TITLE: COMPARISON OF CENTRAL VENOUS CATHETERS FOR ASPIRATION OF VENOUS AIR EMBOLISM
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The relative efficiency of balloon-tipped vs plain catheters for aspiration of venous air embolism (VAE) was compared in a human heart model similar to that of Bunegin and Albin.

Four catheters (Table) were studied in a silastic model of the right atrium, tricuspid valve, and vena cavae. A 10% glycerol-water solution was circulated at 60 pulsations/min with an output of 3.7-4.0 L/min. Catheter tips were positioned at 1 cm intervals from -3 to +3 cm around the RA-SVC junction with the model at 80° and 65° inclinations. Air, 10 cc, was infused over 30 s; 10 trials for each catheter, position, and inclination. Aspiration from the test catheter at 40 cc/min began 5 s later and continued for 75 s. Balloon catheters were studied with balloons inflated and deflated. Air recovery was compared by ANOVA and Tukey's multiple comparison, $p < 0.05$, for all combinations.

Our study demonstrates efficacy of air recovery is dependent on: 1) patient position (inclination of the heart), 2) catheter type, and 3) catheter tip position, and demonstrates no benefit in positioning the catheter tip inside the atrium, or in using balloon-tipped catheters. (Table).

The 16-ga single orifice catheter is best at an inclination of 65°, while the 14-ga Bunegin-Albin multi-orifice is slightly more effective at 80°. Both catheters function most efficiently at or above the RA-SVC junction.

Table. Best position of each catheter and percentage of air aspirated (AA) at 80° and 65° inclinations of the heart.

Catheter	Position at 80°	% AA ± SD	Position at 65°	% AA ± SD
B-A 14-ga MO	-1cm	62 ± 5*	0cm	38 ± 2
16-ga SO	-3cm	56 ± 7	-3cm	86 ± 2*
7-Fr PA Angio (distal dwn)	-1cm	28 ± 2	-1cm	22 ± 1
7-Fr PA Angio (distal up)	0cm	30 ± 2	0cm	50 ± 3
7-Fr PA Angio (proximal dwn)	-3cm	54 ± 2	-2cm	68 ± 2
7-Fr PA Angio (proximal up)	0cm	26 ± 1	-3cm	15 ± 1

*Best catheter at each angle. B-A 14-ga MO, Bunegin-Albin multi-orifice; 16-ga SO, single-orifice; PA Angio distal, balloon distal to orifices; PA Angio proximal, balloon proximal to orifices; dwn, deflated; up, inflated.

TITLE: TENSILE STRENGTH OF SPINAL MICRO-CATHETERS
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This study examined the tensile strength of three spinal microcatheters and one 20-gauge epidural catheter.

We used 4-cm distal segments of catheters in a Universal Testing Instrument set with an initial 1-cm path between the specimen grips and a crosshead (stretch) rate of 200 mm/min, at an ambient temperature of 24°C. The data parameters were load (kg) and extension (mm) at the catheter breakpoint. We examined four types of catheters (n = 4 each): Preferred Medical Products, polyurethane, 27 ga; Kendall "Cospan", polyimide, 28 ga; TFX/Rusch "Microspinal," polyimide, 32 ga; and Burron, nylon, 20 ga. Data were analyzed using analysis of variance, with Tukey's studentized range as a post hoc test and $\underline{P} = 0.05$.

The three microcatheters had similar mean loads at the catheter breakpoint (0.46 - 0.52 kg) (fig.). These differed significantly from the 2.90-kg mean load at breakpoint for the 20-ga Burron catheter. The Preferred Medical and Kendall microcatheters stretched significantly farther before the catheter breakpoint compared with the other catheters (fig.).

All the microcatheters (27, 28, and 32 ga) had lower tensile strength than the 20-ga catheter tested. These data are consistent with a greater possibility of breaking a catheter during removal of a spinal microcatheter as opposed to a 20-ga epidural catheter.