Malignant pleural mesothelioma and the Society of Thoracic Surgeons Database: An analysis of surgical morbidity and mortality

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Background: To date, reported surgical morbidity and mortality for pleurectomy/decortication and extrapleural pneumonectomy performed for malignant pleural mesothelioma primarily represent the experience of a few specialized centers. For comparison, we examined early outcomes of pleurectomy/decortication and extrapleural pneumonectomy from a broader group of centers/surgeons participating in the Society of Thoracic Surgeons-General Thoracic Database.

Methods: All patients in the Society of Thoracic Surgeons-General Thoracic Database (version 2.081, representing 2009-2011) who underwent pleurectomy/decortication or extrapleural pneumonectomy for malignant pleural mesothelioma were identified. Patient characteristics, morbidity, mortality, center volume, and procedure were examined using univariable and multivariable analyses.

Results: A total of 225 patients underwent pleurectomy/decortication ($n = 130$) or extrapleural pneumonectomy ($n = 95$) for malignant pleural mesothelioma at 48 centers. Higher volumes of procedures ($\geq$5/y) were performed at 3 pleurectomy/decortication and 2 extrapleural pneumonectomy centers. Patient characteristics were statistically equivalent between pleurectomy/decortication and extrapleural pneumonectomy groups, except those undergoing extrapleural pneumonectomy were younger (63.2 ± 7.8 years vs 68.3 ± 9.5 years; $P < .001$) and more likely to have received preoperative chemotherapy (30.1% vs 17.8%; $P = .036$). Major morbidity was greater after extrapleural pneumonectomy, including acute respiratory distress syndrome (8.4% vs 0.8%; $P = .005$), reintubation (14.7% vs 2.3%; $P = .001$), unexpected reoperation (9.5% vs 1.5%; $P = .01$), and sepsis (4.2% vs 0%; $P = .03$), as was mortality (10.5% vs 3.1%; $P = .03$). Multivariate analyses revealed that extrapleural pneumonectomy was an independent predictor of major morbidity or mortality (odds ratio, 6.51; $P = .001$). Compared with high-volume centers, increased acute respiratory distress syndrome was seen in low-volume centers performing extrapleural pneumonectomy (0% vs 12.5%; $P = .05$).

Conclusions: Extrapleural pneumonectomy is associated with greater morbidity and mortality compared with pleurectomy/decortication when performed by participating surgeons of the Society of Thoracic Surgeons-General Thoracic Database. Effects of center volume require further study. (J Thorac Cardiovasc Surg 2014;148:30-5)

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Malignant pleural mesothelioma (MPM) is an aggressive malignancy of the pleura associated with a median survival of only 4 to 19 months.[1-3] Epidemiologic studies suggest that the incidence of MPM worldwide is underestimated and increasing.[4,5] The available, albeit limited, data on the treatment of patients with MPM suggest that multimodality therapy produces superior results compared with other strategies; however, the exact role of surgery in the treatment program has been controversial, and most of these data are derived from retrospective studies with known selection and reporting biases.[6,7] Macroscopic complete resection is thought to be the most achievable goal of surgical resection, but the optimal cytoreductive procedure is debated.

Extrapleural pneumonectomy (EPP) entails en bloc resection of the parietal pleura, lung, ipsilateral hemidiaphragm, and pericardium, with pericardial and diaphragmatic reconstruction. Pleurectomy/decortication (PD) involves resection of the parietal and visceral pleura, but spares the lung. Pericardial or diaphragmatic resection may be

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Abbreviations and Acronyms

ARDS	= acute respiratory distress syndrome
EPP	= extrapleural pneumonectomy
MPM	= malignant pleural mesothelioma
PD	= pleurectomy/decortication
STS-GTD	= Society of Thoracic Surgeons-General Thoracic Database

incorporated into PD when required. Proponents of each procedure argue the oncologic merits of each operation, but to date, a long-term survival advantage of one over the other has not been clearly shown. The role of surgery in the treatment of MPM became further debated after publication of the Mesothelioma and Radical Surgery (MARS) trial in 2011, which attempted to compare EPP with no EPP in patients with MPM.[8] The authors concluded that EPP within the context of trimodality therapy did not offer benefit; however, this trial was criticized for factors, including study design, small sample size, and high rate of mortality after EPP.[9,10]

The relative morbidity and mortality of PD and EPP are consistently reported in the literature. Although EPP seems to have a substantially greater morbidity and mortality than PD, the available data are largely from single institution studies and are representative of specialized centers. In a retrospective review of 663 patients with MPM treated with EPP or PD at 3 institutions, operative mortality rates of 7% for EPP and 4% for PD were reported, and rates of severe (grade 3-5) postoperative adverse events were 18.7% in EPP and 8.3% in PD.[6] A systematic review of 34 series comprising 2463 patients undergoing EPP at 26 institutions demonstrated perioperative mortality rates of EPP that ranged from 0% to 11.8%, with a median value of 5.5%. Overall perioperative complication rates for EPP were 22% to 82%, with 12.5% to 48% major morbidity.[11] In a separate systematic review of 1270 patients undergoing PD for MPM within 26 series, operative mortality ranged from 0% to 25%, with a weighted average of 4%.[12] Similar to other complex procedures, such as pneumonectomy and esophagectomy, the morbidity and mortality of EPP (and PD) might be expected to be lower at higher-volume centers,[13-15] although this remains unproven.

To more clearly define the morbidity and mortality of both PD and EPP, reflected by the experience of a broad range of thoracic surgeons and institutions, we reviewed data from the Society of Thoracic Surgeons-General Thoracic Database (STS-GTD). This database currently includes data from approximately 827 surgeons from 238 institutions across the United States. Within this construct, we examined the incidence of major complications and death for each procedure and identified predictive factors. Our hypothesis was that, among participants of the STS-GTD, EPP results in greater morbidity and mortality than does PD for patients with MPM. We also attempted to evaluate the contribution of center volume on postoperative morbidity and mortality after each of these procedures.

METHODS

Database and Patients

The research performed at Duke Clinical Research Institute on the STS-GTD is approved by the Duke University Institutional Review Board and was granted a waiver of informed consent and Health Insurance Portability and Accountability Act authorization. Individual participating institution's data collection is approved by the local institutional review board to ensure that patient privacy and confidentiality are protected. The STS-GTD, version 2.081 (2009-2011) was queried to identify patients with the diagnosis of "pleural tumor, malignant (eg, mesothelioma) 163.9," who underwent EPP (Current Procedural Terminology = 32445; n = 95) or PD (Current Procedural Terminology = 32320; n = 130). Prior versions of the STS-GTD did not distinguish between primary and secondary pleural tumors and were therefore not queried. Patients undergoing incomplete procedures, that is, "decortication, pulmonary-total, (32220)," "decortication, pulmonary-partial, (32225)," and "pleurectomy, parietal (32310)," were excluded. The number of PD and EPP procedures performed annually in each of the participating centers was recorded.

Definitions

Mortality was defined as death within 30 days, or before discharge. Major postoperative complications after PD or EPP were considered to be acute respiratory distress syndrome (ARDS), bronchopleural fistula, pneumonia, reintubation, placement of tracheostomy, pulmonary embolus, empyema, sepsis, myocardial infarction, ventricular arrhythmia requiring treatment, bleeding requiring reoperation, and unexpected return to the operating room. Minor complications included atrial arrythmias and prolonged air leak.

Statistical Analysis

The study design was approved by the Society of Thoracic Surgeons Access & Publications Committee, and statistical analyses were performed at the Duke Clinical Research Institute according to Society of Thoracic Surgeons protocol. Comparisons were performed using the 2-sample nonparametric Wilcoxon test for continuous variables and the Fisher exact test for categoric variables. To identify correlates of major morbidity and mortality, logistic regression analyses were performed. When developing the multivariable model, we first considered univariable logistic regressions to evaluate univariable associations of each variable in Table 1 with the presence of major morbidity or mortality. The multivariable analysis initially considered variables with a univariable probability value of less than .10. The model fits well as indicated by a not significant Hosmer–Lemeshow goodness-of-fit test (P = .34). The Nagelkerke R-square is 0.30 and C-statistic is 0.80.

RESULTS

Centers and Patients

During the study period, 286 patients with a diagnosis of MPM underwent pleural procedures. Eighteen patients undergoing "decortication, pulmonary-total," 13 patients undergoing "decortication, pulmonary-partial," and 30 patients undergoing "pleurectomy, parietal" were excluded as

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TABLE 1. Patient characteristics

Characteristic	PD n = 130	EPP n = 95	*P* value
Age (mean ± SD)	68.3 ± 9.5	63.2 ± 7.8	<.001
Male	104 (80)	80 (84.2)	.49
Race			.64
Caucasian	116 (90.6)	86 (90.5)	
Black	5 (3.9)	6 (6.3)	
Hispanic	5 (3.9)	3 (3.2)	
Body mass index	27.3 ± 3.6	27.2 ± 4.1	.77
Smoking history			.40
Never	51 (39.2)	45 (47.4)	
Past or current	79 (60.8)	50 (52.7)	
FEV1% (mean ± SD)	72.9 ± 21.3	73.3 ± 16.3	.84
DLCO% (mean ± SD)	74.0 ± 26.3	74.5 ± 18.4	.98
ASA risk class			.22
I	0 (0.0)	1 (1.1)	
II	23 (17.7)	10 (10.5)	
III	98 (75.4)	74 (77.9)	
IV	9 (6.9)	9 (9.5)	
V	0 (0.0)	1 (1.1)	
Zubrod score			.50
0	30 (23.1)	16 (16.8)	
1	86 (66.2)	70 (73.7)	
2	10 (7.7)	8 (5.4)	
3	4 (3.1)	1 (1.1)	
Coronary artery disease	13 (10.1)	9 (9.7)	1.0
Congestive heart failure	1 (0.8)	0 (0.0)	1.0
Hypertension	66 (51.2)	54 (56.8)	.42
Peripheral vascular disease	2 (1.3)	5 (5.4)	.13
Cerebral vascular disease	1 (0.8)	3 (3.3)	.31
COPD	6 (4.7)	10 (10.8)	.11
Diabetes	17 (13.2)	10 (10.8)	.68
Pulmonary hypertension	0 (0.0)	2 (2.2)	.11
Last creatinine level (mean ± SD)	1.0 ± 0.3	1.0 ± 0.3	.99
Last hemoglobin level (mean ± SD)	12.5 ± 1.9	12.3 ± 1.9	.63
Preoperative chemotherapy	23 (17.8)	28 (30.1)	.036
Preoperative radiotherapy	1 (0.8)	2 (2.2)	.57
Steroid use	0 (0.0)	1 (1.1)	.42

ASA, American Association of Anesthesiology; *COPD*, chronic obstructive pulmonary disease; *DLCO*, diffusing capacity of the lungs for carbon monoxide; *EPP*, extrapleural pneumonectomy; *FEV1*, forced expiratory volume in 1 second; *PD*, pleurectomy/decortication; *SD*, standard deviation.

inadequate oncologic operations. The final study cohort consisted of 130 patients undergoing PD and 95 patients undergoing EPP.

At least 1 operation for MPM, either PD or EPP, was performed among 48 participating centers during the study period of 3 years. Twenty-four centers performed PD, 37 centers performed EPP, and 13 centers performed both PD and EPP. Higher-volume centers performed 15 PD or EPP operations during the study period (≥5/y) (Figure 1). By using this criterion, only 3 centers qualified as higher-volume PD centers, and only 2 centers qualified as higher-volume EPP centers. Only one of these centers qualified as a higher-volume center for both PD and EPP.

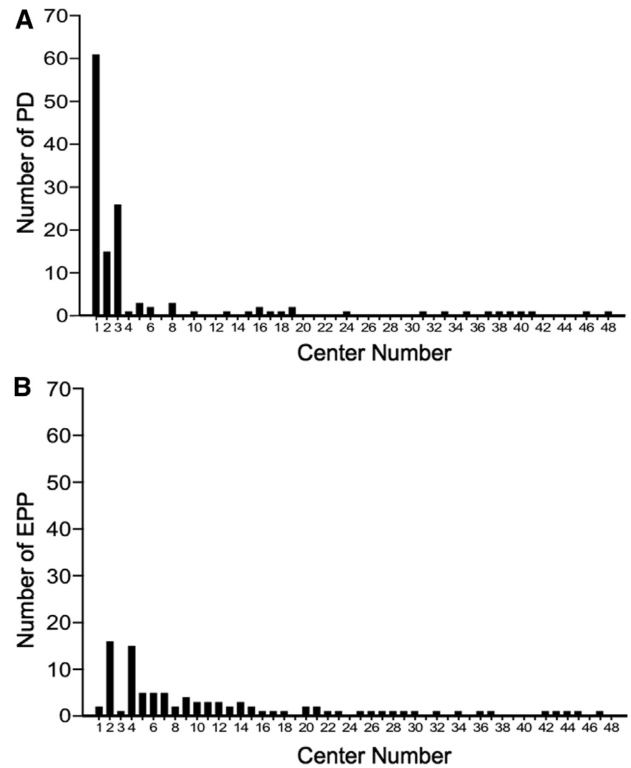

FIGURE 1. Number of PDs (A) and EPPs (B) performed in patients with MPM at each of the 48 participating centers during the 3-year time period of this study. *EPP*, Extrapleural pneumonectomy; *PD*, pleurectomy/decortication.

Patient Characteristics

Comparisons of preoperative characteristics between patients in the PD and EPP groups are shown in Table 1. The PD and EPP groups were statistically similar with 2 exceptions: Patients in the EPP group were younger than patients undergoing PD, and they more frequently received preoperative chemotherapy than patients in the PD group. There were no statistical differences in performance status, American Association of Anesthesiology risk classification, pulmonary function, or medical comorbidities between PD and EPP groups. Of the 225 patients, 36 (16%) underwent cervical mediastinoscopy before their EPP or PD operation. Twenty-three patients (24.2%) undergoing EPP and 13 patients (10%) undergoing PD underwent cervical mediastinoscopy. Staging data were not captured in this version of the STS-GTD.

Morbidity and Mortality

Table 2 displays the rates of major postoperative morbidities and mortality after PD and EPP. Compared with patients undergoing PD, patients undergoing EPP had significantly higher rates of ARDS (8.4% vs 0.8%), reintubation (14.7% vs 2.3%), sepsis (4.2% vs 0%), and unexpected return to the operating room (9.5% vs 1.5%).

TABLE 2. Rates of major postoperative morbidity and mortality in patients undergoing pleurectomy/decortication or extrapleural pneumonectomy for malignant pleural mesothelioma

Event	PD n = 130	EPP n = 95	*P* value
ARDS	1 (0.8)	8 (8.4)	.005
Bronchopleural fistula	0 (0.0)	1 (1.1)	.42
Pneumonia	3 (2.3)	5 (5.3)	.29
Reintubation	3 (2.3)	14 (14.7)	.001
Tracheostomy	3 (2.3)	7 (7.4)	.10
Pulmonary embolus	2 (1.5)	0 (0.0)	.51
Empyema	1 (0.8)	1 (1.1)	1.0
Sepsis	0 (0.0)	4 (4.2)	.031
Myocardial infarction	1 (0.8)	2 (2.1)	.57
Ventricular arrhythmia requiring treatment	1 (0.8)	2 (2.1)	.57
Bleeding requiring reoperation	0 (0.0)	0 (0.0)	1.0
Unexpected return to the operating room	2 (1.5)	9 (9.5)	.010
At least 1 major complication	5 (3.8)	23 (24.2)	<.001
Mortality	4 (3.1)	10 (10.5)	.027
At least 1 major complication or mortality	6 (4.6)	24 (25.3)	<.001

ARDS, Acute respiratory distress syndrome; *EPP*, extrapleural pneumonectomy; *PD*, pleurectomy/decortication.

Of the 17 patients requiring reintubation, 7 had a tracheostomy placed. EPP was associated with a significantly higher rate of postoperative mortality (10.5%) than was PD (3.1%). Other complications are shown in Table 3 and include atrial arrhythmias requiring treatment (41.1% vs 11.5%) in those undergoing EPP or PD. Prolonged air leak was observed in 23.1% of patients undergoing PD and in 1.1% of patients undergoing EPP, where this represented a bronchopleural fistula.

Determinants of Postoperative Morbidity and Mortality

Univariable and multivariable models were constructed to determine whether procedure (EPP or PD) was independently associated with major postoperative morbidity or mortality in patients undergoing cytoreductive surgery for MPM. Table 4 displays the significant univariable predictors, as well as the corresponding multivariable model for these variables. Univariable predictors of major postoperative morbidity and mortality included operation type (EPP), center volume (<5 procedures per year), peripheral vascular disease, cerebrovascular disease, and lower preoperative hemoglobin level. In the multivariable model, procedure type (EPP) and cerebrovascular disease were retained as independent predictors of major postoperative morbidity or mortality.

TABLE 3. Other postoperative events in patients undergoing pleurectomy/decortication or extrapleural pneumonectomy for malignant pleural mesothelioma

Event	PD n = 130	EPP n = 95	*P* value
Air leak >5 d duration	30 (23.1)	1 (1.1)	N/A
Atelectasis requiring bronchoscopy	1 (0.8)	3 (3.2)	.31
Initial ventilator support >48 h	2 (1.5)	4 (4.2)	.24
Atrial arrhythmia requiring treatment	15 (11.5)	39 (41.1)	<.001
DVT requiring treatment	1 (0.8)	2 (2.1)	.57
Wound infection	1 (0.8)	2 (2.1)	.57
Recurrent laryngeal nerve paresis	0 (0.0)	2 (2.1)	.18
Renal failure	4 (3.1)	8 (8.4)	.13
Chylothorax	1 (0.8)	0 (0.0)	1.0
Unexpected admission to ICU	5 (3.8)	9 (9.5)	.099
Length of stay (mean d ± SD)	8.1 ± 8.7	10 ± 7.4	.001

DVT, Deep vein thrombosis; *EPP*, extrapleural pneumonectomy; *ICU*, intensive care unit; *PD*, pleurectomy/decortication; *SD*, standard deviation; *N/A*, not compared.

Center Volume

A comparison of all preoperative characteristics listed in Table 1 was performed for patients undergoing PD at higher- and lower-volume PD centers, and separately for patients undergoing EPP at higher- or lower-volume EPP centers. There were no statistically significant differences in preoperative variables among these groups except that patients who underwent PD at higher-volume centers were more likely to have a lower American Association of Anesthesiology risk class (I-II: 21.6%, III: 77.5%, IV-V: 1.0%) than those who underwent PD at lower-volume centers (I-II: 3.6%, III: 67.9%, IV-V: 28.6%; $P < .001$). No differences in major postoperative morbidity or mortality were found between higher- or lower-volume PD centers. When examining EPP centers, there was a trend toward a higher rate of ARDS in lower-volume centers when compared with higher-volume centers (12.5% vs 0.0%; $P = .05$) (Table 5). The mortality rate after EPP was 6.5% at higher-volume centers and 12.5% at lower-volume centers, although this difference was not statistically significant ($P = .49$).

DISCUSSION

The treatment of patients with MPM often involves a coordinated multimodality treatment approach that incorporates surgery, systemic therapy (chemotherapy), and radiation. Although the role of surgery in the treatment of MPM remains controversial, many think that macroscopic complete resection improves long-term outcome in these patients.[3] However, a surgical standard of care for patients with MPM has not been established.

Comparisons of survival and recurrence outcomes between PD and EPP have been flawed by their mostly retrospective nature, imbalanced patient characteristics, and varying adjuvant treatments. Whereas EPP may be associated with improved rates of local control (33% local recurrence) compared with PD (65% local recurrence),[6] several historical series have suggested that patients with MPM treated with PD may have an overall better median survival than after EPP.[16] Conversely, a recent retrospective analysis of the International Association for the Study of

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TABLE 4. Univariable and multivariable analyses for predictors of major postoperative morbidity or mortality

Event	Univariate		Multivariate	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Procedure (EPP)	6.99 (2.73-17.90)	<.001	6.51 (2.07-20.47)	.001
Center volume <5 procedures/y*	3.42 (1.52-7.70)	.002	1.38 (0.49-3.93)	.54
Peripheral vascular disease	9.69 (2.05-45.76)	.006	4.42 (0.60-32.69)	.14
Cerebrovascular disease	21.11 (2.12-210.31)	.005	16.0 (1.02-251.30)	.03
Last hemoglobin level	0.80 (0.65-0.99)	.037	0.80 (0.63-1.02)	.07

CI, Confidence interval; *EPP*, extrapleural pneumonectomy; *OR*, odds ratio. *Center volume was individualized to procedure (EPP or PD).

Lung Cancer Mesothelioma database including 1494 patients treated with surgery with curative intent suggested a possible overall survival benefit in patients with stage I undergoing EPP (49 months) compared with PD (23 months).[7] Because the superiority of one procedure over another in providing improved cancer-specific survival is unproven, an accurate understanding of the operative risk associated with each procedure is critical.

The current representation of postoperative risk in MPM surgery is largely based on data from specialty centers. Therefore, we have sampled the multi-institutional STS-GTD to determine the frequency of postoperative morbidity and mortality after EPP and PD in MPM among a wider variety of surgical centers in the United States. In this report, in which PD was associated with a mortality rate of 3.1%, EPP was associated with a mortality rate of 10.5%, generally higher than previously published in large retrospective series. In the largest single institution series of 328 patients undergoing EPP, Sugarbaker and colleagues[15] reported 3.4% operative mortality associated with this procedure, and in a 3-institution series that included 385 patients undergoing EPP, operative mortality was 7%.[6] In our report, EPP also was associated with a higher rate of major morbidity (24.2%) than PD (3.8%). This is again generally higher than previously published results, including those demonstrating 18% serious (grade 3) or greater adverse events after EPP.[6] We therefore hypothesized that higher center volume might be associated with decreased mortality and morbidity after surgical cytoreduction for MPM.

Forty-eight participating centers performed PD or EPP for MPM; however, only few centers demonstrated a substantially higher relative volume for either procedure. Only 3 centers performed more than 5 PDs per year, and only 2 centers performed more than 5 EPPs per year. Overall, higher-volume centers seemed to favor PD over EPP, which may suggest that experienced surgeons recognize the operative risks of EPP and reserve this operation for selected patients. We found that the mortality rate of EPP was lower in higher-volume centers (6.5%) compared with lower-volume centers (12.5%), although this did not reach statistical significance.

TABLE 5. Major morbidity and mortality in patients undergoing pleurectomy/decortication or extrapleural pneumonectomy based on center volume

Characteristic	PD			EPP		
	Higher volume ≥5/y	Lower volume <5/y	*P* value	Higher volume ≥5/y	Lower volume <5/y	*P* value
Cases	102 (78.4)	28 (21.5)	<.001	31 (32.6)	64 (67.4)	<.001
ARDS	0 (0.0)	1 (3.6)	.22	0 (0.0)	8 (12.5)	.050
Bronchopleural fistula	0 (0.0)	0 (0.0)	1.0	0 (0.0)	1 (1.6)	1.0
Pneumonia	2 (2.0)	1 (3.6)	.52	1 (3.2)	4 (6.2)	1.0
Reintubation	3 (2.9)	0 (0.0)	1.0	4 (12.9)	10 (15.6)	1.0
Tracheostomy	2 (2.0)	1 (3.6)	.52	1 (3.2)	6 (9.4)	.42
Pulmonary embolus	1 (1.0)	1 (3.6)	.39	0 (0.0)	0 (0.0)	1.0
Empyema	1 (1.0)	0 (0.0)	1.0	0 (0.0)	1 (1.6)	1.0
Sepsis	0 (0.0)	0 (0.0)	1.0	0 (0.0)	4 (6.2)	.3
Myocardial infarction	1 (1.0)	0 (0.0)	1.0	0 (0.0)	2 (3.1)	1.0
Ventricular arrhythmia requiring treatment	1 (1.0)	0 (0.0)	1.0	0 (0.0)	2 (3.1)	1.0
Bleeding requiring reoperation	0 (0.0)	0 (0.0)	1.0	0 (0.0)	0 (0.0)	1.0
Unexpected return to the operating room	1 (1.0)	1 (3.6)	.39	3 (9.7)	6 (9.4)	1.0
At least 1 major complication	3 (2.9)	2 (7.1)	.29	6 (19.4)	17 (26.6)	.61
Mortality	4 (3.9)	0 (0.0)	.58	2 (6.5)	8 (12.5)	.49
At least 1 major complication or mortality	4 (3.9)	2 (7.1)	.61	6 (19.4)	18 (28.1)	.45
Length of stay (mean d ± SD)	7.9 ± 6.9	9.1 ± 13.7	.51	8.3 ± 4.7	10.8 ± 8.3	.052

ARDS, Acute respiratory distress syndrome; *EPP*, extrapleural pneumonectomy; *PD*, pleurectomy/decortication; *SD*, standard deviation.

Our multivariate analyses showed that whereas procedure (EPP), lower center volume, peripheral vascular disease, cerebrovascular disease, and low hemoglobin level were each predictors of postoperative morbidity or mortality, only procedure (EPP) and the presence of cerebrovascular disease were independent predictors of this outcome. The reason for which cerebrovascular disease, and not other more common risk factors, independently predicted postoperative morbidity and mortality is not completely known, but we speculate that it may in some way be a surrogate for a less fit surgical candidate.

The selection of EPP or PD for patients with MPM is based on a number of factors, including tumor burden, distribution of disease, surgeon preference and experience, and institutional factors. Although it is likely that center and surgeon volume and experience do influence morbidity and mortality outcomes after EPP and PD, our analyses did not reveal center volume to be an independent predictor of morbidity or mortality after either of these 2 procedures. Interpretation of our center volume analyses is constrained by the limited number of patients in these analyses, and we believe that the influence of center volume deserves attention in larger future studies. With further maturation of the STS-GTD, and with the recent efforts of large international multi-institutional databases, these analyses will become more feasible.

Study Strengths and Limitations

The use of a multi-institutional general thoracic surgery database is one of the strengths of this study. We believe that our data represent a broader surgeon and center experience than most previously published reports; however, there are certainly a number of centers that treat patients with MPM who are not captured by this database. Other limitations of this report include its retrospective study design and the associated selection and information biases. Although our EPP and PD patient cohorts were relatively balanced in preoperative characteristics, our analyses were limited by the absence of histology data and staging data, and both of these factors are likely to influence the surgeon's choice of procedure. It is possible that EPP in these patients is a marker of more extensive disease, and that patients who underwent this procedure had a higher degree of lung involvement. Furthermore, although a balanced comparison of long-term outcomes of EPP and PD for patients with MPM also is necessary to make an informed decision for choice of operation, this currently cannot be derived from our dataset. Finally, PD is not a truly standardized operation and completeness of resection could be variable depending on the operating surgeon. We approached this by excluding patients who most likely represented an incomplete resection (operations coded as pulmonary decortication and parietal pleurectomy).

CONCLUSIONS

In patients with MPM undergoing surgical cytoreduction, a long-term advantage in survival or recurrence has not been conclusively demonstrated for either EPP or PD over one another. Taken together, the results of our study and the experience of others suggest that PD is associated with less postoperative morbidity and mortality than is EPP.

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