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Short paper

Outcome after type A aortic dissection repair in patients with preoperative cardiac arrest

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Abstract

Aim of the study: Patients presenting with acute type A aortic dissection (ATAAD) and cardiac arrest before surgery are considered to have very poor prognosis, but limited data is available. We used a large database to evaluate the outcome of ATAAD patients with a cardiac arrest before surgery.

Methods: We evaluated 1154 surgically treated ATAAD patients from the Nordic Consortium for Acute Type A Aortic Dissection (NORCAAD) database between 2005 and 2014. Patients with (n = 44, 3.8%) and without preoperative cardiac arrest were compared and variables univariably associated with mortality in the cardiac arrest group were identified. Median follow-up time was 2.7 years (interquartile range 0.5–5.5).

Results: Thirty-day mortality in the arrest and non-arrest group was 43.2% and 16.6%, respectively (odds ratio [OR] 3.83, CI 2.06–7.09; $P < 0.001$). In the nine patients with ongoing cardiopulmonary resuscitation when cardiopulmonary bypass was initiated, five died intraoperatively and one died after 65 days. In patients surviving the operation, stroke was significantly more common in the arrest group (48.4% vs 18.2%; OR 4.21, CI 2.05–8.67; $P < 0.001$). In total, 50.0% (22/44) of the arrest patients survived to the end of follow-up. Non-survivors in the arrest group more often had DeBakey type I dissection, cardiac tamponade, cardiac malperfusion and higher preoperative serum lactate (all $P < 0.05$).

Abbreviations: ATAAD, acute type A aortic dissection; CPR, cardiopulmonary resuscitation; ECG, electrocardiography; HR, hazard ratio; IQR, interquartile range; NORCAAD, the Nordic Consortium for Acute Type A Aortic Dissection; OR, odds ratio.

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Conclusions: Early mortality and complications after ATAAD surgery in patients with a preoperative cardiac arrest are high, but mid-term outcome after surviving the initial period is acceptable. Preoperative cardiac arrest should not be considered an absolute contraindication for a surgical ATAAD repair.

Keywords: Type A aortic dissection, Cardiac arrest, Malperfusion, Outcome

Introduction

Acute type A aortic dissection (ATAAD) is a life-threatening condition with a high mortality. Previous studies report that 25–53% of ATAAD patients do not reach the hospital alive due to rupture of the aorta or severe organ malperfusions.[1–4] Out of those who survive the transport to an operating unit, 8.2–17.6% succumb en route to the operating room and additional patients die during or after surgery.[1,4] Thirty-day mortality after surgery varies between 22.6 and 47.4%.[1,4–10]

Cardiac arrest in patients with ATAAD may be caused by myocardial malperfusion, cardiac tamponade or aortic rupture.[11,12] ATAAD patients with preoperative cardiac arrest are generally presumed to have a dismal prognosis. In fact, preoperative cardiac arrest may be considered a contraindication for surgery in ATAAD patients.[11,13,14] Studies evaluating patients with ATAAD and cardiac arrest before surgery is scarce and mid- or long-term outcome data has not been presented before.[11,15] Therefore, we used a large, multinational registry to evaluate the characteristics and prognosis in surgically treated ATAAD patients with preoperative cardiac arrest, and identified factors related to mortality.

Methods

Patients and data collection

This was a retrospective study from the Nordic Consortium for Acute Type A Aortic Dissection (NORCAAD) database.[16] The database consists of 1159 consecutive patients operated for ATAAD between 2005 and 2014 at eight Nordic university hospitals. Study design and data collection have been previously described.[16] Patients that were accepted for surgical treatment and survived until the start of surgery were included in the database. Information on preoperative cardiac arrest was missing from five patients, leaving 1154 for overall analysis. Information about general daily function were collected from patient records in each centre in March 2018. Follow-up regarding survival was 100% complete.

Definitions

Preoperative arrest was defined as circulatory collapse that required a period of cardiopulmonary resuscitation (CPR) within 24 h prior to surgery. Cardiac tamponade was defined as blood in the pericardium that clinically affected the heart's hemodynamic performance. Preoperative cardiac malperfusion was defined as ST-segment changes on ECG, and/or signs of myocardial ischemia on echocardiogram, and/or raised myocardial injury markers. Cerebral malperfusion was defined as clinical signs of stroke and gastrointestinal malperfusion was defined as mesenteric or liver ischemia detected by computed tomography. Initial systolic blood pressure < 90 mmHg was considered as hypotensive shock. Acute kidney injury was defined according to the serum creatinine component of the RIFLE criteria.[17] Unstable hemodynamics when entering the operating room was described as having hypotensive shock, ventricular arrhythmia or ongoing CPR. Perioperative myocardial infarction was defined as increased myocardial injury markers and/or a new Q-wave or bundle branch block.

Statistics

The statistical analyses were performed using IBM SPSS Statistics version 25 (IBM, Armonk, NY, USA). Categorical variables were compared using Chi-squared test for non-ordered categorical variables and Fisher's exact test for dichotomous variables. Odds ratios (OR) were calculated using logistic regression model. Continuous variables were reported as median with interquartile range (IQR) and compared using Mann–Whitney U-test. Univariable Cox regression analysis was used to identify predisposing factors and report the hazard ratios (HR) for overall mortality. The proportional hazard was checked by visually reviewing the log (−log(Survival)) vs log(time) figure and was found satisfied in both groups for the time period where events were occurring. Log-rank test was used to detect statistical differences in mid-term survival between the groups. OR and HR were reported with 95% confidence interval (CI), P-values <0.05 were considered statistically significant and all tests were two-tailed.

Results

General

In total, 44/1154 (3.8%) ATAAD patients experienced cardiac arrest < 24 h before surgery. Baseline characteristics for ATAAD patients with and without cardiac arrest prior to surgery are presented in Table 1. Characteristics of the cardiac arrest episodes are described in Table 2. The characteristics of cardiac arrest patients who survived the follow-up period (n = 22) and non-survivors (n = 22) are compared in Table 3. The mean overall follow-up was 3.3 years (median 2.7, IQR 0.5–5.5).

Outcomes

Early outcome is presented in Table 1. Thirty-day mortality in the arrest and non-arrest group was 43.2% and 16.6%, respectively (Odds ratio (OR) 3.83, 95%CI 2.06–7.09; $P < 0.001$). In patients surviving the operation, stroke was more common in the arrest group (48.4% vs 18.2%; OR 4.21, 95%CI 2.05–8.67; $P < 0.001$). Nine out of 26 cardiac arrest patients who survived to discharge were discharged to another hospital or to a rehabilitation centre, seven were discharged to another intensive care unit, three were discharged to their homes while seven patients' discharge location remained unknown.

For 30-day survivors, mean follow-up was 4.0 years (median 3.7, IQR 1.6–6.1). In the cardiac arrest group, the cumulative survival was

Table 1 – Preoperative characteristics in operated acute type A aortic dissection patients with (n = 44) or without preoperative cardiac arrest (n = 1110). Number of patients with percentages or median with interquartile range (IQR) were indicated.

	Preoperative arrest group		Non-arrest group		
	Available number of patients		Available number of patients		P-value
Age (years)	44	66.6 (52.5–71.25)	1100	63.0 (54.0–70.8)	0.67
Male gender	44	31 (70.5%)	1110	750 (67.6%)	0.75
Active smoking	35	11 (31.4%)	811	248 (30.6%)	1.00
Hypertension	44	22 (50.0%)	1108	577 (52.1%)	0.88
History of coronary artery disease	44	1 (2.3%)	1107	47 (4.2%)	1.00
Known thoracic aortic aneurysm	43	5 (11.6%)	1107	106 (9.6%)	0.60
Use of antiplatelet drugs	44	15 (34.1%)	1110	361 (32.5%)	0.87
Previous cardiac or aortic surgery	44	3 (6.8%)	1110	61 (5.5%)	0.73
Hypotensive shock	44	24 (54.5%)	1026	227 (22.1%)	<0.001
Organ malperfusions					
Cardiac malperfusion	44	12 (27.3%)	1020	76 (7.5%)	<0.001
Cerebral malperfusion	43	5 (11.6%)	1021	85 (8.3%)	0.40
Gastrointestinal malperfusion	42	3 (7.1%)	1021	33 (3.2%)	0.17
Preoperative lactate in serum (mmol/l)	30	5.5 (2.4–8.7)	598	1.5 (1.0–2.6)	<0.001
Pericardial tamponade	43	26 (60.5%)	1086	172 (15.8%)	<0.001
Intraoperative variables					
Perioperative myocardial infarction	37	9 (24.3%)	1084	62 (5.7%)	<0.001
Intraoperative death	44	13 (29.5%)	1110	72 (6.5%)	<0.001
Postoperative variables					
Prolonged ventilation	34	16 (47.1%)	1076	337 (31.3%)	0.06
Stroke	31	15 (48.4%)	1088	198 (18.2%)	<0.001
Dialysis	44	5 (11.4%)	1110	118 (10.6%)	0.88
Cardiac arrest	35	3 (8.6%)	1081	76 (7.0%)	0.73
Atrial fibrillation	34	19 (55.9%)	1078	411 (38.1%)	0.04
Resternotomy for bleeding	36	6 (16.7%)	1087	224 (20.6%)	0.57
Septicemia	35	6 (17.1%)	1088	106 (9.7%)	0.16
Length of ICU stay (days)	44	4 (0.5–5.5)	1110	4 (2–7)	0.49
30-day mortality	44	19 (43.2%)	1110	184 (16.6%)	<0.001

P-value was tested using Chi-square for non-ordered categorical variables, Fisher's exact test for dichotomous variables, Mann–Whitney U-test for continues variables and logistic regression for dichotomous postoperative variables. IQR = interquartile range; ICU = intensive care unit.

Table 2 – Characteristics of cardiac arrest episodes and mortality in type A aortic dissection patients that presented with preoperative cardiac arrest <24 h before surgery.

	Number of patients N (%)	30-day mortality N (%)
Location of the first cardiac arrest episode (n = 44)		
Outside hospital	22 (50.0%)	8 (36.4%)
At the referring hospital	7 (15.9%)	4 (57.1%)
At the operating hospital	7 (15.9%)	3 (42.8%)
In the operating room	8 (18.2%)	4 (50.0%)
Rhythm (n = 33)		
Shockable	14 (42.4%)	3 (21.4%)
Non-shockable	19 (57.6%)	9 (47.4%)
ROSC (n = 32)		
ROSC achieved	25 (78.1%)	12 (48.0%)
No ROSC before operation	7 (21.9%)	4 (57.1%)
Unstable hemodynamics[a] in operating room (n = 40)	23 (52.3%)	11 (47.8%)
Ongoing CPR during cardiopulmonary bypass initiation (n = 40)	9 (22.5%)	5 (55.6%)

ROSC = return of spontaneous circulation; CPR = cardiopulmonary resuscitation.
[a] Unstable hemodynamics was defined as systolic blood pressure <90 mmHg, ventricular arrhythmia or cardiac arrest.

49.2%, 49.2% and 49.2% at 1, 3 and 5 years, respectively, and in the non-arrest group, the survival were 79.7%, 76.1% and 72.1%, respectively. Information about daily function at the end of follow-up was available in 15 of the 22 surviving arrest patients; 12 of the patients were independent in their daily life. Three out of 15 patients had neurological dysfunctions; one had impaired vision, one had lower limb paresis and one was not able to write for unknown reasons.

Table 3 – Characteristics of overall survivors (n = 22) and non-survivors (n = 22) in the cardiac arrest group. Hazard ratio for mortality with 95% confidence interval are from univariable Cox regression.

Variables	Available number of patients	Survivors N = 22 N (%) or median (IQR)	Non-survivors N = 22 N (%) or median (IQR)	Univariable Cox regression HR (95% CI)	P-value
Clinical background					
Age (median)	44	66.2 (52.0–73.0)	66.7 (54.0–68.0)	0.99 (0.96–1.03)	0.74
Male gender	44	14 (63.6%)	17 (77.3%)	1.54 (0.57–4.18)	0.40
Hypertension	44	10 (45.5%)	12 (54.5%)	0.80 (0.35–1.85)	0.60
Active smoking	35	6 (33.3%)	5 (29.4%)	1.04 (0.37–2.96)	0.94
Hyperlipidemia	43	5 (22.7%)	2 (9.5%)	0.47 (0.11–2.02)	0.31
Family history of Aortic dissection	36	2 (10.5%)	1 (5.9%)	0.67 (0.09–5.05)	0.70
Previous cardiac or aortic surgery	44	1 (4.5%)	2 (9.1%)	1.34 (0.31–5.75)	0.69
Use of antiplatelet drug	44	5 (22.7%)	10 (45.5%)	1.93 (0.83–4.49)	0.13
Clinical presentation					
Sudden pain	43	17 (77.3%)	17 (81.0%)	1.33 (0.45–3.97)	0.61
DeBakey type I	41	11 (50.0%)	17 (89.5%)	6.21 (1.20–22.67)	0.023
Hypotensive shock	44	11 (50.0%)	13 (59.1%)	1.35 (0.58–3.17)	0.49
Cardiac tamponade	43	9 (40.9%)	17 (81.0%)	4.94 (1.45–16.85)	0.01
Malperfusion					
Cardiac	44	3 (13.6%)	9 (40.9%)	2.51 (1.06–5.94)	0.04
Cerebral	43	3 (14.3%)	2 (9.1%)	1.33 (0.39–4.51)	0.65
Gastrointestinal	42	1 (4.8%)	2 (9.5%)	0.84 (0.11–6.27)	0.86
Location	44				
In-hospital		8 (36.4%)	14 (63.6%)	2.04 (0.85–4.87)	0.11
Out-hospital		14 (63.6%)	8 (36.4%)		
Non-shockable rhythm	33	9 (47.4%)	10 (71.4%)	3.26 (0.90–11.77)	0.07
Ongoing CPR during cardiopulmonary bypass initiation	40	3 (16.7%)	6 (27.3%)	1.52 (0.59–3.91)	0.38
Preoperative lactate in serum (mmol/l)	30	3.4 (1.7–7.6)	6.3 (4.8–11.8)	1.13 (1.01–1.27)	0.04
Time from diagnosis to operation (hours)	39	3.0 (0.3–5.3)	2.8 (1.0–4.2)	0.97 (0.90–1.04)	0.45

P-value was tested using Chi-square for non-ordered variables and Fisher's exact test for dichotomous variables. For continues variables Mann–Whitney U-test was used. IQR = interquartile range; CPR = cardiopulmonary resuscitation.

Discussion

The main finding of this study was that operated ATAAD patients that experienced a preoperative cardiac arrest before the start of surgery had approximately 50% overall survival after five years. These patients had a very high operative risk, but outcome was acceptable if the patient survived to discharge. This indicates that patients with preoperative cardiac arrest should not be automatically denied operative treatment and that in carefully selected patients, survival and function can be acceptable.

In the present study, cardiac arrest occurred before the ATAAD diagnosis was established in 22/44 (50%) of the arrest patients. The survival in ATAAD patients with out-of-hospital cardiac arrest was more favourable (36.4% 30-day mortality) than patients with in-hospital cardiac arrest (50.0%). This is assumably biased by patient selection as ATAAD patients with out-of-hospital cardiac arrest that survive until surgery represents a subgroup of patients. Nevertheless, early outcome in surgically treated ATAAD patients with cardiac arrest was still markedly better than reported in ATAAD patients that are not operated (90–100% mortality).[2,11]

The early outcome of cardiac arrest patients in the present study was better than previously reported. In the study by Meron et al., that included all non-traumatic aortic dissection/rupture as a cause of cardiac arrest in a single centre between 1992 and 2002, only one out of 21 (4.7%) ATAAD patients survived surgery.[11] In another single centre study by Godon et al., which included ATAAD patients with in-hospital cardiac arrest, only 13% (3/23) of the patients survived until hospital discharge.[15] The definition of cardiac arrest before surgery and patient selection in the respective studies may contribute to the diverging results. The high early mortality for in-hospital cardiac arrest patients in the present study is partly explained by the poor survival (3/9) in the patients with ongoing CPR until cardiopulmonary bypass was established. In addition, one of the remaining patients had severe neurological sequelae. Hence, only two of the nine patients recovered.

The mid-term survival for the cardiac arrest patients was acceptable. In fact, the last non-surviving cardiac arrest patient died on the 65th postoperative day, while the remaining 22 (50%) arrest patients were alive at the end of follow-up. Furthermore, despite the fact that 47% of the cardiac arrest hospital survivors were diagnosed postoperatively with stroke, 12 of the 15 patients for whom we were able to obtain information about gross functional ability lived independently. Notably, only three patients had any permanent neurological deficits. The results indicate that despite initial poor prognosis, the patients who eventually survive the procedure can have an acceptable daily function. We do acknowledge, however, that the follow-up time was limited and for seven patients the information about recovery was not available. Therefore, although our findings can be regarded as encouraging, they should be interpreted with caution.

Limitations and strengths

The main limitations of this study are the retrospective design and the limited number of patients with cardiac arrest. This study included only surgically treated ATAAD patients, therefore, we did not have information on patients that did not survive to operating theatre, nor if they refused or were denied surgery. The current study also has several strengths: no previous study has reported outcomes in ATAAD patients with cardiac arrest from a large multicentre database. Patients were followed in mandatory nationwide population registries with complete follow-up regarding survival. Moreover, the study population was relatively homogenous, and the standard of health care offered in the eight centres is similar.

Conclusions

Early mortality and complication rate after ATAAD surgery in patients with a preoperative cardiac arrest was high but mid-term outcome in patients surviving the initial period was acceptable. Therefore, a preoperative cardiac arrest episode should not be considered as an absolute contraindication for surgical repair of ATAAD.

Conflicts of interest

None.

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