Transfusion and Coagulation Management in Acute Type A Aortic Dissection

Philipp Pfeiffer[1], Vanessa Buchholz[1], Chris Probst[1], Ahmed Ghazy[1], Hendrik Treede[1], Daniel-Sebastian Dohle[1]

[1]Department of Cardiovascular Surgery, University Medical Center Mainz, 55131 Mainz, Germany

Background

- Acute type A aortic dissection (AAD) leads to activation of coagulation pathways and a decrease in available coagulation factors
- Surgical repair involves cardiopulmonary bypass (CPB), heparin administration, hypothermic circulatory arrest, and blood dilution, which further impair coagulation
- Ensuring hemostasis is crucial, as rethoracotomy increases hospital mortality significantly
- Transfusion and coagulation products are routinely required intra- and postoperatively to establish sufficient hemostasis

Objective

- This retrospective study investigates the impact of various factors on the quantity of transfusions and coagulation factors needed during AAD treatment

Methods

- Patients were identified using our institutional aortic database
- Demographics, comorbidities, clinical status at time of presentation, procedural details, and the postoperative course were analyzed retrospectively
- Intra- and postoperative transfusions, administered coagulation factors, chest-drain and rethoracotomy rates were obtained from clinical records and stratified according to the clinical status at time of presentation
- Multivariable linear regression models for transfusion and substitution were calculated including the variables: age, gender, BSA, oral anti-coagulation, Penn classification, CPB and distal ischemia times, lowest temperature, and extent of surgical repair

Results

- **369 patients were operated for AAD between 01/2017 and 12/2022**
- **Demographics, the prevalence of risk factors, and the clinical status at presentation are representative for AAD patients**

Patient demographics	Total (n=369)
DeBakey type I dissection	281 (76.2%)
Age [years]	65.5±13.1
Male	235 (63.7%)
BMI [kg/m²]	27.3±5.4
BSA [m²]	2.0±0.3
Hypertension	257 (69.6%)
Diabetes mellitus	27 (7.3%)
Nicotine abuse	79 (21.4%)
Coronary artery disease	65 (17.6%)
COPD	43 (11.7%)
Oral anticoagulation	51 (13.8%)
Previous cardiac surgery	28 (7.6%)

Values are n (%) or mean ± standard deviation

Status at presentation	Total (n=369)
Aortic valve regurgitation	218 (59.1%)
Bicuspid aortic valve	15 (4.1%)
Penn classification	
Penn A (no shock or malperfusion)	156 (42 %)
Penn B (malperfusion)	113 (31 %)
Penn C (shock)	37 (10%)
Penn BC (shock and malperfusion)	63 (17%)

Values are n (%) or mean ± standard deviation

Results

- **Most patients were treated with a hemiarch procedure, followed by total arch replacement**
- **Postoperative complications occurred within anticipated ranges for AAD patients**

Surgery	Total (n=369)
Extension of repair	
Isolated proximal repair	22 (6.0%)
Hemiarch replacement	206 (55.8%)
Arch replacement	134 (36.3%)
Other proximal repair	7 (1.9%)
Aortic valve replacement	59 (16.0%)
Aortic root replacement	66 (17.9%)
Cardiopulmonary bypass [minutes]	222±76
Cross-clamping [minutes]	124±48
Lowest temperature [°C]	23.4±4.1

Values are n (%) or mean ± standard deviation

Postoperative course	Total (n=369)
Hospital stay [days]	14.7±11.2
In hospital death	54 (14.6%)
Rethoracotomy	41 (11.1%)
Dialysis	66 (17.9%)
Tracheotomy	26 (7.0%)

Values are n (%) or mean ± standard deviation

Results: Transfusions and Coagulation Factors

		Total (n=369)	Penn A (n=156)	Penn B (n=113)	Penn C (n=37)	Penn BC (n=63)	p-value
pRBC [250 ml units]	intraOP	3.99±4.15	3.08±2.67	3.37±3.26	5.89±4.99	6.25±6.35	**<0.001**
	24h	1.31±2.56	0.76±1.58	1.16±1.90	1.90±2.68	2.94±4.66	**<0.001**
Platelets [250 ml units]	intraOP	1.95±2.14	1.60±0.95	1.93±1.08	2.38±1.40	2.62±4.55	**0.007**
	24h	0.19±0.71	0.06±0.32	0.14±0.55	0.16±0.58	0.72±1.43	**<0.001**
FFP [250 ml units]	intraOP	2.22±3.60	1.47±2.71	2.29±3.42	2.73±3.91	3.67±5.00	**<0.001**
	24h	1.82±3.54	1.05±2.10	1.49±2.98	3.26±5.05	3.96±5.47	**<0.001**
PCC [IU]	intraOP	2475±1590	2035±1174	2720±1462	2795±1552	2934±2331	**<0.001**
	24h	178±699	59±260	130±444	329±953	551±1413	**<0.001**
Fibrinogen [g]	intraOP	3.94±2.44	3.35±1.79	4.02±2.30	5.03±2.85	4.63±3.30	**<0.001**
	24h	0.35±1.28	0.17±0.76	0.30±1.04	1.10±2.69	0.53±1.46	**0.002**
Chest Drain [ml]	24h	786±614	681±507	739±485	841±542	1165±974	**<0.001**
Rethoracotomy		41 (11.1%)	12 (7.7%)	12 (10.6%)	5 (13.5%)	12 (19.0%)	0.106
In hospital death		54 (14.6%)	9 (5.8%)	9 (8.0%)	11 (29.7%)	25 (39.7%)	**<0.001**

pRBC: packed red blood cells, FFP: fresh frozen plasma, PCC: Prothrombin complex concentrate
Values are n (%) or mean ± standard deviation

- **Significantly more transfusion and coagulation products were used in patients with preoperative shock and/or malperfusion**

Results: Multivariate linear regression

Dependent variable	Independent variable	coefficient	95% CI	p-value
intraOP pRBC [250 ml units]	BSA [m^2]	-2.40	-4.35 – -0.45	**0.016**
	Penn C	1.84	0.49 – 3.19	**0.008**
	Penn BC	1.89	0.81 – 2.97	**0.001**
	CPB time [min]	0.03	0.02 – 0.03	**<0.001**
intraOP Platelets [250 ml units]	Penn C	0.68	0.20 – 1.16	**0.006**
	Penn BC	0.52	0.13 – 0.90	**0.009**
	Root replacement	0.42	0.05 – 0.79	**0.025**
intraOP FFP [250 ml units]	Penn BC	1.57	0.48 – 2.66	**0.005**
intraOP PCC [IU]	BSA [m^2]	1178	276 – 2081	**0.011**
	Preoperative oral anticoagulation	569	33 – 1104	**0.037**
	Penn B	501	78 – 924	**0.020**
	Penn BC	684	185 – 1183	**0.007**
	CPB time [min]	3.46	0.48 – 6.45	**0.023**
intraOP Fibrinogen [g]	BSA [m^2]	1.69	0.36 – 3.01	**0.013**
	Penn C	1.51	0.60 – 2.43	**0.001**
	Penn BC	0.96	0.23 – 1.70	**0.010**
	CPB time [min]	0.01	0.00 – 0.01	**0.024**

- **Significant factors for transfusions and the substitution of coagulation factors are shock, the duration of cardiopulmonary bypass, root replacement, the patient's size, and the preoperative use of oral anticoagulation**
- **Other tested variables did not contribute significantly**

Conclusions

- Surgical repair for AAD remains major surgery requiring blood transfusions and coagulation factors in almost all patients
- The most important significant factors that necessitate transfusions and substitution of coagulation factors are shock, duration of cardiopulmonary bypass, and patient's size
- Other factors such as lowest temperature during hypothermic circulatory arrest, gender, age, or distal extent of the surgery were not associated with a higher need for transfusion and coagulation products
- With proper management taking the mentioned factors into account, acceptable rethoracotomy and chest drain rates can be achieved with good clinical outcome