

TITLE: Intracranial Air Embolism Is Detected By The Transcranial Doppler (TCD) During Cardiopulmonary Bypass Procedures.

AUTHORS: M.S. Albin*, M.D., C. Hantler*, M. P., L. Bunegin*, B.S., F. Grover^o, M.D., D. Cohen^o, M.D., H. Mitzel* M.S.

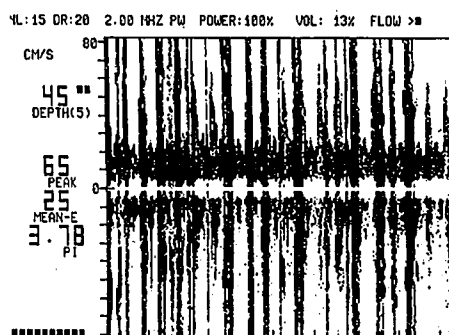
AFFILIATION: Department of Anesthesiology* and Surgery^o (Cardiothoracic), University of Texas Health Science Center at Audie Murphy Memorial Veteran's Hospital, San Antonio, Texas.

A previous study has indicated that the TCD can detect and image air passing through the middle cerebral artery (MCA) of monkeys in volumes as small as 0.8 ul. The purpose of this study is to report the incidence of intracranial-intraarterial air and the time period of occurrence during coronary artery bypass grafts (CABG) and valve replacements (VR). This study was approved by the Institutional Review Board of the University of Texas Health Science Center at San Antonio and informed consent obtained from all subjects. A total of 27 patients were studied (Table) using the TCD (Transpect-Medasonics) with the pulsed Doppler probe imaging the MCA. The output from the TCD was connected to a VCR and a video tape made of each procedure. Criteria for determining the presence of aeric embolism included both the characteristic high velocity signal of short duration as well as the hollow, metallic auditory "chirp". Doppler signals not showing both of these characteristics were rejected. The tape of each procedure was reviewed and each episode of air noted in a 10 minute epoch during cannulation (CANN), bypass (BYP), and immediately after bypass (AFTBYP). The episodes in each 10 minute time frame

of the CABG group were compared to the VR group with a 2-way analysis of variance (ANOVA). The ANOVA was performed on rank scores of the frequencies, a statistically conservative procedure to mitigate the extreme skewness of the raw frequency distribution. Both main effects tests were statistically significant, indicating that, on average, the incidence of air emboli are higher ($p < .0001$) for VR than CABG patients, and increase across time frame. Further tests indicated that only the AFTBYP groups differ from the bypass groups ($p < .002$), on average. The table indicates the mean ranks of emboli incidence for the 6 groups:

	CANN	BYP	AFTBYP
VR	45.7 ± 18.7	61.4 ± 7.6	78.6 ± 2.3
CABG	29.9 ± 16.1	38.8 ± 22.4	40.5 ± 21.7

The video print below indicates an almost continuous flow of air bubbles in the MCA during a VR procedure after bypass.



A459

TITLE: Air Aspiration Characteristics of a Silicon Multiorificed Catheter.

AUTHORS: Leonid Bunegin, B.S., Maurice S. Albin, M.D., Laimis Sadzius, M.D.

AFFILIATION: Neuroanesthesia Laboratory, Department of Anesthesiology, University of Texas Health Science Center at San Antonio and Department of Anesthesiology, Center for Cardiovascular Surgery, Vilnius, Lithuania, SSR.

The superiority of silicone elastomer (Silastic) over polyethylene polyurethane, and polyvinylchloride catheters with respect to iatrogenic thrombophlebitis and clot formation has been previously reported. Additionally, the potential for vascular erosion with semi-rigid catheters has given impetus to the development of soft silastic catheters for vascular access. This study was designed to evaluate the air aspiration characteristics of a silicone version of the polyurethane Bunegin-Albin multiorifice catheter.

A pneumatically driven, anatomically equivalent silicone right atrial model was adjusted so as to mimic human pumping action with an output of 3.5 liters/min at a rate of 70 beats/min. The circulating fluid (normal saline, glycerine mixture) had a kinematic viscosity (absolute viscosity/density) close to that of human blood. Either a 16 ga. Bunegin-Albin polyurethane multiorificed catheter or a multiorificed silicone version of the same catheter was inserted through an access port and positioned so that the catheter tip was just beyond the junction of the superior vena cava and the right atrium in the model right atrium. The atrial model was positioned so that the midfrontal plane was at an angle of 80° from the horizontal. A doppler ultrasonic detector was positioned over the atrial model. Air was infused into the

circulating fluid at a rate of 10 ml/min for one min. Aspiration commenced for one minute at 40 ml/min upon doppler activation. Each catheter was subjected to 10 trials. The mean percentage of air recovered by each catheter was compared using a paired t test $p < 0.05$ was considered significant.

The polyurethane multiorificed catheter removed $82.9 \pm 1.9\%$ of the infused air as opposed to $74.0 \pm 4.6\%$ for the silicone catheter. The difference was not statistically significant.

The difference in the aspiration efficiency between the two catheters, is not significant, most likely because of the relatively large variability associated with silicone catheter aspiration. Direct observations of the catheter-embolism interaction suggests that the polyurethane catheters are more easily "wetted" by the embolic air than the silicone catheters. This may permit a more intimate contact between the catheter and embolism facilitating less variability in aspiration efficiency. The stiffer polyurethane catheter tended to precess within the cava with each cardiac cycle resulting in regular tip contact with the atrial wall. With the silicone catheter however, no catheter precession was noted, instead, the catheter fluttered close to the axis of the cava with the tip rarely coming in contact with the atrial wall.

