Title: Echocardiographic Assessment of Myocardial Contractility During Halothane and Isoflurane Anesthesia

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Introduction: Previous studies have shown that at equivalent anesthetic levels of halothane and isoflurane, cardiac output and left ventricular dp/dt are lower with halothane. It has thus been postulated that halothane is a greater depressant of myocardial contractility than isoflurane. These studies, however, did not control for the effects of pre- and afterload on cardiac performance. The slope of the relationship between end-systolic pressure and end-systolic volume over a range of loading conditions, known as the end-systolic pressure-volume relationship (ESPVR), is a measure of myocardial contractility that is not affected by drug induced changes in pre- and afterload. To assess the effect of halothane and isoflurane on myocardial contractility, we measured the ESPVR at equivalent anesthetic levels of both agents during phenylephrine induced changes in loading conditions.

Methods: Following informed consent and approval by the human research committee, 10 ASA 1 patients between the ages of 21 and 46 were studied. All received morphine sulfate, 0.1 mg/kg IM, diazepam, 10 mg PO, and atropine, 0.4 mg IM, for pre-medication. A radial intra-arterial catheter was inserted, and anesthesia was induced with thiopental, 4 mg/kg, fentanyl, 5 ug/kg, and vecuronium, 0.1 mg/kg. Patients were intubated and ventilated with 100% oxygen and ventilation was controlled to keep end-tidal PCO2 at 40 mmHg. Patients were randomly assigned to receive either halothane or isoflurane. The experimental paradigm called for measurement of ESPVR during the awake state (control), 10 min following the attainment of a 0.5 MAC end-tidal (et) volatile anesthetic concentration (0.5 MAC) and 10 min following the attainment of a 1.0 MAC ET volatile anesthetic concentration (1 MAC). Only after completion of studies was surgical stimulus applied.

To determine the ESPVR, changes in end-systolic pressure and volume were generated by infusing phenylephrine at 150 ug/min intravenously until a 30 mmHg rise in diastolic notch pressure was obtained. During the infusion, an external echocardiogram of the left ventricle at mid-papillary muscle level and intra-arterial pressure were continuously recorded. At a later time, end-systolic echograms at end-expiration were identified at approximately 5 mmHg increments of diastolic notch blood pressure using a Microsonics echo-analyzer. The intra-cavitary left ventricular end-systolic area was measured, and end-systolic volume was calculated using a spherical approximation so that Volume = π(Area + r)^3/2. Linear regression analysis was used to calculate the slope of the relationship between end-systolic volume and pressure. The slope of the ESPVR at each anesthetic level was determined for each patient individually, and these slopes were averaged to determine the mean ESPVR for each group of patients at each anesthetic level. Between group comparisons of the slopes at each anesthetic level were made using a t-test for unpaired data.

Results: Five patients were studied with each agent. Figure 1 shows the mean slopes of the ESPVR for the halothane and isoflurane groups during the awake control state and during 0.5 and 1.0 MAC volatile anesthetic administration. There was a dose-dependent depression of myocardial contractility, as defined by the ESPVR, for both agents. Further, there was no difference between slopes at any anesthetic level for the two groups.

Discussion: Our data indicate that halothane and isoflurane are equipotent depressants of myocardial contractility in man at equivalent anesthetic doses. This is in agreement with earlier work by Seifen, et al., in the dog. Isoflurane's greater vasodilating properties, as compared to halothane, may explain the greater cardiac performance found by others when comparing these two agents at equal doses. Isoflurane induced vasodilation would produce a greater cardiac output and left ventricular dp/dt for the same level of myocardial depression as caused by halothane.

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