Microvascular effects of esmolol in postoperative atrial fibrillation: a prospective pilot study in cardiac surgery

W. Fornier^{1,2}, M. Jacquet-Lagrece¹, T. Collenot¹, P. Teixeira¹, P. Portran¹, R. Schweizer¹,
M. Ovize^{2,3}, J.L. Fellahi^{1,2}

¹Department of Anesthesiology and Intensive care, University Hospital Louis Pradel, Lyon, France;

²Inserm U 1060, Faculty of Medicine, Claude Bernard Lyon I University, Lyon, France

³Department of Cardiology, University Hospital Louis Pradel, Lyon, France

Background and goal of study

Postoperative atrial fibrillation (POAF) is commonplace after cardiothoracic surgery. Rate control with betablockers is recommended as a first-line therapy in patients macro-hemodynamically stable. Esmolol is a short-acting β 1-selective betablocker whose microcirculatory effects have not been yet investigated. We tested the hypothesis that esmolol could improve the POAF-related microvascular dysfunction.

Materials and Methods

After approval of the Ethical Committee, we prospectively included 20 cardiothoracic surgical patients with POAF in the Teaching University Hospital Louis Pradel (Lyon, France). Microcirculation was assessed by near-infrared spectroscopy (NIRS) and a vascular occlusion test (VOT) at successive time points: before esmolol infusion, during incremental doses of esmolol (25, 50, 100, and 200 μ g/kg/min) and after return to sinus rhythm. Esmolol dose regimen was increased every 45 minutes until heart rate reached a targeted value between 60 and 90 beats/min. NIRS parameters included StO_2 , StO_2 min, StO_2 max, ΔStO_2 , and both desaturation and resaturation speeds. Data before and after cardioversion were compared with a paired Student *t* test or a Wilcoxon test. A one-way ANOVA for repeated measurements or a Friedman test were used to compare the effects of incremental doses of esmolol.

Results and discussion

StO_2 and resaturation speed were significantly improved between POAF and return to sinus rhythm: StO_2 64.5 % $\pm$ 3.9 vs. 67.0 % $\pm$ 5.1, $p=0.047$; and resaturation speed 0.6 %/s (0.45-0.99) vs. 0.7 %/s (0.50-1.03), $p=0.02$. ΔStO_2 was significantly lower after return to sinus rhythm, 8.0 $\pm$ 4.5 vs. 6.0 $\pm$ 4.5, $p=0.026$. During esmolol infusion, StO_2 and resaturation speeds were not statistically different (Figure 1). No significant difference was found at any other time point for StO_2 min, StO_2 max, ΔStO_2 and desaturation speed. On the other hand, mean arterial pressure showed a trend toward a decrease ($p = 0.054$) whereas pulse pressure had a significant reduction ($p < 0.001$). Heart rate was lowered as expected ($p = 0.031$).

Keywords

Peripheral tissue oxygen saturation; Postoperative atrial fibrillation; Microvascular dysfunction, Near-infrared spectroscopy, Esmolol

Figure 1: Boxplots from microcirculation values during POAF and its treatment with esmolol. Continuous variables were analyzed with a repeated measures analysis of variance (ANOVA test) and a Friedman test, depending on their homogeneity of variances. (A) StO_2 , (B) Resaturation speed.

Impact of spontaneous cardioversion on macro and microcirculation variables

VARIABLES	POAF	SR	p value
HR (beats per minute)	133 (116-139)	74 (67-84)	0.001
MAP (mmHg)	79 $\pm$ 12.3	80 $\pm$ 12.5	0.897
PP (mmHg)	51 $\pm$ 14	59 $\pm$ 15	< 0.001
SpO ₂ (%)	95 (94-96)	97 (96-98)	0.046
StO ₂ (%)	64.5 $\pm$ 3.9	67.0 $\pm$ 5.1	0.047
Resaturation speed (%/sec.)	0.62 (0.46-0.99)	0.66 (0.50-1.03)	0.020
Desaturation speed (%/sec.)	0.08 (0.05-0.09)	0.09 (0.05-0.10)	0.529
ΔStO_2 (%)	8.0 $\pm$ 4.5	6.0 $\pm$ 4.5	0.026
StO ₂ min (%)	40 (39-41)	40 (40-46)	0.396
StO ₂ max (%)	73 (71-77)	73 (71-76)	0.483

Data are absolute values, means $\pm$ SD or medians (25th and 75th percentiles). Continuous variables were analyzed with a paired Student *t* test and a Wilcoxon test, according to distribution. HR: heart rate, MAP: mean arterial pressure, PP: pulse pressure, SpO₂: Saturation of peripheral oxygen.

Conclusion

Stable hemodynamic POAF is associated with significant microvascular dysfunction. Rate control with intravenous esmolol showed a not significant trend toward a dose-dependent improvement in POAF-related microvascular dysfunction.