Frailty Characteristics Predict Respiratory Failure in Patients Undergoing Tracheobronchoplasty

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Background. **Respiratory complications are the leading cause of morbidity in patients undergoing tracheobronchoplasty, yet risk stratification systems on this population are insufficient. We investigated the association between frailty and risk of major respiratory complications after tracheobronchoplasty.**

Methods. **A retrospective review was made of 161 consecutive tracheobronchoplasties (October 2002 to September 2016). A frailty index was developed by the deficit-accumulation approach comprising 26 multidomain preoperative variables. The main outcome was a composite endpoint of major respiratory complications within 30 days of surgery. Odds ratio (OR) and 95% confidence interval (CI) were estimated using logistic regression.**

Results. **The cohort consisted of 103 women (64%), median age of 58 years (interquartile range, 51 to 66) and median FI of 0.25 (interquartile range, 0.1 to 0.3). Forty-eight patients (30%) had respiratory complications, the most common being respiratory failure (n = 27, 16.8%) and pneumonia (n = 25, 15.5%). Severe frailty (frailty index ≥0.33) was strongly associated with major respiratory complications (73.8% versus 2.5%; OR 58.8, 95% CI: 9.6 to 358.3). The association with severe frailty appeared stronger for respiratory failure (47.6% versus 2.5%; OR 30, 95% CI: 4.7 to 189.9) than for pneumonia (40.5% versus 0%; OR 35.2. 95% CI: 2.0 to 599.8). Further adjustment for intraoperative crystalloid volume or forced expiratory volume in 1 second moderately attenuated the association between frailty with major respiratory complications (OR 17.4. 95% CI: 2.0 to 150.8), respiratory failure (OR 13.1, 95% CI: 1.7 to 95.8), and pneumonia (OR 20.1, 95% CI: 1.1 to 341.8).**

Conclusions. **Frailty, as indicated by frailty index, was associated with major respiratory complications, particularly respiratory failure after tracheobronchoplasty. Preoperative identification of frailty may help guide decision making for patients considering this effective, although arduous procedure.**

(Ann Thorac Surg 2018;106:836–41)

Respiratory complications are the leading cause of morbidity among patients undergoing surgical central airway stabilization (tracheobronchoplasty [TBP]) for severe diffuse tracheobronchomalacia (TBM) [1–3]. Detailed risk stratification models to predict respiratory complications do not exist, however, and currently available risk stratification systems, such as the American Society of Anesthesiologists (ASA) or The Society of Thoracic Surgeons adult cardiac surgery risk model, do not consider the physiologic characteristics specific to this high-acuity population.

Frailty is a state of reduced physiologic reserve that results from accumulated deficiencies in a number of organ systems and can be distinguished from the aging process and comorbidities [4]. Frailty can be examined using the phenotypic frailty (eg, weight loss, exhaustion, physical inactivity, weak grip strength, and slow walking speed) [5]. Alternatively, a frailty index (FI) can be calculated by counting the number of health deficits (which can include symptoms, signs, diseases,

Accepted for publication May 21, 2018.

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Presented at the Fifty-fourth Annual Meeting of The Society of Thoracic Surgeons, Fort Lauderdale, FL, Jan 27–31, 2018.

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The Supplemental Table can be viewed in the online version of this article [https://doi.org/10.1016/j.athoracsur.2018.05.065] on http://www.annalsthoracicsurgery.org.

0003-4975/$36.00
https://doi.org/10.1016/j.athoracsur.2018.05.065

Abbreviations and Acronyms

ASA = American Society of Anesthesiologists
CI = confidence interval
FEV_1 = forced expiratory volume in 1 second
FI = frailty index
OR = odds ratio
6WMT = 6-minute walk test
TBM = tracheobronchomalacia
TBP = tracheobronchoplasty

disabilities, and diagnostic test abnormalities) on the grounds that the more deficits a person has, the more frail that person is [6]. Several studies have shown that a FI predicts postoperative complications in a wide range of elective and emergency operations [7, 8]. Yet, to our knowledge, implications of frailty assessment to assess the risk of postoperative respiratory complications in patients undergoing TBP for severe diffuse TBM have not been investigated.

This study was conducted to evaluate the risk of 30-day postoperative respiratory complications using an FI that was developed from routinely collected preoperative variables in patients with severe diffuse TBM undergoing TBP.

Patients and Methods

Study Design and Population

This retrospective cohort study was approved by the Beth Israel Deaconess Medical Center Institutional Review Board (protocol no. 2005P-000112). Informed consent was obtained from all patients. The cohort included all consecutive patients aged at least 18 years who were diagnosed with severe diffuse TBM and selected for TBP based on a stenting trial from October 2002 to September 2016. Severe diffuse TBM was defined as complete or near-complete collapse (more than 90% of anteroposterior wall diameter) of the trachea or bilateral main bronchi, or both, as demonstrated by dynamic bronchoscopy or computed tomography scanning [9–11]. Excluded were patients who underwent cervical tracheoplasty or resection and reconstruction for extrathoracic tracheal malacia. Our protocols for dynamic bronchoscopy, computed tomography scanning, and TBP techniques have been described elsewhere [10, 11].

Measurements

Preoperative patient characteristics, including demographics, comorbidities, medications, and laboratory and pulmonary function test data, were extracted from electronic medical records at the time of the initial visit. Comorbidity burden was quantified by the chronic illnesses in the cardiovascular, pulmonary, endocrine, and immune systems, and by polypharmacy, defined as five or more outpatient medications taken regularly by a patient before surgery [12]. Nutritional status was measured based on the body mass index as well as on albumin level within 30 days of the operation. Functional status was evaluated by the Karnofsky performance scale of daily living and the Medical Research Council score assessing the degree of functional impairment secondary to dyspnea [11, 13]. Mobility and endurance were quantified using a 6-minute walk test (6MWT).

Intraoperative variables, such as operation time (incision time to closure time), estimated blood loss, fluid administration (crystalloid, colloid and blood products), and urinary output were collected from the anesthesia and/or operative records.

Frailty Index

A FI was calculated based on the deficit-accumulation approach, which has been extensively validated in both hospitalized and ambulatory populations [14]. We quantified frailty as a proportion of health deficits present among 26 preoperative variables that represent the presence or severity of impairment in the following domains: comorbidities, nutritional status, functional limitations, and mobility (see Supplemental Table 1 for definition of individual variables and their scoring). Each item is equally weighted, and partial points are allowed to reflect the extent of impairment or severity. The list of items and scoring were determined a priori. For example, recognized cutpoints for forced expiratory volume in 1 second (FEV_1 [%]) and diffusing capacity of lung for carbon monoxide (%) were used according to the American Thoracic Society/European Respiratory Society taskforce [15]. For 6MWT, we assigned 1 for distance less than 785 feet (25th percentile), denoting severe impairment; 0.5 for distance between 785 feet and 1,099 feet (25th to 50th percentile), denoting moderate impairment; 0.25 for distance between 1,100 feet and 1,419 feet (50th to 75th percentile), denoting mild impairment; and 0 for distance greater than 1,420 feet (75th percentile), denoting no impairment. A similar cutpoint approach was utilized to assign scores based on the Karnofsky performance scale. This FI was computed for patients who had at least 20 of 26 items. For example, a patient with 10 deficits of 24 items assessed during the preoperative visit has a FI of 0.42 (10 of 24). As a proportion, a FI can range from 0 to 1, although previous studies suggest a submaximal threshold of approximately 0.6, above which survival may not be possible [14].

Outcomes

The main outcome was a composite endpoint of major respiratory complications within 30 days of surgery. Major respiratory complications included (1) pneumonia, defined according to standard criteria (new or progressive pulmonary infiltrates on chest radiograph plus two or more of the following criteria: fever 38.5°C or greater or hypothermia less than 36°C, leukocytosis 12,000 white blood cells per mm^3 or more, or leukopenia less than 4,000 white blood cells per mm^3, or documentation of pathologic organism by Gram stain or culture) [16]; (2) respiratory failure, defined as postoperative invasive ventilation dependence for 48 hours or more, or