Será o VOTE suficiente para guiar a terapêutica? Estudo prospetivo sobre a caraterização fenotípica.

Artigo Original

Autores

Maria Marques da Silva
Unidade Local de Saúde São João, Porto;
Faculdade de Medicina da Universidade do Porto

António Andrade
Unidade Local de Saúde São João, Porto;
Faculdade de Medicina da Universidade do Porto

Sónia Pires Martins
Unidade Local de Saúde São João, Porto;
Faculdade de Medicina da Universidade do Porto

Ricardo Vaz
Unidade Local de Saúde São João, Porto;
Faculdade de Medicina da Universidade do Porto;
Centro de Investigação em Tecnologias e Serviços de Saúde (CINTESIS), Porto

Jorge Rodrigues
Unidade Local de Saúde São João, Porto;
Faculdade de Medicina da Universidade do Porto

João Viana Pinto
Unidade Local de Saúde São João, Porto;
Faculdade de Medicina da Universidade do Porto

Correspondência:
Maria Marques da Silva
mjmarquesdasilva@gmail.com

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Resumo

Objetivos: Demonstrar a heterogeneidade existente na classificação VOTE, através de uma avaliação fenotípica mais extensa baseada na documentação iconográfica obtida durante a DISE.
Desenho do Estudo: Estudo prospetivo observacional.
Material e Métodos: Foi realizada uma avaliação de DISE com base na classificação VOTE, complementada pela análise da morfologia do palato, distância subjetiva da espinha nasal posterior à parede posterior da nasofaringe, do joelho ao velum, descrição dos padrões de colapso ao nível do joelho, velum, base da língua (superior e inferior) e epiglote, e classificação de Friedman das amígdalas linguais.
Resultados: Foram incluídos 50 doentes (idade média 47,2 ± 8,4 anos; 68% homens), 35 com diagnóstico confirmado de AOS. Verificou-se uma acentuada heterogeneidade fenotípica entre doentes com classificação VOTE semelhante.
Conclusões: A classificação VOTE, por si só, pode subestimar a complexidade anatómico-funcional evidenciada na DISE. A caracterização fenotípica detalhada é fundamental para uma abordagem terapêutica individualizada em casos de roncopatia e AOS.

Palavras-chave: Apneia Obstrutiva do Sono (AOS); Fenótipo; Obstrução das Vias Aéreas; Endoscopia do Sono Induzido por Fármacos (DISE); Classificação VOTE

Introduction

Drug-induced sleep endoscopy (DISE) is a diagnostic procedure that allows for the dynamic assessment of upper airway collapse during pharmacologically induced sleep, enabling clinicians to identify anatomical structures contributing to upper airway obstruction[1]. This method has gained widespread acceptance as a tool to guide surgical decision-making in patients with obstructive sleep apnea (OSA), offering critical insights that may be missed during awake examinations[2]. Several studies have shown that DISE findings lead to changes in the surgical treatment approach in nearly 50% of OSA patients[3]. However, despite its widespread use, numerous challenges remain regarding DISE standardized application and interpretation. A universally accepted DISE methodology and classification system has yet to be established, making this a subject of ongoing debate. The VOTE classification (Velum-Oropharynx-Tongue-Epiglottis), one of the most widely used, provides both qualitative and quantitative insights into upper airway dynamics[4,5]. However, this classification does not encompass all patterns and configurations of collapse and obstruction at different upper airway levels that can be observed during DISE[5,6]. Striking the right balance in a classification system is inherently difficult: on one hand, it should be simple and reproducible to ensure inter-observer reliability and promote a shared language among clinicians; on the other hand, such simplicity may mask distinct patterns under broad categories. A critical analysis of pharyngeal collapse patterns is crucial for DISE to effectively inform surgical treatment decisions and serve as a reliable predictor of surgical outcomes[8]. A growing body of research suggests that DISE assessment should extend beyond traditional classification models to include a detailed analysis of pharyngeal airway morphology[5,7]. Key factors influencing obstruction include the shape of the soft palate, the distance from the posterior nasal spine to the posterior pharyngeal wall, and the distance between the anatomical genu and the velum. Additionally, the degree of anteroposterior and lateral wall obstruction at the levels of the genu and velum has been identified as a critical determinant of airway patency and surgical outcomes[5,7]. Recent studies underscore the importance of evaluating the complex interplay among these structural elements, as this may lead to a more precise understanding of airway collapse mechanisms and help refine patient selection for surgery[5,7,8]. Therefore, this study aims to demonstrate the phenotypic heterogeneity underlying identical VOTE classifications through an extended and structured phenotypic DISE assessment. This includes analysis of soft palate morphology, subjective distances from the posterior nasal spine to the posterior pharyngeal wall and from the genu to the velum, and the identification of distinct anteroposterior and lateral wall collapse patterns at key anatomical levels.

Material and Methods

This study analysed DISE procedures performed in adult patients at the Department of Otorhinolaryngology from January 2023 to January 2025. DISE was carried out following a standardized sedation protocol to ensure reproducibility and reliability, using a continuous infusion of propofol. Sedation depth was assessed with the Bispectral Index (BIS), aiming for values between 50 and 70 throughout the procedure. During the procedure, flexible nasopharyngolaryngoscopy was performed to evaluate the velopharyngeal, oropharyngeal, and hypopharyngeal zones. Subsequently, intraoral placement was performed to assess tongue positioning and to evaluate the occurrence of airway collapse. The assessments were reviewed by two investigators.

DISE examinations were classified according to the VOTE classification, which assesses the site, degree, and pattern of upper airway obstruction at four anatomical levels: velum, oropharynx, tongue base, and epiglottis.

While applying the VOTE classification, a more detailed assessment of the collapse features was performed concurrently. The subjective distances from the posterior nasal spine to the posterior wall of the nasopharynx (PNS-NP) and from the genu to the velum were assessed as either short or long, with a 15 mm cut-off (figure 1 and 2). The degree of anteroposterior obstruction at both the velum and genu, as well as lateral wall obstruction at these levels, was evaluated. Obstruction between 50% and 75% was considered partial, while obstruction exceeding 75% was considered complete. Additionally, palatal morphology was categorized as vertical, intermediate, or

Figure 1
Distance from the posterior nasal spine to the posterior wall of the nasopharynx (A – short, B – Long)

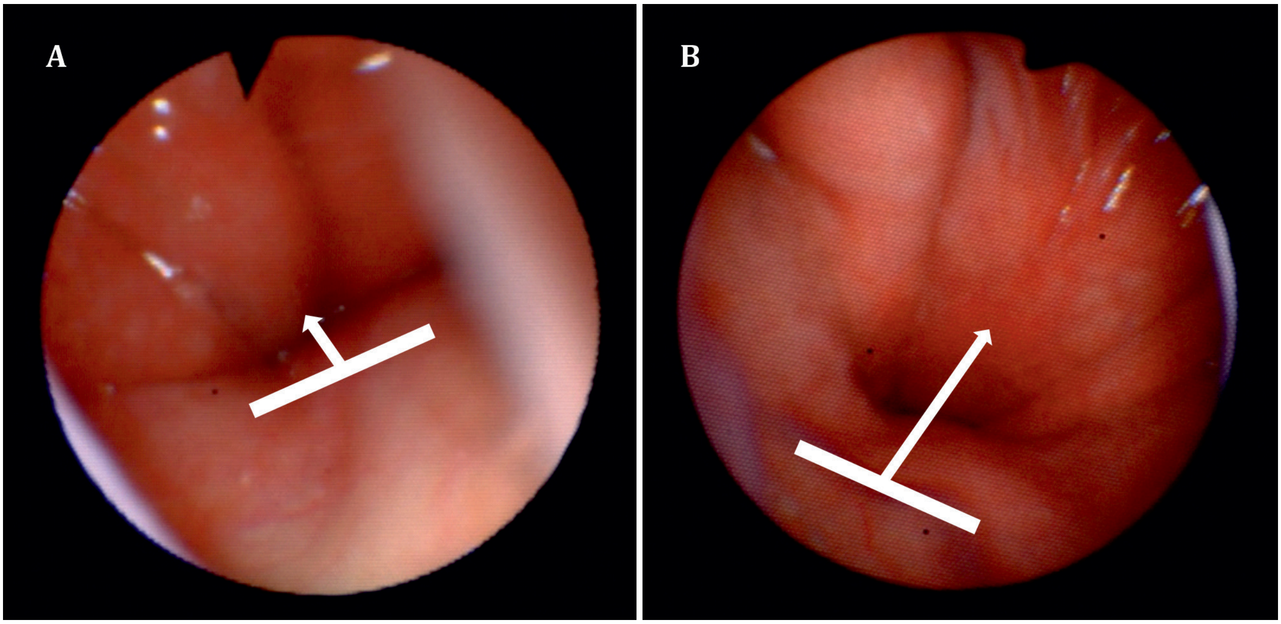
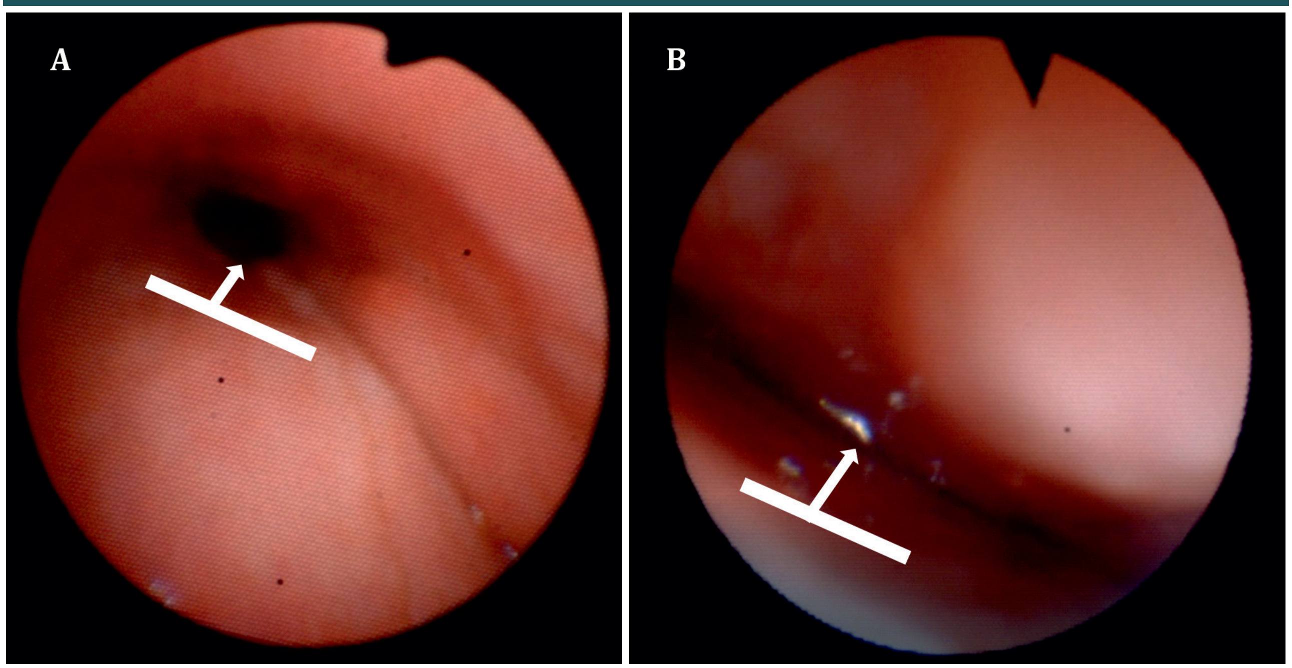


Figure 2
Distance from the genu to the velum (A – short, B – Long)



oblique, according to Woodson T (2019)[8]. At the tongue base, anteroposterior collapse was analysed, with obstructions characterized in both the superior and inferior portions. The Moore classification was applied to further delineate tongue base collapse, and the Friedman classification was used to assess the lingual tonsils[5,9]. The study was approved by the local ethics committee and was designed and conducted in compliance with Good Clinical Practice regulations and the Helsinki Declaration.

Results

A total of 50 patients were included, with a mean age of 47.2 ± 8.4 years. Thirty-four (68%) were male, while 16 (32%) were female. All patients underwent polysomnography, and obstructive sleep apnea was confirmed in 35 patients, classified as mild in 16 cases, moderate in 8, and severe in 11.

Most patients exhibited complete concentric obstruction at the velum level, while isolated anteroposterior (AP) or lateral collapse was less frequent. In the oropharynx, 27 patients presented with some degree of obstruction (partial or complete), and only 23 had no collapse. Tongue base obstruction was predominantly AP, with 30 patients exhibiting either partial or complete collapse. Regarding the epiglottis, the majority of patients (36) showed partial or complete AP obstruction. A detailed overview of VOTE classification is provided in Table 1.

Among patients with AP obstruction at the velum in the VOTE classification (n = 23), the palate was described as vertical in 9 cases, intermediate in 10, and oblique in 4. Genu-velum distance was considered short in 12 cases and long in 1. A short PNS-NP distance was found in six patients, and it was long in 16. Among patients with complete AP obstruction, only 14 showed complete obstruction at genu level, four had partial obstruction and three had no obstruction at this level. When evaluating pharynx lateral walls, we found that 2 and 1 of these patients had obstruction superior to 50% at the velum and genu level, respectively. In those with complete concentric obstruction, the palate was oblique in 17 cases, intermediate in 5, and vertical in three. A short genu-velum distance was found in 17 patients and long in eight. PNS-NP distance was short for two patients, the remaining 23 had a long PNS-NP distance. While all patients with complete concentric obstruction exhibited complete AP collapse at the velum, only four had collapsed at the genu. Complete lateral wall obstruction was observed at the velum in 22 patients and at the genu in three.

Among the 19 patients with complete AP collapse at the tongue base, seven were classified as grade 4, six as grade 3, two as grade 2, and three as grade 1, according to Friedman's lingual tonsil classification. In this group, seven patients were classified as Moore A, eight as Moore B, and four as Moore C. Also, 14 had secondary collapse of the epiglottis.

Table 1
VOTE Classification

	Degree of Obstruction	Total	Antero-Posterior	Lateral	Concentric
Velum	No obstruction	1			
	Partial	2	2	0	0
	Complete	47	21	1	25
Oropharynx lateral walls	No obstruction	23			
	Partial	15		15	
	Complete	12		12	
Tongue base	No obstruction	20			
	Partial	11	11		
	Complete	19	19		
Epiglottis	No obstruction	14			
	Partial	13	12	0	
	Complete	23	23	0	

Table 2
Anatomical Characteristics by Velum Obstruction Pattern on VOTE Classification

	Partial AP (n=2)	Complete AP (n=21)	Complete Lateral (n=1)	Complete Concentric (n=25)
Palate shape				
Vertical	0 (0%)	9 (42.9%)	0 (0%)	3 (12%)
Intermediate	2 (100%)	8 (38.1%)	1 (100%)	5 (20%)
Oblique	0 (0%)	4 (19.0%)	0 (0%)	17 (68%)
Posterior Nasal Spine Distance				
Short (<15 mm)	0 (0%)	6 (28.6%)	0 (0%)	2 (8%)
Long (>15 mm)	2 (100%)	15 (71.4%)	1 (100%)	23 (92%)
Genu Velum Distance				
Short (< 15mm)	1 (50%)	11 (52.4%)	1 (100%)	17 (68%)
Long (>15 mm)	1 (50%)	10 (47.6%)	0 (0%)	8 (32%)

Table 3
Velum Collapse Patterns by Velum Obstruction Pattern on VOTE classification

	Partial AP (n=2)	Complete AP (n=21)	Complete Lateral (n=1)	Complete Concentric (n=25)
Antero Posterior Velum Collapse				
75–100%	0 (0%)	21 (100%)	0 (0%)	25 (100%)
50–75%	2 (100%)	0 (0%)	0 (0%)	0 (0%)
0–50%	0 (0%)	0 (0%)	1 (100%)	0 (0%)
Antero Posterior Genu Collapse				
75–100%	0 (0%)	14 (66.7%)	0 (0%)	4 (15%)
50–75%	1 (50%)	4 (19.0%)	0 (0%)	11 (44%)
0–50%	1 (50%)	3 (14.3%)	1 (100%)	10 (40%)
Lateral Velum Collapse				
75–100%	0 (0%)	0 (0%)	1 (100%)	22 (88%)
50–75%	1 (50%)	2 (9.5%)	0 (0%)	3 (12%)
25–50%	1 (50%)	5 (23.8%)	0 (0%)	0 (0%)
0–25%	0 (0%)	14 (66.7%)	0 (0%)	0 (0%)
Lateral Genu Collapse				
75–100%	0 (0%)	0 (0%)	0 (0%)	3 (12%)
50–75%	0 (0%)	1 (4.8%)	1 (100%)	7 (28%)
25–50%	1 (50%)	0 (0%)	0 (0%)	6 (24%)
0–25%	1 (50%)	20 (95.2%)	0 (0%)	9 (36%)

Discussion

This study highlights the limitations of relying solely on the VOTE classification to guide treatment planning in OSA. While VOTE provides a simple and standardized classification for identifying collapse patterns, our findings reveal substantial phenotypic heterogeneity within identical VOTE categories. Such variability directly impacts the selection of surgical procedures and their anticipated efficacy. Although De Vito et al. (2023) previously acknowledged that the VOTE classification does not cover all patterns of events that occur during DISE examination, our study reinforces this premise by incorporating a broader range of phenotypic characteristics that may influence upper airway dynamics[9,11].

Patients with sleep apnea exhibit unique palatal anatomies that can significantly impact the effectiveness of different palatopharyngoplasty techniques. Woodson previously categorized palatal shape as oblique, intermediate, or vertical[11], noting that a vertical-shaped palate correlates with poorer outcomes after hypoglossal nerve stimulation[12]. Moreover, while an oblique palatal phenotype may be successfully treated with a reposition pharyngoplasty, the vertical type may be more appropriately treated with a transpalatal advancement[10]. In our sample, 12 patients exhibited a vertical-shaped palate. Among them, 9 presented with complete anteroposterior collapse and 3 with complete concentric collapse according to the VOTE classification. We hypothesize that if the distance between the posterior pharyngeal wall and the posterior nasal spine is short, surgeries limited to the soft palate are limited in their ability to increase the retropalatal airway, and transpalatal advancement surgery may be more effective in this situation. To our knowledge, no previous study has evaluated whether the PNS–NP distance influences pharyngoplasty results or if transpalatal advancement is more effective in patients with vertical-shaped palates. Further studies are needed to study this hypothesis.

Distal palatal length may differ between individuals, and the distance from the genu to the velum has been shown to be associated with a worse prognosis when the length is over 15 mm[13]. In our cohort, 17 of the 25 patients with complete concentric collapse at the velum level presented a genu–velum distance greater than 15 mm.

Woodson describes palatal obstruction at the velum and genu levels and evaluates separately anteroposterior and lateral wall collapse at these levels[11]. Comesso et al (2024) evaluated 209 DISEs using Woodson's palate shape evaluation and found that genu anteroposterior narrowing was associated with worse surgical results and genu lateral wall collapse was associated with better surgical outcomes after palatal surgery[14]. Among the patients with complete concentric collapse in our study, four had complete anteroposterior collapse at the genu level, which aligns with a potentially worse surgical prognosis. Furthermore, it is also important to consider the possibility of secondary palatal anteroposterior collapses due to tongue base collapse, which may lead to failure of palatal surgery without correction of the tongue collapse[15]. These findings reinforce the importance of evaluating the interaction between tongue base and palatal dynamics. Moreover, some authors believe that latero-lateral and anteroposterior simultaneous palatal collapse should be differentiated from circumferential palatal collapse, however there is still no evidence that these different phenotypes have different pathophysiology or surgical outcomes[10]. At the hypopharynx level, Woodson has described collapses as Moore type A (proximal tongue collapse), Moore type B (proximal and distal tongue collapse), Moore type C (distal tongue collapse), and primary epiglottic collapse[5]. In our sample, 11 patients were identified with Moore A and 8 with Moore B collapse, these patterns are often associated with overlapping palatal collapse; four patients revealed a Moore type C; Proximal tongue collapses are usually associated with lingual tonsil hypertrophy and the lingual tonsil should be graded according to Friedman's lingual tonsil grading system[9].

On the other hand, distal tongue collapses may be more closely associated with macroglossia or tongue base collapse due to low muscle tone. Transoral DISE may be useful to predict tongue collapse due to poor muscle tone by direct visualization of tongue position during sedation [15]. We believe that one should consider hypopharyngeal phenotypes when treating sleep apnea to tailor surgeries individually and maximize surgical success. While lingual tonsil hypertrophy and macroglossia can be addressed with tongue base reduction techniques, such as laser or coblator lingual tonsillectomy, midline glossectomy or TORS, tongue base collapse resulting from low muscle tone should be treated with hypoglossal nerve stimulation or suspension techniques, including tongue suspension and genioglossus advancement[16,21]. Furthermore, secondary epiglottic collapse may not require surgical intervention if the tongue base collapse is addressed, or they may be managed with less invasive procedures such as the epiglottic stiffening procedure[22]. In contrast, primary epiglottic collapse may need more invasive surgical options, such as epiglottopexy or epiglottectomy[23].

Although DISE is currently considered the standard of care in sleep apnea surgery, it is essential for surgeons to integrate additional assessments alongside DISE to optimize surgical outcomes. In fact, a review published in 2023 demonstrated that data from objective examinations, cephalometry, and polysomnography can serve as valuable predictors of palatal surgery success[24]. Specifically, a Grade I classification on the Friedman Scale, along with an isolated pharyngeal collapse observed during the Muller maneuver, has been associated with more favourable outcomes[24,25]. Furthermore, cephalometric parameters such as a retropalatal space exceeding 8.5–10 mm and larger transverse maxillary dimensions are linked to higher surgical success, while an increased hyoid-to-mandibular plane distance correlates with a less favourable prognosis [24, 25]. Also, data from polysomnography, like an AHI of less than 28/hour or evidence of positional obstructive sleep apnea, have also been associated with higher surgical success [24]. This study presents some limitations that should be acknowledged. Although it was designed prospectively and based on recent advances in the phenotypic characterization of upper airway collapse, the current analysis includes a relatively small number of patients, reflecting the early stage of an ongoing data collection process. The detailed phenotypic assessment applied - extending beyond the traditional VOTE classification - offers richer anatomical insight but introduces potential subjectivity, particularly in the evaluation of palate shape, collapse level, and wall dynamics, which may affect interobserver reliability. Additionally, no surgical outcome data were analysed at this stage, limiting the ability to correlate the identified phenotypes with treatment success. Further studies with larger patient cohorts and postoperative follow-up are needed to validate these findings and determine their prognostic significance. These findings reinforce the importance of moving beyond simplified classification systems to embrace a more nuanced anatomical and functional assessment of upper airway collapse. A detailed and individualized approach may be key to tailoring surgical strategies, improving patient counselling, and ultimately enhancing treatment outcomes in OSA.

Conclusion

The phenotypic variability underlying identical VOTE classifications highlights the limitations of relying solely on this classification for treatment decision-making in OSA. A more detailed and structured assessment of upper airway collapse - such as palatal shape, pharyngeal airway dimensions, and tongue base collapse patterns - might better capture clinically relevant differences and support a more personalized treatment plan. Further prospective studies are necessary to validate these observations and to develop integrated algorithms that extend beyond VOTE in guiding individualized treatment strategies.

Conflict of interest

The authors declare that they have no conflict of interest regarding this article.

Data Confidentiality

The authors declare that they followed the protocols of their work in publishing patient data

Protection of Human and Animal Subjects

The authors declare that the procedures followed are in accordance with the regulations established by the directors of the Committee for Clinical Research and Ethics and in accordance with the Declaration of Helsinki of the World Medical Association.

Privacy Policy, Informed Consent, and Ethics Committee Authorization

The authors declare that they have written consent for the use of patient photographs in this article.

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Availability of Scientific Data

There are no publicly available datasets related to this work

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