

The saw-tooth sign on spirometry: An early clue to obstructive sleep apnea

Le signe en dents de scie sur la spirométrie: Un indice précoce de l'apnée obstructive du sommeil

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A 43.7-year-old man, an occasional shisha smoker, was referred for spirometry to investigate exertional dyspnea (grade II on the modified medical research council scale). His medical history revealed no prior pulmonary disease, cardiac failure, stroke, or neuromuscular disorder. Surgical history included an appendectomy in 2001, a fistula surgery in 2006, and gynecomastia surgery in 2017. Spirometry was done using a spirometer (Medisoft, Sorinnes, Belgium), according to the most updated international guidelines (American thoracic society and European respiratory society-2019 guide), and the 2023-race-neutral reference equations were applied (1). Spirometry showed normal forced vital capacity (FVC, 120%, z-score = 1.33), forced expiratory volume in one second (FEV₁, 127%, z-score = 1.33), and FEV₁/FVC ratio (0.80, z-score = 0.86) (1). However, flow-volume loops revealed abnormal morphology, with oscillatory irregularities predominantly on the inspiratory limb, producing a characteristic “saw-tooth” sign (Figure 1). The latter was reproducible on three repeated and reproducible FVC maneuvers. Technical artifact was excluded through careful assessment, patient cooperation was satisfactory, and equipment calibration was verified, confirming a true physiological abnormality. The “saw-tooth” sign raised suspicion for upper airway obstruction.

Following this abnormal sign, a more detailed patient interview and clinical examination were performed. The patient reported progressive daytime sleepiness, nocturnal snoring, nocturia, and morning headaches. Daytime fatigue was severe, interfering with daily

activities, and he admitted drowsiness while driving, raising safety concerns. Examination revealed morbid obesity (body mass index (BMI) = 40.3 kg/m²) with central adiposity (neck circumference 48 cm, waist 124 cm) and a Mallampati score of grade III, suggesting pharyngeal narrowing. The Epworth sleepiness scale score was 16/24, confirming excessive daytime somnolence. Blood pressure was normal, and no craniofacial, chest, or cardiovascular abnormalities were noted.

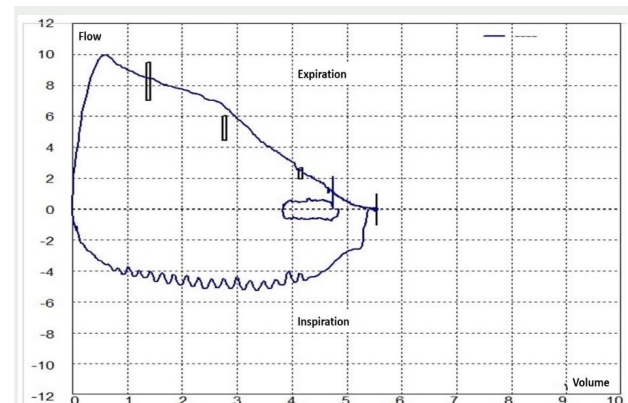


Figure 1. The “saw-tooth” sign during the inspiratory phase of the forced vital expiratory maneuver.

These findings, together with the spirometric “saw-tooth” sign, strongly suggested sleep-disordered breathing, and ventilatory polygraphy was subsequently ordered. Polygraphy (Neuron Spectrum AM, Neurosoft Ltd., Ivanovo, Russia) confirmed severe obstructive sleep apnea (OSA), with an apnea–hypopnea index of 33.17 events

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per hour. The disorder was positional, predominating in the supine position (supine index 53/h; nonsupine index 26.5/h). Frequent oxygen desaturations were recorded during obstructive events, with a time spent below 90% oxygen saturation of 4.6% and a moderate oxygen desaturation index of 26.6 events/h. Cardiac rhythm remained stable throughout the recording, with no arrhythmic episodes detected. Continuous positive airway pressure (CPAP) therapy was recommended, and patient education regarding adherence and mask use was provided. Weight reduction and lifestyle modifications were also advised.

Several mechanisms can explain the appearance of "saw-tooth" sign on spirometry. First, this sign is caused by rapid, intermittent changes in respiratory driving pressure or upper airway resistance (2). Second, changes in resistance can stem from structural narrowing, like lesions or adiposity, causing tissue fluttering (ie; Bernoulli's principle), or from upper airway instability due to muscle dysfunction (2). This is common in neuromuscular or extrapyramidal disorders like Parkinson's disease (2). Third, abnormal activity of respiratory pump muscles, such as diaphragmatic myoclonus, can alter driving pressure (2). Finally, spurious oscillations can occur without pathology from coughs, sound, or glottal closure (2).

The "saw-tooth sign" in the flow-volume loop often receives little attention in routine medical practice. While it is not pathognomonic, its presence can provide an early clue for sleep-disordered breathing in snoring patients (3). The sign has been reported in 12-44% of OSA patients and is more frequent in obese patients with pharyngeal narrowing (4). However, it can also occur in neuromuscular disorders with bulbar weakness, extrapyramidal syndromes such as Parkinson's disease, upper airway stenosis from tumors or scarring, burn injuries with airway deformities, herpes zoster with diaphragmatic nerve involvement, Leeuwenhoek's disease with diaphragmatic myoclonus, and tracheobronchomalacia with dynamic airway collapse (4). Artifacts due to poor technique may mimic the sign, emphasizing the need for careful interpretation within the clinical context (4). A retrospective study by Bourne et al. (3) demonstrated that the presence of the "saw-tooth" sign increased the likelihood of OSA diagnosis by 2.12 times, even after adjusting for age, sex, BMI, and smoking history. Similarly, Levent et Sarimen (4) reported that patients with the "saw-tooth" sign exhibited longer obstructive apneas and greater oxygen desaturation, indicating a more severe disease. These findings highlight the importance of recognizing subtle spirometric abnormalities, particularly in settings with limited access to advanced diagnostics. Spirometry, being widely available, inexpensive, and non-invasive, can thus facilitate early detection of respiratory abnormalities. Integrating spirometric findings with clinical history and physical examination enables targeted investigations such as ventilatory polygraphy, allowing timely diagnosis and intervention. Early recognition and treatment of OSA, including CPAP therapy and lifestyle modification, can significantly reduce morbidity and improve quality of life.

In conclusion, the "saw-tooth" sign, though uncommon and non-specific (5), is a valuable spirometric marker of upper airway instability. Its recognition should prompt evaluation for sleep-disordered breathing, particularly in obese patients. Early diagnosis and management of OSA can prevent long-term cardiovascular, metabolic and neurocognitive complications, especially in high-risk populations such as obese snoring patients with pharyngeal narrowing.

DECLARATIONS. The authors wish to disclose that two artificial intelligence tools (ChatGPT 3.5 ephemeral, and QuillBot) were used to enhance the clarity and coherence of the manuscript writing. The tools were employed solely for language refinement purposes, ensuring that the text was clear and coherent without altering the scientific content or generating new text.

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