

Title: SONOMICROMETRIC EVALUATION OF POSTOPERATIVE CARDIAC FUNCTION

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**INTRODUCTION.** The use of pulse-transit sonomicrometry transducers for dynamic measurement of left-ventricular (LV) geometry was developed by Rushmer (1) and has recently been applied to monitoring global LV function intraoperatively (2). Under conditions of rapidly changing LV compliance, LV dimensions are more sensitive determinants of preload than filling pressures such as mean left atrial pressure (LAP) or pulmonary artery wedge pressure (PAWP). This study was designed to evaluate sonomicrometry for measuring both global and regional LV function following cardiac surgery.

**METHODS.** With institutional approval and informed consent, twenty consecutive patients undergoing coronary artery bypass grafting were studied. The patients were all males, and the mean age was 55.6 years (41-60 years). The mean preoperative ejection fraction was 53% (29-76%). Prior to induction of anesthesia, catheters were inserted percutaneously into the radial and pulmonary arteries. Anesthesia consisted of fentanyl and diazepam; muscle relaxation was achieved with pancuronium. At operation and just prior to weaning off cardiopulmonary bypass, 5 mm hemispheric ultrasonic dimension transducers were sutured to the anterior and posterior epicardial surfaces across the minor axis of the LV for measurement of minor axis diameter (LVD). A single 4-0 chromic catgut suture was used for each transducer, and accurate positioning could be accomplished without monitoring the ultrasonic waveform. Fluid-filled catheters were introduced for measurement of LAP and pleural pressure (PLP). In nine patients, a micromanometer was passed into the LV for measurement of intracavitary LV pressure (LVP). Transducer leads were exteriorized through the chest tube tracts and coupled to a sonomicrometer. A specially designed sonomicrometer provided a sampling rate of 3 kHz, a frequency response of 0 to 50 kHz, and a minimal resolution of approximately 0.08 mm. LVD was visually displayed for detection of quantitative changes in LV function. Physiological measurements of LV diameter, pressure, and cardiac output were obtained after arrival in the intensive care unit and at 6, 12 and 20 hours postoperatively. Additional data were recorded during specific interventions such as extubation. All data were recorded on FM tape, digitized and computer analyzed.

**RESULTS.** During the first 12 hours postoperatively, there was a progressive increase in LVD, reflecting improved diastolic filling. This change in preload was not detected by LAP, PAWP, or transmural LV pressure. Systolic change in LVD correlated well with changes in thermodilution stroke volume so that LVD could be used as an on-line index of cardiac output. End-diastolic LVD increased significantly ( $p < 0.01$ ) following extubation whereas LAP decreased. In five patients with preoperative regional wall motion abnormalities, dyskinesia was observed on the LVD tracing but resolved over the first 12 postoperative hours. In one patient, similar systolic dysfunction, without resolution, was the first indication of perioperative myocardial infarction.

**DISCUSSION.** Sonomicrometry measures the transit time of a burst of ultrasound between identical piezoelectric transducers. Because the velocity of ultrasound in blood and tissue is constant, the measured time delay is linearly related to the distance between the transducers. The technique yields high resolution data, utilizes stable electrical calibrations, and is virtually free from drift or temperature sensitivity. The data presented here demonstrate that ultrasonic monitoring offers important advantages over conventional monitoring techniques, in that LV loading conditions and regional function can be continuously and accurately observed after cardiac surgery. Thus, dynamic analysis of ventricular dimensions significantly improves the characterization of myocardial performance after cardiac surgical procedures.

#### REFERENCES.

1. Rushmer RF, Franklin DL and Ellis RM: Left ventricular dimensions recorded by sonocardiometry. *Circ Res* 4:684-688, 1956.
2. Chitwood WR, Hill RC, Sink JD, et al: Measurement of global ventricular function in patients during cardiac operations using sonomicrometry. *J Thorac Cardiovasc Surg* 80:724-735, 1980.