

Predictive Factors for Percutaneous Endoscopic Gastrostomy Tube Placement After Anterior Cervical Fusion

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Abstract

Study Design: Retrospective case-control study.

Objectives: To identify incidence and risk factors for percutaneous endoscopic gastrostomy (PEG) tube placement after anterior cervical fusion (ACF).

Methods: Adult patients undergoing elective ACF with/without corpectomy for spondylosis from 2002 to 2011 were identified using the Nationwide Inpatient Sample database. The primary outcome measure was PEG tube placement; secondary outcomes included in-hospital mortality, total hospital charges, and discharge disposition. Multiple regression analyses were conducted to identify independent predictors of PEG tube placement.

Results: Of 164 097 patients, 217 (0.13%) required a PEG tube. Patients needing PEG tube placement were older (69 vs 52 years; $P < .001$) and more likely to be male (65% vs 46.6%; $P < .001$) when compared with control patients. After regression analysis, age over 65 year (odds ratio [OR] = 4.16; $P < .001$) was the strongest independent predictor for PEG tube placement; other associated factors included male gender (OR = 2.14; $P < .001$), congestive heart failure (OR = 4.11; $P < .001$), anemia (OR = 3.52; $P < .001$), alcohol abuse (OR = 2.80; $P = .009$), renal failure (OR = 2.25; $P = .003$), chronic lung disease (OR = 1.78; $P < .001$), corpectomy (OR = 2.16; $P < .001$), and fusion of ≥ 3 segments (OR = 1.74; $P < .001$). Mortality rate for patients requiring PEG tube placement was 5.1% versus 0.05% for controls ($P < .001$); average hospital charges were \$134 379 versus \$39 519 ($P < .001$), and nonroutine discharges were seen in 89.3% versus only 6.4% for controls ($P < .001$).

Conclusions: The incidence of PEG tube placement after ACF was 0.13% in this study. Identified risk factors included age >65 , corpectomy, fusion of ≥ 3 segments, and various comorbidities. Additionally, there may be increased risk of in-hospital mortality, hospital charges, and nonroutine discharges among these patients.

Keywords

percutaneous endoscopic gastrostomy, anterior cervical fusion, PEG tube, dysphagia, nationwide inpatient sample

Introduction

Dysphagia is one of the most common complaints after anterior cervical fusion (ACF) procedures. Though most cases are mild, in approximately 5% to 7% of cases dysphagia may persist over 6 months after surgery.¹ Risk factors for dysphagia include multilevel procedures,²⁻⁶ female gender,^{4,6-8} long operative time,^{3,5,9} and older age (usually above 60),^{3,10,11} among others.¹ Primary treatment interventions are behavioral and include changes in posture, swallowing maneuvers, and diet modifications.¹² When nutritional needs cannot be met or when there is a high risk of aspiration, a temporary feeding tube may be necessary.¹

One such type of enteral support that can be used after ACF procedures is the percutaneous endoscopic gastrostomy (PEG) tube.¹³⁻¹⁵ While PEG tubes have been shown to be more

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efficacious than nasogastric tubes for maintaining body weight,^{16,17} they have been associated with a higher probability of dependence and long-term use.^{16,18,19} However, the incidence of their use after cervical spine surgery for degenerative spine disease is currently unknown, and there is limited data regarding risk factors for their placement.

The aim of this study is to determine the incidence of PEG tube placement after ACF procedures for cervical spondylosis and to identify associated predictive factors. Secondary objectives include identification of the in-hospital mortality rate, total hospital charges, and discharge disposition of patients who required PEG tube placement.

Methods

Data Source and Inclusion Criteria

This retrospective case-control study utilized the Nationwide Inpatient Sample (NIS) database for the years 2002 to 2011. The NIS is the largest publicly available inpatient database in the United States and contains patient discharge information from a 20% sample of community hospitals in the country. De-identified data on any given patient's primary diagnosis, procedures performed, and any inpatient complications are coded in the form of *International Classification of Diseases 9th Edition* (ICD-9) codes.

For this study, adult patients (>18 years of age) who underwent an anterior cervical fusion (code 81.02) were identified in the initial search. Nondegenerative cases ($n = 15\,595$), patients younger than 18 years of age ($n = 32$), combined anterior-posterior fusion procedures ($n = 4,165$), patients without data regarding number of levels fused ($n = 33\,459$), and nonelective admissions ($n = 34\,772$) were excluded from this study. The final cohort consisted of 164 097 patients.

Examined Variables

Data extracted included patient age, gender, race, primary payer, comorbidities, number of levels fused, revision status, data regarding corpectomy procedures, use of recombinant human bone morphogenetic protein-2 (rhBMP-2), length of stay, and inpatient mortality. The primary exposure (ie, independent) variable was PEG tube placement (procedure code 43.11). In-hospital mortality, total hospital charges (excluding professional fees), and discharge disposition were secondary outcome measures. A nonroutine discharge was defined as such if patients were discharged to a short-term hospital, skilled nursing facility, intermediate care facility, another type of facility, home health care, or against medical advice.

Data Analysis

General patient data and frequencies were compared between patients not requiring PEG tube placement (controls) and those requiring PEG tube placement (cases). Two-tailed unpaired t tests were used for continuous variables and the χ^2 /Fisher's exact test for categorical data. Any parameters significantly

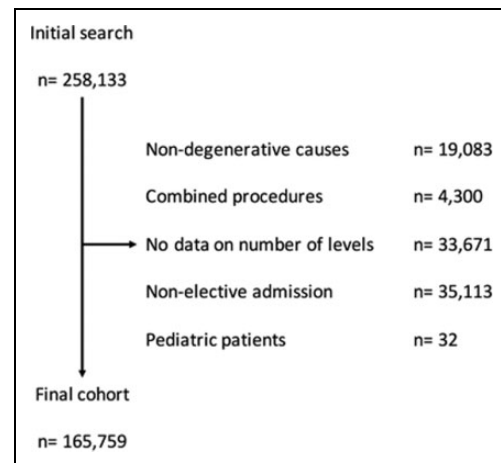


Figure 1. Patient selection criteria.

different between groups (P value $<.01$) were included in a stepwise multiple logistic regression model with backward elimination to identify independent risk factors for PEG tube placement. Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). All data was analyzed using STATA SE 12 (StataCorp LP, College Station, Texas). Given the large sample size, only P -values $<.01$ were considered statistically significant.

Results

From 2002 to 2011, a total of 164 097 patients who underwent an ACF and met our inclusion criteria were identified (Figure 1). There were 217 cases (0.13%; 95% CI = 0.11% to 0.15%) of PEG tube placement, which correspond to the cases in this study. The tube was placed on average on postoperative day 11 (median = 9; range = 3-62). General patient demographics are shown in Table 1, and there were multiple statistically significant differences between groups. Patients in the PEG tube group were significantly older, with an average age of 69 years compared with 52 years in the control group ($P < .001$). Likewise, the proportion of males was significantly higher in the PEG tube group (65.0% vs 46.6%, $P < .001$). There were also significant differences in primary payer between groups ($P < .001$).

The proportion of patients with history of alcohol abuse ($P < .001$), deficiency anemia ($P < .001$), congestive heart failure ($P < .001$), chronic pulmonary disease ($P < .001$), diabetes ($P < .001$), hypertension ($P < .001$), and renal failure ($P < .001$) was also significantly different between groups.

In the PEG tube group, there were 28.6% of patients who underwent fusion of 3 or more spinal segments, compared with 12.8% in the control group ($P < .001$; Table 2). Similarly, a higher proportion of patients in the PEG group underwent corpectomy (14.8% vs 5.4%; $P < .001$).

Outcomes

Length of stay was significantly longer for patients who required PEG tube placement (median of 13 days vs 1 day for

Table 1. General Demographics of Patients With and Without PEG Tube Placement After Anterior Cervical Fusion.

Parameter	No PEG Tube	PEG Tube	P Value
Number of cases	163,880	217	
Age (average years)	52 ± 12	69 ± 12	<.001 ^a
Age >65 (%)	14.7	63.6	<.001 ^a
Male gender (%)	46.6	65.0	<.001 ^a
Race			
Caucasian (%)	84.1	77.1	.020
African American (%)	8.5	15.4	
Hispanic (%)	3.9	3.4	
Other (%)	3.5	4.1	
Primary payer			
Medicare (%)	22.9	72.4	<.001 ^a
Medicaid (%)	5.1	3.7	
Private insurance (%)	60.3	19.4	
Other (%)	11.7	4.5	
Comorbidities			
Alcohol abuse	0.9	5.1 ^b	<.001 ^a
Deficiency anemia	2.0	14.3	<.001 ^a
Chronic blood loss anemia	0.1	5.1 ^b	.047
Congestive heart failure	0.9	11.5	<.001 ^a
Chronic lung disease (%)	14.3	29.5	<.001 ^a
AIDS (%)	0.05	0.0	.754
Diabetes (%)	12.8	22.1	<.001 ^a
Drug abuse (%)	0.6	5.1 ^b	.558
Hypertension (%)	39.5	63.1	<.001 ^a
Liver disease (%)	0.7	5.1 ^b	.053
Obesity (%)	8.1	8.3	.928
Renal failure (%)	0.8	8.8	<.001 ^a
Peptic ulcer	0.01	0.0	.871

Abbreviations: PEG, percutaneous endoscopic gastrostomy; NIS, Nationwide Inpatient Sample.

^aIndicates statistical significance.

^bThe NIS does not allow publication of values less than 11, so 11 was used as the minimum for this complication.

controls; $P < .001$; Table 2). The in-hospital mortality rate was also higher in the PEG group (5.1% vs 0.05%; $P < .001$), as well as the nonroutine discharge rate (90.3% vs 9.7%; $P < .001$).

Factors Associated With PEG Tube Placement

Multiple logistic regression analysis identified several independent predictors of PEG tube placement (Table 3). Overall, the strongest independent predictor was age over 65, with an odds ratio of 4.16 (95% CI = 2.88-6.00). Male patients were also more likely to undergo tube placement (OR = 2.14; 95% CI = 1.61-2.85) when compared with females. The 2 strongest comorbid predictors were congestive heart failure (OR = 4.11; 95% CI = 2.60-6.49) and deficiency anemia (OR = 3.52; 95% CI = 2.32-5.35). In terms of operative parameters, corpectomy was a stronger predictor of PEG tube placement (OR = 2.16; 95% CI = 1.47-3.17) than ≥ 3 level fusion procedures (OR = 1.74; 95% CI = 1.29-2.36). A receiver operating characteristic curve analysis was performed, revealing an area under the curve of 0.838, suggesting "good" model predictability (Figure 2).²⁰

Table 2. Operative Parameters and Outcomes of Patients with and without PEG Tube Placement After Anterior Cervical Fusion.

Parameter	No PEG Tube	PEG Tube	P Value
Number of cases	163 880	217	
1-2 level fusion (%)	87.2	71.4	<.001 ^a
≥ 3 level fusion (%)	12.8	28.6	
Revision procedure (%)	0.4	0.0	.359
Corpectomy (%)	5.4	14.8	<.001 ^a
Use of rhBMP-2 (%)	7.1	8.3	.503
Length of stay (median, IQR)	1 (1-2)	13 (13-19)	<.001 ^a
Inpatient mortality (%)	0.05	5.1	<.001 ^a
Hospital charges (mean \$)	39 519 ± 24 323	134 379 ± 117 477	<.001 ^a
Nonroutine discharge (%)	9.7	90.3	<.001 ^a
Discharge disposition			
Home discharge (%)	90.4	9.7	<.001 ^a
Short-term hospital (%)	0.01	1.8	
Skilled nursing facility (%)	0.7	27.7	
Intermediate care (%)	0.04	0.5	
Other/unknown ^b	8.8	60.4	

Abbreviations: PEG, percutaneous endoscopic gastrostomy; rhBMP-2, recombinant human bone morphogenetic protein-2; IQR, interquartile range.

^aIndicates statistical significance.

^b"Other/unknown" includes, but is not limited to, discharge with home health care, against medical advice, hospice care, and others.

Table 3. Independent Predictors of PEG Tube Placement.

Parameter	Odds Ratio	95% Confidence Interval	P Value
Demographic predictors			
Age >65	4.16	2.88-6.00	<.001
Male gender	2.14	1.61-2.85	<.001
Comorbid predictors			
Congestive heart failure	4.11	2.60-6.49	<.001
Deficiency anemia	3.52	2.32-5.35	<.001
Alcohol abuse	2.80	1.29-6.09	.009
Renal failure	2.25	1.32-3.81	.003
Chronic lung disease	1.78	1.32-2.41	<.001
Operative predictors			
Corpectomy	2.16	1.47-3.17	<.001
≥ 3 level fusion	1.74	1.29-2.36	<.001

Abbreviation: PEG, percutaneous endoscopic gastrostomy.

Discussion

The number of cervical spine surgical procedures has been increasing during the past decades in the United States, with most of them corresponding to ACFs.^{21,22} In 2009 alone, more than 180 000 patients underwent cervical spine surgery, with an estimated population-adjusted incidence of 60.8 procedures per 100 000 people.²¹ One of the most common complaints after an ACF procedure is dysphagia, and while it is commonly regarded as a complication, others argue it is "an inevitable result of the surgery."¹ Although most cases are mild, severe swallowing difficulty may increase the risk of aspiration and

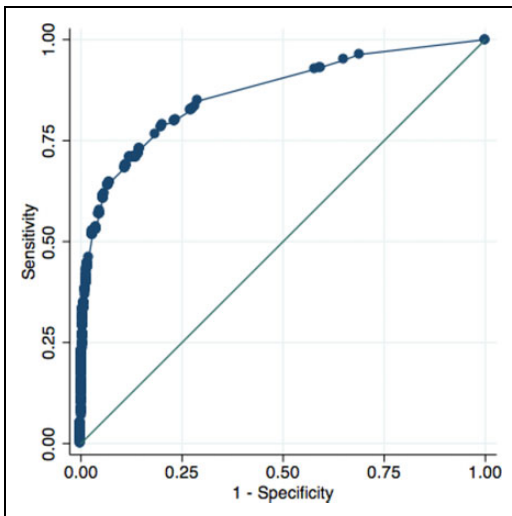


Figure 2. Receiver operating characteristic curve analysis of the regression model. This model included age >65, male gender, history of congestive heart failure, deficiency anemia, alcohol abuse, renal failure, and chronic lung disease, corpectomy, and ≥ 3 level fusion procedures. The area under the curve was calculated at 0.838.

impair postoperative nutrition.¹ In such cases, a temporary feeding tube (typically NG tube or PEG tube) may be required.

PEG was first introduced in 1980, and it is currently the preferred method for medium- and long-term enteral feeding.²³ Though it is used after ACF procedures, there is limited data regarding the incidence of its usage and associated risk factors.¹³⁻¹⁵ In this study, after examining short-term outcomes of 164 097 patients undergoing anterior cervical spine surgery, we found a PEG tube placement incidence of 0.13%, or 1 in every 756 procedures. The most important predictive factor was age over 65, but other associated risk factors included male gender, congestive heart failure, deficiency anemia, alcohol abuse, renal failure, chronic lung disease, corpectomy, and fusion of 3 or more spinal segments.

Tumalian et al reported outcomes of 200 patients who underwent single or multi-level anterior cervical discectomy and fusion with titanium plate fixation, polyetheretherketone spacer, and rhBMP-2.¹³ There were 5 patients in whom severe dysphagia was identified (2.5%), and 5 required PEG tube placement (2%). These 5 patients stayed in the hospital for an average of 13 days. Three of the 4 patients with PEG tube were able to regain complete swallowing function after 2 to 3 months, and the fourth patient required permanent PEG tube due to a coexisting diagnosis of amyotrophic lateral sclerosis.¹³ Of note, all patients who required enteral feeding underwent multilevel procedures (1 underwent 4-level anterior cervical discectomy and fusion [ACDF], 2 underwent 3-level ACDF, and 1 underwent 2-level ACDF), and half were repeat operations.¹³ Yaremchuk et al reported PEG tube placement in 6 out of 260 patients (2.3%) who underwent ACF with rhBMP-2, compared with 4 out of 515 patients (0.8%) in whom rhBMP-2 was not used ($P = .089$).¹⁵ Last, Saullé et al found a 20% risk of PEG tube usage after examining outcomes of

30 patients who underwent same-day anterior-posterior cervical spine fusion; average duration of PEG tube was 6 months.¹⁴ These previous rates of PEG tube placement are higher than the 0.13% rate found in our study, but may be explained by the fact that they were much smaller studies with risk of selection bias.

The most important predictive factor for PEG was age over 65 (OR = 4.16). Multiple studies have suggested that anterior approaches in the elderly population may result in higher rates of dysphagia and other complications when compared with younger patients,^{3,10,11} and it may be reasonable to consider a posterior approach in this population. Congestive heart failure, anemia, alcohol abuse, renal failure, and chronic lung disease also increased the risk for PEG tube placement in the present study, which could be attributed to the association between these conditions and malnutrition.²⁴⁻²⁷

Corpectomy and fusion of 3 or more levels were also among the identified independent risk factors. Eleraky et al reported a 7.6% rate of transient dysphagia in 185 patients who underwent cervical corpectomy, but none of these patients required PEG tube placement.²⁸ Lee et al investigated rates of dysphagia in 121 patients who underwent corpectomy and 173 who underwent discectomy; the patient self-reported rates of dysphagia (assessed in telephone interviews) were similar between both groups at 1, 2, 6, 12, and 24 months postoperatively.⁷ However, no subanalysis on the severity of dysphagia between groups was reported, as well as no information regarding treatment.⁷ The fact that corpectomy did increase the risk for PEG tube placement in our study could be explained by the fact that these operations are more extensive than a discectomy, but definitely warrant more investigation before definitive conclusions can be made. On the other hand, Bazaz et al found that the prevalence of dysphagia at 1 and 2 months after surgery was significantly higher for patients undergoing fusion of 3 or more spinal levels when compared with single or 2-level fusion.⁶ Similarly, 3 out of 4 patients who required PEG tube placement in Tumalian et al's study had undergone fusion of 3 or more levels.¹³

The in-hospital mortality rate for patients who underwent PEG tube placement was 5.1%, compared with 0.05% for the control group. Similarly, hospital charges were 2.4 times higher in the PEG group. Commensurate with our findings, Singh et al found significant differences in mortality (4.5 per 1000 vs 1.8 per 1000), length of hospitalization (5.5 vs 2 days), and costs (\$19 853 vs \$12 778) for patients who experienced dysphagia after ACF when compared with patients who did not experience this; nonetheless, no data on PEG tube placement was reported.²⁹ Last, the majority of patients in the PEG tube group in our study had a nonroutine discharge; this included discharge to short-term hospital, nursing facilities, and other types of facilities.

To the best of our knowledge, this is one of the first studies to examine the incidence of PEG tube placement after ACF procedures on a nationwide scale. Parameters associated with the condition were identified, and may be taken into consideration for surgical planning and risk stratification. More important, a significantly higher risk of mortality was identified, as

well as the financial impact of PEG tube placement in the short-term period.

Limitations

This study has several limitations inherent to usage of large administrative databases. Given that identification of diagnoses, procedures, and complications is based on use of ICD-9 codes, there is risk of coding and reporting bias. Additionally, the NIS does not contain information on patients' neurological status, myelopathy severity, radiographic parameters, presence of preoperative gastroesophageal reflux disease, preoperative dysphagia, or specific instrumented levels (ie, C3/C4 fusion vs C5/C6). Information outside the hospital stay is not available, and thus it is not possible to determine the duration of PEG tube use. Likewise, readmissions are not captured by the NIS, so it is possible a subset of patients were discharged with dysphagia/malnutrition and had to be readmitted for PEG tube placement. Nevertheless, the most important objective was identification of the incidence of PEG tube placement, which was something that is possible to do with such a large database.

Conclusion

The incidence of PEG tube placement after ACF procedures was 0.13% in this study. The most important independent predictor of PEG tube placement was age over 65, but other associated factors included male gender, heart failure, deficiency anemia, alcohol abuse, renal failure, chronic lung disease, corpectomy, and fusion of 3 or more spinal levels. Though uncommon, there may be a significantly increased risk of in-hospital mortality, increased hospital charges, and nonroutine discharge for patients requiring PEG tube placement.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Daniel M. Sciubba, MD: Consultant for Medtronic, Stryker, Depuy Synthes, Globus, and Orthofix.

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