Utility of fiberoptic endoscopic evaluation of swallowing in patients undergoing left ventricular assist device implantation

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Abstract

Background: Dysphagia following cardiac surgery is common and associated with adverse outcomes. Among patients receiving left ventricular assist device (LVAD), we evaluated the impact of fiberoptic endoscopic evaluation of swallowing (FEES) on outcomes. *Methods:* A single-center pilot study was conducted in adults ([?]18 years of age) undergoing durable LVAD (February 2019-January 2020). Six patients were prospectively enrolled, evaluated, and underwent FEES within 72 hours of extubation—they were compared to 12 control patients. Demographic, surgical, and postoperative outcomes were collected. Unpaired two-sided t-tests and Fisher's Exact tests were performed. *Results:* Baseline characteristics were similar between groups. Intraoperative criteria including duration of transesophageal echo (314 $\pm$ 86 min) and surgery (301 $\pm$ 74 min) did not differ. Mean time of intubation was comparable (57.3 vs. 68.7 hours, p=0.77). In the entire cohort, 30-day, 1-year, 2-year, and 3-year mortality were 0%, 5.6%, 5.6%, and 16.7%, respectively. Sixty-seven percent of the patients that underwent FEES had inefficient swallowing function. The FEES group trended to a shorter hospital length of stay (LOS) (29.1 vs. 46.6 days, p=0.098), post-implantation LOS (25.3 vs 30.7 days, p=0.46), and lower incidence of postoperative pneumonia (16.7% vs. 50%, p=0.32) and sepsis (0% vs. 33.3%, p=0.25). *Conclusions:* FEES did not impact 30-day, 1-year, 2-year, or 3-year mortality. Patients who underwent FEES trended toward shorter LOS, and lower postoperative pneumonia and sepsis rates, though not statistically significant. A higher incidence of dysphagia among patients undergoing FEES despite comparable baseline risk factors with controls suggests FEES may detect subclinical dysphagia.

Introduction

Postoperative aspiration and dysphagia is an increasingly common, yet understudied, complication post cardiac surgery and has been reported in up to 67% of cases.[1–5] Dysphagia is characterized by impairments in swallowing efficiency (inability to adequately propel food and liquid from the mouth to the stomach) and swallowing safety (inability to protect the airway during swallowing), leading to aspiration of ingested materials into the trachea and pulmonary tract.[6] Consequences of dysphagia following cardiac surgery include malnutrition reintubation, increased hospital length of stay (LOS), and aspiration pneumonia.[6] Although preventable, the latter represents the leading cause of morbidity following open heart surgery.[7,8] Previous studies have suggested that timely diagnosis of dysphagia is critical to prevent devastating aspiration events.[9]

The use of flexible endoscopy to evaluate dysphagia, fiberoptic endoscopic evaluation of swallowing (FEES), has been shown to be a safe, convenient, and effective tool for evaluating dysphagia.[10–17] Notably, when compared to the modified barium swallow (MBS) study, numerous studies have demonstrated that FFES has greater or equal sensitivity to detect key swallowing parameters: delay in swallowing initiation, penetration, aspiration, and pharyngeal residue.[18–21] Additionally, FEES has been suggested to more frequently identify penetration and aspiration compared to MBS.[11,20] Furthermore, FEES is an attractive alternative to conventional video fluoroscopy for evaluating dysphagia due to its portability and absence of radiation exposure, and potential to reduce the incidence of aspiration pneumonia.[10]

We conducted a single-center prospective pilot study to evaluate the impact of FEES on health-related outcomes among patients undergoing durable left ventricular assist device (LVAD) implantation. Specifically, we aimed to assess the incidence of developing dysphagia and related postoperative outcome measures between patients that underwent FEES and a cohort of matched control patients with similar baseline risk factors.

Patients and Methods

Study Population and Patient Characteristics

Institutional Review Board approval was obtained for this single-center study of FEES in adult patients ([?]18 years of age and <90 years of age) undergoing durable LVAD placement. Patient informed consent was obtained for postoperative FEES. Over a one-year period (February 2019 – January 2020), 25 patients received a durable ventricular assist device at the study institution; patients undergoing biventricular assist device implantation were excluded. Six patients undergoing durable LVAD placement were enrolled prospectively during the study period. These patients underwent FEES within 72 hours of extubation postoperatively. A group of 12 control patients also undergoing durable LVAD placement but not FEES from the same one-year period were evaluated for comparison.

Data Collection

Data was collected retrospectively from the electronic medical record. Demographic and baseline data collected include sex, age, body mass index (BMI), race, tobacco use, and past medical history including diabetes mellitus, hypertension, and hyperlipidemia. Predicted operative mortality was calculated for each patient, accounting for patient risk factors, using the European System for Cardiac Operative Risk Evaluation II (EuroSCORE II) [22]. Intraoperative data collected include LVAD device type, transesophageal echocardiography (TEE) time, cardiopulmonary bypass (CPB) time, total operative time, and total intubation time including during the postoperative period. The intent of therapy as bridge to transplant or destination therapy was also recorded. Total intubation time was recorded for the primary intubation event from the immediate preoperative intubation time to postoperative extubation time.

Dysphagia variables collected include whether a speech-language pathologist (SLP) was consulted, whether a barium swallow study was performed and time to swallow study following surgery, and dysphagia status and severity. Dysphagia status was recorded as a binary variable, and severity was recorded as described in the electronic medical record as mild, moderate, or severe.

Health-related outcomes recorded include total time NPO postoperatively, intensive care unit (ICU), postoperative and total length of stay (LOS), incidence of pneumonia and sepsis, 30-day readmission, and 30-day, 1-year, 2-year, and 3-year mortality. Total time NPO was defined as the time from surgery to the first diet order by mouth excluding orders for ice chips. Pneumonia was recorded when the medical record documented clinical suspicion, supporting chest x-ray findings and clinical features, and a plan of management.

Statistical Analysis

Unpaired two-sided t-tests and Fisher's Exact tests were performed for continuous and categorical variables, respectively. Survivorship between patients undergoing FEES was compared to the control group using the Kaplan-Meier method and the log-rank test. Patients were censored at date of death or most recent follow-up as appropriate. All statistical analyses were performed using R Software (version 3.6.3; R Core Team, Vienna, Austria) with a defined $\alpha = 0.05$.[23]

Results

Demographics

Of the 18 patients (66.7% male) included for analysis, six (33.3%) underwent FEES examination following LVAD surgery (Table 1). Patients undergoing FEES were comparable in age (62 ± 15 *vs* 54 ± 12 years,$P = 0.32$) and BMI (32.9 ± 8.2 *vs* 28.1 ± 4.5, $P = 0.23$) to the matched control patients. Sex and race were

comparable between cohorts ($P = 1.00$ and $P = 0.67$, respectively). There were no substantial differences between cohorts in the incidence of active tobacco use, diabetes mellitus, hypertension, and hyperlipidemia. Matched control patients had higher EuroSCORE II values though not statistically significant (6.0 ± 3.2 *vs* 10.6 ± 6.5,$P = 0.06$). All patients underwent LVAD implantation with either the HeartMate III or HeartWare ($P = 0.85$). Patients in the FEES cohort did not differ from the matched cohort based on TEE time (325.2 ± 40.4 *vs* 308.1 ± 103.0 minutes, $P = 0.62$), CPB time (91.3 ± 26.0 *vs* 96.1 ± 39.7 minutes, $P = 0.71$), operative time (308.5 ± 34.3 *vs* 297.4 ± 88.8 minutes, $P = 0.38$), and total intubation time (68.7 ± 75.9 *vs* 57.3 ± 82.3 minutes,$P = 0.77$).

Dysphagia Status

Dysphagia status is shown in Table 2. Postoperative NPO time trended higher in the cohort undergoing FEES but did not differ significantly between groups (175.2 ± 185.3 *vs* 50.5 ± 67.7 hours, $P = 0.16$). Half of the LVAD patients were consulted by a SLP. While SLP consultation was similar between FEES and matched control cohorts (66.7% *vs* 41.7%, $P = 0.62$), all four patients who underwent a barium swallow study were in the FEES cohort (66.7%*vs* 0%, $P = 0.005$). Time to swallow trended towards shorter times in the FEES group (8.0 ± 6.2 *vs* 28.4 ± 14.5 days,$P = 0.06$). The detected incidence of dysphagia was significantly greater in the FEES cohort compared to matched controls (66.7%*vs* 0%, $P < 0.001$). Of the six patients that underwent FEES, four were determined to be dysphagic; severity ranged from mild ($N = 2$) to moderate ($N = 1$) to severe ($N = 1$). Dysphagia status and severity was not noted in any of the matched control patients, as these statuses were dependent on either FEES or MBS.

Health-Related Outcomes

Patients in the FEES cohort did not significantly differ based on Cardiac ICU (CICU) LOS (10.9 ± 7.3 *vs* 12.1 ± 5.1 days, $P = 0.72$), postoperative LOS (25.3 ± 13.2 *vs* 30.7 ± 15.4 days,$P = 0.46$), and total LOS (29.1 ± 12.9 *vs* 46.6 ± 29.4 days,$P = 0.10$) (Table 3). Patients that underwent FEES trended towards a lower incidence of postoperative pneumonia (16.7% *vs* 50.0%,$P = 0.32$) and postoperative sepsis (0% *vs* 33.3%,$P = 0.25$). One patient in each cohort was readmitted within 30 days; however, 30-day and 1-year mortality were 0% and 5.6%, respectively, for the entire cohort. Mortality at 2 and 3 years, and Kaplan-Meier survivorship did not differ between groups (Figure 1).

Conclusions

Despite the increasing popularization of the use of FEES, its efficacy specifically in the setting of cardiac surgery has not been well studied, and consequently is seldomly used.[11] In a 2021 study, tracheal aspiration was found to be prevalent, costly to patients, and associated with increased morbidity and mortality after adult cardiac surgery.[24] Given the high incidence of dysphagia and concurrent silent aspiration and subsequent pneumonia in cardiac surgery patients, demonstration of the efficacy of FEES in the setting of cardiac surgery could play an important role in increasing its utilization and improving health-related outcomes.[25]

Postoperative dysphagia following cardiac surgery is common, multifactorial, and is associated with increased morbidity and increased LOS.[3,6] FEES is a convenient tool for evaluating dysphagia and has been shown to decrease the incidence of aspiration pneumonia in other settings, but its use in postoperative cardiac surgical care has not adopted as standard of care.[10,11] In our review of patients undergoing durable LVAD implantation, patients that underwent FEES trended towards shorter total hospital and post-implant LOS and lower postoperative pneumonia and sepsis rates. In the entire LVAD cohort we had zero 30-day, and 5.6% 1-year mortality, and so FEES intervention did not impact mortality. Mortality at 2 and 3 years were 5.6% and 16.7%, respectively.

Dysphagia is a significant complication post cardiac surgery that requires attention and mitigation. Risk factors for developing dysphagia following cardiac surgery include TEE use, prolonged operative duration, prolonged mechanical ventilation, New York Heart Association classes III and IV, and larger endotracheal tube size.[1,2,4,5,9,24,26,27] TEE use was identified as an independent predictor of dysphagia among 869 patients undergoing cardiac surgery.[5] In another study of operative duration and dysphagia among 838

patients undergoing cardiac surgery, no patients who were operated on for less than 4.5 hours developed dysphagia, suggesting an association exists between operative duration and dysphagia.[4] Studies have also identified prolonged mechanical ventilation as a risk factor for dysphagia among patients undergoing cardiac surgery.[1,2,4,5,9,26]

Identifying dysphagia in patients early in the postoperative period may also contribute to reduced adverse outcomes associated with dysphagia. Though prior studies demonstrate FEES use in adult and pediatric settings outside of cardiac surgical care is safe and effective for evaluating dysphagia[10–17], it has not been until recently that studies have incorporated FEES to detect dysphagia in cardiac surgery.[28] In a prospective trial of adult patients undergoing elective cardiac surgery, FEES was used as confirmatory testing for patients failing a targeted swallow screen; the study found the true incidence of dysphagia after cardiac surgery to be significantly higher than previously recognized.[24,27,29] In a study of 60 patients with dysphagia of various origin, FEES had high sensitivity and validity for detection of dysphagia.[30] Although the study was not limited to patients undergoing cardiac surgery, the finding that FEES has high sensitivity and validity for detecting dysphagia may explain the higher incidence of dysphagia noted among LVAD patients undergoing FEES in the current study despite comparable baseline risk factors with the control group. These findings suggest that dysphagia may be under-diagnosed without instrumentation, and early subclinical dysphagia can be detected with FEES.

We believe that while our pilot study importantly contributes to understanding how FEES can be integrated into LVAD surgery postoperative care, it is limited due to small sample size and low event rates, limiting our ability to draw conclusions that can be generalized beyond the patients in the present study. We found reduced adverse clinical outcomes following durable LVAD implantation; however, a larger prospective study is warranted to delineate the significance of these preliminary findings.

Author Contributions

OMS was responsible for data collection and drafting the article. KAH was responsible for data analysis and drafting the article. EP, MA, and EIJ were responsible for study design, data interpretation, and critical revision. All authors approved this article.

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Tables

Table 1. Baseline Demographics

Variable
Preoperative
Age, years
Mean (SD)
Median (IQR)
Male
Race
Asian
Black
Hispanic
White
Other
BMI, kg/m^2, mean ± SD
Tobacco use
Diabetes
Hypertension
Hyperlipidemia
EuroSCORE II, mean ± SD
Intraoperative
Bridge to transplant
Device
HeartMate III
HeartWare
TEE time, minutes[a]
CPB time, minutes
Operative time, minutes
Total Intubation time, hours

Values are % (n) unless otherwise indicated.
BMI = body mass index; CPB = cardiopulmonary bypass; EuroSCORE = European System for Cardiac Operative Risk Ev
[a]Data unavailable for two patients in matched cohort

Table 2. Dysphagia Status

Variable	All patients ($n = 18$)	FEES ($n = 6$)
NPO time, hours	92.1 ± 129.3	175.2 ± 185.3
SLP Consultation	50.0 (9)	66.7 (4)
Study Performed	——	——
Barium Swallow	22.2 (4)	66.7 (4)

Time to Swallow[a], days	18.2 ± 15.0	8.0 ± 6.2
Dysphagia Status	——	——
Not Noted	66.7 (12)	0 (0)
Within Normal Limit	11.1 (2)	33.3 (2)
Dysphagic	22.2 (4)	66.7 (4)
Dysphagia Severity	——	——
Mild	11.1 (2)	33.3 (2)
Moderate	5.6 (1)	16.7 (1)
Severity	5.6 (1)	16.7 (1)
Values are % (n) unless otherwise indicated.	Values are % (n) unless otherwise indicated.	Values are % (n) unless otherv
SLP = Speech-Language Pathologist	SLP = Speech-Language Pathologist	SLP = Speech-Language Path
[a]Reported for 4 patients in each cohort	[a]Reported for 4 patients in each cohort	[a]Reported for 4 patients in ea

Table 3. Health-related Outcomes

Variable	All patients (n = 18)
CICU LOS, days	11.7 ± 5.7
Postoperative LOS, days	28.9 ± 14.5
Total LOS, days	40.8 ± 26.1
NPO time, hours	92.1 ± 129.3
Pneumonia	38.9 (7)
Sepsis	22.2 (4)
30-day readmission	11.1 (2)
30-day mortality	0 (0)
1-year mortality	5.6 (1)
2-year mortality	5.6 (1)
3-year mortality	16.7 (3)
Values are % (n) unless otherwise indicated.	Values are % (n) unless otherwise ind
CICU = Cardiac Intensive Care Unit; LOS = length of stay; NPO = not by mouth	CICU = Cardiac Intensive Care Unit;

Figures

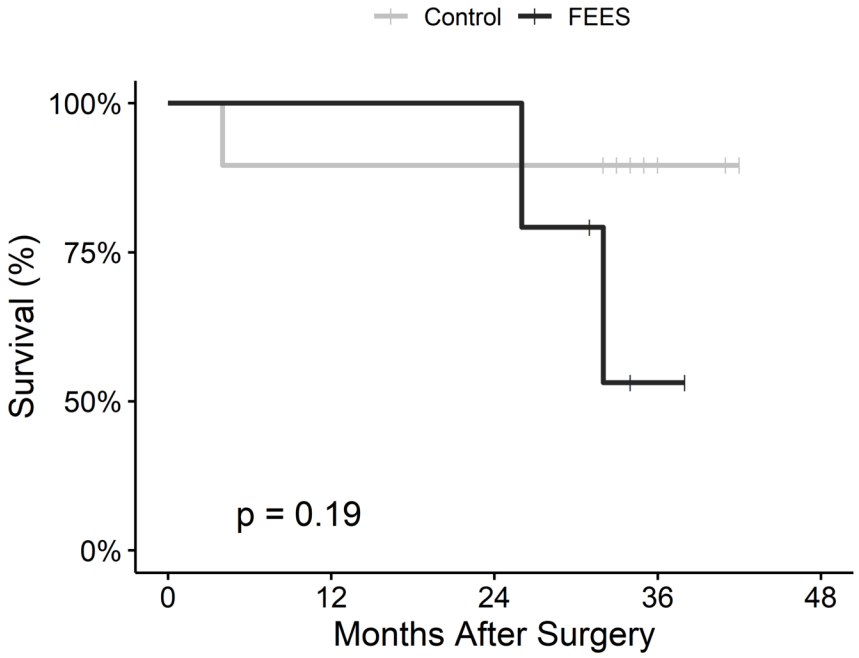

Figure 1 . Kaplan-Meier survivorship for patients undergoing FEES compared to matched controls with log-rank test. FEES, fiberoptic endoscopic evaluation of swallowing.