

Impact of Routine Placement of Two Chest Tubes on Pneumothorax and Subcutaneous Emphysema After Robotic Mitral Valve Surgery

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INTRODUCTION

Robotic cardiac surgery introduces respiratory considerations, including CO₂ insufflation, single-lung ventilation, and port-based access that predispose to pneumothorax and subcutaneous emphysema (SE). In our early experience, SE was common and, when severe, increased postoperative resource utilization. A quality-improvement protocol introducing a routinely placed second, anterior chest tube was implemented. This study evaluated whether routine placement of two chest tubes reduces the incidence of postoperative pneumothorax and SE following robotic mitral valve surgery.

METHODS

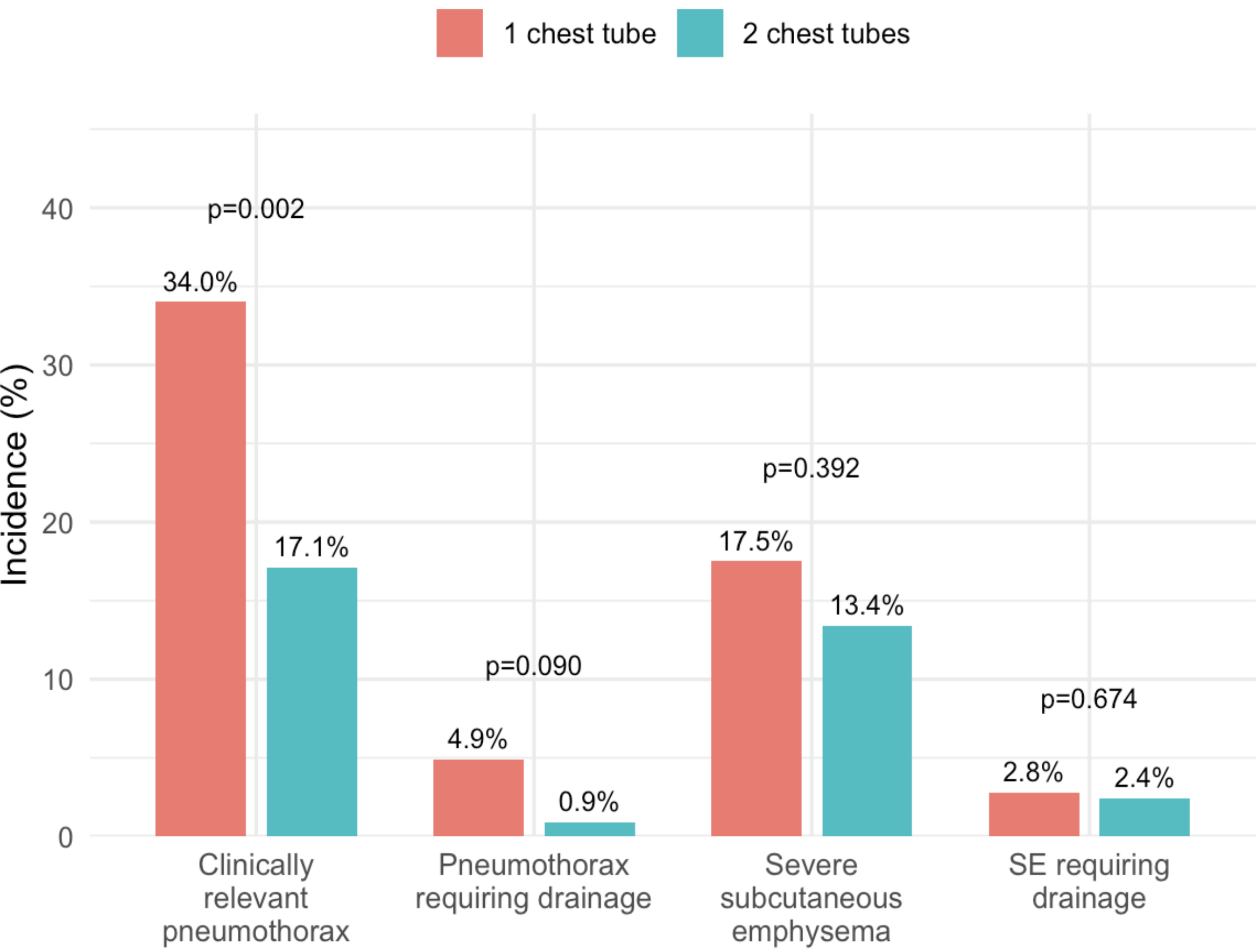
Consecutive patients undergoing robotic mitral valve surgery between September 2021 and August 2025 were analyzed. Patients with conversion to sternotomy (n=5) or three chest tubes (n=1) were excluded, leaving 209 patients: 103 with a single chest tube (Era 1) and 106 with two tubes (Era 2). Postoperative chest radiographs were reviewed by dedicated radiologists using standardized diagnostic criteria. Co-primary endpoints were clinically relevant pneumothorax ($\geq$ moderate grade) and severe SE and statistical significance was assessed using a Bonferroni-adjusted α of 0.025.

CONCLUSIONS

Routine placement of a second, anterior chest tube after robotic mitral valve surgery significantly reduced clinically relevant pneumothorax, despite the two-tube cohort having higher baseline risk and more complex procedures. A numerical trend toward reduced severe SE was also observed.

RESULTS

Baseline characteristics showed that Era 2 patients were older, had higher STS risk, and more COPD. Era 2 also included more complex procedures. Clinically relevant pneumothorax occurred more often in the one-tube group (34.0% vs 17.1%, p=0.002). Pneumothorax requiring drainage was lower with two tubes (4.9% vs 0.9%, p=0.09). Severe SE occurred in 17.5% vs 13.4% (p=0.392). On multivariable analysis, one tube remained independently associated with clinically relevant pneumothorax (OR 2.51). Lower BMI was the only independent predictor of severe SE.



Variable	1 Chest Tube (N=103)	2 Chest Tubes (N=106)	All (N=209)	P Value
Pneumothorax (PTX)	62 (60.2%)	74 (69.8%)	136 (65.1%)	0.145
Pneumothorax Grade				
Tiny	9 (8.7%)	26 (24.5%)	35 (16.7%)	
Small	18 (17.5%)	29 (27.4%)	47 (22.5%)	
Moderate	33 (32.0%)	18 (17.0%)	51 (24.4%)	0.002
Medium	2 (1.9%)	1 (0.9%)	3 (1.4%)	
Severe	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Pneumothorax Side				
Right	54 (52.4%)	70 (66.0%)	124 (59.3%)	
Left	0 (0.0%)	1 (0.9%)	1 (0.5%)	0.222
Bilateral	0 (0.0%)	3 (2.8%)	3 (1.4%)	
Time To Occurrence (PTX)	2 (0-3)	1 (0-2)	1 (0-3)	0.085
Relevant Pneumothorax ($\geq$ Moderate)	35 (34.0%)	19 (17.9%)	54 (25.8%)	0.008
Pneumothorax Needing Additional Drainage	5 (4.9%)	1 (0.9%)	6 (2.9%)	0.09
Subcutaneous Emphysema (SE)	63 (61.2%)	61 (57.5%)	124 (59.3%)	0.594
Subcutaneous Emphysema Grade				
Mild	44 (42.7%)	47 (44.3%)	91 (43.5%)	
Moderate	1 (1.0%)	0 (0.0%)	1 (0.5%)	0.604
Severe	18 (17.5%)	14 (13.2%)	32 (15.3%)	
Subcutaneous Emphysema Side				
Right	48 (46.6%)	56 (52.8%)	104 (49.8%)	
Left	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.921
Bilateral	4 (3.9%)	5 (4.7%)	9 (4.3%)	
Time To Occurrence (SE)	0 (0-1)	0 (0-1)	0 (0-1)	0.426
Severe Subcutaneous Emphysema	18 (17.5%)	14 (13.2%)	32 (15.3%)	0.392
SE Needing Additional Drainage	2 (1.9%)	3 (2.8%)	5 (2.4%)	0.674
Chest Tubes				
Total Chest Tube Output Excl)	820 (455-1335)	883 (540-1628)	851 (188-1417)	0.062
Chest Tube Duration (Days)	3 (2-4)	3 (2-4)	3 (2-4)	0.156
Addition Chest Tube Inserted (Within Hospitalization)	7 (6.8%)	7 (6.6%)	14 (6.7%)	0.956
Tap Or Reinsertion (Within 30days)	11 (10.7%)	10 (9.4%)	21 (10.0%)	0.765
Time To Tap Or Reinsertion	8 (4-13)	10 (3-22)	9 (3-16)	0.429
Number Of Chest Radiographs	6 (5-7)	6 (5-8)	7 (5-7)	0.387
Computed Tomography Scan	12	9 (8.5%)	21 (10.0%)	0.447