Contemporary Outcomes in Surgical Pulmonary Embolectomy

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Introduction

- Venous thromboembolism as third most common cause of hospital-related death
  - 296,000 deaths in USA
- Dr. Friedrich Trendelenburg in 1872 and 1907
- Dr. Martin Kirschner in 1924
- Dr. Denton Cooley in 1961
Research Questions

- Define the role of surgical pulmonary embolectomy relative to other treatment modalities
- Evaluate modern surgical pulmonary embolectomy outcomes
Methods

- Retrospective study
- Single large academic medical center
- 2008-2022
- STS database
- Pulmonary severity groups based on presence of right ventricular dysfunction (RVD) and hemodynamic stability
  - Submassive PE, massive PE, and massive PE with cardiac arrest
- Primary outcomes: 30-day mortality and adverse outcome composite
- Secondary outcomes: ICU and post-operative length of stay, 1 year mortality
- SAS statistical software
## Results

| Table 1. Patient Characteristics and Outcomes, by Severity. |
|-----------------|-----------------|-------------------|-----------------|-----------------|
| PE severity     | Submassive (N = 23) | Massive (N = 23) | Massive with arrest (N = 10) | P-value |
| Characteristics |                 |                   |                             |        |
| Female          | 13 (57%)         | 9 (39%)           | 6 (60%)                     | 0.39   |
| Age, median (25p, 75p) | 52 (38, 67)     | 60 (46, 64)       | 57.5 (46, 66)              | 0.89   |
| Race            |                 |                   |                             | 0.17   |
| Black           | 15 (65%)         | 13 (57%)          | 3 (30%)                     |        |
| White           | 8 (35%)          | 10 (43%)          | 7 (70%)                     |        |
| Postoperative outcomes |         |                   |                             |        |
| ICU LOS, median (25p, 75p) | 3 (2, 7)       | 4 (3, 8)          | 4 (2, 13)                   | 0.31   |
| Postop LOS, median (25p, 75p) | 8 (7, 20)     | 11 (7, 18)        | 12 (6, 16)                  | 0.76   |
| Adverse outcome composite  | 1 (4.4%)        | 4 (17.4%)         | 5 (50.0%)                   | 0.01   |
| New dialysis    | 0               | 3 (13.0%)         | 1 (10.0%)                   | 0.22   |
| Stroke          | 1 (4.4%)         | 1 (4.4%)          | 0                            | 1.00   |
| Multisystem organ failure | 1 (4.4%)       | 2 (8.7%)          | 3 (30.0%)                   | 0.11   |
| 30-day mortality| 1 (4.4%)         | 2 (8.7%)          | 5 (50.0%)                   | < 0.01 |
| 1-year mortality| 2 (8.7%)         | 3 (13.0%)         | 5 (50.0%)                   | 0.02   |

PE, pulmonary embolism. ICU, intensive care unit. LOS, length of stay.

a - Composite of new dialysis, stroke, multisystem organ failure, and 30-day mortality.
Table 2 - Unadjusted and adjusted odds ratios and hazard ratios for adverse outcome composite, 30-day mortality, and 1-year mortality following pulmonary embolectomy, by severity (Massive with arrest group as reference).

<table>
<thead>
<tr>
<th>PE Severity</th>
<th>Submassive</th>
<th>P-value</th>
<th>Massive</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adverse outcome composite</strong></td>
<td></td>
<td></td>
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<tr>
<td>Unadjusted OR (95% CI)</td>
<td>0.05 (&lt;0.01-0.48)</td>
<td>0.01</td>
<td>0.21 (0.04-1.09)</td>
<td>0.06</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)</td>
<td>0.04 (&lt;0.01-0.65)</td>
<td>0.02</td>
<td>0.27 (0.04-1.80)</td>
<td>0.18</td>
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<tr>
<td><strong>30-day Mortality</strong></td>
<td></td>
<td></td>
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<tr>
<td>Unadjusted OR (95% CI)</td>
<td>0.05 (&lt;0.01-0.48)</td>
<td>0.01</td>
<td>0.10 (0.01-0.64)</td>
<td>0.02</td>
</tr>
<tr>
<td>Adjusted OR (95% CI)</td>
<td>0.03 (&lt;0.01-0.58)</td>
<td>0.02</td>
<td>0.10 (0.01-0.87)</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>1-year Mortality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted HR (95% CI)</td>
<td>0.13 (0.02-0.65)</td>
<td>0.01</td>
<td>0.20 (0.05-0.83)</td>
<td>0.03</td>
</tr>
<tr>
<td>Adjusted HR (95% CI)</td>
<td>0.17 (0.03-0.90)</td>
<td>0.04</td>
<td>0.35 (0.08-1.58)</td>
<td>0.17</td>
</tr>
</tbody>
</table>

PE, pulmonary embolism. OR, odds ratio. CI, confidence interval. HR, hazard ratio.

a - Composite of new dialysis, stroke, multisystem organ failure, and 30-day mortality.
b - Adjusted for sex, age, and race.
Discussion

- Significant difference in outcomes between severity of PE
  - Submassive PE: 1 out of 23 patients had serious post operative complications

- Historical data of post operative mortality after SPE most likely reflection of selecting only the most critically ill patients or those in extremis
  - Stein et al. published SPE operative mortality was 32% between 1961 and 2006 vs 20% for those between 1986 and 2006
  - Preoperative cardiac arrest 59% vs 29% who did not experience cardiac arrest

- Our data in the past 12 years: overall operative mortality of 14% with 50% with preoperative cardiac arrest and 7% without
  - Similar to Kon et al. published overall operative mortality of 16% with 44% with preoperative cardiac arrest and 11% without

- Increase in SPE from 1995 to 2014, rate of 0.6% to 5% with patients being offered SPE have less severe symptoms at presentation led to improved surgical outcomes

- Reevaluation of treatment algorithm for PE
Meneveau et al. demonstrated increase in 30-day mortality with repeat systemic thrombolysis compared to SPE group

- Additional studies show no difference in rates of 30-day and 2-year mortality between SPE and systemic thrombolysis

SEATTLE II study in 2015 demonstrated 2.7% 30-day mortality rate for catheter directed thrombolysis

FLARE study in 2019 demonstrated 1% 30-day mortality and 13% major adverse events

No prospective trials comparing percutaneous mechanical thrombectomy with SPE

Current guidelines from ESC and PERT Consortium

- Include surgical pulmonary embolectomy in intermediate-high risk PE; consider catheter directed treatment equivalent to SPE
Limitations and Future Research Opportunities

- Limitations:
  - Single institution
  - Small population
- Evaluation comparing catheter-based thrombolytics vs SPE
Conclusion

- Surgical Pulmonary embolectomy is an effective and safe treatment in patients with sub-massive and massive PE
References


Questions?