

The role of premature atrial contractions as the main triggers of postoperative atrial fibrillation

Lena Jidéus, MD, PhD^{a,*}, Milos Kesek, MD^c, Per-Olof Joachimsson, MD, PhD^b
Mats Ericson, MD, PhD^d, Leif Nilsson, MD, PhD^a, Carina Blomström-Lundqvist, MD, PhD^c

^aDepartment of Surgical Sciences, Thoracic and Cardiovascular Surgery, University Hospital, S-751 85 Uppsala, Sweden

^bDepartment of Cardiothoracic Anesthesiology, University Hospital, S-751 85 Uppsala, Sweden

^cDepartment of Medical Sciences, Cardiology, University Hospital, S-90188 Umeå, Sweden

^dDepartment of Human Resources, Management and the Environment, Mid Sweden University, S-83135 Östersund, Sweden

Received 12 April 2005

Abstract

To better understand the pathogenesis of postoperative atrial fibrillation (AF), the mode of onset of AF after coronary artery bypass grafting was analyzed with respect to the autonomic balance, the heart rate (HR), and the presence of arrhythmias preceding the onset of sustained AF.

Method: Holter recordings of 24 hours, obtained from the first postoperative morning until clinically documented sustained AF, were analyzed in 29 untreated patients and in 13 patients treated with thoracic epidural anesthesia (TEA), who all developed AF after coronary artery bypass grafting. The presence of arrhythmias, the HR, and the autonomic balance, assessed by heart rate variability in the frequency domain, were analyzed at predefined time intervals within the 3-hour period before AF onset. Supraventricular premature beats (SPBs) and ventricular premature beats triggering the onset of AF were also evaluated.

Result: An SPB triggering the onset of AF can be identified in 21 (72.4%) of 29 untreated patients and in 12 (100%) of 12 TEA-treated patients in whom the recordings permitted such an analysis. The heart rate variability components analyzed during 5-minute periods for 30 minutes before AF onset did not differ significantly from those at corresponding times at the first postoperative day in either patient group. The HR during the 8 beats immediately before AF onset was lower in TEA-treated than in untreated patients.

Conclusion: The finding of an SPB at the onset of postoperative AF in most of the patients and irrespective of changes in HR supports the hypothesis that postoperative AF is primarily triggered by latent focal atrial activity. The autonomic tone did not seem to be of major importance in the population studied.

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Keywords:

Atrial fibrillation; Coronary artery bypass surgery; Premature atrial contraction; Autonomic tone

1. Introduction

Recent studies in patients with paroxysmal atrial fibrillation (PAF) have shown that the arrhythmia is triggered by focal electrical activity manifested as isolated extrasystoles or slow/rapid atrial rhythms [1]. Despite extensive investigations aiming at the identification of risk factors for the initiation of postoperative atrial fibrillation (AF), its

pathogenesis has remained unresolved [2]. Analysis of heart rate variability (HRV) indicated that a moderate increase in sympathetic tone and a loss of excessive vagal tone before the onset of postoperative AF were important triggering factors [3]. In our previous study, we demonstrated that preoperative supraventricular arrhythmias occurred with a higher frequency in patients who developed sustained AF after coronary artery bypass grafting (CABG) compared with those who maintained sinus rhythm [4]. Moreover, after CABG, plasma levels of catecholamines and certain neuropeptides were raised, consistent with an increased

* Corresponding author. Tel.: +46 18 611 40 16; fax: +46 18 611 39 26.
E-mail address: lena.jideus@akademiska.se (L. Jidéus).

sympathetic tone [4]. Treatment with thoracic epidural anesthesia (TEA) for suppression of the increased sympathetic outflow after surgery had, however, no effect on the incidence of postoperative AF [5]. Other studies, however, demonstrated that atrial overdrive pacing resulted in a significant reduction of the number of supraventricular premature beats (SPBs) before AF, in conjunction with a reduced incidence of postoperative AF [6]. Although TEA reduced the total number of SPB in patients developing postoperative AF [5], it did not, as opposed to atrial pacing therapy, translate into a reduced incidence of AF.

The observation that pulmonary vein (PV) foci are frequently the initiating mechanism of PAF [1] urged us to study whether early atrial contractions, before and at the AF onset, may also be of importance for the initiation of postoperative AF. Latent PV foci may hypothetically become mechanically activated by the distension of the PVs after surgery [4]. The still unclear role of the autonomic nervous system (ANS) for the initiation of postoperative AF prompted us also to study the temporal changes in the autonomic tone using HRV and heart rate (HR) before AF onset.

2. Material and methods

2.1. Study group

Of the 96 patients undergoing elective CABG at our department and who were studied with regard to the mechanism of postoperative AF [4,5,7], 29 patients developed sustained AF (defined as AF \geq 30 seconds) and constituted the study group (Table 1). Another 13 patients who had been treated with TEA and developed AF after CABG were also studied. The study was approved by the Local Ethics Committee of Uppsala University.

Table 1
Demographic and surgical data

Variables	Non-TEA group (n = 29)	TEA group (n = 13)
Age (y)	65.7 \pm 7.4	64.5 \pm 6.1
Male (%)	79.3	100
Duration of angina pectoris (y)	4.3 \pm 4.1	4.3 \pm 4.5
Canadian class (I-IV)	2.4 \pm 0.6	2.4 \pm 0.7
NYHA (I-IV)	2.9 \pm 0.3	2.9 \pm 0.3
No. of previous myocardial infarctions (%)	41.4	23.1
LV function		
Good (%)	86.2	61.5
Moderate dysfunction (%)	13.8	38.5
No. of vessels diseased	2.7 \pm 0.6	2.9 \pm 0.3
Preoperative use of β -blockers (%)	82.8	92.3
Postoperative use of β -blockers (%)	51.7	46.21
BMI (kg/m ²)	25.6 \pm 3.4	26.8 \pm 3.3
No. of distal anastomoses	3.4 \pm 1.0	3.8 \pm 1.0

Data are shown as mean \pm 1 SD. There was no significant difference between the 2 patient groups. NYHA indicates New York Heart Association functional class; LV, left ventricular; BMI, body mass index.

2.2. Procedures pre-, intra-, and postoperatively

All operations were performed with a standard technique for cardiopulmonary bypass and moderate hypothermia (30°C–32°C) described in detail elsewhere [7]. The first day after operation was defined as day 1. The patients' ordinary medical treatment, including β -blocking agents, was administered until the morning of surgery and reinstated on the day after the operation, depending on the patients' clinical status. Thoracic epidural anesthesia was administered from the day of surgery until AF occurred using a technique described earlier [5].

2.3. Holter electrocardiogram of 24 hours

Holter recordings of 24 hours, from the morning the day after surgery until clinically documented sustained AF, were obtained by a standard Del Mar Avionics 3-channel tape recorder (Model 459; Del Mar Avionics, Irvine, Calif). Tapes and batteries were exchanged every 24 hours. The electrocardiographic (ECG) signal was digitized and stored using a commercially available personal computer-based system. All recordings were visually scanned and analyzed using a Del Mar Model 563 StrataScan Holter Analysis System [5].

2.4. Arrhythmia definitions

A supraventricular tachyarrhythmia (SVT) was defined as regular or irregular narrow QRS complex tachycardia with 3 or more consecutive beats with an HR of 100 beats per minute or more. Atrial fibrillation was defined as the absence of consistent P waves before each QRS complex and with an irregular ventricular rate. An SPB was defined as a narrow QRS complex occurring with 20% or more prematurity and differentiated from sinus arrhythmia on the basis of P-wave morphology, cyclic changes in preceding R-R intervals, or both. A ventricular premature beat (VPB) was defined as a broad QRS complex occurring with 20% or more prematurity.

2.5. Arrhythmia analysis and the mode of onset

The mean number of SPB, VPB, and the number of episodes of SVT per hour were manually analyzed for each 1-hour period recorded during the 3 hours before AF onset and compared with those at day 1. The mode of onset of AF was analyzed with regard to the presence of an SPB or a VPB at the initiation of AF onset, that is, during the very last beat before AF onset and an increase/decrease in HR unrelated to premature (HR-8) beats during the very last 8 beats before the onset of sustained AF. An SPB at the AF onset (Fig. 1) was regarded as present if identified by both independent observers who were blinded to different tracings of the AF onset from Holter recordings. An increase/decrease in HR was defined as present if the HR-8 was 10 beats per minute higher/lower the spontaneous variation in HR (ie, control rhythm) during the last 3 hours before AF onset. The presence of nonsustained SVT during the very last 8 beats before the AF onset was also analyzed.

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