

Bronchial Thermoplasty: A Novel Treatment for Severe Asthma Requiring Monitored Anesthesia Care

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Dexmedetomidine used in monitored anesthesia care produces a safe and effective technique well documented in research. We report the successful use of dexmedetomidine for sedation during bronchial thermoplasty, a new treatment for patients with severe

persistent asthma refractory to inhaled corticosteroids and long-term β -2 agonists.

Keywords: Asthma, bronchial thermoplasty, dexmedetomidine.

Bronchial thermoplasty is a novel and promising, nonpharmacologic treatment for certain individuals with severe persistent asthma. We report the safe and effective use of dexmedetomidine with propofol infusion and minimal opioid use in achieving moderate sedation for this procedure.

Dexmedetomidine, a potent α -2 agonist, has a pharmacologic profile favorable for its use as an anesthetic adjunct in a wide variety of cases. Dexmedetomidine receptors are found in the central nervous system as well as on sympathetic postganglionic neurons.¹ α -2 Agonists stimulate inhibitory neurons in the medullary vasomotor center and decrease sympathetic nervous system outflow. The effects include sedation, analgesia, peripheral vasodilation, and decreases in systolic blood pressure, while preserving respiratory drive. In addition, studies have documented its anesthetic-sparing effects and production of hemodynamic stability.^{1,2} Given its characteristics, dexmedetomidine is a complementary option for moderate sedation in stimulating outpatient procedures.

In April 2010, the US Food and Drug Administration approved a medical device used for bronchial thermoplasty, a nonpharmacologic treatment of severe and persistent asthma that is refractory to corticosteroids and long-acting β -2 agonist medications.³ The Alair System (Asthmatx, Inc, Sunnyvale, California) uses radiofrequency electrical energy through an electrode-catheter system to systematically heat airway smooth muscle (ASM) distal to the mainstem bronchi in a controlled manner. The premise behind the treatment is that airway obstruction from central conducting airways down to the fourth generation of the tracheobronchial tree all contribute to the total resistance to airflow in hyperreactive airways.⁴ By decreasing ASM and diminishing its constrictive capabilities, overall airflow resistance may

decrease.⁴ Subsequent research on bronchial thermoplasty with subjects who have moderate to severe persistent asthma have resulted in improved quality of life indexes, as defined by the researchers and the asthma community, such as increased numbers of symptom-free days, decreased use of rescue inhalers, and decreased airway hyperresponsiveness.⁵

Clinical studies on bronchial thermoplasty have documented this procedure using general anesthesia as well as moderate sedation. Current recommendations for moderate sedation have cited using a midazolam (Versed) and fentanyl combination in addition to topical anesthetics administered by the pulmonologist to achieve desired conditions. With moderate sedation, goals for anesthesia include anxiolysis, diminishing the cough reflex, analgesia, decreasing airway secretions, reducing patient movement, and maintenance of spontaneous ventilation.⁶ In our facility, the sedation for the first stage of a 3-stage bronchial thermoplasty treatment was administered by a sedation nurse and a pulmonologist. During this particular treatment, increased doses of fentanyl and then propofol boluses were necessary to blunt the patient's cough reflex, and apnea was noted as an undesired side effect. Subsequently, anesthesia services were requested for the final 2 treatments to help safely achieve the stated goals. We report the safe and effective use of dexmedetomidine with propofol infusion and minimal opioid use in achieving moderate sedation for this procedure and present our case for comparison with the above midazolam-fentanyl technique.

Case Summary

A 20-year-old woman with a history of severe persistent asthma presented to the pulmonary laboratory for bronchial thermoplasty. This treatment would be the last of a 3-stage treatment regimen aimed at reducing the mass

of ASM in her asthmatic lungs. This young woman had asthma since childhood and medical treatment methods were not controlling her frequent exacerbations.

Assessment of the patient revealed that her asthma was stable since the last bronchial thermoplasty 1 month previously. Her lungs were clear to auscultation bilaterally. She denied symptoms from her allergic rhinitis. The patient appeared comfortable and in no respiratory distress. Her history included mild esophageal reflux; however, she denied having symptoms currently. Her medications included albuterol, fluticasone and salmeterol combined oral inhaler (500 µg and 50 µg, respectively), azelastine nasal spray, and prednisone. Prednisone therapy was started as part of the perioperative regimen for the bronchial thermoplasty. Weighing 90 kg, the patient had a body mass index (BMI) of 34 kg/m²; however, she was a college athlete and had a body habitus consisting of lean muscle mass. The patient had no other medical problems.

During the first treatment, a sedation nurse and pulmonologist administered intermittent boluses of midazolam (Versed) and fentanyl in addition to the pulmonologist spraying topical anesthetic into the patient's airway. This moderate-sedation technique was consistent with the current recommendations of bronchial thermoplasty experts.⁶ Later during this procedure a pulmonologist administered boluses of propofol to provide additional sedation and attenuate the patient's coughing. A total of midazolam, 5 mg; fentanyl, 250 µg; and propofol, 200 mg, was given for the procedure, which lasted about an hour. The patient's heart rate ranged from 80/min before the procedure to 128/min intraprocedure, with tachycardia present for 60% of the procedure time. Blood pressure started at 115/63 mm Hg with a high of 139/79 mm Hg during the procedure. The patient experienced periods of apnea and restlessness during this first treatment stage. Anesthesia services were requested to provide moderate sedation for the next 2 treatments.

On arrival to the pulmonary laboratory for the last stage of treatment, monitors were placed and the patient was immediately given dexmedetomidine, 1 µg/kg intravenously (IV), over approximately 10 minutes. Routinely, spirometry measurements are obtained before the start of bronchial thermoplasty treatment. Spirometry measurements were obtained minutes after administering dexmedetomidine. At this time, midazolam and fentanyl would not be appropriate because of their associated respiratory effects and possible alterations to spirometry. Oxygen at 4 L/min was administered via a nasal cannula with end-tidal carbon dioxide (ETCO₂) monitoring. Midazolam, 2 mg; glycopyrrolate, 0.4 mg; fentanyl, 50 µg; and a propofol infusion at 50 µg/kg/min were administered IV before the start of procedure. In addition, small boluses of propofol, 10 to 20 mg, were administered during the first 10 minutes of treatment when the pulmonologist was



Figure 1. Catheter-Tip 4-Pronged Electrode That Is Inserted Via Bronchoscope

(Image provided courtesy of Boston Scientific Corporation, Natick, Massachusetts.)

topically applying the posterior part of the pharynx and vocal cords with lidocaine. The bronchial thermoplasty procedure started approximately 20 minutes after the first dose of dexmedetomidine was administered.

The pulmonologist navigated a fiberoptic bronchoscope through the nasal passage into the upper lobes of the right and left lungs. Radiofrequency energy was intermittently applied through a 4-pronged electrode (Figure 1) touching the smooth muscle of the bronchioles (Figure 2). Topical 1% lidocaine was sprayed several times into the airways by the pulmonologist during the procedure before deploying heat energy to a section of smooth muscle. The propofol infusion was titrated to a maximum of 75 µg/kg/min (total 335 mg for the entire case) based on blood pressure tolerance, respiratory status, and patient comfort. Fentanyl, 25 µg, was given midprocedure to help with coughing related to treatment and irritation caused by fiberoptically visible mucous plugs.

The patient maintained normal sinus rhythm and heart rate, and blood pressure and the respiratory rate remained stable throughout the procedure. Blood pressure ranged from 104/62 mm Hg to 115/63 mm Hg during treatment. There was no time that the patient appeared uncomfortable or in distress. Throughout the procedure the patient was sedated but easily arousable. Oxygen saturation before the procedure started at 99% and decreased to 95% during the most stimulating parts of the treatment, which coincided with a 10-mg propofol bolus. The oxygen was titrated up to 6 L/min via nasal cannula and insufflation of oxygen was applied. At one instance when the sedated patient's oxygen saturations dropped to 89% despite supplemental oxygen and a normal respiratory rate, the patient was asked to take a deep breath, and the saturations corrected quickly. At no time during the procedure did the patient experience any symptoms of her reactive airway disease, such as wheezing or dyspnea. The procedure finished in less than 1 hour. The propofol

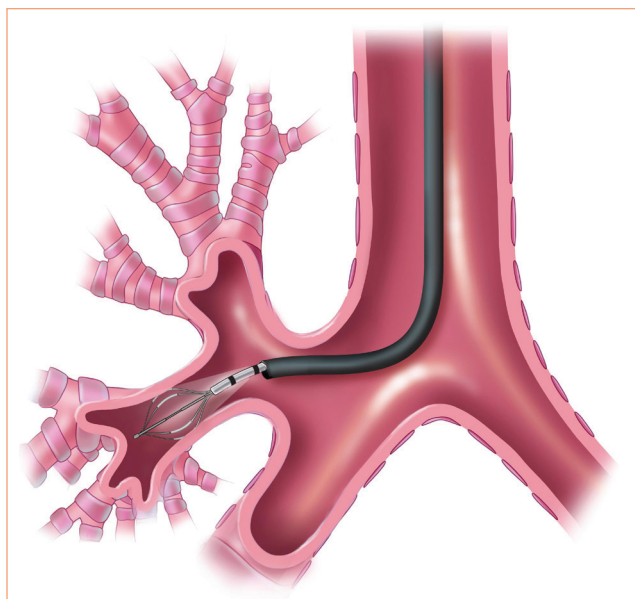


Figure 2. Deployed Catheter-Tip 4-Pronged Electrode Emitting Radiofrequency Energy to Directly Heat Smooth Muscle of the Bronchiole

(Image provided courtesy of Boston Scientific Corporation, Natick, Massachusetts.)

infusion was stopped shortly before the end of surgery, and the patient was allowed to continue sleeping while monitored by the pulmonary nursing team. Both the patient and pulmonologist were satisfied with the quality of monitored anesthesia care.

Discussion

Clinical studies on bronchial thermoplasty have shown promising results for patients who undergo this treatment, resulting in decreased use of rescue medication, improved lung function, and improved quality of life as measured on the Asthma Quality of Life Questionnaire and the Asthma Control Questionnaire.⁵ The bronchial thermoplasty technology uses radiofrequency energy delivered through a catheter with electrodes on the distal end that directly heat the smooth muscle of the airway. The focused application of thermal energy selectively reduces the mass of ASM. The destruction of the ASM mass has the dual benefits of reversing the accumulation of ASM secondary to remodeling and reducing the ability of the ASM to constrict when stimulated, hence reducing bronchoconstriction.⁷ The thermal energy is delivered to distal airways with diameters between 3 and 10 mm. Treatment is provided by a pulmonologist via bronchoscopy in 3 stages, 3 weeks apart. The right lower pulmonary lobe is treated first. The second treatment targets the left lower lobe, and the final treatment is to the upper lobes of the right and left lungs. The divided treatment approach is in place to lower the risk of causing an asthma exacerbation and to prevent diffuse

pulmonary edema caused by treatment of the entire tracheobronchial tree.⁵

Although similar to a bronchoscopy, which is often done under sedation by nurses or pulmonologists in the pulmonary laboratory, bronchial thermoplasty procedures are longer than currently performed bronchoscopies, are more stimulating, and are done for patients who generally have very reactive airways.⁶ Intraprocedural risk includes coughing, wheezing, dyspnea, bleeding, and the risk of mechanical airway obstruction secondary to the fiberoptic scope. Success of bronchial thermoplasty and patient satisfaction are dependent on patient anxiolysis, analgesia, minimized secretions, adequate topical anesthesia, and minimal patient movement.⁶ Experienced clinicians in bronchial thermoplasty, Mayse et al⁶ recommend a combination of midazolam and fentanyl titrated to effect based on their fast onset, short duration of action, and known sedating properties. However, the authors noted that benzodiazepines and opioids have a synergistic effect and potentiate respiratory depression.⁶

Dexmedetomidine, a highly selective α -2 agonist, produces sedation, dose-dependent analgesia, and attenuation of catecholamine release. Onset of action is approximately 15 minutes after IV administration. The quality of sedation produced by dexmedetomidine differs from that produced by midazolam, which acts on γ -aminobutyric acid receptors. α -2 Agonists achieve sedation by decreasing sympathetic nervous system activity and the level of arousal while preserving spontaneous ventilation.⁸

A recent randomized clinical trial studied the difference in sedation with the “standard practice” of midazolam and fentanyl vs dexmedetomidine infusion during transesophageal echocardiogram and found that the sedation was adequate in both techniques; however, dexmedetomidine produced less respiratory depression and less oxygen desaturation.² Other end points to this study were heart rate and blood pressure. Dexmedetomidine was found to achieve better hemodynamic response to stimulation than the midazolam-fentanyl standard.² In related studies and reviews, the use of dexmedetomidine infusion has been reported to be effective for both sedation and facilitation of endotracheal tube placement during awake fiberoptic intubation.⁹⁻¹¹ In addition, the sedating effects of dexmedetomidine have been shown to be similar to that of propofol for perioperative sedation, with better control of hemodynamic parameters and improved analgesia and lower opioid requirements.¹²⁻¹⁴ These benefits have also translated into the use of dexmedetomidine for sedation and hemodynamic stability in the intensive care unit.^{9,15}

Dexmedetomidine, however, may have limited utility for sedation during outpatient colonoscopy. In a Polish study by Jalowiecki and colleagues,¹⁶ dexmedetomidine demonstrated significant hemodynamic changes (hypotension and bradycardia) and longer “time to home readi-

ness" compared with the meperidine/midazolam group or fentanyl group. The hemodynamic changes reported may have been from the quicker loading dose of 1 µg/kg (15 minutes vs 20 minutes in our patient), followed by an infusion rate of 0.2 µg/kg/h (no infusion in our patient). We observed no substantial hemodynamic changes requiring rescue medications in our patient during or after the bronchial thermoplasty.

In summary, bronchial thermoplasty is a novel treatment for severe persistent asthma that is refractory to corticosteroid and long-acting β-2 agonist medications. We present a case in which dexmedetomidine, 1 µg/kg, was given 20 minutes before the start of bronchial thermoplasty treatment to serve as the basis for consistent moderate sedation for an otherwise highly stimulating bronchoscopy. Given the staged approach to this procedure, patient sedation is necessary for only 1 to 1.5 hours. The administration of dexmedetomidine before the beginning of the procedure without continuous infusion was enough to provide a therapeutic level with desirable pharmacologic effects. The duration of action of 2 to 3 hours lasted through to the observation time after the procedure. Dexmedetomidine allowed for the dosage reduction of midazolam, fentanyl, and propofol in this particular case. The unique properties of dexmedetomidine produced arousable sedation, hemodynamic stability, and maintenance of respiratory drive in a patient with a history of hyperreactive airways. Dexmedetomidine is not known to have specific antitussive properties such as the opioids. However, clonidine, an α-2 agonist, has been demonstrated clinically to suppress the fentanyl-induced cough, which is a known undesirable side effect of fentanyl boluses.¹⁷ During the procedure and at its completion, the pulmonologists remarked that the patient's coughing and agitation were considerably reduced with the addition of dexmedetomidine compared with the midazolam-fentanyl standard used for the first stage of treatment, thereby facilitating the procedure with no interruptions.

As bronchial thermoplasty becomes a more common procedure using monitored anesthesia care, we believe that dexmedetomidine may be a prudent choice for producing safe and effective sedation.

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