



Comparing open gastrostomy tube to percutaneous endoscopic gastrostomy tube in heart transplant patients



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H I G H L I G H T S

- OGT may result in less mortality than PEG in heart transplant patients.
- Complications occur more frequently when heart transplant recipients receive PEG.
- PEG in heart transplant recipients does not result in decreased LOS or total cost.

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Introduction: Impaired wound healing due to immunosuppression has led some surgeons to preferentially use open gastrostomy tube (OGT) over percutaneous gastrostomy tube (PEG) in heart transplant patients when long-term enteral access is deemed necessary.

Methods: The National Inpatient Sample (NIS) database (2005–2010) was queried for all heart transplant patients. Those receiving OGT were compared to those treated with PEG tube.

Results: There were 498 patients requiring long-term enteral access treated with a gastrostomy tube, with 424 (85.2%) receiving a PEG and 74 (14.8%) an OGT. The PEG cohort had higher Charlson comorbidity Index (4.1 vs. 2.0, $p = 0.002$) and a higher incidence of post-operative acute renal failure (31.5 vs. 12.7%, $p = 0.001$). Post-operative mortality was not different when comparing the two groups (13.8 vs. 6.1%, $p = 0.06$). On multivariate analysis, while both PEG (OR: 7.87, 95%CI: 5.88–10.52, $p < 0.001$) and OGT (OR 5.87, 95%CI: 2.19–15.75, $p < 0.001$) were independently associated with mortality, PEG conferred a higher mortality risk.

Conclusions: This is the largest reported study to date comparing outcomes between PEG and OGT in heart transplant patients. PEG does not confer any advantage over OGT in this patient population with respect to morbidity, mortality, and length of stay.

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1. Introduction

Heart transplantation is the gold standard treatment for patients with end stage heart failure (HF) refractory to medical management [1]. While many studies have focused on increasing the donor pool for heart transplant recipients [2–7], few studies

have focused on maximizing survival and quality of life in these patients. Occasionally, heart transplant recipients may require long term enteral access because they are not capable of eating and/or not meeting their nutritional demands. Percutaneous gastrostomy tube (PEG) has become the procedure of choice given its lower cost and postoperative complication rate compared to open surgical gastrostomy (OGT) [8,9]. Heart transplant patients present a unique obstacle as they require immunosuppressive medications to prevent rejection that have the unintended effect of impairing wound healing [10]. Open gastrostomy tube allows suturing of the stomach

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to the anterior abdominal wall which may decrease the risk of tube dislodgement and intra-peritoneal contamination as compared to PEG tube. To date, there have been no studies comparing outcomes between PEG and OGT in heart transplant patients. The goal of this study is to compare postoperative morbidity and mortality in open surgical gastrostomy versus percutaneous gastrostomy tube in heart transplant patients. We hypothesize that heart transplant patients undergoing OGT would have better outcomes as compared to PEG because of impaired wound healing secondary to immunosuppression.

2. Methods

2.1. Database

The National Inpatient Sample (NIS) Database developed by the Healthcare Cost and Utilization Project (HCUP) was used for this study. This database contains data from approximately 7 million hospital stays each year from a stratified sample of 20% of non-federal US hospitals. The NIS is the largest publicly available all payer inpatient health care database in the United States. Our analysis was based on a self-weighting design that reduces the margin of error for estimates and produces population based estimates. The NIS is a publically available de-identified database and was granted exempt status from our IRB committee.

2.2. Study population

Adult heart transplant patients that underwent PEG tube or OGT placement between 2005 and 2010 were identified by the International Classification of Disease, Ninth Revision (ICD-9) diagnosis and procedure code. Patients were selected based on diagnosis code for heart transplant (V42.1) and then separated into groups based on the procedure code for open gastrostomy tube (43.19) and percutaneous gastrostomy tube (43.11).

2.3. Data and statistical analysis

The primary outcome was inpatient mortality after gastrostomy tube placement. Secondary outcomes included in-hospital complications, length of stay, and cost. Common postoperative complications were identified by ICD-9 code as established in previous studies [11]. All continuous variables are presented as mean \pm standard deviation. Weighted frequencies and weighted multivariate logistic regression analysis using clinically relevant variables were used to examine post-operative complications and mortality. Covariates included in the model were age, female sex, race, hospital bed size, Charlson comorbidity index, PEG tube and OGT placement. Odds ratio (OR) with 95% confidence intervals were presented for each covariate. A *p*-value less than 0.05 was considered statistically significant. Data was analyzed using SAS 9.2 software (SAS Institute, Cary, NC).

3. Results

3.1. Baseline characteristics

A total of 498 heart transplant recipients required enteral access. Of these, 424 (85.1%) underwent PEG tube and 74 (14.9%) underwent OGT placement. As seen in Table 1, the patients in these two groups were not significantly different with respect to male gender (76.2% vs. 78.4%, *p* = 0.68) and age (56.3 vs. 42.7, *p* = 0.08). The PEG cohort had higher Charlson Comorbidity Index (4.1 vs. 2.0, *p* = 0.003), was more likely to be Caucasian (73.5% vs. 53.3%, *p* < 0.001), and more likely to have Medicare (56.5% vs. 30%,

Table 1
Baseline characteristics of patients undergoing gastrostomy tube placement.

	PEG (n = 424)	OGT (n = 74)	p Value
Age	56.3 \pm 48.9	42.7 \pm 59.5	0.08
Charlson Comorbidity Index	4.1 \pm 5.3	2.0 \pm 5.2	0.003
Male (%)	323 (76.2)	58 (78.4)	0.68
Caucasian (%)	312 (73.5)	39 (53.3)	<0.001
Hispanic (%)	13 (3.1)	13 (18.3)	<0.001
Other Race (%)	36 (8.4)	5 (7.5)	<0.001
Private Insurance (%)	111 (26.2)	31 (42)	<0.001
Medicare (%)	239 (56.5)	15 (20)	<0.001
Medicaid (%)	59 (13.8)	23 (31.6)	<0.001

p < 0.001). The PEG cohort was less likely to be Hispanic (3.1% vs. 18.3%, *p* < 0.001) and less likely to have private payer status (26.2% vs. 42%, *p* < 0.001).

3.2. Post-operative outcomes

As seen in Table 2, the PEG cohort had higher incidence of acute renal failure when compared to the OGT group (31.5% vs. 12.7%, *p* = 0.001). Post-operative pneumonia (3.4% vs. 0, *p* = 0.11), surgical site infection (4.8% vs. 6.4%, *p* = 0.56), DVT (3.5% vs. 0%, *p* = 0.10), and incidence of pulmonary embolus (PE) (2.6% vs. 0%, *p* = 0.16) were not different when comparing the two groups. Total hospital charges (\$224,000 vs. 183,000, *p* = 0.41) were also similar (Fig. 1). Patients receiving OGT had a shorter length of stay (20.0 vs. 15.0, *p* = 0.01).

3.3. Survival

Postoperative mortality in the PEG cohort was not significantly higher than the OGT cohort (13.8% vs 6.1%, *p* = 0.07). On multivariate analysis, as shown in Table 3, while both placement of PEG tube (OR: 7.87, 95%CI: 5.88–10.5, *p* < 0.001) and OGT (OR 5.87, 95% C.I: 2.19–15.75, *p* < 0.001) were associated with mortality, PEG tube added greater mortality risk. Charlson Comorbidity Index (OR 1.23, 95% C.I: 1.18–1.27, *p* < 0.001) and increasing age (OR 1.01, 95% C.I: 1.0–1.01, *p* < 0.005) were also associated with increased mortality. Variables associated with better survival included Caucasian race (OR: 0.87, 95%CI: 0.79–0.96, *p* < 0.005) and admission to a teaching hospital (OR: 0.83, 95%CI: 0.75–0.92, *p* < 0.001).

4. Discussion

Percutaneous gastrostomy tube (PEG) has become the method of choice for long term enteral access in the majority of patients given its cost effectiveness and ease of use compared to open surgical gastrostomy (OGT) [9]. While there is a consensus that PEG should be the procedure of choice in most patients [12], data on which procedure benefits heart transplant recipients is lacking. These patients present a unique obstacle as they require high doses

Table 2
Outcomes of patients undergoing gastrostomy tube placement.

	PEG (n = 424)	OGT (n = 74)	p Value
Mortality (%)	58 (13.8%)	4 (6.1%)	0.066
Acute Kidney Failure (%)	133 (31.5)	9 (12.7)	0.001
Pneumonia	14 (3.4%)	0 (0%)	0.11
DVT	15 (3.5%)	0 (0%)	0.102
Pulmonary Embolism	11 (2.6%)	0 (0%)	0.16
Surgical Site Infection	20.2 (4.8%)	5 (6.4%)	0.56
Length of Stay (mean, days)	20.0	14.0	0.01
Hospital Charges	224 k \pm 575 k	183 k \pm 353 k	0.414

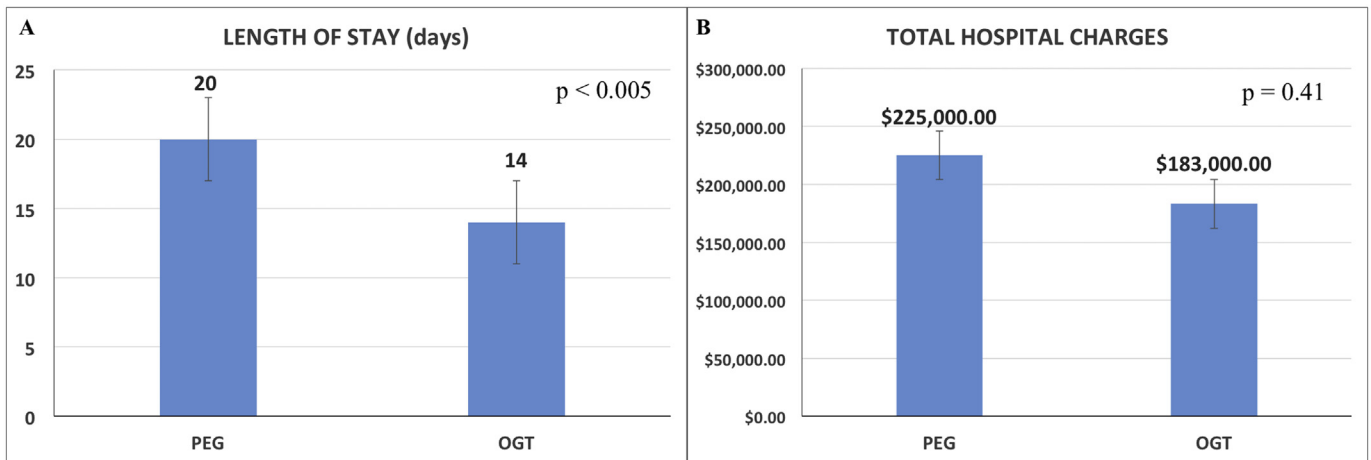


Fig. 1. A comparison of (A) length of stay and (B) total hospital charges in PEG and OGT in heart transplant recipients.

Table 3

Multivariable logistic regression for inpatient mortality after gastrostomy tube placement.

Covariate	Odds ratio	95% confidence interval	p Value
Age	1.01	1.0–1.01	<0.005
Caucasian	0.87	0.79–0.96	<0.005
PEG	7.87	5.88–10.5	<0.001
OGT	5.87	2.19–15.75	<0.001
Teaching Hospital	0.83	0.75–0.92	<0.001
Charlson Comorbidity Index	1.23	1.18–1.27	<0.001

of immunosuppression that have the unintended side effect of impairing wound healing. This goal of this study was to examine outcomes in PEG and OGT in heart transplant recipients.

While some studies suggest that OGT has a higher mortality rate when compared to PEG [13] others have shown comparable mortality rates [8,9] [14]. Currently, no study to date has evaluated the ideal method of long term feeding access in heart transplant patients. Our analysis demonstrated that in-hospital mortality was not different with PEG or OGT. However, when adjusting for comorbidities on multivariate analysis, while both PEG and OGT were associated with mortality, PEG conferred a greater mortality risk. The reason for increased mortality associated with PEG placement cannot be determined from the database. Heart transplant recipients are typically on maintenance regimens including a calcineurin inhibitor, an antimetabolite agent, and varying doses of corticosteroids [15]. These medications hinder the immune response and impair wound healing that is essential in forming a fibrotic tract around the PEG tube. This could increase the risk of dislodgement, internal leakage, peritonitis, and other postoperative complications that may contribute to worse mortality. Unfortunately, these complications cannot be ascertained from the NIS database. OGT placement allows for surgical pexying of the stomach to the abdominal wall under direct visualization. This may facilitate tract formation and minimize the risk of intraperitoneal leak and intraabdominal complications as compared to PEG placement.

Other variables associated with increased mortality on multivariate analysis include Charlson Comorbidity Index (OR 1.23, 95% C.I: 1.18–1.27, $p < 0.001$) and age (OR 1.01, 95% C.I: 1.0–1.01, $p < 0.005$). These findings are consistent with previous literature that shows elevated mortality with increasing Charlson Comorbidity Index [16] and age [17]. Caucasian race (OR 0.87, 95% C.I: 0.79–0.96, $p < 0.005$) and admission at a teaching hospital (OR

0.83, 95% C.I: 0.75–0.92, $p < 0.001$) were associated with survival. Caucasian race has not been associated with survival in patients receiving a surgical feeding tube [18], however, it has been shown to be associated with survival for heart transplant recipients in previous studies [3,4]. Future studies are needed to further delineate this association. High volume centers are associated with improved patient survival with all complex surgical procedures including solid organ transplantation [19], which suggests that teaching centers are likely an indication for these centers.

Previous studies have shown that OGT placement is associated with a higher complication rate than PEG tube placement [20]. Interestingly, this study showed the PEG cohort was associated with an increased incidence of acute renal failure and development of any postoperative complication. Our study is the first to date to document these findings. The exact etiology of this association is unclear, although increased incidence of acute renal failure may be a direct consequence of increased intraperitoneal complications. Unfortunately, this information is not available in the NIS database. In addition, the group receiving PEG tube had a higher degree of comorbidities than the OGT cohort and the increased complications could be a result of these comorbidities. Other studies have shown an increased incidence of wound infection and respiratory complications with OGT [21], however, no difference was observed in this study. Additional in-hospital complications including DVT, PE, myocardial infarction, and pneumonia were not statistically significant between the two cohorts.

Median length of stay (20.0 vs 14.0 days, $p < 0.005$) was longer in the PEG cohort, which may be related to the increased incidence of postoperative complications and/or higher comorbidities. Patients in the PEG cohort were more likely to be discharged to a skilled nursing or intermediate care facility (42.8% vs. 13.4%, $p < 0.001$) while those in the OGT cohort were more frequently discharged home (25.7% vs. 40.6%, $p < 0.001$). Interestingly, total hospital charges were not significantly different between the two groups (\$224,000 vs. \$183,000, $p = 0.41$). This finding is contrary to previous studies that show a cost-advantage with PEG [21]. The previously reported benefits of PEG tube placement including lower cost and lower incidence of complications have not been demonstrated in this unique patient population.

The major limitation of this study is that it is a retrospective analysis of a large database. These databases are restrained to in-hospital events and as a result under represent the actual incidence of mortality and other complications as they may occur after the index hospitalization. Additionally, it is not possible to identify

individual's comorbidities that could have preferentially predisposed to postoperative complications. The two cohorts were disparate with respect to Charlson Comorbidity Index, ethnicity, and payer status which we attempted to control for with multivariate analysis. However, we were not able to control for selection bias as the database does not include information on previous abdominal surgeries, the indication for placement, or patients' disease severity at time of surgery. Furthermore, as previously stated this analysis is also dependent on accurate coding of diagnoses, complications, and procedures and is therefore inherently subject to coding and reporting bias.

This is the largest study to date comparing outcomes between PEG and OGT in heart transplant patients. PEG does not confer any advantage over OGT in this patient population with respect to morbidity, mortality, and length of stay. Therefore, consideration should be given to OGT, although future randomized studies are needed before recommending OGT in all heart transplant recipients.

Conflict of interest statement

The authors have no conflicts of interest to disclose.

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Temple University Hospital IRB.

Consent

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Author contribution

VA—Concept/design, data analysis/interpretation, drafting article, critical revision, approval of article.

ST—Data analysis/interpretation, drafting article, critical revision, approval of article.

SJ—Drafting article, critical revision, approval of article, statistics.

JG - Data analysis/interpretation, critical revision, approval of article, statistics.

YT - Critical revision, approval of article.

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AG—Concept/design, Data analysis/interpretation, drafting article, critical revision, approval of article.

Guarantor

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References

- [1] Heart Failure Society of America, J. Lindenfeld, N.M. Albert, J.P. Boehmer, S.P. Collins, J.A. Ezekowitz, et al., HFSA 2010 comprehensive heart failure practice guideline, *J. Card. Fail.* 16 (6) (2010 Jun) e1–194.
- [2] S.N. Jayarajan, S. Taghavi, E. Komaroff, A.A. Mangi, Impact of low donor to recipient weight ratios on cardiac transplantation, *J. Thorac. Cardiovasc Surg.* 146 (6) (2013 Dec) 1538–1543.
- [3] S. Taghavi, C. Beyer, H. Vora, et al., Noncardiac surgery in patients on mechanical circulatory support, *ASAIO J. Am. Soc. Artif. Intern. Organs* 1992 60 (6) (2014 Dec) 670–674.
- [4] S. Taghavi, S.N. Jayarajan, E. Komaroff, A.A. Mangi, Continuous flow left ventricular assist device technology has influenced wait times and affected donor allocation in cardiac transplantation, *J. Thorac. Cardiovasc Surg.* 147 (6) (2014 Jun) 1966–1971, 1971.e1.
- [5] S. Taghavi, S.N. Jayarajan, L.M. Wilson, E. Komaroff, A.A. Mangi, Cardiac transplantation with ABO-compatible donors has equivalent long-term survival, *Surgery* 154 (2) (2013 Aug) 274–281.
- [6] S. Taghavi, S.N. Jayarajan, L.M. Wilson, E. Komaroff, J.M. Testani, A.A. Mangi, Cardiac transplantation can be safely performed using selected diabetic donors, *J. Thorac. Cardiovasc Surg.* 146 (2) (2013 Aug) 442–447.
- [7] S. Taghavi, L.M. Wilson, S.H. Brann, J. Gaughan, A.A. Mangi, Cardiac transplantation can be safely performed with low donor-to-recipient body weight ratios, *J. Card. Fail.* 18 (9) (2012 Sep) 688–693.
- [8] M. Gauderer, J. Ponsky, R. Izant, Gastrostomy without laparotomy: a percutaneous endoscopic technique, *J. Pediatr. Surg.* 15 (6) (1980 Dec) 872–875.
- [9] J. Mellinger, J. Ponsky, Percutaneous endoscopic gastrostomy: state of the art, *Endoscopy* 30 (1998) 126–132.
- [10] R. Bootun, Effects of immunosuppressive therapy on wound healing, *Int. Wound J.* 10 (1) (2013 Feb) 98–104 [Int Wound J. 2013] - PubMed - NCBI.
- [11] Kilic A, Sheer A, Shah A, Russell S, Gourin C, Lidor A. Outcomes of cholecystectomy in US heart transplant recipients. *Ann. Surg.* 258(2):312–317.
- [12] R.R. Bankhead, C.A. Fisher, R.H. Rolandelli, Gastrostomy tube placement outcomes: comparison of surgical, endoscopic, and laparoscopic methods, *Nutr. Clin. Pract. Off. Publ. Am. Soc. Parenter. Enter. Nutr.* 20 (6) (2005 Dec) 607–612.
- [13] J. Stern, Comparison of percutaneous endoscopic gastrostomy with surgical gastrostomy at a community hospital, *Am. J. Gastroenterol.* 81 (12) (1986 Dec) 1171–1173.
- [14] I. Rustom, A. Jebreel, M. Tayyab, R. England, N. Stafford, Percutaneous endoscopic, radiological, and surgical gastrostomy tubes: a comparison study in head and neck cancer patients, *J. Laryngol. Otol.* 120 (6) (2006 Jun) 463–466.
- [15] A. Aliabadi, A.B. Cochrane, A.O. Zuckermann, Current strategies and future trends in immunosuppression after heart transplantation, *Curr. Opin. Organ Transpl.* 17 (5) (2012 Oct) 540–545.
- [16] W. Kim, K.Y. Song, H.-J. Lee, S.U. Han, W.J. Hyung, G.S. Cho, The impact of comorbidity on surgical outcomes in laparoscopy-assisted distal gastrectomy: a retrospective analysis of multicenter results, *Ann. Surg.* 248 (5) (2008 Nov) 793–799.
- [17] G.L. Lu-Yao, P. Albertsen, J. Warren, S.L. Yao, Effect of age and surgical approach on complications and short-term mortality after radical prostatectomy—a population-based study, *Urology* 54 (2) (1999 Aug) 301–307.
- [18] O. Cohen, D. De La Zerda, R.E. Beygui, D. Hekmat, H. Laks, Ethnicity as a predictor of graft longevity and recipient mortality in heart transplantation, *Transpl. Proc.* 39 (10) (2007 Dec) 3297–3302.
- [19] A. Kilic, E.S. Weiss, D.D. Yuh, et al., Institutional factors beyond procedural volume significantly impact center variability in outcomes after orthotopic heart transplantation, *Ann. Surg.* 256 (4) (2012 Oct) 616–623.
- [20] K. Dwyer, D. Watts, J. Thurber, R. Benoit, Percutaneous endoscopic gastrostomy: the preferred method of elective feeding tube placement in trauma patients, *J. Trauma* 52 (1) (2002 Jan) 26–32 [J Trauma. 2002] - PubMed - NCBI.
- [21] K.N. Apelgren, J. Zambos, Is percutaneous better than open gastrostomy? A clinical study in one surgical department, *Am. Surg.* 55 (9) (1989 Sep) 596–600.