Impact of preoperative atrial fibrillation on the late outcome of off-pump coronary artery bypass surgery

Kazuaki Fukahara\textsuperscript{a,}\textsuperscript{*}, Keiju Kotoh\textsuperscript{a}, Toshio Doi\textsuperscript{a}, Takuro Misaki\textsuperscript{a}, Shigeki Sumi\textsuperscript{b}

\textsuperscript{a} Department of Surgery 1, University of Toyama, 2630 Sugitani, Toyama 930-0194, Japan
\textsuperscript{b} Division of Biostatistics and Clinical Epidemiology, University of Toyama, 2630, Sugitani, Toyama, 930-0194, Japan

Received 28 September 2009; received in revised form 25 January 2010; accepted 26 January 2010; Available online 20 March 2010

Abstract

Objective: The impact of pre-existing atrial fibrillation on the long-term outcome in patients after off-pump coronary revascularisation is not well known. This study aims to determine the independent effects of preoperative atrial fibrillation on the early and late outcomes of off-pump coronary artery bypass surgery. Methods: A total of 513 patients undergoing isolated coronary artery bypass surgery using off-pump approach between 2000 and 2005 were studied. Twenty-six of them (5.1%) had preoperative atrial fibrillation (15 had paroxysmal atrial fibrillation and 11 had persistent or permanent atrial fibrillation) and the other 487 patients were in normal sinus rhythm. Early and late outcomes were compared retrospectively between patients with preoperative atrial fibrillation and patients in sinus rhythm. The median follow-up period for the entire study population was 3.3 ± 2.7 years. Results: The baseline characteristics of the patients with preoperative atrial fibrillation were generally similar to those of patients in sinus rhythm. However, the patients with atrial fibrillation had a significantly lower left ventricular ejection fraction compared with those in sinus rhythm (50 ± 15 vs 56 ± 12%, p = 0.03). The mean age of the atrial fibrillation group was almost 3 years more than that of the sinus rhythm group. Operative mortality was similar in patients with atrial fibrillation (3.8%) and those in sinus rhythm (1.0%). Ten patients developed cerebral infarction within 7 days after surgery, including one patient (3.8%) from the atrial fibrillation group and nine patients (1.8%) from the sinus rhythm group. Long-term survival was significantly decreased in the atrial fibrillation group (5-year survival: 70 ± 6.9% vs 87 ± 1.8%; p = 0.0018). Freedom from cerebral complications was also significantly decreased in the atrial fibrillation group (5-year survival: 85 ± 8.3% vs 95 ± 1.2%; p = 0.0009), but there were no differences in cardiac death and major cardiac adverse events. On Cox proportional hazards regression analysis, preoperative atrial fibrillation was a significant adverse predictor for survival (hazard ratio = 3.0, 95% confidence intervals (CIs) 1.3–6.9; \(p = 0.009\)) and independent predictor of late cerebral infarction (hazard ratio = 6.2, 95% CIs 2.0–19.3; \(p = 0.0002\)). Conclusions: Uncorrected preoperative atrial fibrillation is strongly associated with poor long-term survival and increased late cerebral complications after off-pump coronary artery bypass surgery. Concomitant atrial fibrillation surgery should be considered to improve the long-term results of surgical revascularisation.

\(\copyright\) 2010 European Association for Cardio-Thoracic Surgery. Published by Elsevier B.V. All rights reserved.

Keywords: Atrial fibrillation; Coronary artery bypass; Off-pump; Postoperative complications; Follow-up studies

1. Introduction

Atrial fibrillation (AF) is the most common arrhythmia associated with cardiovascular diseases. The incidence of AF increases with age and with cardiac co-morbidities, such as hypertension, ventricular dysfunction, valvular heart disease and ischaemic heart disease [1–3]. As a result of the increasing age of patients requiring myocardial revascularisation for ischaemic heart disease, preoperative AF is not rare and is increasing among the patients who undergo coronary artery bypass grafting (CABG). Data from the Society of Thoracic Surgery National Adults Cardiac Database collected during the years 2002 and 2003 revealed that the prevalence of AF was 5.3% among patients undergoing isolated CABG, but it increased to 6.1% in 2005 [4].

Several studies have identified preoperative AF as a significant marker of increased cardiovascular morbidity and mortality after cardiac surgery [5–7]. In patients having mitral valve surgery, preoperative AF has been identified as an independent predictor of overall survival and late stroke [5,8,9]. Moreover, it has been reported that AF is associated with an increased risk of perioperative mortality and morbidity and with poor long-term survival in patients undergoing CABG [7,10,11]. However, these reports were based on patients undergoing conventional CABG with cardiopulmonary bypass and the impact of pre-existing AF on the outcome of off-pump coronary revascularisation is not clear. Accordingly, this study aims to determine the independent effect of preoperative AF on the early and late outcomes of off-pump CABG.
2. Patients and methods

2.1. Study population

From January 2000 to December 2005, 513 patients underwent isolated CABG using the off-pump approach at our institution, and 26 of them (5.1%) had preoperative AF (15 had paroxysmal AF and 11 had persistent or permanent AF). The other 487 patients were in sinus rhythm (SR). Our institutional ethics committee approved the use of the patient data for this study. The requirement for individual patient consent was waived because of the retrospective nature of the study design and the use of data collected during routine management. Patients were excluded if they had a history of arrhythmia other than AF and/or prior implantation of permanent pacemaker or cardioverter defibrillator.

Patient demographic data, symptoms, co-morbidities, clinical findings and operative details were obtained from the departmental database, which was supplemented by review of charts, electrocardiographic and echocardiographic reports as well as operative records. Data on postoperative events and the current status of patients were collected from cardiologists or family doctors caring for each patient. In case of patients who reported events, medical records were collected and the events were adjudicated. The median follow-up period for the entire study population was 3.3 ± 2.7 years.

2.2. Definitions

Preoperative AF was classified as permanent, persistent or paroxysmal according to the American Heart Association/ American College of Cardiology guidelines [12]. All patients were monitored daily until 7 postoperative days with continuous electrocardiogram (ECG) telemetry. Postoperative AF was classified as permanent or new-onset AF and was based on detection of AF lasting for more than 15 min by telemetry. Postoperative cerebrovascular events were defined as focal neurological deficits persisting for more than 72 h. All cerebrovascular events were diagnosed by a neurologist and confirmed by computed tomography and/or magnetic resonance imaging. Transient ischaemic attacks and cerebral haemorrhage were not counted as cerebrovascular events in this study. Deaths were classified as all-cause death and cardiac-related death. The latter included death from myocardial infarction, congestive heart failure, arrhythmia and other cardiac events. Major adverse cardiac events were defined as cardiac death, myocardial infarction, congestive heart failure and repeat surgical revascularisation or percutaneous coronary intervention.

2.3. Surgical technique

On the basis of their eligibility for off-pump CABG, surgery was performed via left anterior thoracotomy and/or a small upper laparotomy incision, or else via median sternotomy. Major indications for off-pump CABG via left anterior thoracotomy included isolated proximal disease of the left anterior descending or diagonal artery, while off-pump CABG via a small upper laparotomy incision was done for isolated stenosis of the right coronary artery. Off-pump CABG with median sternotomy was performed in patients with multi-vessel disease. The operative techniques and anaesthetic protocol for off-pump CABG have been described previously [13]. Even in patients with AF, corrective surgery such as the Maze procedure or pulmonary vein isolation was not performed and intra-operative direct current electrical cardioversion was not attempted.

2.4. Perioperative anticoagulant and anti-arrhythmic therapy

For perioperative anticoagulation, anti-platelet agents and/or warfarin sodium was suspended 6 days before surgery, except in patients with acute coronary syndrome. Instead, heparin was given by subcutaneous injection or continuous intravenous infusion (12 000 IU—15 000 IU day$^{-1}$) until the time of surgery. At the time of operative procedure, heparin sodium (150 IU kg$^{-1}$) was administered, maintaining an activated clotting time greater than 300 s. After the anastomosis, protamine sulphate (0.75 mg kg$^{-1}$) was given intravenously. Intra-operative anticoagulation protocol was same for patients with SR or AF. After surgery, a continuous intravenous infusion of heparin was given on the first postoperative day, and oral aspirin was started on the second postoperative day. Postoperative follow-up of patients was done at monthly intervals by a cardiologist or family doctor. Anti-platelet therapy, warfarin sodium or anti-arrhythmic drugs were given as required. Patients in AF received anticoagulation with warfarin sodium, aiming to achieve an international normalised ratio (INR) between 1.5 and 2.5, and patients in SR received anti-platelet therapy unless it was contraindicated.

2.5. Statistical analysis

The primary endpoints of the study were late mortality and major adverse cardiac and cerebrovascular events. Continuous variables were expressed as the mean ± standard deviation, and categorical variables were expressed as the number (percentage). The unpaired Student’s t-test or Wilcoxon rank-sum test was used to compare continuous variables and the chi-square test was employed to compare categorical variables. Logistic regression analysis was used to assess predictors of early postoperative cerebral infarction. Survival was calculated with the Kaplan–Meier method and the survival curves were compared using the log-rank test. The Cox proportional hazards regression model was used to identify predictors of survival from among the following variables: age, sex, preoperative AF, history of stroke, peripheral artery disease, chronic renal failure (on haemodialysis), preoperative left ventricular ejection fraction aorta no-touch technique and new-onset postoperative AF. All statistical analyses were performed with the SPSS software package (SPSS Japan version 12, Tokyo, Japan). Statistical significance was defined as $p < 0.05$.

3. Results

3.1. Preoperative clinical profile and operative data

Patient demographic data and preoperative clinical features are summarised in Table 1, while operative data
Table 1
Patient clinical characteristics.

<table>
<thead>
<tr>
<th>Variables</th>
<th>AF group (n = 26)</th>
<th>SR group (n = 487)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>69.9 ± 10.1</td>
<td>67.0 ± 9.8</td>
<td>0.14</td>
</tr>
<tr>
<td>Gender (male, %)</td>
<td>22 (84.6)</td>
<td>379 (77.8)</td>
<td>0.41</td>
</tr>
<tr>
<td>Unstable AP</td>
<td>5 (19.2)</td>
<td>55 (11.3)</td>
<td>0.22</td>
</tr>
<tr>
<td>Acute MI</td>
<td>2 (7.7)</td>
<td>31 (6.4)</td>
<td>0.79</td>
</tr>
<tr>
<td>Previous MI</td>
<td>9 (34.6)</td>
<td>196 (40.2)</td>
<td>0.57</td>
</tr>
<tr>
<td>Left main stem disease</td>
<td>13 (50.0)</td>
<td>160 (32.9)</td>
<td>0.07</td>
</tr>
<tr>
<td>Number of diseased vessels</td>
<td>0.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3 (11.5)</td>
<td>62 (12.7)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10 (38.5)</td>
<td>176 (36.1)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>13 (50.0)</td>
<td>246 (51.1)</td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>15 (57.7)</td>
<td>272 (55.9)</td>
<td>0.85</td>
</tr>
<tr>
<td>Hyperlipidaemia</td>
<td>6 (23.1)</td>
<td>138 (37.6)</td>
<td>0.14</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>2 (7.7)</td>
<td>69 (14.2)</td>
<td>0.35</td>
</tr>
<tr>
<td>Peripheral artery disease</td>
<td>2 (7.7)</td>
<td>30 (6.2)</td>
<td>0.75</td>
</tr>
<tr>
<td>COPD</td>
<td>0</td>
<td>14 (2.9)</td>
<td>0.38</td>
</tr>
<tr>
<td>Past history of stroke</td>
<td>7 (26.9)</td>
<td>95 (19.5)</td>
<td>0.36</td>
</tr>
<tr>
<td>Haemodialysis</td>
<td>2 (7.7)</td>
<td>17 (3.5)</td>
<td>0.27</td>
</tr>
<tr>
<td>LV-EF (%)</td>
<td>50.0 ± 14.6</td>
<td>56.1 ± 12.2</td>
<td>0.02</td>
</tr>
<tr>
<td>LV-Dd (mm)</td>
<td>52.7 ± 5.8</td>
<td>50.9 ± 5.8</td>
<td>0.26</td>
</tr>
</tbody>
</table>

AF: angina pectoris; MI: myocardial infarction; COPD: chronic obstructive pulmonary disease; LV-EF: left ventricular ejection fraction; LV-Dd: left ventricular end-diastolic diameter.

are summarised in Table 2. The baseline characteristics of the patients with preoperative AF were generally similar to those of patients in SR. However, the patients with AF had a significantly lower left ventricular ejection fraction (LVEF) of patients in SR. However, the patients with preoperative AF were generally similar to those in SR group than in the SR group (85 ± 8.3% vs 95 ± 1.2%, p = 0.009) (Fig. 3). However, there were no differences in cardiac death (the 5-year rate of freedom from cardiac death was 92 ± 5.4% in the AF group vs 96 ± 1.0% in the SR group, p = 0.127) or major adverse cardiac events (the 5-year freedom rate was 81 ± 8.7% vs 90 ± 1.8%, respectively, p = 0.549) (Figs. 2 and 4). According to Cox proportional hazards regression analysis, preoperative AF (hazard ratio = 3.0, 95% CI: 1.3–6.9; p = 0.009), peripheral artery disease (hazard ratio = 3.0, 95% CI: 1.4–6.0; p = 0.003) and haemodialysis (hazard ratio = 9.2, 95% CI: 4.2–19.9; p < 0.0001) were significant adverse predictors for survival. In addition, preoperative AF (hazard ratio = 6.2, 95% CI: 2.0–19.3; p = 0.0002) and haemodialysis (hazard ratio = 8.49, 95% CI: 1.7–42.9; p = 0.001) were independent predictors of late cerebral infarction (Table 3).

3.2. Early outcome

Hospital death occurred in one patient (3.8%) from the AF group and five patients (1.0%) from the SR group. However, the patients with AF had a significantly lower left ventricular ejection fraction (LVEF) of patients in SR. However, the patients with preoperative AF were generally similar to those in SR group than in the SR group (85 ± 8.3% vs 95 ± 1.2%, p = 0.009) (Fig. 3). However, there were no differences in cardiac death (the 5-year rate of freedom from cardiac death was 92 ± 5.4% in the AF group vs 96 ± 1.0% in the SR group, p = 0.127) or major adverse cardiac events (the 5-year freedom rate was 81 ± 8.7% vs 90 ± 1.8%, respectively, p = 0.549) (Figs. 2 and 4). According to Cox proportional hazards regression analysis, preoperative AF (hazard ratio = 3.0, 95% CI: 1.3–6.9; p = 0.009), peripheral artery disease (hazard ratio = 3.0, 95% CI: 1.4–6.0; p = 0.003) and haemodialysis (hazard ratio = 9.2, 95% CI: 4.2–19.9; p < 0.0001) were significant adverse predictors for survival. In addition, preoperative AF (hazard ratio = 6.2, 95% CI: 2.0–19.3; p = 0.0002) and haemodialysis (hazard ratio = 8.49, 95% CI: 1.7–42.9; p = 0.001) were independent predictors of late cerebral infarction (Table 3).

3.3. Late outcome

There were eight late deaths in the AF group and 63 late deaths in the SR group. The long-term survival rate of the AF group was significantly lower than that of the SR group, with 5-year survival being 70 ± 9.6% versus 87 ± 1.8% (p = 0.0018) (Fig. 1). A similar outcome was observed with regard to freedom from cerebral infarction, since the rate of freedom from cerebral infarction was also significantly lower in the AF group than in the SR group (85 ± 8.3% vs 95 ± 1.2%, p = 0.009) (Fig. 3). However, there were no differences in cardiac death (the 5-year rate of freedom from cardiac death was 92 ± 5.4% in the AF group vs 96 ± 1.0% in the SR group, p = 0.127) or major adverse cardiac events (the 5-year freedom rate was 81 ± 8.7% vs 90 ± 1.8%, respectively, p = 0.549) (Figs. 2 and 4). According to Cox proportional hazards regression analysis, preoperative AF (hazard ratio = 3.0, 95% CI: 1.3–6.9; p = 0.009), peripheral artery disease (hazard ratio = 3.0, 95% CI: 1.4–6.0; p = 0.003) and haemodialysis (hazard ratio = 9.2, 95% CI: 4.2–19.9; p < 0.0001) were significant adverse predictors for survival. In addition, preoperative AF (hazard ratio = 6.2, 95% CI: 2.0–19.3; p = 0.0002) and haemodialysis (hazard ratio = 8.49, 95% CI: 1.7–42.9; p = 0.001) were independent predictors of late cerebral infarction (Table 3).

Fig. 1. Kaplan–Meier survival curves (overall survival) after off-pump coronary artery bypass grafting for patients with preoperative atrial fibrillation (AF group) and sinus rhythm (SR group).
4. Discussion

AF is significantly prevalent in patients undergoing coronary artery revascularisation for ischaemic heart disease and has substantial prognostic implications. A recent report [4] based on the Society of Thoracic Surgeons National Cardiac Database indicated that the prevalence of preoperative AF was 27.3% (12 235/44 875 patients) in patients having mitral valve surgery, 14.0% (10 590/75 821 patients) in those having aortic valve surgery, and 6.1% (22 388/369 854 patients) in those undergoing isolated CABG in North America from 2004 to 2006. Despite the widespread application of ablative technology such as unipolar and bipolar radio-frequency, high-intensity focussed ultrasound, microwave, laser and cryoablation, which facilitate rapid and safe performance of concomitant AF correction surgery compared with traditional cut-and-sew techniques, corrective surgery for AF was only done in 24% of patients with isolated CABG who had preoperative AF according to the same report [4] from the STS database. By contrast, 54% of patients undergoing mitral valve surgery who had a history of AF underwent corrective surgery. Thus, cardiac surgeons are less likely to perform corrective surgery for AF in patients undergoing CABG than they are for those having mitral valve surgery. Because off-pump CABG was our standard approach for coronary artery revascularisation, we did not add concomitant AF correction surgery before 2005 (the end of this study), even if patients had preoperative AF.

Table 3
Cox proportional hazard regression model for overall mortality and cerebral infarction.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Overall mortality</th>
<th>Cerebral infarction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>p Value</td>
</tr>
<tr>
<td>Age</td>
<td>1.1 (1.06—1.14)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Gender (male)</td>
<td>1.1 (0.6—2.0)</td>
<td>0.683</td>
</tr>
<tr>
<td>Preoperative AF</td>
<td>3.0 (1.3—6.9)</td>
<td>0.009</td>
</tr>
<tr>
<td>History of stroke</td>
<td>1.7 (1.0—3.0)</td>
<td>0.051</td>
</tr>
<tr>
<td>Peripheral artery disease</td>
<td>3.0 (1.4—6.0)</td>
<td>0.003</td>
</tr>
<tr>
<td>Haemodialysis</td>
<td>9.2 (4.2—19.9)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Preoperative LV-EF</td>
<td>1.0 (0.95—1.00)</td>
<td>0.016</td>
</tr>
<tr>
<td>Aorta no-touch technique</td>
<td>0.6 (0.3—1.1)</td>
<td>0.103</td>
</tr>
<tr>
<td>New-onset postoperative AF</td>
<td>1.0 (0.6—1.8)</td>
<td>0.917</td>
</tr>
</tbody>
</table>

HR: hazard ratio; CI: confidence interval; AF: atrial fibrillation; LV-EF: left ventricular ejection fraction.
4.1. Principal findings

In the present study, patients with preoperative AF were managed similarly to those in preoperative SR without corrective surgery for AF or electrical cardioversion. Therefore, we could investigate the association of uncorrected preoperative AF with the long-term clinical outcome after isolated off-pump CABG. Compared with patients in SR preoperatively, patients with preoperative AF had a worse prognosis, including a higher mortality rate and more frequent cerebral infarction. Preoperative AF was also a significant predictor of long-term mortality and cerebral infarction. However, preoperative AF was not a predictor of early mortality or morbidity. Occurrence of major adverse cardiac events (including cardiac death) was also not significantly different between patients with preoperative AF and patients in SR.

4.2. Early results

In our series, early mortality was similar between the two groups and only one patient from the AF group developed cerebral infarction within 7 days after surgery. Risk analysis did not identify preoperative AF as a predictor of early postoperative cerebral infarction. Ad et al. [7] reported that preoperative AF was associated with an increased risk of perioperative mortality and morbidity after CABG. They observed that patients with preoperative AF had a higher mortality rate (5.2% for AF patients vs 2.2% for those without AF) and higher rates of major complications, including cerebral infarction (2.6% for AF patients vs 1.4% for those without AF), with the differences being statistically significant. They investigated a total of 281,567 patients, including 15,755 patients (5.6%) with preoperative AF. In the Cleveland Clinic series of 46,984 CABG patients [10], preoperative AF was an independent risk factor for early and late death after CABG by propensity matching. It appears that our study was too small to detect the statistical association of preoperative AF with early mortality and morbidity.

Risk factors for early postoperative cerebral infarction in patients undergoing CABG have been reported as advanced age, diabetes, a history of cerebral infarction, cardiac dysfunction, peripheral artery disease and atrial fibrillation [14,15]. Due to marked improvement of techniques and equipment for exposing and stabilizing the beating heart, the performance of off-pump CABG has increased. The latest Japanese Association of Thoracic Surgery (JATS) Annual Report (2006) [16] showed that the off-pump approach was used for 58.4% of CABG procedures performed in Japan. Because the off-pump approach avoids arterial cannulation, cardiopulmonary bypass and aortic cross-clamping, it is thought to be associated with a lower rate of postoperative complications. The incidence of early postoperative cerebral infarction might be also reduced by avoiding cardiopulmonary bypass and aortic cross-clamping [17]. However, it has been reported that the pattern of perioperative stroke differs between the on-pump and off-pump approaches [18]. That is, stroke predominantly occurs several days after off-pump CABG, possibly due to hypercoagulability as a reaction to surgery. Therefore, we generally start anticoagulant therapy relatively early after off-pump CABG. Preoperative AF and early postoperative new-onset AF could not be confirmed as independent risk factors by the present study, possibly because of our early institution of postoperative anticoagulant therapy.

4.3. Late results

In general, AF occurs in elderly patients and those with more advanced cardiac disease, and therefore would be expected to increase the risk of perioperative complications and decrease late survival. In our series, preoperative co-morbidities were also more common among the patients with preoperative AF, including cardiac dysfunction, a high prevalence of left main trunk disease and more emergency operations. When these differences were adjusted by multivariate analysis, preoperative AF was still an independent significant predictor of mortality and cerebral infarction.

Other studies on the effects of preoperative AF in patients undergoing cardiac surgery have also indicated an increase of operative mortality or a lower late survival rate in patients with preoperative AF [5—11]. These studies involved patients having mitral valve surgery, aortic valve surgery and coronary artery revascularisation [19]. In subjects from the original cohort of the Framingham heart study [20], which allowed population-based investigation of the long-term mortality of patients with AF, the odds ratio of AF for death was 1.5 (95% CI: 1.2—1.8) in men and 1.9 (95% CI: 1.5—2.2) in women. An important finding of our study was that patients with preoperative AF had a significantly lower survival rate than patients in the SR group, and their risk of mortality was increased almost threefold, which is much higher than in the Framingham heart study. In surgical myocardial revascularisation, selection of patients for off-pump CABG includes high-risk patients with advanced age, renal dysfunction, chronic obstructive pulmonary disease and severe atherosclerotic change. Our study population was an unmatched surgical group and the risk of preoperative AF associated with ischaemic heart disease might have led to far worse results than would be seen in patients with AF alone. There might be a high-risk subgroup of AF patients, and AF patients who have ischaemic heart disease requiring surgical revascularisation might be considered a high-risk population.

The rate of cerebral infarction was significantly higher in the AF group and affected the poor outcome for mortality, since late deaths secondary to cerebral infarction were frequent in this study. Although all of the AF patients in this study were managed by cardiologists or family doctors and had appropriate medications including anticoagulant therapy, there was a high incidence of cerebral infarction over time. Cox proportional hazards analysis showed that the hazard ratio of preoperative AF for cerebral infarction was 6.2, which was similar to that in haemodialysis patients and much higher than that for patients with a past history of stroke.

The impact of AF on the risk of cerebral complications is well recognised, but studies investigating the influence of preoperative AF on late cardiac morbidity have yielded conflicting results. We found a tendency for preoperative AF to have an adverse influence on major adverse cardiac events.
including cardiac death, but it was not statistically significant. However, our study was hindered by its sample size and limited duration of follow-up, so the power to detect a significant difference of event-free survival was decreased.

4.4. Current policy on concomitant AF surgery in CABG patients

Based on the results of this study, our current policy for patients undergoing CABG who have AF that may be converted to SR is to perform concomitant AF surgery under cardiopulmonary bypass. If preoperative AF seems likely to be irreversible (based on the ECG data, left atrial size and the duration of AF), we perform left appendage ligation during off-pump CABG, because most strokes in AF patients are thought to arise from thrombus in the left atrial appendage [21]. In patients with paroxysmal AF and high-risk comorbidities, such as old age, cardiac dysfunction and atherosclerosis, the ablation procedure for pulmonary vein isolation and left appendage ligation should be performed with the off-pump approach. Akpinar et al. [22] reported the efficacy of concomitant off-pump CABG and bipolar radio-frequency ablation in 33 patients without operative mortality or major complications.

The Maze procedure has low perioperative risk and achieves excellent late freedom from AF, so there is evidence that adding the Maze procedure to cardiac surgery in patients with AF is associated with improved quality of life and a lower risk of late stroke, bleeding and mortality [23–25]. Although the Maze procedure remains the gold standard for surgical treatment of AF, it requires cardiopulmonary bypass and atriotomy. It should be still argued about the surgical strategy including ablation methods to treat the AF with ischaemic heart disease in high-risk population. In the present study, uncorrected preoperative AF was strongly associated with poor long-term survival and an increased rate of late cerebral infarction after off-pump CABG. Therefore, concomitant AF surgery should be considered to improve the long-term results of surgical revascularisation. As a final point, we also must investigate whether the additional AF correction procedure increases perioperative morbidity and mortality.

4.5. Limitations

There were several limitations of the present study. First, it was a retrospective and non-randomised investigation. Conclusions derived from a retrospective observational study are necessarily limited in application. Further, the number of subjects was small with a total of 513 off-pump coronary artery bypass patients including 26 preoperative AF patients. There was a relatively short follow-up period with 3.3 years median follow-up period. However, the results of this study were statistically robust with a stable SE and we think that the interpretation of the results was proper. In addition, the questionnaires and clinical examinations performed before surgery may not have accurately captured paroxysmal AF and may potentially have underestimated the prevalence of AF, although the prevalence of 5.1% in our study population was similar to that in other studies of AF. Finally, because of database limitations, we could not evaluate the prognostic impact of the type of AF (permanent or paroxysmal), duration of AF, medications for AF before or after surgery and the ventricular rate in patients with preoperative AF, all of which are factors that may affect cardiac function and the prognosis.

References

Appendix A. Conference discussion

Dr P. Ruchat (Lausanne, Switzerland): For surgeons who believe in and perform the maze procedure, your conclusion is very nice.

Also, the methodology of your study is very robust. A few issues based on common sense need to be addressed.

My first question is, can you reject the null hypothesis using late mortality and conclude that there is a difference in your group of AF, which is aged 70, compared to the sinus rhythm group, which is aged 67, using a follow-up of 3 years? I think if you use a statistical method with the same time of difference of age with very bad cases and the same follow-up, you probably cannot, even if the log-rank test is positive, tell this in the clinical situation. This is my first question.

Dr Misaki: Our patients are a little older in the atrial fibrillation group. But it included only 26 patients, so we need more patients to answer such a question. So I’m going to do the study in a larger patient group. We are trying to use the Japan database for the analysis.

Dr Ruchat: This was my second question. You have 26 patients with preoperative AF, 15 patients having paroxysmal AF and 11 patients with persistent or permanent AF. I think it’s not possible to make a differentiation in the effect of persistent or paroxysmal AF in your results.

And then the last question is, the difference between your curve on the global survival is mainly during the first 6 months, then the curves are parallel. Do you have an explanation for that? Thank you very much.

Dr Misaki: Very difficult question, but all of our patients were taken over by the cardiologist so I cannot provide the reason. And I think that paroxysmal AF and chronic AF are completely different for outcome. It may be that chronic AF has to be cured by maze operation with cardiopulmonary bypass and paroxysmal AF is easier to cure by PV isolation, so it has a very different setup for treatment.