Title: COMPARISON OF BRACHIAL, RADIAL, AND AORTIC ARTERIAL PRESSURE MONITORING DURING CARDIAC SURGERY

Authors: G.P. Gravlee, M.D., A.L. Pauca, M.D., A.R. Cordell, M.D., S.A. Mills, M.D., A.S. Hudspeth, M.D.

Affiliation: Departments of Anesthesia and Surgery, The Wake Forest University Medical Center, The Bowman Gray School of Medicine, Winston-Salem, North Carolina 27103

Introduction: Previous studies suggest that radial artery pressures may be lower than central aortic or femoral arterial pressures during cardiac surgery after cardiopulmonary bypass (CPB).[1,2] We measured brachial, radial, and central aortic pressures simultaneously to determine the incidence and character of central-to-peripheral arterial pressure differences during cardiac surgery.

Methods. After obtaining informed consent we placed a 20 gauge two-inch catheter (Angiocath) into a brachial and a radial artery on alternating opposite sides in 40 adult cardiac surgical patients. Each catheter was attached via 30 inches of high-pressure tubing and 2 stopcocks to a Gould P50 transducer and the tracings simultaneously monitored and recorded on a Hewlett-Packard thermal recorder. Aortic pressures were measured through the arterial infusion cannula used for CPB. Radial and brachial pressures were measured at eight predetermined intervals during the procedure (3 before CPB, 5 after CPB). Two additional measurement times were subsequently added. Mean arterial pressures were derived from the area under the pressure curve. Dynamic response of each monitoring system was determined before the procedure and during CPB (mean resonant frequency 20 ± 6 Hz, mean damping coefficient 0.27 ± 0.05).[3] Complete hemodynamic measurements using a triple-lumen Swan-Ganz catheter accompanied each set of blood pressure measurements. This study was approved in advance by our Human Research Committee.

Results. The results for systolic and mean arterial pressures are shown in Tables 1 and 2. The number of patients studied at each time is shown in parentheses. Pre-CPB brachial and radial pressures were very similar, showing the mean radial systolic pressures (RSP) exceeding mean brachial systolic pressures (BSP) by 2 mmHg. Immediately after CPB the aortic systolic pressure (ASP) exceeded the BSP, which in turn exceeded RSP. These differences resolved by 10 minutes post-CPB in most patients. At two minutes post CPB, ASP exceeded RSP by more than 10 mmHg in 17 of 33 (52%) patients (range -9 to +29), whereas ASP exceeded BSP by more than 10 mmHG in 7 of 33 (21%) patients (range -5 to +25). A similar, less pronounced trend was observed, in the mean arterial pressures. The diastolic arterial pressures were nearly identical by the three techniques at all measurement periods. Using analysis of covariance, neither systemic vascular resistance (SVR) nor duration of CPB accounted for the differences in arterial pressure measurement techniques immediately after CPB. SVR was lowest (793 dyne-sec cm^{-5}) at 2 minutes post-CPB, when the central-to-peripheral pressure gradient was greatest.

Discussion. Some individual patients showed large central-to-peripheral pressure gradients after CPB, most of which resolved within 10-20 minutes. The reason for these differences is uncertain, but it is insignificantly related to systemic vascular resistance. Paradoxically, SVR was lowest when the systolic gradient was greatest. Perhaps the regional blood flow to the hands is compromised during nonpulsatile CPB or by rewarming as suggested by Stern.[1] We conclude: 1) Central-to-peripheral systolic and mean pressure gradients often exist immediately after CPB. 2) These gradients usually resolve within 10 minutes. 3) Monitoring brachial arterial pressure reduces but does not eliminate this effect. 4) Direct measurement of aortic pressure for the first 10 minutes after CPB will frequently facilitate clinical management.

Table 1
Systolic arterial pressure

	Time	Radial	Brachial	Aortic
Before CPB	1.	134±24(40)§	132±23(40)	ND
	2.	117±16(40)§	115±16(40)	ND
	3.	121±19(40)§	119±19(40)	ND
	4.	118±27(7)	116±28(7)	114±28(7)
After CPB	5.	95±16(33)§#	99±16(33)*	104±15(33)
	6.	108±23(40)#	110±22(40)*	115±24(21)
	7.	113±20(40)	114±21(40)	113±16(10)
	8.	119±17(39)	119±16(39)	ND
	9.	123±17(40)	122±16(40)	ND
	10.	121±23(39)	122±23(39	ND

Number of patients shown in parentheses:
ND - not determined
* shows $p < .05$ compared to aortic
§ shows $p < .05$ compared to brachial
# shows $p < .05$ compared to aortic
Time code: 1 - pre-induction; 2 - post-induction; 3 - chest open, 4 - pre-CPB; 5-10 - 2, 5, 10, 20, 30, and 60 min post-CPB, respectively.

Table 2
Mean arterial pressure

	Time	Radial	Brachial	Aortic
Before CPB	1.	87±15(40)	87±14(40)	ND
	2.	78± 9(40)	78± 9(40)	ND
	3.	81±13(40)	81±13(40)	ND
	4.	77±13(7)*	77±10(7)*	79±10(7)*
After CPB	5.	71±12(33)§#	74±13(33)	77±12(33)
	6.	75±13(40)§#	78±13(40)	80±12(21)
	7.	79±13(40)	80±14(40)	79±11(10)
	8.	83±12(39)	85±12(39)	ND
	9.	87±12(40)	88±12(40)	ND
	10.	85±16(39)	87±16(39)	ND

Legend and time code same as Table 1

References:
1. Stern DH, Gerson JI, Allen FB, et al.: Anesthesiology 57: A174, 1982.
2. Beker B, LaFontaine E, Lin CY: Proceedings of Society of Cardiovascular Anesthesiologists, 5th Annual Meeting: 198, 1983.
3. Gardner RM: Direct blood pressure measurement dynamic response requirements, Anesthesiology 54: 227-236, 1981.