. Complement Ther Med. 2000;8(3):151–6.

51. Wardrop PJC, Ravichandran S, Hair M, et al. Do wind and brass players snore less? a cross-sectional study of snoring and daytime fatigue in professional orchestral musicians. Clin Otolaryngol. 2011;36(2):134–8.

52. Randerath WJ, Galetke W, Domanski U, et al. Tongue-muscle training by intraoral electrical neurostimulation in patients with obstructive sleep apnea. Sleep. 2004;27(2):254–9.

53. Ravesloot MJL, Van Maanen JP, Dun L, et al. The undervalued potential of positional therapy in position-dependent snoring and obstructive sleep apnea—a review of the literature. Sleep Breath. 2013;17(1):39–49.

54. Van Maanen JP, Meester KAW, Dun LN, et al. The sleep position trainer: a new treatment for positional obstructive sleep apnoea. Sleep Breath. 2013;17(2):771–9.

55. De Ruiter MHT, Benoist LBL, De Vries N, et al. Durability of treatment effects of the sleep position trainer versus oral appliance therapy in positional osa: 12-month follow-up of a randomized controlled trial. Sleep Breath. 2018;22(2):441–50.

56. Dieltjens M, Verbruggen AE, Braem MJ, et al. Determinants of objective compliance during oral appliance therapy in patients with sleep-related disordered breathing: a prospective clinical trial. JAMA Otolaryngol Neck Surg. 2015;894.

57. Doff MHJ, Hoekema A, Wijkstra PJ, et al. Oral appliance versus continuous positive airway pressure in obstructive sleep apnea syndrome: a 2-year follow-up. Sleep. 2013;36(9):1289–96.

58. Wellman A, Genta PR, Owens RL, et al. Test of the starling resistor model in the human upper airway during sleep. J Appl Physiol. 2014;117(12):1478–85.

59. Moxness MHS, Nordgård S. An observational cohort study of the effects of septoplasty with or without inferior turbinate reduction in patients with obstructive sleep apnea. BMC Ear Nose Throat Disord. 2014;14:11.

60. Friedman M, Tanyeri H, Lim JW, et al. Effect of improved nasal breathing on obstructive sleep apnea. Otolaryngol Neck Surg. 2000;122(1):71–4.

61. Fujita S, Conway W, Zorick F, et al. Surgical correction of anatomic abnormalities in obstructive sleep apnea syndrome: uvulopalatopharyngoplasty. Otolaryngol Neck Surg. 1981;89(6):923–34.

62. Sher AE, Schechtman KB, Piccirillo JF. The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. Sleep. 1996;19(2):156–77.

63. Powell N, Riley R, Guilleminault C, et al. A reversible uvulopalatal flap for snoring and sleep apnea syndrome. Sleep. 1996;19(7):593–9.

64. Neruntarat C. Uvulopalatal flap for obstructive sleep apnea: short-term and long-term results. The Laryngoscope. 2011;121(3):683–7.

65. Zhou TC, Hsia JC. The uvulopalatal flap. Oper Tech Otolaryngol-Head Neck Surg. 2015;26(2):78–84.

66. Pang KP, Tan R, Puraviappan P, et al. Anterior palatoplasty for the treatment of osa: three-year results. Otolaryngol Neck Surg. 2009;141(2):253–6.

67. Selcuk A, Ozer T, Esen E, et al. Evaluation of effects of anterior palatoplasty operation on upper airway parameters in computed tomography in patients with pure snoring and obstructive sleep apnea syndrome. Eur Arch Otorhinolaryngol. 2017;274(5):2183–8.

68. Binar M, Karakoc O. Anterior palatoplasty for obstructive sleep apnea: a systematic review and meta-analysis. Otolaryngol Neck Surg. 2018;158(3):443–9.

69. Ugur KS, Ark N, Kurtaran H, et al. Anterior palatoplasty for selected mild and moderate obstructive sleep apnea: preliminary results. Eur Arch Otorhinolaryngol. 2014;271(6):1777–83.

70. Pang KP, Vicini C, Montevecchi F, et al. Long-term complications of palate surgery: a multicenter study of 217 patients. The Laryngoscope. 2020;130(9):2281–4.

71. Pang KP, Piccin O, Pang EB, et al. Combined expansion pharyngoplasty and anterior palatoplasty for the treatment of osa. Indian J Otolaryngol Head Neck Surg. 2016;68(4):528–33.

72. Pang KP, Woodson BT. Expansion sphincter pharyngoplasty: a new technique for the treatment of obstructive sleep apnea. Otolaryngol Neck Surg. 2007;137(1):110–4.

73. Li H, Lee L. Relocation pharyngoplasty for obstructive sleep apnea. The Laryngoscope. 2009;119(12):2472–7.

74. Oh H, Kim HG, Pyo S, et al. The clinical efficacy of relocation pharyngoplasty to improve retropalatal circumferential narrowing in obstructive sleep apnea patients. Sci Rep. 2020;10(1):2101.

75. Cahali MB, Formigoni GGS, Gebrim EMMS, et al. Lateral pharyngoplasty versus uvulopalatopharyngoplasty: a clinical, polysomnographic and computed tomography measurement comparison. Sleep. 2004;27(5):942–50.

76. Vicini C, Hendawy E, Campanini A, et al. Barbed reposition pharyngoplasty (brp) for osahs: a feasibility, safety, efficacy and teachability pilot study. “we are on the giant’s shoulders.” Eur Arch Otorhinolaryngol. 2015;272(10):3065–70.

77. Moffa A, Giorgi L, Carnuccio L, et al. Barbed pharyngoplasty for snoring: does it meet the expectations? a systematic review. Healthcare. 2023;11(3):435.

78. Babademez MA, Gul F, Teleke YC. Barbed palatoplasty vs. expansion sphincter pharyngoplasty with anterior palatoplasty. The Laryngoscope. 2020;130(4).

79. Friedman M, Gillespie MB, Shabdiz FA, et al. A new office-based procedure for treatment of snoring: the s.i.le.n.c.e. study. Laryngoscope Investig Otolaryngol. 2020;5(1):24–30.

80. Salamanca F, Costantini F, Mantovani M, et al. Barbed anterior pharyngoplasty: an evolution of anterior palatoplasty. Acta Otorhinolaryngol Ital Organo Uff Della Soc Ital Otorinolaringol E Chir Cerv-facc. 2014;34(6):434–8.

81. Friedman M, Ibrahim H, Joseph NJ. Staging of obstructive sleep apnea/hypopnea syndrome: a guide to appropriate treatment. The Laryngoscope. 2004;114(3):454–9.

Annexes

Tables

Table I. *VOTE classification system used during DISE to assess the degree and configuration of upper airway obstruction at four anatomical levels: velum, oropharynx, tongue base and epiglottis. Adapted from Kezirian et al. (2011).*[42]

Structure	**Degree of obstruction (0-2)** [1]	**Configuration**		
		A-P[2]	Lateral	Concentric
Velum				
Oropharynx				
Tongue base				
Epiglottis				

[1] *0 = no obstruction (<50% collapse)*

1 = partial obstruction (50–75% collapse)

2 = complete obstruction (>75% collapse)

x = not assessable

[2] *anteroposterior collapse*

***Table II**. Overview of surgical techniques for roncopathy and sleep-disordered breathing, including surgical principles, primary anatomical targets, clinical indications, outcomes and common complications.*

Technique	Surgical Principle	Primary Target	Best Indication (DISE)	Outcome	Common Complications
UPPP	Ablative: excision of uvula and soft palate	Oropharyngeal airway diameter	Limited use	Variable	Nasal regurgitation, stenosis, pain, dysphonia
UPF	Reconstructive: uvula repositioning	Palatal shortening	Palatal collapse	Moderate	Globus, flap dehiscence
ESP	Muscle repositioning	Lateral pharyngeal walls	Lateral wall collapse	Good	Globus, xerostomy
Anterior Palatoplasty	Palatal stiffening	Soft palate vibration	A–P collapse	Good in selected patients	Globus, xerostomy
Relocation Pharyngoplasty	Reconstructive advancement	Circumferential narrowing	Concentric collapse	Moderate-good	Dysphagia, dysgeusia
BRP	Barbed suspension	Lateral + palatal	Lateral + palatal collapse	Good, fast recovery	Suture extrusion (rare), dysphagia
Tonsillectomy	Tissue reduction	Tonsillar obstruction	Tonsillar hypertrophy	Adjunctive benefit	Hemorrhage, pain

Table III. *Baseline demographic and clinical characteristics.*

** Higher scores indicate greater symptom burden. Snoring frequency, duration and intensity were scored on 1–4 ordinal scales as defined in the Methods.*

Variable	**Value**
Demographics	
Age, median (IQR), years	50 (29-50)
Age range, years	25-66
Male sex, n (%)	14 (93.3)
Female sex, n (%)	1 (6.7)
Baseline Clinical Characteristics	
Baseline Epworth score, median (IQR)	9 (IQR 5–13)
High-risk Berlin questionnaire, n (%)	12 (80%)
Baseline snoring frequency, median (IQR)	3 (2-4) *
Baseline snoring duration, median (IQR)	3 (2-3) *
Baseline snoring intensity, median (IQR)	3 (2-3) *
Baseline SnoreLab score, median (IQR)	88 (48-113)

Table IV. *VOTE classification in supine position, main obstructive component on DISE and surgical procedure for each patient.*

Patient	VOTE Classification	DISE Main Obstructive Component	Surgery Performed
1	V AP-2, O-0, T-AP1, E-0	AP collapse	Anterior palatoplasty + septoplasty + turbinate surgery
2	V AP-2, O-LL1, T-2, E-1	AP collapse	Barbed pharyngoplasty + septoplasty + turbinate surgery + anterior palatoplasty
3	V AP-2, O-LL1, T-2, E-1	AP collapse	Anterior palatoplasty + partial uvulectomy + septoplasty + turbinate surgery
4	V CC-2, O-LL2, T-0, E-0	Soft palate + lateral wall collapse	Anterior palatoplasty + barbed pharyngoplasty + septoplasty + turbinate surgery
5	V AP-2, O-0, T-AP2, E-0	AP collapse with tongue base involvement	Uvulopalatal flap + septoplasty + turbinate surgery
6	V AP-2, O-0, T-AP1, E-0	AP collapse	Anterior palatoplasty
7	V AP-2, O-CC0, T-AP1, E-0	AP + lateral wall collapse	Anterior palatoplasty + barbed pharyngoplasty + partial uvulectomy
8	V LL-1, O-LL1, T-0, E-0	Partial lateral wall collapse	Septoplasty + turbinate surgery + uvulectomy + tonsillectomy
9	V CC-2, O-CC2, T-AP1, E-0	Concentric velopharyngeal collapse	Barbed pharyngoplasty
10	V LL-1, O-LL2, T-1, E-0	Lateral wall collapse	Barbed pharyngoplasty
11	V AP-2, O-0, T-0, E-0	Anteroposterior palatal collapse	Anterior palatoplasty+ septoplasty + turbinate surgery
12	V CC-2, O-CC2, T-AP2, E-0	Velopharyngeal + tongue base collapse	Relocation pharyngoplasty + septoplasty + turbinate surgery
13	V AP-2, O-LL1, T-AP2, E-1	Complete retropalatal AP collapse + lateral wall contribution	Barbed pharyngoplasty+ uvuloplasty + septoplasty + turbinate surgery
14	V LL-2, O-LL2, T-AP1, E-0	Lateral wall collapse	Relocation pharyngoplasty + barbed pharyngoplasty
15	V AP-2, O-0, T-0, E-0	AP collapse	Septoplasty + anterior palatoplasty

Notes: Patients undergoing Barbed Pharyngoplasty were all subjected to tonsillectomy. AP refers to anteroposterior collapse in VOTE classification and to anterior palatoplasty when referring to surgical procedures.

Table V. *Friedman test results for Epworth Sleepiness Scale.*

Variable	χ^2	df	p-value
Epworth	10.720	2	0.005

Table VI. *Pairwise comparisons of Epworth Sleepiness Scale scores using Wilcoxon signed-rank test with Bonferroni correction.*

Comparison	p-value	Adjusted significance ($p < 0.0167$)
Preoperative vs 1 month	0.027	Not significant
1 month vs 3 months	0.282	Not significant
Preoperative vs 3 months	0.001	Significant

Note: Bonferroni-adjusted significance level set at $p < 0.0167$.

Table VII. *Friedman test results for partner-reported snoring outcomes.*

Variable	χ^2	df	p-value
Frequency	12.235	2	0.002
Duration	18.865	2	< 0.001
Intensity	7.280	2	0.026

Table VIII. *Pairwise comparisons of partner-reported outcomes using Wilcoxon signed-rank test with Bonferroni correction.*

Variable	Comparison	p-value	Adjusted significance (p< 0.0167)
Frequency	Pre vs 1M	0.013	Significant
	1M vs 3M	0.096	Not significant
	Pre vs 3M	0.010	Significant
Duration	Pre vs 1M	0.007	Significant
	1M vs 3M	0.034	Not significant
	Pre vs 3M	0.001	Significant
Intensity	Pre vs 1M	0.008	Significant
	1M vs 3M	0.096	Not significant
	Pre vs 3M	0.002	Significant

Table IX. *Friedman test results for Berlin Questionnaire Categories.*

Category	χ^2	df	p-value
C1 (Snoring)	23.405	2	< 0.001
C2 (Fatigue)	5.429	2	0.066

Table X. *Pairwise comparisons of Berlin Questionnaire Categories using Wilcoxon signed-rank test with Bonferroni correction.*

Category	Comparison	p-value	Adjusted significance ($p < 0.0167$)
C1 (Snoring)	**Pre vs 1M**	**0.002**	**Significant**
	1M vs 3M	0.317	Not significant
	Pre vs 3M	**0.002**	**Significant**
C2 (Fatigue)	Pre vs 1M	0.194	Not significant
	1M vs 3M	0.102	Not significant
	Pre vs 3M	0.046	Not significant

Table XI. *Comparison of SnoreLab scores between preoperative and 1-month assessments (Wilcoxon signed-rank test).*

Comparison	Z	p-value
Pre vs 1 Month	−2.547	**0.011**

Figures

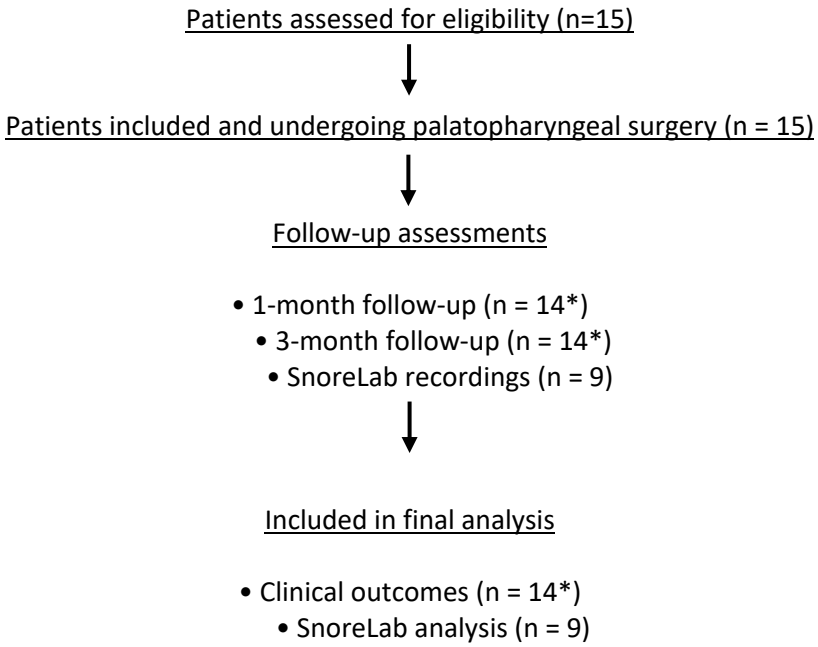


Figure 1. *Flowchart of patient inclusion, follow-up, and outcome assessment.*
**One patient was lost to follow-up.*

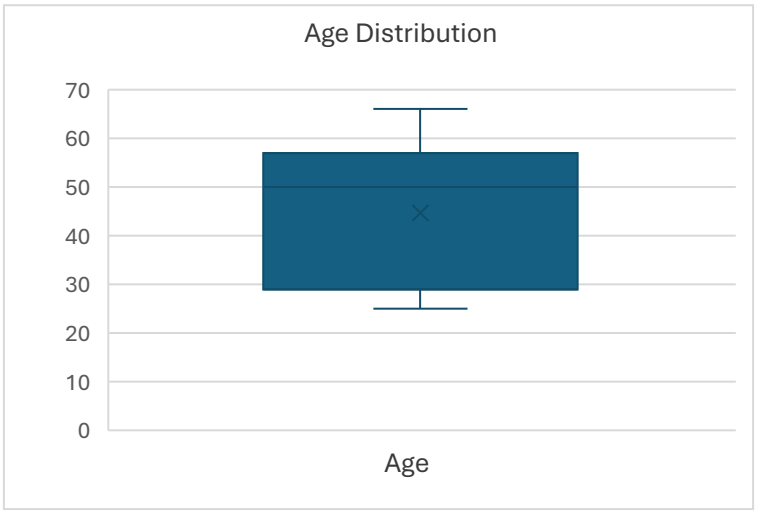


***Figure 2**. Study population age distribution.*

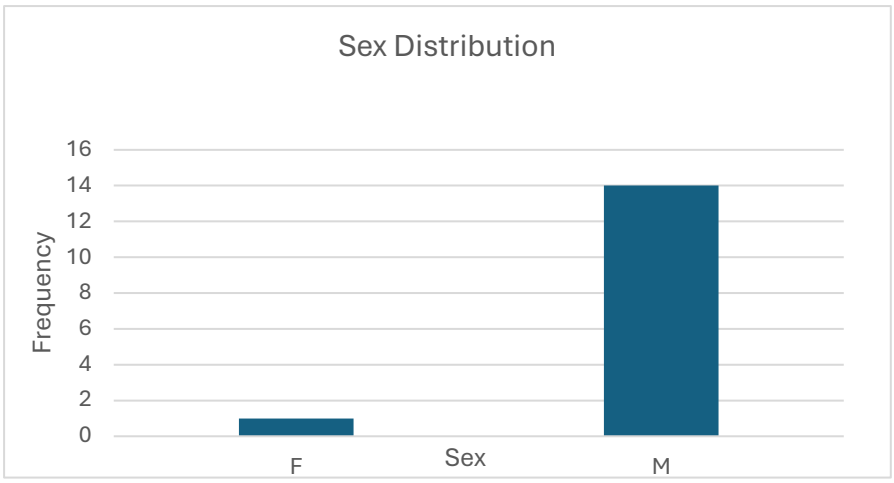


Figure 3. *Study population sex distribution.*

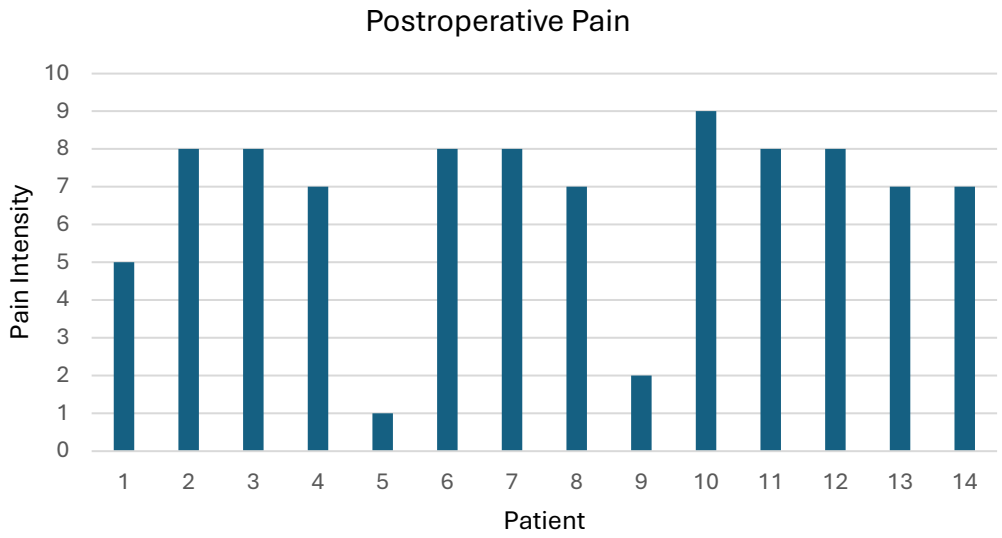


Figure 4. *Pain intensity reported by each patient.*

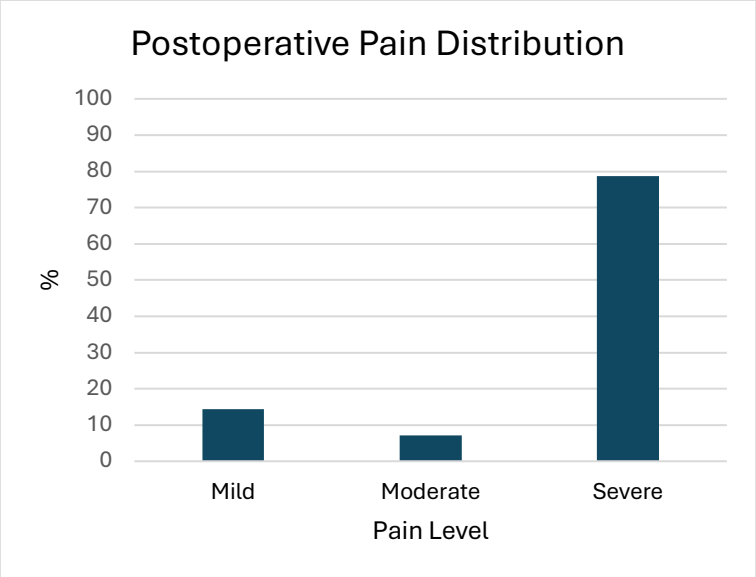


Figure 5. *Postoperative pain distribution.*

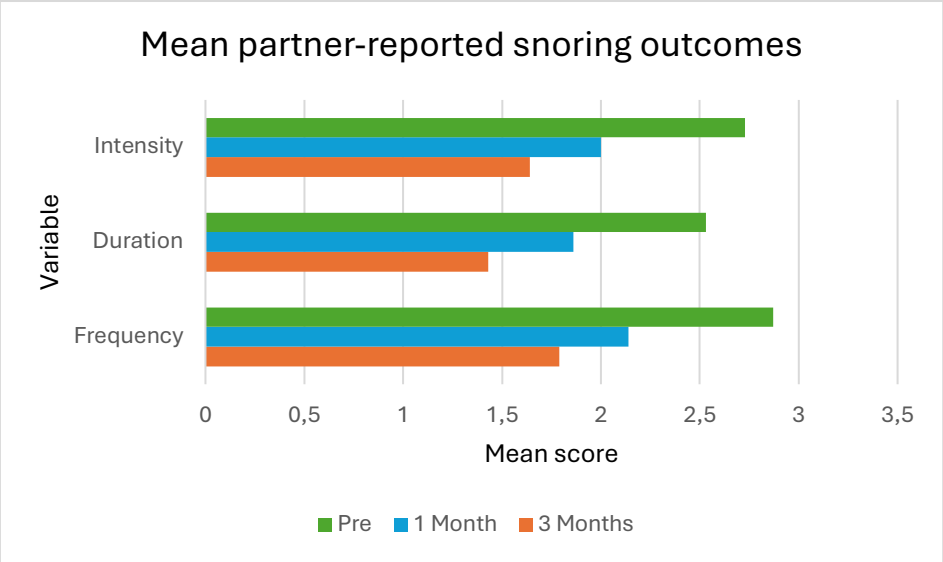


Figure 6. *Mean partner-reported snoring outcomes (frequency, duration and intensity) at preoperative, 1-month and 3-month time points.*

INSTITUTO DE **CIÊNCIAS BIOMÉDICAS ABEL SALAZAR**