Acute Kidney Injury Following Pulmonary Thromboendarterectomy

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Poster #7

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Background

- Pulmonary thromboendarterectomy (PTE) is an established technique to improve pulmonary and cardiovascular function in chronic thromboembolic pulmonary hypertension (CTEPH), however its effect on renal function is not known.

Objectives and Hypothesis

- Since PTE surgery requires complete circulatory arrest, we hypothesized that it would be associated with development of acute kidney injury (AKI). In addition, we postulated that the enhancement in cardiovascular performance would result in an improvement in renal function at hospital discharge.

Patients and Methods

- We reviewed data from 123 adult patients with CTEPH undergoing PTE enrolled in a prospective trial of a lung protective ventilation strategy to prevent acute lung injury. AKI was determined by the AKIN/KDIGO AKI serum creatinine and urine output criteria. Outcomes included duration of mechanical ventilation, intensive care unit and hospital stay, and renal function at discharge.

Results

Figure 1. Patient Flow Chart. Applying (asterisk) the actual sCr and UO criteria by the AKIN/KDIGO classification system.

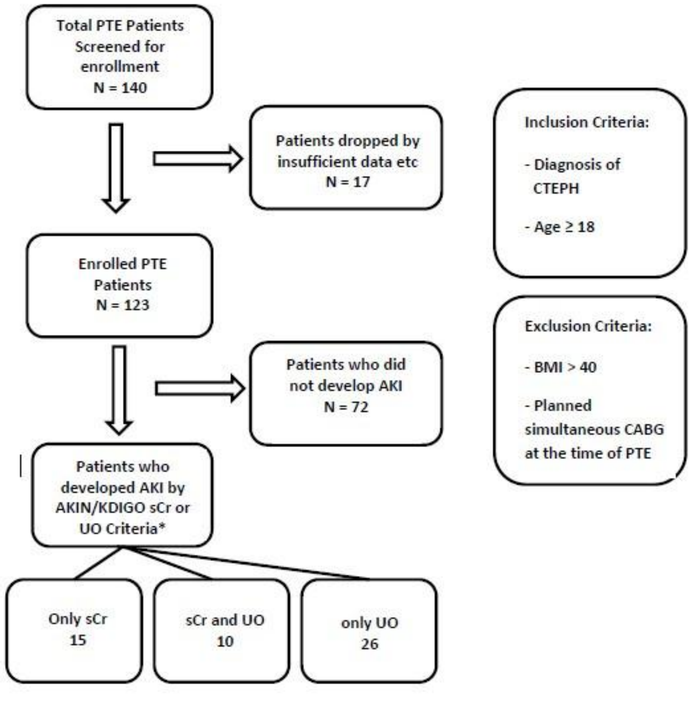

Figure 2. During the ICU stay after PTE surgery in the ICU, the mean sCr changes in No AKI group, AKI group by KDIGO criteria, AKI with sCr criteria and AKI by UO criteria

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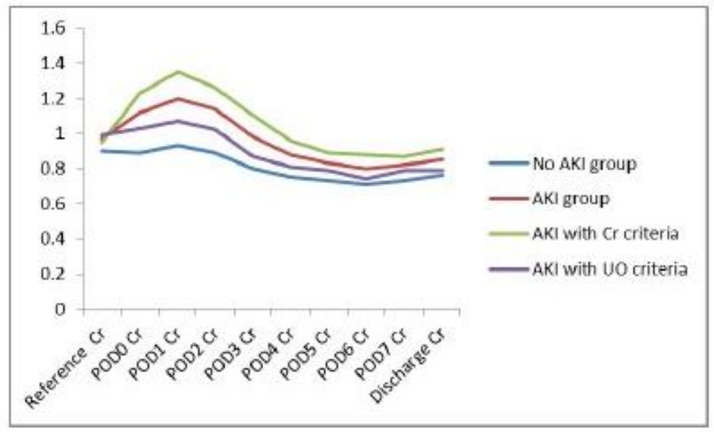

Table 1. Patient Characteristics & Clinical Outcomes in Whole PTE Cohorts (n=123)

Patient characteristics	
Age, year	52.2 ± 13.7[a]
Gender (% of male)	63 (51.2)
Race, Caucasian (%)	100 (81.3)
Race, African American (%)	15 (12.2)
Race, Others (%)	8 (6.5)
Preoperative baseline body weight, kg	84.1 ± 19.5
Height, cm	172.6 ± 11.8
BMI	28.3 ± 5.0
Preoperative reference sCr, mg/dL	0.93 ± 0.23
Hb, preoperative	13.4 ± 1.8
Hct, preoperative	39.3 ± 5.4
Glucose, preoperative	109.7 ± 16.3
Albumin, baseline	3.7 ± 0.4
Preoperative CKD-EPI GFR < 60 mL/min per 1.73 m^2, no. (%)	12/123 (9.8)
NYHA class 2, preop (%)	24 (20)
NYHA class 3, preop (%)	93 (76)
NYHA class 4, preop (%)	5 (4)
Intraoperative data	
Lowest SBP, intraop (mmHg)	85.5 ± 7.5
Lowest DBP, intraop (mmHg)	46.2 ± 4.1
Highest SBP, intraop (mmHg)	135.7 ± 17.1
Highest DBP, intraop (mmHg)	78.0 ± 9.9
Infused crystalloids during surgery (mL)	1275 ± 456
Intraoperative UO (mL)	776 ± 434
CPB time, min	281.9 ± 46.8
Aortic cross-clamp time (Circulatory arrest time), min	37.0 ± 12.6
Cooling time, min	97.8 ± 20.2
Rewarming time, min	129.6 ± 21.9

[a]The ± values are means ± S.D. [b]The values are medians (minimum, maximum). [c]Paired Samples t Test : P < 0.001

Table 2. Pre-OP and Pre-discharge Hemodynamic Changes after PTE

Variable	Pre-OP	Pre-discharge	*P*-value
PVR (dynes/sec/cm^{-5})	724.3 ± 367.3[a]	251.2 ± 122.6	0.000[b]
PAP, systolic (mmHg)	76.1 ± 20.3	41.3 ± 12.1	0.000
PAP, diastolic (mmHg)	27.7 ± 9.7	17.1 ± 5.8	0.000
PAP, mean (mmHg)	45.6 ± 11.3	25.7 ± 7.3	0.000
CI (L/min/m^{-2})	2.2 ± 0.6	2.8 ± 0.7	0.000
RAP (mmHg)	10.3 ± 5.5	9.3 ± 3.5	0.054

[a]The ± values are means ± S.D. [b]Paired samples t test

Table 3. Comparison between AKI and No AKI group by KDIGO AKI Criteria

Variable	No AKI (n=72)	AKI (n=51)	*P*-value
Intraoperative and postoperative data			
Infused crystalloids during surgery (mL)	1299 ± 501	1281 ± 480	0.939
Intraoperative UO (mL)	772 ± 484	812 ± 449	0.512
Delta PVR	-471.9 ± 312.6	-406.1 ± 289.0	0.328
Delta PAP, systolic	-33.2 ± 18.6	-31.0 ± 15.5	0.586
Delta PAP, diastolic	-7.0 ± 8.2	-7.3 ± 8.9	0.814
Delta PAP, mean	-16.4 ± 9.1	-16.3 ± 10.4	0.767
Delta Cardiac index	0.58 ± 0.66	0.57 ± 0.75	0.931
Delta RAP	2.27 ± 5.93	-0.27 ± 6.56	0.079
CPB time, min	282 ± 41	276 ± 54	0.415
Aortic cross-clamp time, min	39 ± 13	41 ± 15	0.843
Cooling time, min	107 ± 22	104 ± 20	0.507
Rewarming time, min	135 ± 23	130 ± 22	0.592
Clinical outcome data			
sCr at discharge (mg/dL)	0.75 ± 0.17	0.86 ± 0.21	0.008
Discharge CKD-EPI GFR < 60 mL/min per 1.73 m^2, no. (%)	1 (1.4)	2 (3.8)	0.389
Length of mechanical ventilation (days)	3.5 ± 3.1	4.1 ± 5.0	0.668
Length of ICU stay (days)	4 (3, 14)[b]	5.5 (3, 25)	0.011
ICU stay > 4 days, no. (%)	23 (32)	21 (54)	0.029
Length of hospital stay (days)	12 (6, 37)	15 (8, 71)	0.029
Hospital stay after surgery, days[b]	10 (6, 25)	12 (6, 31)	0.029
ICU mortality (%)	0	0	–
Hospital death, no. (%)	0	0	–

[a]The ± values are means ± S.D. [b]Reported as median (range) [c]Mann-Whitney *U* test

Summary and Conclusions

- Fifty-one (41%) patients developed AKI following PTE surgery; 25 (20%) met the serum Cr and 26 (21%) the urine output criteria.
- Underlying CKD (estimated GFR < 60 ml/min per 1.73 m2) was present in 10% and was more frequent in patients with AKI.
- The mean time to development & duration of AKI were 2.7 & 2.3 days, respectively.
- AKI and no-AKI patients had a similar duration of ventilator requirement (median of 1.0 day, p=0.77) and significantly longer median lengths of stay in the ICU and hospital.
- At discharge, renal function had improved in 40.6%, was unchanged in 56.1%, & had worsened in 3.3%.
- A similar trend was seen in patients with pre-existing chronic kidney disease (n=13) with over 76% showing improvement to an estimated GFR >60 ml/min.
- We observed a high incidence of AKI following PTE which was associated with worse outcomes.
- Renal function improved following PTE and was similar in AKI and no-AKI patients. These findings highlight the importance of measuring renal function changes in CTEPH patients undergoing PTE.