

permits healing and recovery by removing the deleterious agent or by healing of the liver and a return to normal steroid metabolism with consequent inactivation of endogenous estrogens.

Summary. Pathologic changes in the liver and kidneys of male rats fed carbon tetra-

chloride is described. Striking atrophy of the secondary sex organs but no significant changes in weight of testes follows variable periods of carbon tetrachloride feeding. Withdrawal of the poisonous agent results in healing of the liver and partial weight recovery of the sex accessories.

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Catheterization of the Coronary Sinus and the Middle Cardiac Vein in Man.*

R. J. BING, L. D. VANDAM, F. GREGOIRE, J. C. HANDELSMAN, W. T. GOODALE,[†] AND J. E. ECKENHOFF.

From the Department of Surgery, the Johns Hopkins University and Hospital, Baltimore, Md.

A technique of intravenous catheterization of the coronary sinus has been developed recently in intact dogs by Goodale and Lubin,¹ using the Cournand intravenous catheter.² This method has been employed by Eckenhoff and co-workers³ to measure coronary blood flow, using the nitrous oxide method developed by Kety and Schmidt for the determination of cerebral blood flow.⁴ The procedure appears to be less hazardous than the method in intact dogs previously reported by Harrison and co-workers,⁵ which involved the use of a brass balloon cannula. In a combined study of 20 different dogs,^{1,3} as many as 7 catheterizations and 4 duplicate measure-

ments of coronary flow have been performed on the same dog at monthly intervals. These developments suggested that a similar procedure might be followed in the determination of coronary blood flow in man. This paper is a preliminary report of 9 successful catheterizations of the coronary vessels in man.

Methods. Most of the patients studied had congenital heart disease. Consequently, catheterization of the heart of these individuals was primarily undertaken to obtain information concerning the nature of the cardiac anomalies.^{6,7,8} Only one subject, (No. 7, Table I), had a normal heart. For catheterization of the right heart the technique of Cournand² was followed, using standard No. 7 catheters. Passage of the catheter into the coronary sinus or the middle cardiac vein was verified by (a) fluoroscopic control, (b) recording of pressures, and (c) determinations of blood oxygen and carbon dioxide contents. It was assumed that the coronary sinus had been successfully intubated if the systolic pressures were below ventricular and above auricular systolic pres-

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[†] First Lt., Medical Corps, A.U.S., Army Chemical Center, Maryland.

¹ Goodale, W. T., Lubin, M., and Banfield, W. G., in press.

² Cournand, A., *Fed. Proc.*, 1945, **4**, 207.

³ Eckenhoff, J. E., Hafkenschiel, J. H., Harmel, M., Goodale, W. T., Lubin, M., and Kety, S. S., in press.

⁴ Kety, S. S., and Schmidt, C. F., *Am. J. Physiol.*, 1945, **143**, 53.

⁵ Harrison, T. R., Friedman, B., and Resnick, H., Jr., *Arch. Int. Med.*, 1936, **57**, 927.

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⁷ Bing, R. J., Vandam, L. D., and Gray, F. D., Jr., *Bull. Johns Hopkins Hosp.*, 1947, **80**, 121.

⁸ Bing, R. J., Vandam, L. D., and Gray, F. D., Jr., *Bull. Johns Hopkins Hosp.*, 1947, **80**, 323.

TABLE I.
Blood Gas Values Obtained from Catheterization of Heart and Coronary Sinus.

No.	Date	Age, yrs	Sex	O ₂ content				A-V oxygen difference	
				R.A. vol. %	R.V. vol. %	C.S. vol. %	F.A. vol. %	Coronary F.A.-C.S.	Systemic F.A.-Rt. Heart
1.	5/31/46	16	M	18.8	18.5	6.7	22.9	16.2	4.4
2.	7/ 2	16	M	17.0	18.0	8.8	22.0	13.2	5.0
3.	26	17	F	18.1	17.8	8.3	24.6	16.3	6.8
4.	31	16	M	24.0	24.9	9.5	28.2	18.7	4.2
5.	8/ 5	14	F	15.2	17.3	6.3	21.2	14.9	5.0
6.	2/14/47	19	F	9.5	12.6	5.5	16.8	11.3	7.3
7.	5/ 2	23	F	—	13.4	5.0	16.2	11.2	2.8
8.	20	11	F	14.9	14.8	5.2	17.6	12.4	2.8
9.	23	28	F	18.3	19.9	8.9	24.9	16.0	6.6

R.A.—Right auricle.

R.V.—Right ventricle.

C.S.—Coronary sinus.

F.A.—Femoral artery.

tures,⁹ and if the oxygen contents of the sinus blood were significantly below those of returning mixed venous blood.¹ Under fluoroscopy the catheter enters the coronary sinus just below the region of the tricuspid valve, slightly medial, superior and anterior to the inferior vena cava. When the catheter is in the coronary sinus, it is seen curved upward toward the base of the heart. When the middle coronary vein is intubated, the catheter lies alongside the lower borders of the heart with the tip directed toward the apex. In the first five cases intubation of these vessels was fortuitous. A similar experience has been reported by others.¹⁰ In the remaining 4 cases, catheterization of the sinus was carried out deliberately. Pressures were recorded with the Hamilton manometer.¹¹ All gas analyses were performed with the manometric method of Van Slyke and Neill.¹²

Results. Table I demonstrates that the oxygen contents of coronary venous blood were significantly below those of both right auricular and ventricular blood. The difference between the oxygen contents of peripheral arterial blood, (and consequently of coronary arterial blood), and of coronary venous blood varied from 11.3 to 18.7 vol %, while the total systemic arteriovenous oxygen difference varied from 2.8-7.3 vol %, (Table I). In three cases in which pressures were recorded, the average blood pressure in the coronary sinus was 12 mm Hg.

Summary. The coronary sinus and the middle cardiac vein of man has been successfully catheterized. Work is in progress to utilize this technique in the measurement of coronary blood flow in man.

⁹ Best and Taylor, 4th Edition, p. 278.

¹⁰ Dexter, L., and Sosman, M. C., *Radiology*, 1947, **48**, 441.

¹¹ Hamilton, W. F., Broener, G., and Brotman, I., *Am. J. Physiol.*, 1934, **107**, 427.

¹² Van Slyke, D. D., and Neill, J. M., *J. Biol. Chem.*, 1924, **61**, 523.