Increased age is an independent risk factor for radiographic aspiration and laryngeal penetration after thoracotomy for pulmonary resection

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Objectives: Aspiration is an increasingly recognized complication after thoracotomy for pulmonary resection, but mechanisms of postoperative aspiration are poorly characterized. This study sought to evaluate risk factors to better define postthoracotomy aspiration.

Methods: Three hundred twenty-one consecutive patients underwent clinical bedside swallowing evaluations after thoracotomy for pulmonary resection on postoperative day 1. Results of videofluoroscopic swallowing studies were independently reviewed by 2 speech pathologists and were assigned aspiration–penetration scores of either 1 (normal) or greater than 1 (abnormal) based on the worst swallow. Operative, demographic, and outcomes data were abstracted for each patient, and multivariate regression analysis was performed.

Results: Seventy-three (22.7%) patients failed bedside evaluation and proceeded to undergo videofluoroscopic swallowing studies. Forty-four (60.3%) patients had an abnormal videofluoroscopic swallowing study result with a mean aspiration–penetration score of 3.9 ± 0.3. Multivariate analysis showed that older age (68.8 vs 56.2 years, $P = .002$), prior premature spillage ($P = .0006$), and vallecular residuals after the swallow ($P < .0002$) were all associated with aspiration. Interestingly, certain variables were not independently associated with aspiration, including presence of gastroesophageal reflux disease, operative approach or degree of resection, mediastinal lymphadenectomy, preoperative thoracic radiation, same hospitalization reoperation, and pathology.

Conclusions: Postoperative risk of aspiration after thoracotomy for pulmonary resection is characterized by repeatable episodes of oropharyngeal discoordination on videofluoroscopic swallowing studies. We recommend routine videofluoroscopic swallowing studies for all patients older than 67 years before the initiation of oral intake to diminish the incidence of postoperative aspiration. (J Thorac Cardiovasc Surg 2010;140:573-7)

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Complications after thoracotomy for pulmonary resection have been investigated since the inception of thoracic surgery. Aspiration has recently been characterized as a complication after thoracic surgery, with a reported incidence nearing 20%.[1] The exact mechanism and risk factors associated with aspiration, however, remain poorly defined.

In one of the few studies to address the topic of aspiration after thoracic surgery, Herrera and colleagues[2] demonstrated that head and neck malignancies contribute to postoperative aspiration after pulmonary resection. The purpose of the current study was to expand on prior research to detail risk factors associated with aspiration after thoracotomy for pulmonary resection and to better define the pathophysiology of radiographic aspiration and penetration in these patients. In undertaking this study, we hypothesized that advanced age, prior head and neck radiation, and mediastinal lymphadenectomy would predispose patients to postoperative aspiration. In addition, we hypothesized that global dysfunction affecting multiple aspects of swallowing mechanics would lead to aspiration after thoracotomy.

MATERIALS AND METHODS

Experimental Design

After approval by the Institutional Review Board at the University of South Florida and the H. Lee Moffitt Cancer Center, a protocol was initiated by which consecutive patients undergoing thoracotomy for pulmonary resection from January 1, 2005, through December 31, 2007, underwent a clinical bedside swallowing investigation by a licensed speech pathologist on postoperative day 1. This protocol was part of a larger quality control measure within the hospital and was considered local standard of care, and therefore no informed consent was obtained. Standard surgical procedure at the H. Lee Moffitt Cancer Center included the use of double-lumen endotracheal tubes, a variety of surgical approaches depending on the anatomic location of the lesion, and thoracic epidural catheters for postoperative pain management. All patients were first evaluated at the bedside by a certified speech pathologist. Bedside evaluations were conducted with the patient in an upright position, and they were instructed to swallow a variety of substances ranging from thin liquids to thickened liquids to a pureed diet to solid food. Clinical signs of dysphagia or aspiration were noted and included throat clearing, coughing after a swallow, a change in oxygen saturations or respiratory rate after per os presentations, or a change of wet vocal quality after the swallow. Failure of the bedside swallowing

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Disclosures: None.

Received for publication April 15, 2009; revisions received Jan 30, 2010; accepted for publication Feb 27, 2010; available ahead of print May 31, 2010.

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0022-5223/$36.00

doi:10.1016/j.jtcvs.2010.02.049

Abbreviations and Acronyms

ASP–PEN = aspiration–penetration scale
CVA = cerebrovascular accident
FEESST = fiberoptic endoscopic evaluation of swallowing with sensory testing
VFSS = videofluoroscopic swallowing study

investigation led to a videofluoroscopic swallowing study (VFSS). Per the recommendations of the speech pathologist, patients failing VFSSs were maintained on a modified diet or nothing per os as the situation mandated until improvement of swallowing could be documented. Patients with minor swallowing derangements were treated with dietary modification and positional swallowing maneuvers, whereas patients with more severe changes in swallowing patterns were not allowed oral intake and were re-evaluated both clinically and radiographically in 2 to 4 days. Patient demographics, surgical data, and outcomes were all prospectively recorded and stored in a secure database.

Evaluation for Aspiration

All patients failing bedside evaluation underwent further testing with a VFSS. Each VFSS was independently reviewed and scored based on the worst swallow by 2 separate speech pathologists using the aspiration–penetration scale (ASP–PEN) developed by Rosenbek and associates (Table 1).[3] Patients were then subsequently grouped according to their ASP–PEN scores: patients with a score of 1 were deemed to have normal swallowing function, whereas patients with a score of greater than 1 were labeled as having abnormal function and at risk for aspiration events. Based on the recommendations of the speech pathologists, each VFSS was scored on 16 anatomic and physiologic abnormalities often seen in dysphagia to try to establish a pattern consistent with postoperative penetration and aspiration in this subset of patients (Table 2).

Data Analysis

All data pertaining to risk factor analysis was submitted to univariate analysis, including all variables listed in Table 2. Univariate analysis was conducted with the Mantel–Haenszel test or Fisher's exact test for categorical variables and the 2-sided Student's *t* test for continuous variables. Backward logistic regression multivariate analysis with a significance level of .1 was summarily used to adjust for possible confounders. Data are presented as medians with means ± standard deviations, where appropriate.

RESULTS

Three hundred twenty-one consecutive patients underwent a bedside clinical swallowing evaluation, and 73 (22.7%) failed and required VFSSs for further evaluation of swallowing dysfunction. Forty-four (60.3%) patients had an abnormal VFSS result with a median ASP–PEN score of 3.0 (3.9 ± 1.9; ASP–PEN score of 2 in 9 patients, ASP–PEN score of 3 in 20 patients, ASP–PEN score of 5 in 9 patients, and ASP–PEN score of 8 in 6 patients). The overall incidence of laryngeal penetration or aspiration (ASP–PEN score >1) was 13.7% (44/321 patients). One patient experienced a witnessed aspiration event after negative bedside evaluation (0.3%).

The perioperative mortality rate was 2.7%, with a single death in each group (ie, ASP–PEN score >1 and ASP–PEN score of 1). Likewise, 1 patient in each group required reintubation during hospitalization. For patients with ASP–PEN scores of greater than 1, a percutaneous gastrostomy was required in a single patient, and 3 patients required placement of a tracheostomy for severe respiratory failure. There were no tracheostomies or gastrostomies placed in patients with an ASP–PEN score of 1. Length of stay was 6 days (6.6 ± 3.7 days) for patients with an ASP–PEN score of 1 and 7 days (9.3 ± 8.6 days) for patients with an ASP–PEN score of greater than 1 ($P = .08$).

Clinical Risk Factors Associated With Postoperative Penetration and Aspiration

Univariate analysis identified male sex, prior head and neck cancer, and advanced age as significant risk factors associated with postoperative aspiration and penetration (Table 3). When subjected to multivariate analysis, advanced age and certain physiologic swallowing derangements were significantly associated with both events (Table 4).

Dysfunctional Swallowing Mechanics

Univariate analysis identified the following dysfunctional mechanisms in patients experiencing aspiration: penetration of laryngeal vestibule before/during the swallow, residuals in the pyriform sinuses, residuals in the valleculae, decreased laryngeal elevation, reduced tongue base retraction, and premature spillage. When subjected to multivariate analysis, residuals in the valleculae and premature spillage of swallowed contents into the pharynx were demonstrated to be significantly associated with aspiration. These are the radiographic hallmarks of penetration and aspiration in this cohort of patients.

DISCUSSION

Aspiration has long been recognized as a potential complication in certain patient populations, including patients who undergo cerebrovascular events, those who undergo operations on the cervical spine, and those who undergo extensive head and neck surgery.[4-6] Nearly 80% of patients with acute cerebrovascular accidents (CVAs) have dysphagia.[7] In this patient population advanced age in conjunction with aspiration was an independent risk factor for the development of pneumonia.[8] Age has also been shown to be an independent predictor of aspiration pneumonia during the first 6 months after acute CVA.[9] The exact mechanism of dysphagia and aspiration after CVA is unclear, but a recent study indicated that decreased laryngeal sensation and decreased pharyngeal transit time of the food bolus might predispose this group of patients to an increased incidence of aspiration.[10]

Aspiration has been overlooked, however, as a source of potential morbidity and mortality in the thoracic surgical literature in spite of the fact that patients undergoing thoracic