Original Study

Non-neurological outcomes of anterior and posterolateral approaches in the surgical treatment of thoracic disc disease: a retrospective study

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Background: Symptomatic thoracic disc herniation (TDH) is rare, and for those patients that fail conservative treatment, two main categories of surgical approaches exist—anterior and posterolateral. In many cases either approach would be considered equally appropriate. Recommendations in support of either anterior or posterolateral approaches are currently based on case series and expert opinion. Here, we utilize National Surgical Quality Improvement Program (NSQIP) database to determine and compare the rates of complication associated with anterior or posterolateral approaches in the treatment of TDH.

Methods: An analysis of NSQIP data from 2005 to 2014 was conducted. Patients were included based on a combination of a postoperative diagnosis of TDH. Patients were then grouped according to anterior or posterior approaches on the basis of Current Procedural Terminology (CPT) codes. Propensity score matching was performed to account for baseline demographics [sex, race, age, obesity, diabetes, smoking, history of chronic obstructive pulmonary disease (COPD), history of CHF, and American Society of Anesthesiologists (ASA) class]. The 30-day outcome measures of these patients were analyzed.

Results: A total of 432 patients were identified, 80.3% underwent posterolateral and 19.7% anterior interventions. There were no significant differences in 30-day outcome measures between the anterior or posterior intervention groups. Within the matched group of 170 patients, the anterior group had significantly longer lengths of stay (5.49±3.96 *vs.* 4.01±4.81, P<0.0001), but there were no observed significant differences in the rate of occurrences of UTIs, pneumonias, sepsis, bleeding, intubation, or death.

Conclusions: Posterolateral and anterior approaches carry an equal non-neurological perioperative complication profile. Posterolateral approaches may carry shorter hospital stays compared to anterior interventions.

Keywords: Thoracic; disc; herniation; approach; surgery

Submitted Dec 27, 2017. Accepted for publication May 24, 2018.
doi: 10.21037/jss.2018.05.12
View this article at: http://dx.doi.org/10.21037/jss.2018.05.12

Introduction

Symptomatic thoracic disc herniation (TDH) accounts for 0.15% to 4% of all cases of herniation requiring surgical intervention (1,2). Due to its relatively low incidence, range of clinical presentations, and a conflicting definition of symptomatic herniation, the diagnosis and treatment of TDH remains controversial (3,4). In general, surgical intervention is indicated in patients who present with progressive myelopathy, lower extremity weakness, pain, and extra-spinal complaints (gastrointestinal or cardiopulmonary

discomfort) despite conservative therapy (3,5).

Though the approach to surgical intervention in these patients may be largely impacted by the degree, location, level of the herniation, the consistency of the herniated fragment, and the patient's habitus and comorbidities (4), in many cases, either of the two main categories of surgical approaches, anterior or posterolateral, would be considered equally appropriate. Recommendations in support of either anterior or posterolateral approaches are currently supported primarily by case series based upon small populations and have yet to be elucidated (2,4,6-8). Surgical decision making is based upon these recommendations, expert opinion, and consideration of the characteristics of the disc herniation.

To this end, here, we utilize the Surgeons National Surgical Quality Improvement Program (NSQIP) database to determine and compare the scope and rates of complication associated with anterior or posterolateral approaches in the treatment of TDH.

Methods

Data from the American College of Surgeons National Surgical Quality Improvement Program reported between January 1, 2005 and July 31, 2014 were analyzed. Patients with TDH were identified by postoperative diagnosis [ICD9 codes: (I) 722.11—displacement of thoracic intervertebral disc without myelopathy; (II) 722.51—degeneration of thoracic or thoracolumbar intervertebral disc; and (III) 722.72—intervertebral disc disorder with myelopathy] (9). All patients recorded with a Current Procedural Terminology (CPT) code not solely associated with TDH were excluded.

The operations associated with each patient was then categorized as anterior or posterolateral. Anterior approaches included transthoracic, thoracoscopic, retropleural thoracotomy, and mini-thoracotomy. Posterolateral approaches included the transpedicular, costotransversectomy, lateral extracavitary, and posterior pedicle-sparing transfacet (CPT codes: 21610, 22101, 22112, 22222, 22327, 22532, 22556, 22610, 22840, 22845, 63003, 63016, 63046, 63055, 63077, 63085, 63086, 63101, 63266).

Outcome variables

Baseline demographics, as well as 30-day post-surgical outcomes, were investigated between both groups. These outcomes included: urinary tract infection, pneumonia, sepsis, bleeding transfusions, unplanned intubation, myocardial infarction, stroke/cerebrovascular accident (CVA), the length of hospital stay, readmission, reoperation, and death.

Statistical analysis

Age and length of hospital stay, defined as days from operation until discharge, were described with the mean and standard deviation. Comparison of means between the groups consisted of the Kruskal-Wallis test. Sex, race, obesity status (BMI ≥30), diabetic status, smoking status, chronic obstructive pulmonary disease (COPD), American Society of Anesthesiologists (ASA) class, and occurrence of the following variables: urinary tract infection, pneumonia, sepsis, bleeding transfusion, unplanned intubation, myocardial infarction, stroke/CVA, readmission, reoperation, and death. These variables were described with counts and percentages of the study groups. They were analyzed using Pearson χ^2 test or Fisher exact test where appropriate.

In order to account for the non-random assignment of surgery approach, a propensity score match was performed between the two groups (10-12). A binominal logistic regression model was created to derive the propensity scores with the target variable being receiving anterior or posterolateral approach with the following covariates for matching: sex, race, age, obesity, Diabetes, smoking, history of COPD and ASA class. The matching algorithm used was a 1:1 nearest neighbor matching without replacement, in which each anterior case was matched to a unique posterolateral case on the basis of nearest propensity scores. The optimal caliper width for determining the maximum difference between propensity scores in order to be appropriately matched was calculated by taking 0.2 of the standard deviation of the logit function of the propensity scores (10). Cases were matched to the nearest score first then not to exceed the calculated optimal caliper width. Both matched and unmatched analyses were performed. To measure the statistical difference between the two approaches within each cohort, Pearson χ^2 test or Fisher exact test were conducted for all categorical variables and Kruskal-Wallis test was conducted for all continuous variables. All statistical analyses were conducted using commercially available software (SPSS v22, IBM, Armonk, NY, USA) and the level of significance was set at $P<0.05$.

Results

A total of 432 patients met inclusion criteria (*Table 1*).

Table 1 Baseline characteristics

Variables	General cohort (n=432)		Matched cohort (n=170)		P value
	Anterior approach (n=85)	Posterolateral approach (n=347)	Anterior approach (n=85)	Posterolateral approach (n=85)	
Sex, male	36 (42.4%)	175 (50.4%)	36 (42.4%)	31 (36.5%)	0.433
Race					0.453
White	69 (81.2%)	279 (80.4%)	69 (81.2%)	71 (83.5%)	
Black	8 (9.4%)	42 (12.1%)	8 (9.4%)	4 (4.7%)	
Other	0	7 (2.0%)	0	0	
Unknown	8 (9.4%)	19 (5.5%)	8 (9.4%)	10 (11.8%)	
Age (mean)	52.0±15.2	57.1±13.9	52.0±15.2	47.9±14.2	0.068
Obese, BMI ≥30	44 (51.8%)	189 (54.5%)	44 (51.8%)	41 (48.2%)	0.645
Diabetes	20 (23.5%)	68 (19.6%)	20 (23.5%)	22 (25.9%)	0.437
Smoking	21 (24.7%)	82 (23.6%)	21 (24.7%)	24 (28.2%)	0.602
Hx COPD	6 (7.1%)	9 (2.6%)	6 (7.1%)	9 (10.6%)	0.417
ASA class					0.847
1: healthy	5 (5.9%)	6 (1.7%)	5 (5.9%)	6 (7.1%)	
2: mild systemic disease	28 (32.9%)	144 (41.5%)	28 (32.9%)	24 (28.2%)	
3: severe systemic disease	48 (56.5%)	184 (53%)	48 (56.5%)	49 (57.6%)	
4: severe life threatening disease	4 (4.7%)	13 (3.7%)	4 (4.7%)	6 (7.1%)	
5: moribund without operation	0	0	0	0	

COPD, chronic obstructive pulmonary disease.

Among these, 347 (80.3%) patients underwent a posterolateral approach while 85 (19.7%) were underwent an anterior approach (*Table 1*). The anterior group was composed of 42.2% male, 81.2% white, 9.4% black, 9.4% unknown race, with a mean age of 52.0±15.2 years. The posterolateral group was composed of 50.4% male, 80.4% white, 12.1% black, 2.0% other, 5.5% unknown, with a mean age of 57.1±13.9 years. Presurgical physical status measured as ASA class determined all patients to fall within categories 1 through 4 (healthy through severe life threatening disease), with no patients classified in ASA class 5 (moribund without operation) (*Table 1*).

Following propensity score match, the anterior group demographics remained the same, as each case was successfully matched with a similar case in the posterolateral group. The patients matched from the posterolateral group were 36.5% male, 83.5% white, 4.7% black, 11.8% unknown race, with a mean age of 47.9±14.2 years. Propensity score match yielded no significant difference between anterior and posterolateral cases on the basis of: sex, race, age, obesity, diabetes, smoking status, history of COPD, and ASA class (P>0.05 for all).

Outcome measures

Within the general cohort of 432 patients, the anterior group displayed significantly longer lengths of stay, 5.49±3.96 and 4.13±4.21 days respectively, P<0.0001 (*Table 2*). There were 2 cases of death in the general cohort for patients undergoing the posterolateral approach, but were not found to be significantly different from the anterior group (P>0.05).

Within the matched cohort (n=170), the anterior group had significantly longer lengths of stay (5.49±3.96 *vs.* 4.01±4.81 days, P<0.0001, *Table 2*). There were no deaths in the matched cohort.

In both the general and matched cohorts, no significant differences were observed between the anterior and posterolateral groups in the following postoperative complications: urinary tract infection, pneumonia, sepsis, bleeding transfusion, unplanned intubation (P>0.05 for

Table 2 Outcome measures of general and matched cohorts categorized by surgical approach

Outcome measure	General cohort (n=432)			Matched cohort (n=170)		
	Anterior approach (n=85) (19.7%)	Posterolateral approach (n=347) (80.3%)	P value	Anterior approach (n=85) (50%)	Posterolateral approach (n=85) (50%)	P value
Urinary tract Infection	4 (4.7%)	9 (2.6%)	0.293	4 (4.7%)	1 (1.2%)	0.368
Pneumonia	2 (2.4%)	3 (0.9%)	0.246	2 (2.4%)	2 (2.4%)	1.0
Sepsis	3 (3.5%)	4 (1.2%)	0.139	3 (3.5%)	0	0.246
Bleeding transfusion	7 (8.2%)	26 (7.5%)	0.801	7 (8.2%)	7 (8.2%)	1.0
Unplanned intubation	1 (1.2%)	2 (0.6%)	0.48	1 (1.2%)	1 (1.2%)	1.0
Myocardial infarction	0	0	NA	0	0	NA
Stroke/CVA	0	0	NA	0	0	NA
LOS (days)	5.49±3.96	4.13±4.21	<0.0001	5.49±3.96	4.01±4.81	<0.0001
Readmission[†]	5/69 (7.2%)	25/294 (8.5%)	1.0	5/69 (7.2%)	3/73 (4.1%)	0.485
Reoperation[†]	3/70 (4.3%)	15/299 (5.0%)	1.0	3/70 (4.3%)	0/74 (0%)	0.112
Death	0	2 (0.6%)	1.0	0	0	NA

[†], no data available for variable prior to 2011. CVA, cerebrovascular accident; LOS, hospital length of stay.

all, *Table 2*). In both cohorts, there was no significant difference between the anterior and posterolateral groups in readmission or reoperation from 2011 to 2014, as this data was not available prior to 2011 (P>0.05 for both, *Table 2*). There were no cases of myocardial infarction or stroke/CVAs in either cohort.

Discussion

The goal of this study was to compare intraoperative and 30-day postoperative outcomes between anterior and posterolateral surgical approaches to TDH repair. Of the 432 qualifying patients from the NSQIP database, 80.3% of patients underwent a posterolateral repair while 19.7% underwent an anterior repair.

Perioperative complications

Previous studies have demonstrated inconsistencies in whether the anterior or posterolateral approach is associated with a greater rate of complications, including paraplegia and death (1,13-15). However, our study did not find significantly different rates of perioperative complications including death, urinary tract infection, pneumonia, sepsis, bleeding transfusions, unplanned intubation, readmission, reoperation within the general or matched cohort. The inability to assess neurological outcomes such as paraplegia is a large limitation of the database, and is discussed further below.

Previous studies have reported cardiac complications in association with the anterior approach (1,5,16,17). Yoshihara and Yoneoka's study of 25,413 patients from the National Inpatient Sample database, the retrospective review of 121 patients by Wait *et al.*, and Zhao's *et al.* retrospective analysis of 15 patients all report cardiac complications and myocardial infarctions to be associated with anterior interventions (1,16,17). However, our study did not reveal myocardial infarctions in either group.

In current literature, only Yoshihara and Yoneoka's study has closely examined urinary and renal complications in respect to anterior and posterolateral approaches. Their study demonstrated different rates of urinary and renal complications in anterior *vs.* non-anterior approaches. Our study found similar rates of complications of 4.7% and 1.2% in the anterior *vs.* non-anterior approach, retrospectively, but they were not significantly different (P=0.368) (1).

Unlike our study, previous studies did not utilize a propensity match and thus at baseline, the anterior and posterior groups were found to have significantly different ages, insurance type, and hospital regions.

Length of hospital stay

This study demonstrates that in the propensity-matched patient groups, the posterolateral approach has significantly

Table 3 Complications of surgical intervention by approach

Anterior approach
Neurologic complications (1,4)
Respiratory complications (1,16)
Cardiac complications (1,16,17)
Gastrointestinal complications (1)
Urinary and renal complications (1)
Pulmonary complications (1,5)
Wound related complications (1)
Cerebrospinal fluid leakage (4)
Pneumonia/pleural effusion (4,16,17)
Abducens nerve palsy (18)
Wrong level surgery (4)
Pain of intercostal nerve (17)
Incidental durotomy (16)
Reoperation (16)
Death (1)
Posterolateral approach
Neurologic complications (1,8)
Respiratory complications (1)
Cardiac complications (1)
Gastrointestinal complications (1)
Urinary and renal complications (1)
Pulmonary complications (1,5)
Wound related complications (1,19)
Paraplegia (13-15)
Kyphoscoliosis (14)
Reoperation (8,14,15)
Death (1,13,14)

shorter hospital stays (4.01±4.81 *vs.* 5.49±3.96 days, P<0.001), potentially indicating a faster recovery compared to anterior approaches. Likewise, previous studies have demonstrated that patients undergoing posterolateral interventions have been shown to require shorter hospital stays as compared to the lengths of stay by patients undergoing anterior interventions (1,4). Likewise, Arts and Bartels, who retrospectively compared minitransthoracic and transpedicular discectomies in 100 patients demonstrated significantly higher lengths of hospital stay in the minitransthoracic or anterior intervention group (4). Similarly, Yoshihara and Yoneoka's study found anterior approaches to be associated with longer hospital stays (1). Of note, our study demonstrated shorter mean lengths of stay for both patients undergoing posterolateral and anterior interventions when compared to previous studies.

Study limitations

Although our study examines a larger number of patients as compared to all but one previous study, its retrospective nature lends itself to limitations. Additionally, the NSQIP database only contains data for patients 30 days post-operatively. If patients experienced complications any later than 30 days after surgical repair, then these long-term outcomes were not captured. Due to the retrospective study design of a database, diagnosis is dependent on the ICD9 code, and we are not able to obtain information on the location and characteristics of the disc herniation. In clinical practice, these factors would be a part of the surgical decision-making process and were unable to account for this influence in this study.

Finally, the NSQIP does not include all complications that could be of interest in TDH repairs; it does not provide data on neurologic degeneration following surgery (e.g., paraplegia, hemiplegia), while past studies have documented neurologic degeneration as a complication of both approaches (*Table 3*) (1,4,8,13-15). This is a large limitation, as reported rates of neurologic deficits following surgery range from 1.3–4% in anterior approaches and from 0.9–28.6% in posterolateral approaches in reviews and case series (1,4,8,13-15). Rarer neurological outcomes reported in case reports of anterior approaches include abducens nerve palsy and intercostal nerve pain (17,18). Although neurological outcomes were not available on NSQIP, hospital readmission rates (7.2% *vs.* 4.1%, P>0.05) may be partially representative of these outcomes, as new-onset neurological deficit may warrant hospital readmission.

Conclusions

Ultimately multiple factors play a role in surgical approach, but through this large database analysis, the perioperative complication profiles appear equivalent in all observed measures of morbidity and mortality except for the length of hospital stay. The longer length of hospital stay associated with the anterolateral approach suggests a longer recovery time.

Based on our results, the surgical approach should continue to be based on current guidelines and surgeon's choice.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: This study was completed with NSQIP and was IRB exempt.

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Cite this article as: Nahhas CR, Scheer JK, Khalid SI, Adogwa O, Arnone GD, Bhimani AD, Kheirkhah P, Mehta AI. Non-neurological outcomes of anterior and posterolateral approaches in the surgical treatment of thoracic disc disease: a retrospective study. J Spine Surg 2018;4(2):241-246. doi: 10.21037/jss.2018.05.12

