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„Preoperative Baroreflex Sensitivity and Heart Rate Variability in Patients Experiencing Atrial Fibrillation after Cardiac Surgery“

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Preoperative Baroreflex Sensitivity and Heart Rate Variability in Patients Experiencing Atrial Fibrillation after Cardiac Surgery

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INTRODUCTION

Supraventricular arrhythmias occur with an abundance of 20 - 40% after open heart surgery despite improvements in anaesthesia, surgical technique, and medical therapy [Aranki1996]. The most common types of arrhythmias are atrial fibrillation (AF) or atrial flutter. While post-operative arrhythmias are seldom life-threatening, they can increase morbidity and the duration of hospitalization with increased health care costs [Mooss2004]. The pathogenesis of post-operative AF is considered to be multi-factorial. However, the precise contribution of each risk factor, the pathophysiological mechanisms, and the role of the cardiovascular autonomous system in the post-operative patient are still widely unclear [Amar2004]. The aim of the study presented here was to analyze the influence of pre- and post-operative cardiovascular autonomous control on the occurrence of post-operative AF.

METHODS

58 patients consecutively undergoing isolated aortocoronary bypass surgery, isolated aortic valve surgery or combined aortic valve replacement and bypass surgery were included in the study after approval of the local committee of ethics and informed consent. Exclusion criteria were emergency operations, a history of AF or ventricular arrhythmias, and the use of the radial artery as bypass graft, because the contralateral radial artery was used for invasive pressure monitoring.

The occurrence of atrial fibrillation or of a severe psychosyndrome (first post-operative day), mechanical ventilation (>20 hours after surgery), and the need for inotropic support (>low-dose dopamine 24 hours after surgery) led to post-hoc exclusion; thus, 51 patients remained for analysis. One week after surgery, the patients were divided into two groups: patients remaining in sinus rhythm (group SR, n=33) and patients experiencing at least one episode of AF lasting longer than five minutes (group AF, n=18). Demographic data of both groups did not differ significantly.

After 10-min equilibrations to the environment, non-invasive blood pressure signals were collected from the radial artery by a tonometer (Colin Medical Instruments) at 1000 Hz. Simultaneously, a standard ECG was monitored. Data were sampled for a 30-min period the day before surgery at the hemodynamic laboratory and 24 hours after surgery on the intensive care unit. Care was taken to perform the measurements during the same time of the day for each patient. From the data recorded, the beat-to-beat intervals as well as the beat-to-beat systolic and diastolic values were extracted; premature beats, artefacts, and noise were excluded using an adaptive filter considering the instantaneous variability [Wessel2000]. Spontaneous baroreflex regulation was analyzed using the Dual Sequence Method (DSM) [Malberg2002], whereas heart rate variability (HRV) was analyzed using standard time- and frequency domain measures as well as measures from nonlinear dynamics [Wessel2000].

RESULTS

All patients included in the study survived the operation and did not suffer from major adverse events in the immediate post-operative course. In patients with a post-operative sinus rhythm, the strength of bradycardic and tachycardic regulation (average slope) decreased significantly after surgery. Patients experiencing post-operative AF showed a significant pre-operative decrease in baroreflex sensitivity (BRS) compared to patients remaining in SR (Figure 1). The DSM parameters show that patients in the AF group had a decreased pre-operative bradycardic and tachycardic regulation as compared to patients remaining in SR. Post-operatively, there were no differences between the two groups. The HRV parameters revealed a significant drop of variability due to the surgical intervention in

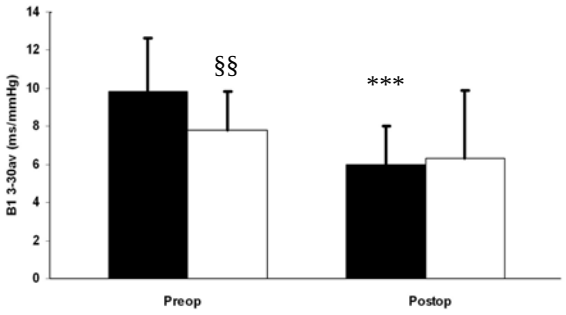

Fig. 1: Baroreflex sensitivity. Average slope of the bradycardic synchronous baroreflex in the range of 3-30 ms/mmHg. Black bars: group SR, white bars: group AF. ***: p<0.001 vs. pre-operative; §§: p<0.01 vs. group SR.

both groups. No differences were noticed between the groups, neither pre- nor post-operatively. The parameter 'Shannon' (the Shannon entropy of the histogram) showed a uniform decrease in both groups (Figure 2).

DISCUSSION

In the pre-operative DSM analysis, a significantly lower BRS for the bradycardic and tachycardic regulation was found in patients, who later developed post-operative AF. After the operation, the time and frequency domain parameters of HRV showed a strong tendency towards less variability and a predominance of sympathetic regulation. There were no major differences between the two groups, which is in agreement with previous findings by other authors. This indicates that the occurrence of post-surgical AF is not solely an effect of surgery, but also due to a certain predisposition that exists prior to surgery already. From these data, it can be hypothesized that a higher ability of the autonomous nervous system to react to pressure fluctuations may be protective to overcome the strong arrhythmic stimuli that are obviously generated by the surgical intervention.

CONCLUSION

In the present study, the BRS and HRV were found to be changed significantly by heart surgery with a cardiopulmonary bypass. This is in very good agreement with the results of a pilot study done in a smaller, more homogeneous patient collective. Furthermore, it was shown that patients experiencing AF after the operation presented a generally lower BRS concerning tachycardic and bradycardic regulation. From these findings, the following conclusions can be drawn: the onset of post-operative AF is not only caused by commonly known clinical risk factors and the influences of the operation, but obviously by the pre-surgical state of the cardiovascular autonomous system.

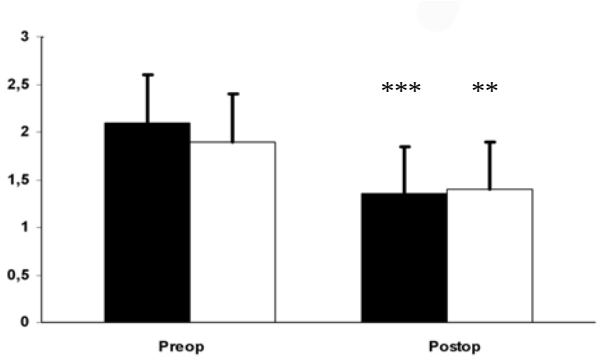

Fig. 2: Shannon entropy. Black bars: group SR, white bars: group AF. **: p<0.01 vs. pre-operative. ***: p<0.001 vs. pre-operative.

For the description of complex phenomena in cardiological data, a comprehensive approach, including BRS, classical HRV, and symbolic dynamics, is recommended. In the present study, analysis of HRV alone would have resulted in minor differences between the groups only. Further studies with larger patient populations will have to evaluate the predictive value of BRS for post-operative AF and to define a subset of the most suitable parameters and their cut-off points.

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