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# Dynamic Bronchoscopy Using Nerve Block Anesthesia for Unexplained Chronic Cough: A Tale of Five Cases

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## ABSTRACT

Excessive central/dynamic airway collapse (ECAC) often presents with chronic cough and inability to expectorate and sometimes accompanied by dyspnea or respiratory infections. The diagnosis of ECAC requires dynamic bronchoscopy. As this procedure requires active patient participation for forceful exhalation, dynamic airway evaluation via bronchoscopy is typically done under mild to moderate sedation. Some patients have an exaggerated cough reflex, which may interfere with accurately evaluating dynamic airway collapse. Here, we present 5 cases of dynamic airway evaluation via bronchoscope performed under a combination of superior laryngeal nerve block and trans-tracheal instillation of lidocaine. We also propose that this technique offers further diagnostic value in comprehensively evaluating vocal cord dysfunction and cough hypersensitivity syndrome. The abstract was presented at the 2024 American Association of Broncho logy and Interventional Pulmonology (AABIP) conference in Charlotte, North Carolina.

**Keywords:** Excessive central/dynamic airway collapse; Bronchoscopy; Respiratory infections; American association of bronchology and interventional pulmonology

## Introduction

Chronic cough, defined as a cough lasting for more than 8 weeks, affects about 2-18% of the adult population[1]. Chronic cough significantly impacts a patient's quality of life, affecting productivity and, in some cases, social life. Although in many cases, this is not life-threatening, it is often considered a nuisance and occasionally psychological distress. It has been estimated that about 12.2 million people reported a chronic cough in the United States for over 12 months in 2021-2022[2]. A detailed history and physical examination can often identify common causes of cough, including ACE-inhibitors, upper airway cough syndrome, cough variant asthma/eosinophilic bronchitis and esophageal dysmotility and reflux[3].

In some cases, the cause remains elusive despite extensive diagnostic workup, adding to the healthcare costs. If the initial workup is negative and cough remains unexplained, along with the history of respiratory infections or inability to expectorate, excessive central airway collapse (ECAC) must be considered[4]. If history suggests exaggerated sensitivity to triggers with hyperactive cough reflex, cough hyper-sensitivity syndrome may be responsible for unexplained chronic cough[5]. These conditions may not be easily diagnosed and require dynamic airway evaluation or a therapy trial. There are no standard di-agnostic criteria for dynamic airway evaluation, but many experts agree on a dynamic bronchoscopy or dynamic computed tomography. Dynamic bronchoscopy is typically performed under mild to moderate sedation and requires active patient participation

during forceful exhalation maneuvers. Many patients often experience exaggerated cough reflexes may frequently hinder dynamic airway evaluation, as this procedure warrants a 'cough free forced exhalation maneuver' to avoid erroneous diagnosis of excessive dynamic airway collapse (EDAC). In this case series, we describe the outcomes of five patients who underwent dynamic bronchoscopy under nerve block anesthesia (superior laryngeal nerve block and trans-tracheal instillation of lidocaine), aiming to evaluate dynamic airway collapse, vocal cord dysfunction and cough hypersensitivity syndrome in a single session of anesthesia.

## Methods

### Characteristics of the five patients

The five patients in this case series had the following characteristics:

- Chronic cough lasting more than 6 months, with an inability to expectorate. None had a history of atopy.
- Respiratory infections in the last year were reported by 3 out of 5 patients.
- All patients were not on ACE inhibitors and had well-controlled hypertension.
- Echocardiogram findings were unremarkable, with normal ejection fraction (EF), E/e' ratio, E/A ratio, tricuspid regurgitant velocity (TRV) and brain natriuretic peptide (BNP) within normal limits.
- ENT evaluation was negative for pathology.
- Pulmonary function tests (PFTs) were within normal limits, except for one patient who had a positive methacholine challenge, for which they were treated with LABA-ICS and Tezepelumab-ekko SQ.
- The high-resolution CT (HRCT) chest was negative in all except one patient, who showed centri-lobular emphysema; however, FEV1/FVC was> 70.
- All patients had trial treatments with an empiric LABA-ICS inhaler, Singulair, 2 weeks of oral prednisone and 6 weeks of proton pump inhibitors (PPIs), with no improvement.
- The Bravo study (for reflux) was negative, though one patient had predominant cough symptoms suggestive of reflux.

### Preparation and methodology

All patients underwent education and simulation before the procedure. The following preparatory steps were taken:

- Informed consent was obtained.
- A checklist ensured no allergies to local anesthetics (LAs) or coagulopathies.
- Intubation equipment was available for emergency use.
- ASA status was 1 or 2 and BMI was less than 35.
- Standard monitoring protocols were followed in the endoscopy suite.
- 0.2 mg of glycopyrrolate IV was administered to minimize secretions and at least an 18-gauge cannula was used.
- Supplemental oxygen was delivered via nasal cannula.
- A bite block was placed before the insertion of the fiberoptic bronchoscope.

### Anesthesia technique

Anesthesia was administered in three stages under strict aseptic precautions:

- **Superior laryngeal nerve block:** The greater cornu of the hyoid bone and the superior cornu of the thyroid cartilage were visualized using ultrasound guidance. A 25G needle was used to inject 1.5 ml of 2% lidocaine on each side (total 3 ml)[6].
    - If only the greater cornu of the hyoid bone was visualized, 2.5 ml of 1% lidocaine was administered on each side[6].
- **Cricothyroid instillation for topical tracheal anesthesia:** A 25G needle was used to instill 0.5 ml of 1% lidocaine at the cricothyroid membrane for skin wheal formation. A 22G needle was then used to instill 4 ml of 2% lidocaine at the midline of the cricothyroid membrane, confirmed by air aspiration[6].
- **Additional anesthesia:** Depending on the pre-test probability of cough hypersensitivity syndrome, either the spray-as-you-go technique or further blocks were employed.
    - The spray as you go technique was used if there was no exaggerated cough reflex. 4 sprays of 10% lidocaine were used in the oral cavity. As the bronchoscope was advanced, 2ml of 1% lidocaine was sprayed on the vocal cords, after which vocal cord maneuvers were performed to identify vocal cord dysfunction. The bronchoscope was further advanced into the tracheobronchial tree and 2 ml of 1% lidocaine was instilled in the trachea and each of the proximal bronchi with a maximum of 6 ml of 1% lidocaine[6].
    - For exaggerated cough reflexes, a glossopharyngeal nerve block was performed and 1.5 ml of 2% lidocaine was administered at the base of the palatopharyngeal arch on each side. A 25G needle was used[6].

### Bronchoscopy and dynamic maneuvers (Figure 1)

- A bite block was placed and the bronchoscope was introduced orally.
- Vocal cord maneuvers, including the "E" maneuver, were performed during inspiration and expiration.
- Dynamic airway maneuvers were conducted at various levels of the airway: upper, mid and lower trachea and proximal and distal main bronchus. Both tidal and forced maneuvers were performed during inspiration and expiration **(Figure 1)**.

## Results

- No complications occurred during or after the procedure.
- One patient was diagnosed with vocal cord dysfunction and was referred to speech therapy.
- Two patients were diagnosed with ECAC/EDAC (exaggerated central airway collapse), which responded well to treatment for obstructive sleep apnea (OSA) with CPAP and pursed-lip breathing. PEP buddy was prescribed with a good response.
- As one patient had asthma with the mosaic pattern on CT Chest suggestive of small airway disease/bronchiolitis

despite maximal therapy, Azithromycin 500 mg on Monday, Wednesday and Friday was added, with a significant response in 1 month.

- No stent trial was considered as none of the patients had significant dyspnea or post-obstructive pneumonia after the use of CPAP and PEP buddy.
- Two patients were diagnosed with cough hypersensitivity syndrome:
- One patient temporarily ceased coughing for up to 2 hours after the superior laryngeal block.
- One patient's cough improved with Gabapentin and low-dose codeine, while another required steroid injections by an ENT specialist, as medical treatments were insufficient.

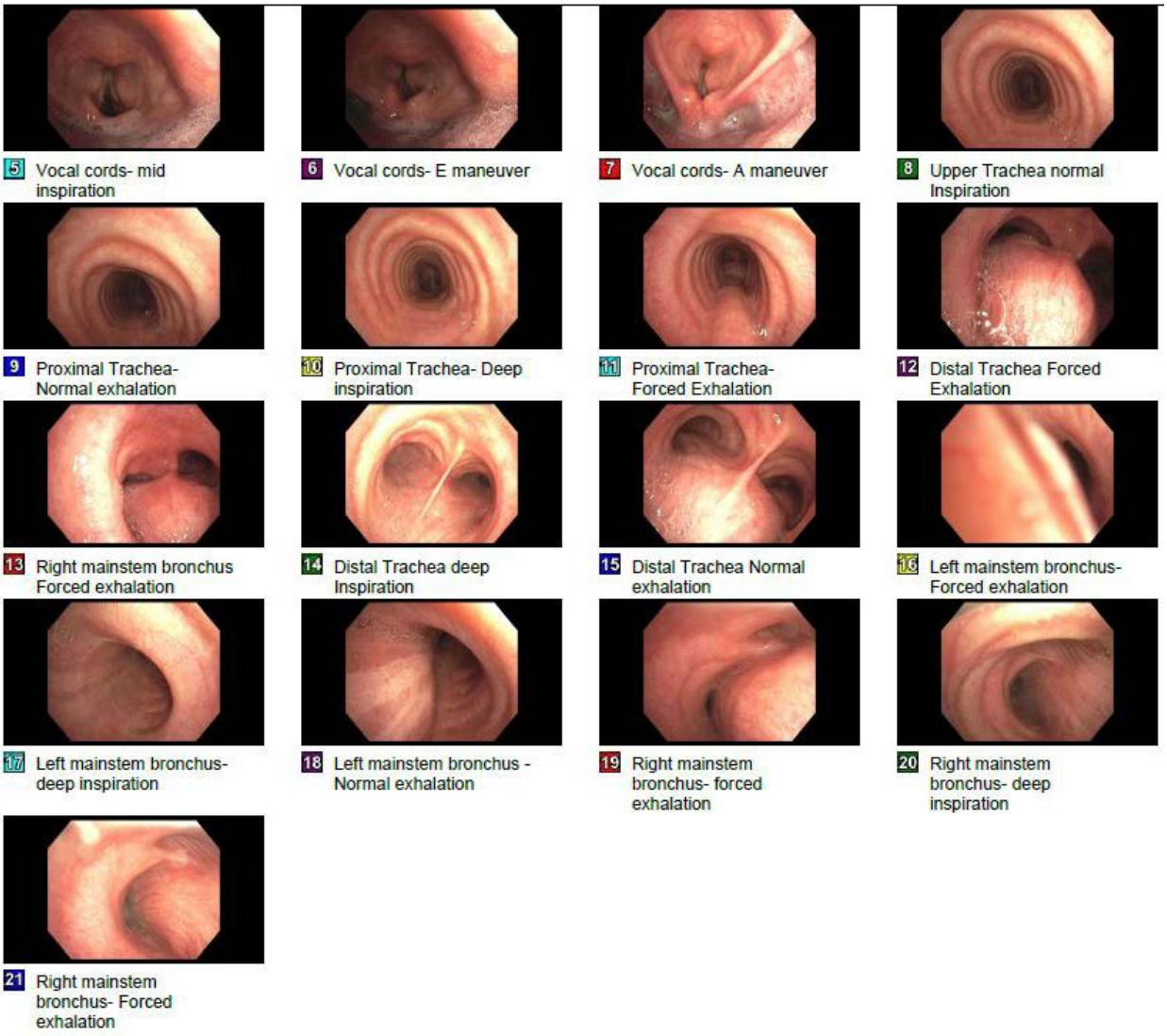


**Figure 1:** Bronchoscopic images during vocal cord and dynamic airway maneuvers under nerve block anesthesia.

**Total anesthetic dosage**

- Glossopharyngeal nerve block: 1.5 ml of 2% lidocaine (3ml of 2% = 60 mg total).
- Lidocaine 10% spray: 4-6 sprays (60 mg total).
- Superior laryngeal nerve block: 1.5 ml of 2% lidocaine (3 ml of 2% = 60 mg total).
- Cricothyroid instillation: 4 ml of 2% lidocaine (4ml of 2% = 80 mg total).
- Topical instillation: 6 ml of 1% lidocaine (60 mg total).
- The total lidocaine dose of 260 mg was within the safe limit of 4.5 mg/kg (or 300 mg).

## Discussion

Chronic cough is a common and disabling symptom, often challenging to diagnose and treat, especially when the etiology remains elusive despite extensive investigation. Traditional diagnostic approaches, including history-taking, physical examination, pulmonary function tests (PFTs), imaging and ENT evaluations, often fail to yield a clear cause in patients with unexplained chronic cough. Dynamic bronchoscopy, a procedure involving real-time airway visualization during forceful exhalation, has emerged as a valuable tool to diagnose Excessive dynamic airway collapse.

In our series of five patients, dynamic bronchoscopy was performed under nerve block anesthesia using a combination of superior laryngeal nerve block and trans-tracheal lidocaine instillation. Using nerve blocks, as opposed to conventional sedation, has several advantages. First, it mitigates the exaggerated cough reflex, which can interfere with airway visualization during the procedure. Second, the prolonged anesthetic effect (up to 180 minutes) allows for a thorough evaluation, especially

in patients with hyper-sensitivity to airway stimulation. This technique has proven safe and effective for evaluating central airway dynamics, providing diagnostic insights into vocal cord dysfunction, cough hypersensitivity syn-drome and exaggerated central airway collapse (ECAC).

**Vocal cord dysfunction (VCD)**

Vocal cord dysfunction, characterized by paradoxical vocal cord movement during inspiration and/or expiration, often mimics asthma or other respiratory conditions. It can be tough to diagnose, as the airway obstruction seen on physical examination or imaging may not be present during normal breathing but can be revealed through dynamic testing. One patient in our series was diagnosed with VCD, high-lighting the role of dynamic bronchoscopy in identifying this often underrecognized condition. This finding emphasizes the importance of incorporating dynamic evaluation into the diagnostic workup for patients with unexplained chronic cough, as treatment for VCD (e.g., speech therapy) can significantly im-prove symptoms[7].

**Cough Hypersensitivity Syndrome (CHS)**

Cough hypersensitivity syndrome (CHS) or cough reflex hypersensitivity, is another critical consideration in patients with chronic cough. CHS can result in a heightened response to stimuli that would not typically provoke coughing. It is thought to be driven by abnormal neural processing of cough stimuli, leading to an exaggerated cough reflex[5,8]. The fact that two patients in our series showed a temporary cessation of coughing following the superior laryngeal block, a well-established technique for desensitizing the laryngeal area, suggests a role for this technique in diagnosing CHS. For patients diagnosed with CHS, medical management options, such as gabapentin or codeine, can offer relief, as evidenced by the response in one patient.

**Excessive Central/Dynamic Airway Collapse (ECAC/EDAC)**

ECAC is an excessive collapse of the airway wall. It can be classified in to excessive dynamic airway collapse and tracheobronchomegalies (TBM) based on the pathophysiology. Excessive dynamic airway collapse (EDAC) refers to an excessive forward displacement of the posterior membranous of the tracheal wall secondary to the weakness of the longitudinal elastic fibers, whereas TBM is due to abnormal motion of the anterolateral or cartilaginous portion of the tracheobronchial wall[4].

Another important finding in our series was the diagnosis of exaggerated central/dynamic airway collapse (ECAC/EDAC) in two patients. ECAC/EDAC involves collapse of the central airways during forced exhalation and can significantly contribute to dyspnea and chronic cough. This condition is often associated with obstructive sleep apnea (OSA), esophageal reflux and the use of inhaled steroids. The diagnosis of ECAC/EDAC was supported by the dynamic evaluation of the airways using bronchoscopy, with two patients responding positively to continuous positive airway pressure (CPAP) therapy, PEP buddy and pursed-lip breathing. If this condition results in frequent pneumonia, a stent trial may be considered[4]. This emphasizes the value of dynamic bronchoscopy in detecting airway abnormalities that may not be evident in routine imaging.

**Anesthesia and procedure considerations**

The use of nerve block anesthesia is a critical element in enabling successful dynamic bronchoscopy. The superior laryngeal nerve block and cricothyroid instillation provide deep and prolonged anesthesia of the upper airway, which minimizes patient discomfort and reduces the likelihood of exaggerated cough reflexes, which could compromise the accuracy of the evaluation. While topical anesthesia may provide sufficient sedation for superficial airway procedures, its short duration (15 minutes) limits its utility for dynamic airway evaluation. In contrast, nerve block anesthesia ensures an extended window for accurately assessing airway collapse and other dynamic features, such as vocal cord dysfunction and cough reflex sensitivity.

**Limitations**

While the results in our series are promising, several limitations exist. First, the sample size is small (n=5) and larger studies are needed to confirm the generalizability of these findings. Additionally, while dynamic bronchoscopy under nerve block anesthesia proved to be safe in our patients, there remains a need for caution when performing nerve blocks, particularly in patients with comorbidities affecting airway anatomy or respiratory function. Careful patient selection and preparation are paramount. Finally, this approach may not universally apply to all chronic cough patients, especially those with severe underlying pulmonary conditions.

## Conclusion

This case series demonstrates that dynamic bronchoscopy using nerve block anesthesia is a safe and effective technique for comprehensively evaluating unexplained chronic cough. The anesthetic technique allows for sufficient airway anesthesia without any sedatives, providing a more thorough dynamic evaluation of the airway. It offers diagnostic insights into vocal cord dysfunction and cough hypersensitivity syndrome, potentially guiding more targeted treatment for patients with chronic cough. Moreover, nerve block anesthesia provides prolonged anesthetic effects (60-180 minutes) compared to topical anesthesia (lasting 15 minutes), enhancing the accuracy of the evaluation. Given the protracted anesthetic effects and the ability to perform dynamic airway assessments, this approach represents an essential advancement in the diagnostic workup of chronic cough.

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