Title: The Effect of High-Dose Fentanyl on Cardiac Metabolic Balance and Coronary Circulation in Patients Undergoing Coronary Artery Surgery

Authors: C.T. Skourtis, M.D., M. Nissen, M.D., L.A. McGinnis, M.D., J. Gallo, M.D., A. Hingelberg, M.D. I. Palacios, M.D., D.G. Lappas, M.D.

Affiliation: Anesthesia Service, Department of Anesthesia, Harvard Medical School at Massachusetts General Hospital, Boston, MA 02114

Introduction: Previous investigators have reported conflicting evidence on myocardial metabolism and coronary hemodynamics after high-dose fentanyl administration.[1,2] The present study was undertaken in an attempt to clarify the effects of fentayl-oxygen anesthesia on myocardial oxygenation and coronary circulation in patients undergoing coronary artery bypass grafting (CABG).

Methods: Informed consent was obtained from 10 patients (ASA III) scheduled for CABG operation. All were on beta-blockers and nitrates. Premedication consisted of morphine 0.1 $mg.kg^{-1}$ and scopolamine 0.4 mg I.M. A Baim coronary sinus (CS) catheter[3] and a pulmonary artery catheter were inserted via the right internal jugular vein under fluoroscopy to ensure appropriate positioning. Additional monitoring included an arterial line and two lead ECG (HR). Arterial (SAP), pulmonary arterial (PAP), right atrial (RAP) and pulmonary wedge (PCWP) (mm Hg) pressures and ECG were recorded throughout the study. Cardiac output (CO, $l.min^{-1}$, CS blood flow ($ml.min^{-1}$) (CSF) and great cardiac vein flow (GCVF) were measured by the thermodilution method. Stroke volume (SV,ml), systemic vascular (SVR) and pulmonary vascular (PVR) resistances ($dyn.sec.cm^{-5}$), myocardial oxygen consumption ($MVO_2$) and lactate uptake were calculated by the standard formulae. Blood samples for lactate and $O_2$ content were withdrawn from the CS and arterial catheters. $O_2$ content were measured by the $LexO_2Con$ apparatus. $FIO_2$ was I.0 throughout the study and $PaCO_2$ maintained within normal limits. Hemodynamic measurements and blood samples were obtained prior to induction (control, phase I), following induction prior to incision (II), and after sternotomy (III).

Results: The data are presented in the Table (mean ±SEM). In phase II, mean SAP and SVR decreased 16% and 22% respectively, while SV remained unchanged. Following sternotomy (phase III), both $\overline{SAP}$ and SVR and SV approximated control values. During the same periods, the other hemodynamic parameters did not change significantly. CSF and GCVF decreased during phase II and returned towards control during phase III. These changes correlated with HR (r=0.97), SAP (r=0.97), PAP (r=0.93), PCWP (r=0.85), PVR (r=0.98), and were well correlated to each other (r=0.87). Arterial $O_2$ content remained constant and that of CS decreased in phase II and III without significant changes in $MVO_2$. Myocardial $O_2$ extraction increased in both phase II and III ($p<0.05$) and was inversely correlated to CSF (r= -0.92) throughout the study. Lactate uptake (calculated in 6 patients) was positive in all phases with the exception of a single patient (phase II, a negligible -0.04 $mmol.l^{-1}$ value).

Discussion: Following induction of anesthesia, a fall in SAP, due to a decrease in SVR, was observed. Myocardial $O_2$ extraction increased while both $MVO_2$ and lactate uptake remained unchanged. In the presence of a small decrease in CSF, this suggests adequate myocardial perfusion. Following sternotomy, $\overline{SAP}$ and SVR approximated the control values. Myocardial $O_2$ extraction remained elevated and $MVO_2$ showed a slight increase, while lactate uptake remained positive. CSF returned towards control levels. This indicates that myocardial tissue perfusion was well preserved under the stress of surgical stimulus. The excellent correlation between CSF and GCVF throughout the study indicates no coronary flow redistribution or steal effect with high-doses of fentanyl.

We conclude that high-dose fentanyl administered in patients with severe coronary artery disease, on beta-blockers, preserves myocardial perfusion during induction of anesthesia and surgical stimulation without altering myocardial supply/demand balance.

References:
1. Sonntag H, et al: Anesthesiology 56:417, 1982.
2. Gilbert M, Christensen O: Acta Anaesth Scand. Suppl 78:9, 1983.
3. Baim D, et al: Am J Cardiol. 46:997, 1980.

TABLE (mean ± SEM)

| | Phase I | Phase II | Phase III |
|---|---|---|---|
| HR | 52 ± 2 | 46 ± 2 | 49 ± 2 |
| $\overline{SAP}$ | 102 ± 7 | 79 ± 6* | 97 ± 5 |
| $\overline{PAP}$ | 19 ± 2 | 15 ± 2 | 16 ± 1 |
| $\overline{PCWP}$ | 14 ± 1 | 10 ± 1 | 10 ± 1 |
| $\overline{RAP}$ | 7 ± 1 | 6 ± 1 | 5 ± 1 |
| CO | 4.2 ± 1 | 4.1 ± .3 | 3.8 ± .3 |
| SV | 79 ± 5 | 81 ± 4 | 77 ± 5 |
| SVR | 1871 ± 150 | 1561 ± 78* | 2037 ± 154 |
| CSF (ml) | 91 ± 7 | 78 ± 7 | 86 ± 6 |
| GCVF (ml) | 59 ± 7 | 47 ± 6 | 49 ± 7 |
| $O_2$cont. | | | |
| Art. | 17.4±0.4 | 17.7±0.5 | 17.5±0.6 |
| CS | 7.4±0.6 | 6.2±0.4* | 6.4±0.7* |
| $O_2$extr. | 10.0±0.4 | 11.5±0.4* | 11.1±0.8* |
| $\overline{MVO_2}$ | 9.3±0.7 | 9.2±0.9 | 9.6±1.1 |

* $p < 0.05$