Ann Thorac Cardiovasc Surg 2014; 20: 383–389
Online July 31, 2013
doi: 10.5761/atcs.oa.13-02268

Original Article

Impact of Severe Postoperative Complications after Cardiac Surgery on Mortality in Patients Aged over 80 Years

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Background: The aims of this study are (1) to investigate the occurrence rate of postoperative complications in patients ≥ 80 years old after cardiac surgery and (2) to elucidate the impact of the most common postoperative complications on mortality.
Methods: Between January 1998 and December 2007, 649 patients aged over 80 years received isolated first-time coronary artery bypass graft (CABG), isolated aortic valve replacement (AVR) or a combination of both in our institute. Prospectively entered patient data were analyzed with respect to major complications and outcome parameters.
Results: Acute renal failure (55.0% vs. 7.5%, p = 0.0001), low cardiac out-put syndrome (43.1% vs. 8.8%, p = 0.0001), sepsis (52.0% vs. 10.3%, p = 0.0001), prolonged respiratory failure with tracheotomy (29.0% vs. 11.0%, p = 0.002), re-thoracotomy due to bleeding (26.9% vs. 10.6%, p = 0.0001), and postoperative laparotomy (30.8% vs. 11.5%, p = 0.033) had a significant impact on mortality. A multivariate analysis revealed that advanced age (OR 1.130, 95%CI; 1.017–1.256, p = 0.023), low output syndrome (OR 5.094, 95%CI; 1.1635–15.871, p = 0.005), renal failure (OR 8.128, 95%CI; 3.347–19.742, p = 0.0001) and sepsis (OR 4.975, 95%CI; 1.420–17.426, p = 0.012) as independent risk factors.
Conclusions: The present study demonstrates that among major complications, low output syndrome, renal failure requiring renal replacement therapy and sepsis, dramatically impaired the postoperative course patients aged over 80 years undergoing CABG, AVR or combined CABG and AVR.

Keywords: cardiac surgery, octogenarians, postoperative complication and mortality

Introduction

Nowadays, cardiac surgery can be performed with an acceptable risk, even in octogenarians[1–3] and nonagenarians. However, studies have shown that older patients are, as a matter of course, more likely to suffer from postoperative complications, resulting in a higher mortality in this particular patient cohort.[4–8]

It is widely accepted that the inferior outcome of elderly patients with major complications may be due to

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Received: January 22, 2013; Accepted: May 31, 2013
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(1) an increased incidence of perioperative adverse events and (2) a limited overall systemic reserve to resist the biological challenge of major complications that may arise as a consequence of adverse events in the postoperative course. However, a detailed analysis of the individual impact of common postoperative adverse events and major complications, specifically in elderly patients, has not been performed so far.

The aims of this study are (1) to investigate the occurrence of postoperative complications in patients aged over 80 years after cardiac surgery and (2) to clarify the impact of individual postoperative complications on the mortality.

Patients and Methods

Patients

Between January 1998 and December 2007, 649 patients aged over 80 years received an isolated first-time aortic valve replacement (AVR group, n = 179), coronary artery bypass grafting (CABG group, n = 311), or CABG and AVR (Combi group, n = 159) in our institute and were included in this study. Patient data on demographics, operative data, perioperative outcome data were prospectively entered in an institutional data registry. In addition, medical records of all patients were retrospectively reviewed for this study. This retrospective study was approved by the institutional ethical board.

Definition of mortality and postoperative major complications

In-hospital death and/or 30 days mortality was defined as 'mortality'. The need of intraoperative or postoperative intraaortic balloon pumping (IABP) was defined as 'postoperative low out-put syndrome'. The need of postoperative renal replacement therapy was defined as 'renal failure', irrespective of the applied system (e.g. continuous or intermittent hemofiltration or hemodiafiltration etc.). 'Prolonged respiratory failure' was defined as repetitive failure of respiratory weaning and necessity of prolonged ventilation beyond a week with the consecutive need for a tracheotomy. 'Stroke' was defined as any neurological deficit with either a positive finding on a cranial CT-scan or with prolonged neurological deficit beyond 24 hours. A need for re-thoracotomy due to bleeding was defined as 'postoperative bleeding'. Laparotomy was performed when an acute abdomen occurred. 'Sepsis' was defined as a combination of positive blood culture and/or imaging results positive for an infection (pneumonia in X-Ray etc.) and two of the following four criteria: (1) core body temperature >38°C or <36°C (2) heart rate >90 beats/min (3) respiratory rate >20 breaths/min or PaCO2 <32 torr (<4.3 kPa) (4) white blood cells >12.000 cells/mm^3, <4.000 cells/mm^3, or >10% immature (band) forms. An infection in the region of the sternal wound associated with a sternal dehiscence and the need for a surgical intervention was defined as 'mediastinitis'.

Statistical analysis

Results are expressed as mean ± standard deviation. Statistical analysis was performed using Student's t-test or one-way ANOVA for continuous variables or χ^2 tests (Fisher's exact tests if n <5) for categorical variables. Logistic regression was also used for the multivariate analysis of risk factors for mortality. A p value less than 0.05 was considered significant. All statistical analyses were performed using SPSS 16.0 software (SPSS Inc., Chicago, Illinois, USA).

Results

Patient characteristics and data on the postoperative course are presented in **Tables 1 and 2**, respectively. Not surprisingly, there were significant differences in patient characteristics and intraoperative parameters among the 3 study groups. However, there was no difference among groups concerning the rate of severe complications except for postoperative low-output syndrome requiring an intraaortic balloon pumping, occurring most frequently in AVR group. To focus on the main purpose of this study, all patients were together analyzed further.

Impact of complications on mortality

The impact of each major complication on the mortality is demonstrated in **Fig. 1**. Acute renal failure requiring a renal replacement therapy (55.0% vs. 7.5%, p = 0.0001), low out-put syndrome requiring an IABP-support (43.1% vs. 8.8%, p = 0.0001), sepsis (52.0% vs. 10.3%, p = 0.0001), prolonged respiratory failure with tracheotomy had (29.0% vs. 11.0%, p = 0.002), Re-thoracotomy due to bleeding (26.9% vs. 10.6%, p = 0.0001), postoperative laparotomy (30.8% vs. 11.5%, p = 0.033) had a significant impact on mortality, but stroke (0% vs. 12%, p = 0.329) and mediastinitis (10.5% vs. 11.9%, p = 0.885) were no predicting factor for mortality.

Table 1 Patient characteristics in each group

Preoperative parameters	Total (n = 649)	AVR group (n = 179)	CABG group (n = 311)	Combi group (n = 159)	p
Age (years)	82.5 ± 3.0	81.9 ± 2.0	81.9 ± 2.0	82.8 ± 2.8	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.0001 AVR vs Combi P = 0.336
Male (n)	319 (49.2%)	55 (30.7%)	188 (60.5%)	76 (47.8%)	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.009 AVR vs Combi p = 0.001
BMI (kg/m^2)	25.8 ± 3.7	25.4 ± 3.7	25.9 ± 3.6	25.9 ± 3.6	AVR vs CABG p = 0.122 CABG vs Combi p = 0.808 AVR vs Combi p = 0.264
Diabetes mellitus (n)	218 (33.6%)	51 (28.5%)	118 (37.9%)	49 (30.8%)	AVR vs CABG p = 0.034 CABG vs Combi p = 0.127 AVR vs Combi p = 0.640
Hypertention (n)	582 (89.7%)	156 (87.2%)	286 (91.7%)	140 (88%)	AVR vs CABG p = 0.085 CABG vs Combi p = 0.168 AVR vs Combi p = 0.802
Hyperlipidemia (n)	435 (67.0%)	90 (50.3%)	238 (76.5%)	107 (67.3%)	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.032 AVR vs Combi p = 0.002
Current smoker (n)	39 (6.0%)	6 (3.4%)	27 (8.7%)	6 (3.8%)	AVR vs CABG p = 0.056 CABG vs Combi p = 0.130 AVR vs Combi p = 0.555
Pulmonary hypertension (n)	119 (18.3%)	47 (26.3%)	19 (6.1%)	53 (33.3%)	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.0001 AVR vs Combi p = 0.155
NYHA class IV (n)	231 (35.6%)	50 (27.9%)	123 (39.5%)	58 (36.5%)	AVR vs CABG p = 0.007 CABG vs Combi p = 0.610 AVR vs Combi p = 0.056
EF (%)	59.3 ± 16.3	60.1 ± 15.7	60.2 ± 15.6	57.0 ± 18.1	AVR vs CABG p = 0.989 CABG vs Combi p = 0.325 AVR vs Combi p = 0.385
EF <40% (n)	192 (29.6%)	40 (23.1%)	105 (36.3%)	47 (32.6%)	AVR vs CABG p = 0.003 CABG vs Combi p = 0.284 AVR vs Combi p = 0.085
Previous infarction (n)	248 (38.2%)	22 (12.3%)	175 (56.3%)	51 (32%)	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.0001 AVR vs Combi p = 0.0001
Creatine kinase (U/L)	88.9 ± 150	68.4 ± 52.2	110.2 ± 208.2	73.2 ± 71.4	AVR vs CABG p = 0.010 CABG vs Combi p = 0.033 AVR vs Combi p = 0.799
Preoperative IABP	32 (4.9%)	1 (0.6%)	25 (8.0%)	6 (3.7%)	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.078 AVR vs Combi p = 0.038
Emergency (n)	62 (9.6%)	9 (5.0%)	44 (14.2%)	9 (5.7%)	AVR vs CABG p = 0.001 CABG vs Combi p = 0.023 AVR vs Combi p = 0.164
Preoperative ventilation (n)	6 (0.9%)	2 (1.1%)	3 (1%)	1 (0.6%)	AVR vs CABG p = 0.911 CABG vs Combi p = 0.683 AVR vs Combi p = 0.683
Preoperative Creatinine (mg/dl)	1.1 ± 0.6	1.0 ± 0.6	1.2 ± 0.5	1.2 ± 0.9	AVR vs CABG p = 0.025 CABG vs Combi p = 0.530 AVR vs Combi p = 0.013
Preoperative dialysis (n)	5 (0.8%)	2 (1.1%)	2 (0.6%)	1 (0.6%)	AVR vs CABG p = 0.574 CABG vs Combi p = 0.985 AVR vs Combi p = 0.633

(Continued)

Table 1 (Continued)

Preoperative parameters	Total (n = 649)	AVR group (n = 179)	CABG group (n = 311)	Combi group (n = 159)	p
Peripheral arterial disease (n)	133 (22.5%)	32 (17.9%)	67 (21.5%)	34 (21.4%)	AVR vs CABG p = 0.330 CABG vs Combi p = 0.968 AVR vs Combi p = 0.417
COPD (n)	145 (22.5%)	41 (22.9%)	64 (20.6%)	40 (25.2%)	AVR vs CABG p = 0.558 CABG vs Combi p = 0.266 AVR vs Combi p = 0.628
Intraoperative parameters					
Operation time (min)	199.1 ± 66.1	175.9 ± 51.2	197.5 ± 66.5	228.3 ± 69.5	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.0001 AVR vs Combi p = 0.0001
CPB time (min)	101 ± 38.6	93.1 ± 28	92.8 ± 37.5	125.8 ± 40.5	AVR vs CABG p = 0.928 CABG vs Combi p = 0.0001 AVR vs Combi p = 0.0001
X-clamp time (min)	58.7 ± 21.2	59 ± 13.1	48.4 ± 18.9	78.2 ± 19	AVR vs CABG p = 0.0001 CABG vs Combi p = 0.0001 AVR vs Combi p = 0.0001
Mean size of prosthesis (mm)		21.8 ± 1.6		22.3 ± 1.6	AVR vs Combi p = 0.005
Number of grafts			2.9 ± 0.9	1.7 ± 0.9	CABG vs Combi p = 0.0001

Table 2 Occurrence of severe complications

	Total (n = 649)	AVR group (n = 179)	CABG group (n = 311)	Combi group (n = 159)	p
Low output syndrome requiring IABP-support (n)	35 (3.5%)	2 (1.1%)	17 (5.5%)	4 (2.5%)	AVR vs CABG p = 0.016 CABG vs Combi p = 0.143 AVR vs Combi p = 0.331
Postoperative dialysis (n)	60 (9.2%)	15 (8.4%)	27 (8.7%)	18 (11.3%)	AVR vs CABG p = 0.909 CABG vs Combi p = 0.358 AVR vs Combi p = 0.363
Tracheotomy (n)	31 (4.8%)	7 (3.9%)	15 (4.8%)	9 (5.7%)	AVR vs CABG p = 0.639 CABG vs Combi p = 0.358 AVR vs Combi p = 0.450
Stroke (n)	7 (1.1%)	3 (1.7%)	4 (1.3%)	0 (0%)	AVR vs CABG p = 0.726 CABG vs Combi p = 0.151 AVR vs Combi p = 0.101
Mediastinitis (n)	19 (2.9%)	4 (2.2%)	9 (2.9%)	6 (3.8%)	AVR vs CABG p = 0.662 CABG vs Combi p = 0.608 AVR vs Combi p = 0.404
Re-thoracotomy due to bleeding (n)	52 (8.0%)	13 (7.3%)	24 (7.7%)	15 (9.4%)	AVR vs CABG p = 0.855 CABG vs Combi p = 0.523 AVR vs Combi p = 0.470
Laparotomy (n)	13 (2.0%)	4 (2.2%)	7 (2.3%)	2 (1.3%)	AVR vs CABG p = 0.991 CABG vs Combi p = 0.457 AVR vs Combi p = 0.497
Sepsis (n)	25 (3.9%)	8 (4.5%)	12 (3.9%)	5 (3.1%)	AVR vs CABG p = 0.742 CABG vs Combi p = 0.695 AVR vs Combi p = 0.527
Duration of ventilation (hours)	61.8 ± 168.1	47.0 ± 113.3	65.3 ± 195.3	61.8 ± 168	AVR vs CABG p = 0.251 CABG vs Combi p = 0.700 AVR vs Combi p = 0.182
ICU stay (days)	5.0 ± 8.0	4.6 ± 7.2	5.2 ± 9.2	5.4 ± 7.5	AVR vs CABG p = 0.423 CABG vs Combi p = 0.845 AVR vs Combi p = 0.387
Mortality	77 (11.9%)	15 (8.4%)	43 (13.8%)	19 (11.9%)	AVR vs CABG p = 0.072 CABG vs Combi p = 0.569 AVR vs Combi p = 0.276

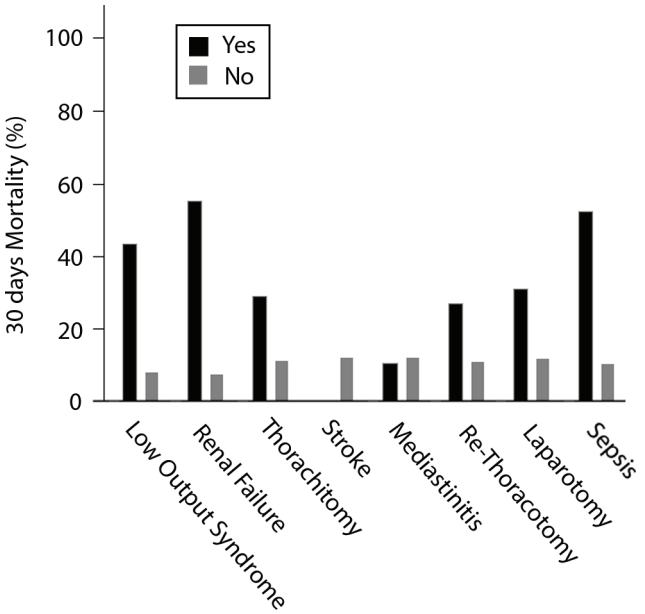

Fig. 1 Mortality in patients with or without severe complications.

Univariate analysis for early mortality

Univariate analysis revealed the following parameters as significant risk factors (**Table 3**): age (p = 0.002), ejection fraction ≤40% (p = 0.003), use of preoperative IABP (p = 0.0001), preoperative ventilation (p = 0.0001), preoperative renal impairment (p = 0.0001), duration of the operation (p = 0.0001), cardiopulmonary bypass time (p = 0.0001), aortic cross-clamp time (p = 0.01), and postoperative need of epinephrine (p = 0.0001), postoperative low output syndrome (p = 0.0001), postoperative renal failure (p = 0.0001), tracheotomy (p = 0.002), re-thoracotomy due to bleeding (p = 0.0001), Laparotomy (p = 0.033) and sepsis (p = 0.0001). Surprisingly, there were more patients with arterial hypertension among the survivors as compared to patients in the 30-d-mortality group (p = 0.016).

Multivariate analysis of preoperative factors for early mortality and severe complications

As composite events including death and severe complications (low output syndrome requiring IABP-support, postoperative dialysis, thorachiotomy, stroke, mediastinitis, re-thoracotomy due to bleeding, laparotomy and sepsis), 193 patients had any event. Preoperative factors were multivariately analysed for those composite events. Age (OR 1.22, 95%CI; 1.015–1.381, p = 0.01), EF <0% (OR 1.08, 95%CI; 1.005–1.384, p = 0.04) and preoperative creatinine (OR 1.23, 95%CI; 1.121–3.578, p = 0.01) were independent risk factors.

Multivariate analysis of all factors for early mortality

All factors including preoperative, intraoperative and postoperative factors were included into multivariate analysis and the results are listed in **Table 4**. Age was revealed as the only preoperative independent risk factor beside the other risk factors represented by the major postoperative complications.

Discussion

The crucial findings of the present study were: (1) simple cardiac surgery such as AVR, CABG or AVR + CABG could be performed with acceptable results even in very elderly patients, especially when no postoperative complications occurred, (2) among major postoperative complications, low out-put syndrome, renal failure requiring renal replacement therapy and sepsis impaired significantly postoperative outcome and these three postoperative complications were independent risk factors and (3) other pre- and intraoperative parameters were no independent risk factors except for an advanced age at the time of operation.

Advances in surgical procedures, anaesthetic techniques and intensive care therapy have pushed the limit of age dramatically over the past decade. Many previous studies have demonstrated that cardiac surgery can be performed with acceptable results not only in octogenarians, but also in nonagenarians.[9–11]

However, it is well known that advanced age is a risk factor for mortality, and elderly patients are more likely to suffer from postoperative complications.[2,3,8,9] Bridges, et al. reported from the Society of Thoracic Surgeons National Database with a total of 662033 patients that operative mortality was 11.8% for patients more than 90 years of age, 7.1% for those 80 to 89 years, and 2.8% for those 50 to 79 years and the incidence of renal failure and prolonged ventilation was highest among patients more than 90 years of age (9.2% and 12.2%), compared with those 80 to 89 years (7.7% and 10.5%) or 50 to 79 years (3.5% and 6.0%).[9] In contrast to their study, mortality in the present study was high as 12%. It may be due to delayed operation in our patient cohort as the prevalence of NYHA IV patients to be 36%.

Previous reports have focused on the prediction of overall mortality and morbidity, but the impact of each complication on mortality has not been well studied. This issue is particularly important in the elderly patients because, as the elderly patients tend to have less tolerance to postoperative complications.

Table 3 Univariate analysis for 30 days mortality

	Dead within 30 days (n = 77)	Survivor (n = 572)	p
Age (years)	83.1 ± 3.3	82.4 ± 2.4	0.002
Male (n)	39 (50.6%)	280 (48.9%)	0.780
BMI (kg/m^2)	25.4 ± 3.8	25.8 ± 3.6	0.313
Diabetes mellitus (n)	30 (39.0%)	188 (32.9%)	0.288
Hypertention (n)	63 (81.8%)	519 (90.7%)	0.016
Hyperlipidemia (n)	47 (61%)	388 (67.8%)	0.234
Current smoker (n)	7 (9%)	32 (5.6%)	0.423
Pulmonary hypertension (n)	12 (12.6%)	107 (18.7%)	0.506
NYHA class IV (n)	33 (42.9%)	198 (34.6%)	0.113
EF <40% (n)	14 (20.3%)	48 (8.9%)	0.003
Previous infarction (n)	33 (42.9%)	215 (36.6%)	0.234
Creatine kinase (U/L)	111 ± 209.4	87 ± 143.2	0.331
Preoprative IABP (n)	11 (14.3%)	21 (3.7%)	0.0001
Emergency (n)	9 (11.7%)	53 (9.3%)	0.498
Preoperative ventilation (n)	4 (5.6%)	2 (0.4%)	0.0001
Preoperative Creatinine (mg/dl)	1.4 ± 1.2	1.1 ± 0.5	0.0001
Preoperative dialysis (n)	1 (1.3%)	4 (0.7%)	0.572
Peripheral arterial disease (n)	16 (20.8%)	117 (20.5%)	0.947
COPD (n)	17 (22%)	128 (22.4%)	0.947
Operation time (min)	247.5 ± 91.8	192.6 ± 59	0.0001
CPB time (min)	124.7 ± 56.8	97.8 ± 34.2	0.0001
X-clamp time (min)	62.9 ± 24.9	58.1 ± 20.6	0.01
Need of Epinephrine	14 (18.2%)	24 (4.2%)	0.0001
Low output syndrome requiring IABP-support (n)	25 (32.5%)	33 (6.8%)	0.0001
Postoperative dialysis (n)	33 (42.9%)	27 (4.7%)	0.0001
Tracheotomy (n)	9 (11.7%)	22 (3.9%)	0.002
Stroke (n)	0 (0%)	7 (1.2%)	0.329
Mediastinitis (n)	2 (2.6%)	17 (3%)	0.855
Re-thoracotomy due to bleeding (n)	14 (18.2%)	38 (6.6%)	0.0001
Laparotomy (n)	4 (5.2%)	9 (1.6%)	0.033
Sepsis	13 (16.9%)	12 (2.1%)	0.0001

Table 4 Multivariate analysis

	OR	95%CI	p
Age	1.130	1.017–1.256	0.023
Low output syndrome	5.094	1.635–15.871	0.005
Renal failure	8.128	3.347–19.742	0.0001
Sepsis	4.975	1.420–17.426	0.012

In the present study, postoperative renal failure requiring renal replacement therapy (55% mortality), postoperative sepsis (52% mortality), low output syndrome requiring intraaortic balloon pumping (43% mortality), postoperative laparotomy due to abdominal complications (31% mortality), prolonged respiratory insufficiency needing tracheotomy (29% mortality) and re-thoracotomy due to postoperative bleeding (27% mortality) were significant risk factors. Among these risk factors only renal failure, sepsis and low output syndrome prove as independent risk factors in our cohort. This finding suggests that in the course of preoperative patient selection and patient preparation a higher level of awareness with respect to these complications is warranted, as they represent life-threatening postoperative events in very elderly patient cohort and any effort should be done to avoid those complications.

Conclusion

The present study demonstrates that among major complications, low output syndrome, renal failure

requiring renal replacement therapy and sepsis, each impaired dramatically the postoperative course in patients undergoing cardiac surgery at an age of over 80 years.

Disclosure Statement

All authors have no conflict of interest.

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