

Atrial fibrillation after coronary artery bypass grafting without cardiopulmonary bypass[☆]

Janusz Siebert^{a,*}, Jan Rogowski^a, Dariusz Jagielak^a, Lech Anisimowicz^a,
Romuald Lango^b, Mirosława Narkiewicz^a

^aDepartment of Cardiac Surgery Institute of Cardiology, Medical University of Gdansk, Debinki 7, 80-211 Gdansk, Poland

^bDepartment of Anesthesiology and Intensive Therapy, Medical University of Gdansk, Debinki 7, 80-211 Gdansk, Poland

Received 7 September 1999; received in revised form 17 January 2000; accepted 26 January 2000

Abstract

Objective: Atrial fibrillation is the most common complication after heart surgery. It rarely has a fatal outcome but causes patient instability, prolongs hospital stay, or even is the reason for perioperative infarction. Although conventional coronary artery bypass grafting (CABG) with cardiopulmonary bypass has excellent short-term and long-term results, the number of coronary operations on a beating heart without cardiopulmonary bypass is still growing. To reduce surgical trauma, off-pump coronary artery bypass grafting via sternotomy (OPCABG) or minimally invasive direct vision coronary artery bypass grafting (MIDCABG) via small thoracotomy are performed. The aim of this study was to estimate the frequency of atrial fibrillation in patients after myocardial revascularization without cardiopulmonary bypass. **Methods:** A retrospective analysis of 48 patients undergoing myocardial revascularization without cardiopulmonary bypass was performed. Twenty-four patients underwent OPCABG and 24 were operated using the MIDCABG technique. The incidence of cardiac arrhythmias was analyzed since operation to the fourth postoperative day. Each patient had continuous ECG monitoring with option of arrhythmia analysis during ICU stay. After discharge from ICU 24-h ECG monitor studies were carried out. Surface 12-lead ECG was accomplished once a day, and additionally each time symptoms of cardiac arrhythmia occurred. Risk factors of atrial fibrillation were estimated. **Results:** Atrial fibrillation occurred in 25% of patients after MIDCABG, in 29% after OPCABG, and in 18% after CABG with cardiopulmonary bypass. This difference has no statistical significance. Risk factors and incidence of postoperative complications were comparable in all groups. **Conclusions:** Atrial fibrillation is a common complication after procedures of myocardial revascularization, performed with or without cardiopulmonary bypass. The occurrence is not dependent on the type of operation. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Atrial fibrillation; Myocardial revascularization; Coronary artery bypass graft; Off-pump coronary artery bypass graft; Minimally invasive direct vision coronary artery bypass graft

1. Introduction

Atrial fibrillation (AF) is the most common complication after heart surgery. It is observed after coronary artery bypass grafting (CABG) (occurrence rate 17–33%) and after valve surgery (occurrence rate 38–64%). Rarely does it cause death, but it may lead to instability of the patient, prolongs the recovery period, and sometimes can be considered as the reason for perioperative heart infarction.

In the majority of papers analyzing results in coronary surgery, AF is being shown as the major complication of

cardiopulmonary bypass [2,3]. However, all the mechanisms of supraventricular rhythm disturbances are not precisely known; there are certain conditions provoking AF [1–5]. Cardiopulmonary bypass (CPB) and cardioplegia, being the standard techniques applied in the majority of CABG operations, can produce some number of complications. Less-invasive techniques, which are being introduced presently in clinical practice, are connected with the reduction of surgical trauma, elimination of cardiopulmonary bypass, and shorter in-hospital and rehabilitation period. This leads to the possibility of liberal qualification criteria for heart operations, giving a chance to more high-risk patients – those of advanced age, with low left ventricular ejection fraction, diseases of kidneys, central nervous system and lungs, and peripheral vascular problems [6–20]. The less-invasive CABG procedures, on the beating

[☆] Presented at the 13th Annual Meeting of the European Association for Cardio-thoracic Surgery, Glasgow, Scotland, UK, September 5–8, 1999.

* Corresponding author. Tel./fax: +48-58-341-7669.

E-mail addresses: jsiebert@amg.gda.pl (J. Siebert),
lanisim@amg.gda.pl (L. Anisimowicz)

Table 1

Clinical data of 87 patients with coronary artery disease, admitted for CABG with (MIDCABG and OPCABG), or without (CABG) cardiopulmonary bypass

	MIDCABG	OPCABG	CABG
Number of patients	24	24	39
Male	18	15	29
Female	6	9	10
Age (years)	59.1 ± 10.5	58.9 ± 8.6	60 ± 7.8
Height (m)	1.70 ± 0.08	1.67 ± 0.08	1.7 ± 0.07
Weight (kg)	77.0 ± 13.4	77.9 ± 11.4	80.4 ± 12.9
Body mass index (kg/m ²)	26.7 ± 4.2	28.1 ± 4.2	28.8 ± 3.16
Unstable coronary disease	10	11	15
Stable coronary disease	14	13	24
Myocardial infarction history	12	16	24
Arterial hypertension	13	15	24
Insulin-dependent diabetes	1	5	6
Preoperative paroxysmal atrial fibrillation	3	4	2
Other preoperative heart-rhythm abnormalities	2	0	0
Left ventricular ejection fraction	58.7 ± 14	59.4 ± 14.5	57 ± 12

heart without cardiopulmonary bypass, can be performed by the standard sternotomy approach (off-pump coronary artery bypass grafting – OPCABG), or by a small anterolateral IV–V left intercostal space thoracotomy approach (minimally invasive direct vision coronary artery bypass grafting – MIDCABG). Rapid development of surgical instrumentation, especially of various stabilizing devices, has allowed wider application of such procedures in patients with multivascular lesions [7,9–11]. The immobilization technique is of special importance, influencing the quality of anastomosis and reducing the early graft occlusion rate [18]. Good results and the low cost of less-invasive operations has resulted in the progressive growth of such procedures. The problem of heart rhythm disturbances in patients after less-invasive, beating-heart CABG procedures appears infrequently in the literature.

The aim of this study was to evaluate the occurrence of AF in patients after CABG operations without cardiopulmonary bypass.

2. Subjects and methods

In the period between October and December 1998, 48 patients with coronary disease were operated on without CPB, using either OPCABG or MIDCABG techniques, and 39 patients underwent standard CABG using CPB. Clinical data are shown in Table 1. Some of the AF risk factors, known from the literature, were found in the analyzed groups.

The frequency of AF occurrence was analyzed, from operation time to the fourth postoperative day. It was estimated using a continuous monitoring ECG system (Hewlett

Packard, USA) with the possibility of rhythm disturbances analysis during the patients' stay in the ICU. Then, during first 24 h after leaving the ICU, each patient was monitored using the Space Lab system (Space Lab, USA).

A 12-lead ECG recording was executed once a day, and in each case of clinical symptoms of rhythm disturbances. The analysis took into account every incident of AF lasting at least 15 min, or requiring medical treatment because of the patient's instability. AF occurrence and its risk factors, known from the literature, were observed during the pre- and perioperative periods. The influence of AF occurrence on the length of stay in the ICU was also analyzed.

A Mann–Whitney test was used for statistical analysis of values expressed in interval scale along with Fisher's exact test for nominal data. The continuous variables were presented as mean ± standard deviation.

3. Results

In the group of 87 analyzed patients, 48 were operated without CPB, 24 using OPCABG, and 24 using MIDCABG. In 39 patients a standard CABG operation with CPB was performed. The incidence of AF in two groups operated on without CPB is shown in Table 2.

The data in Table 3 show a higher incidence of postoperative AF after OPCABG and MIDCABG operations without CPB (13 out of 48) than after CABG with CPB (7 out of 39). This difference was not statistically significant. The odds ratio was 1.7 with 95% confidence interval (0.6–4.8).

The average duration of ICU stay was higher in patients with postoperative AF (2.1 ± 0.9 days) when compared with those without AF (1.7 ± 0.9 days). This difference was not statistically significant. The data are shown in Table 4.

Perioperative complications, presented in Table 5, are not equally distributed among the groups. OPCABG is connected with only one complication – a transient pneumothorax. Standard CABG with CPB had the largest number of perioperative complications, but the groups are too small to draw general conclusions.

No shifts in the level of blood electrolytes were found in patients either without or with AF. All patients were treated with β -blocking agents before intervention, and the treatment was continued immediately after operation. The aver-

Table 2

Atrial fibrillation in 48 patients after CABG procedures, performed without cardiopulmonary bypass

	OPCABG (n = 24)	MIDCABG (n = 24)	
Atrial fibrillation in the perioperative period	7	6	$P = 0.50^a$

^a Fisher's exact test; the difference of mean values is statistically significant when $P < 0.05$.

Table 3
Atrial fibrillation in 87 patients after CABG procedures, performed with or without cardiopulmonary bypass (CPB)

	OPCABG + MIDCABG (<i>n</i> = 48)	CABG with CPB (<i>n</i> = 39)	
Atrial fibrillation in the perioperative period	13	7	<i>P</i> = 0.44 ^a

^a Fisher's exact test; the difference of mean values is statistically significant when *P* < 0.05.

age postoperative ICU stay, calculated for MIDCABG patients, was longer than in the OPCABG group, due to one case requiring long ICU treatment.

4. Discussion

Recent developments in cardiac surgery and coronary surgery have not resulted in a decrease of AF occurrence in the postoperative period. Modern surgical techniques, perioperative heart protection methods and intensive care have enabled surgeons to operate on more patients in considerably more advanced disease and age. This tendency can increase the risk of postoperative complications. Continuous monitoring in ICU departments has also contributed to more frequent diagnosis of AF, which appears to be the most frequent postoperative complication. In spite of the fact that it seldom has serious consequences, AF deserves special attention, because of its common occurrence [2–4].

The average incidence rate of AF in all populations according to the Framingham study is 1.7%. To a large degree it is age-dependent, attaining a level from 2 to 4% among people over 70 years old. In the population of patients with ischemic heart disease, the incidence reaches the level of 4.8% among women and 6.2% among men, depending on the severity of disease.

The range of the postoperative AF incidence-rate, quoted in the literature, is wide ranging, i.e. from 5% to over 40%. Results of different investigations can depend on the applied

Table 4
Influence of postoperative atrial fibrillation (AF) on ICU-stay duration (days) in 87 patients (all coronary procedures are included)

Procedure	No postoperative AF	Postoperative AF	
CABG + OPCABG + MIDCABG	1.70 ± 0.9	2.1 ± 1.2	<i>P</i> = 0.16 ^a

^a Mann-Whitney test. The difference of mean values is statistically significant when *P* < 0.05.

monitoring methods. Continuous ECG monitoring showed AF in 41.3% of patients. Usage of other monitoring methods lowered the registered number of incidents to about 19.9% [3].

In our investigations the incidence-rate of AF was 25% for MIDCABG and 29% for OPCABG patients. Due to the small population investigated, this difference is not statistically significant, and univocal conclusions are impossible. However, our investigation suggests that less-invasive procedures, carried out without the cardiopulmonary bypass, do not cause diminution of AF after operation, in comparison with 'classical' CABG procedures. This fact may create a need for re-analysis of such factors as inadequate myocardial protection or hypothermia during cardiopulmonary bypass, in evaluating the pathogenesis of postoperative AF. Rhythm disturbances can depend on electrolyte shifts connected with revascularization, temporary ischemia, perioperative trauma, epicardial inflammatory reaction, transient postoperative increase of sympathetic activity, 'euthyroid sick syndrome', or ingesting β -blockers before operation.

Most probably, AF risk factors are similar or even identical for types of operations both with or without cardiopulmonary bypass. Advanced age as the risk factor of AF has the best-documented evidence. Structural changes of the myocardium seen in the elderly, such as progressive fibrosis and hypertrophy of the myofibrils, are most probably very important factors [1,3,5].

Other risk-factors can include arterial hypertension and increased atrial volume. In our analysis of both groups, the values of arterial pressure and dimensions of the left atrium did not show any statistically significant differences. Probably, arterial hypertension in connection with ischemia and perioperative damage can result, except for AF, in other rhythm and conductivity disturbances after CABG [3].

The other independent risk factor is male sex. Reports on this have appeared in the literature. The sex hormones' role is believed to be important. However, one should be careful with such conclusions, since postoperative AF incidence rate in male patients is only slightly higher [3,5].

The surgical methods applied in both OPCABG and MIDCABG operations are connected with transient regional ischemia of the myocardium. Slight elevation of the cardiac ischemia enzyme-markers in the perioperative period may be the proof of inadequate myocardial perfusion. Intracoronary shunt devices, used recently by some surgeons in beating-heart surgery, can provide continuity of the target-vessel blood flow during coronary graft anastomosing [19,20]. Prospective studies could eventually show the influence of this technique on the incidence of postoperative AF.

Our data suggest that coronary artery grafting procedures without CPB are connected with a higher incidence of postoperative AF, and that the presence of this complication extends the duration of ICU stay. This should be supported by studies based on larger groups of patients.

Table 5

Perioperative complications in 87 patients after CABG procedures, performed with and without cardiopulmonary bypass

Type of complication	OPCABG (n = 24)	MIDCABG (n = 24)	CABG with CPB (n = 39)
Tamponade	0	0	1
Pneumothorax	1	0	3
Postoperative bleeding – reoperation	0	1	0
Subcutaneous emphysema	0	1	0
Hydrothorax	0	1	0
Temporary mental disorder	0	0	1
Delayed wound healing	0	1	1
Respiratory failure	0	0	1
Transient AV block	0	0	1
Postoperative myocardial infarction with ventricular fibrillation	0	0	1

5. Conclusions

Atrial fibrillation is a common postoperative complication after procedures of myocardial revascularization, performed with or without cardiopulmonary bypass.

Our study did not show any statistically significant difference in the occurrence of AF between groups of patients after different types of CABG operation.

References

- [1] Asher CR, Miller DP, Grimm RA, Cosgrove MD, Chung MK. Analysis of risk factors handicap development of atrial fibrillation early after cardiac valvular surgery. *Am J Cardiol* 1998;82:892–895.
- [2] Borzak S, Tisdale JE, Amin NB, Goldberg AD, Frank D, Pohdi D, Higgins SR. Atrial fibrillation after bypass surgery. *Chest* 1998;113:1489–1491.
- [3] Aranki SF, Shaw DP, Adams DH, Rizzo JR, Couper SG, Vilet MV, Collins JJ, Cohn LH, Burstin RH. Predictors of atrial fibrillation after coronary artery surgery. Current trends and impact on the hospital resources. *Circulation* 1996;94:390–397.
- [4] Allen KB, Matheny RG, Robison RJ, Heimansohn DA, Heimansohn CJ. Minimally invasive versus conventional coronary artery bypass. *Ann Thorac Surg* 1997;64:616–622.
- [5] Almassi GH, Schowalter T, Nikolosi AC, Aggarwal A, Moritz TE, Henderson WG, Tarazi R, Shroyer I, Sethi GK, Grover FL, Hammermeister KE. Atrial fibrillation after cardiac surgery – a major morbid event? *Ann Surg* 1997;226(4):501–513.
- [6] Massetti M, Babatasi G, Lotti A, Bhooyroo S, Le Page O, Khayat A. A less-invasive heart surgery: the preservation of median approach. *Eur J Cardio-thorac Surg* 1998;14(Suppl 1):138–142.
- [7] Rogowski J, Jagielak D, Dudziak M, Lango R, Siebert J, Narkiewicz M. Arterial MIDCAB revascularization LIMA-LAD, GEA-RPD: case report. *Polish Heart J* 1999;50(3):235–237.
- [8] Doty DB, DiRusso GB, Doty JR. Full-spectrum cardiac surgery through and minimal incision: mini-sternotomy (lower half) technique. *Ann Thorac Surg* 1998;65(2):573–577.
- [9] Shennib H. Evolving strategies in minimally invasive coronary artery surgery. *Int J Cardiol* 1997;62(Suppl 1):81–88.
- [10] Fishman RL, Harvey SC, Zellner JL, Pinosky ML, Handy JR. Reducing cardiac surgical trauma: the minimally invasive direct coronary artery bypass. *South Med J* 1997;90:965–971.
- [11] Ribakove GH, Miller JS, Anderson RV, Grossi EA, Appelbaum RM, Cutler WM, Buttenheim PM, Baumann FG. Minimally invasive port-access coronary artery bypass grafting with early angiographic follow-up: initial clinical experience. *J Thorac Cardiovasc Surg* 1998;115:1101–1110.
- [12] Calafiore AM, Di Giammarco G, Teodori G, Gallina S, Maddestra N, Paloscia L, Scipioni G, Iovino T, Contini M. Midterm results after minimally invasive coronary surgery (LAST operation). *J Thorac Cardiovasc Surg* 1998;115:763–771.
- [13] Buffolo E, Gerola LR. Coronary artery bypass grafting without cardiopulmonary bypass through sternotomy and minimally invasive procedure. *Int J Cardiol* 1997;62(Suppl 1):89–93.
- [14] Subramanian VA, McCabe JC, Geller CM. Minimally invasive direct coronary artery bypass grafting: two-year clinical experience. *Ann Thorac Surg* 1997;64:1648–1653.
- [15] Allen KB, Matheny RG, Robison RJ. Minimally invasive versus conventional coronary artery bypass. *Ann Thorac Surg* 1997;64:616–622.
- [16] Calafiore AM, Teodori G, Di Giammarco G, Vitolla G, Iaco A, Iovino T, Cirmeni S, Bosco G, Scipioni G, Gallina S. Minimally invasive coronary artery bypass grafting on a beating heart. *Ann Thorac Surg* 1997;63:72–75.
- [17] Subramanian VA. Less invasive arterial CABG on a beating heart. *Ann Thorac Surg* 1997;63:68–71.
- [18] Mariani MA, Boonstra PW, Grandjean JG, van der Schans C, Dusseljee S, van Weert E. Minimally invasive coronary artery bypass grafting without cardiopulmonary bypass. *Eur J Cardio-thorac Surg* 1997;11:881–887.
- [19] Rivetti LA, Gandra SMA. Initial experience using an intraluminal shunt during revascularization of the beating heart. *Ann Thorac Surg* 1997;63:1742–1747.
- [20] Capasso F, Lucchetti V, Caputo M. Intraluminal shunt prevents left ventricular function impairment during beating heart coronary revascularization. Twelfth Annual Meeting of the European Association for Cardio-thoracic Surgery, Abstract Book, 031, 1998. p. 134.

Appendix A. Conference discussion

Dr J. Melo (Carnaxide, Portugal): Off-pump surgery didn't solve the problem of atrial fibrillation, but in most series, it has reduced the incidence by half. Why do you keep the same incidence of atrial fibrillation? Is there a relation with perioperative management?

Dr Anisimowicz: It is very hard to say. As an adjunct to this study, we have already designed and are carrying out another, comparative, study. So we are on the way to comparing consecutive pump operations and off-pump operations, and this data will be published very soon. Our preliminary findings show that in fact there is no reduction in our material in the off-pump cases.