Conservative Methods for the Determination of Blood Flow of the Digestive Organs

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The normal function of an organ and the integrity of its anatomical structure depend mainly on an undisturbed blood supply. Therefore measurement of the blood flow of the systemic and pulmonary circulations has generated great interest and has found wide applicability.

There has been a great deal of difficulty in determining the blood flow of the digestive organs of the portal area. This difficulty arises mainly from topographic reasons. Because augmentation of the blood supply in cases of inflammatory and ulcerative diseases of the digestive organs has been considered a useful therapeutic principle, it appeared worthwhile to investigate bloodless methods that would enable us to measure the clinically important blood flow to the digestive organs. There are mainly two areas where measurements by this method have been made: the enterohepatic system and the stomach.

In this report we will give primary consideration to methods developed in our laboratory and about which we possess precise information and practical experience. Other valuable methods will be mentioned only briefly.

Methods for Determination of Blood Flow in the Enterohepatic System

Clearance Methods

One of the first methods to help us gain an insight into the blood flow of the liver was the clearance method. Bradley and co-workers determined this in humans by intravenous injection of a substance (bromsulphalein) bound by the liver in such a way that ideally the quantity of injected substance is equal to the quantity eliminated by the liver per unit time. In this way a fixed plasma level is maintained. The amount of dye extracted from every milliliter of blood that passes through the liver is determined in the following manner. If we assume that the dye concentration of the hepatic artery and portal vein blood equals the
predetermined plasma level and, on the other hand, we determine by hepatic vein catheterization the concentration of dye in the blood leaving the liver, it is possible according to the indirect principle of Fick to determine under physiologic conditions the volume rate of blood perfusing the liver. The amount of coloring matter introduced to the tested individuals per unit time (which corresponds at a constant plasma level to the amount of dye eliminated from the liver) is divided by the difference between dye concentrations before and after the blood has entered the liver. In a manner similar to the bromsulphalein method one can also use Rose Bengal or even the urea that is produced by the liver. It is beyond the scope of this paper to discuss in any detail the possible errors in the bromsulphalein method. It may suffice simply to note that these possible errors include (1) different dye concentration in each branch of the hepatic vein, (2) possible mixing of blood from the hepatic vein with blood from the vena cava, (3) distribution of bromsulphalein outside the plasma volume, and (4) disappearance of the dye from the plasma through some route in addition to the liver. The main practical difficulty encountered is in the catheterization of the hepatic vein. Attempts were made to overcome this obstacle by injecting radioactive substances bound by the liver—gold, colloidal chromium phosphate, Rose Bengal. Determination of the disappearance of these substances from the blood as well as of their appearance in the liver was made by using an externally applied counter. One disadvantage of this method lies in the fact that the function of the cells, especially in liver disease, influences this measurement. This disadvantage renders it difficult to state accurately anything concerning the liver blood supply without the use of previous hepatic vein catheterization.

A noteworthy experiment on the determination of the liver blood supply was performed by Waldstein and Arcilla. Their method is based on the phenomenon of galactose clearance. Theoretical considerations as well as evaluation of the disappearance curve of galactose in the peripheral blood have led the authors to a new viewpoint. They take the position that the total blood supply of the liver can be determined with the help of the galactose clearance alone and without the use of radioactive substances or liver vein catheterization.

Davis et al. inject I albumin into the spleen. Information concerning the speed of the blood within the portal vein is gathered by using a scintillation counter applied to the liver. Sampling of blood of the hepatic vein and measuring of the degree of dilution of the radioactive substance allows an estimation of the blood supply to the liver.