References


Catheterization of the Mesenteric and Portal Vein in Calves

Abstract

Two types of catheters (double-lumen polyvinyl and silicone rubber) are described that allow dye injection into the anterior mesenteric vein and blood collection from the portal vein of calves. The catheters have been surgically established in 28 calves. The polyvinyl catheters were patent from 1 to 56 days, and the silicone rubber catheters were patent from 10 to 88 days. A unique method, utilizing a sharpened point of bone, was developed for introducing catheters into blood vessels.

Introduction

Nutrient absorption from the gastrointestinal tract can be calculated if the portal blood flow and arterio-portal concentration difference (corrected for hemoconcentration or dilution) of the nutrient are known. Thus, arterial and portal blood samples are needed for analysis. A variety of techniques for catheterization of the portal vein has been reported (1, 2, 3, 8-14), but all are subject to a number of technical difficulties.

The methods in this study have been used in our laboratory to establish and maintain catheters in the mesenteric and portal vein in chronic experiments with young calves.

Experimental Procedure

Catheters of two types were designed to allow dye injection and blood collection for measuring portal blood flow by the indicator-dilution method and for measuring nutrient concentration in portal blood.

Initially, modified versions of the double-lumen catheters described by Kountz, Dempster, and Shillingford (7) were established by way of the anterior mesenteric vein. Two lengths of polyvinyl tubing (0.15 cm id X 0.23 cm od) were fused for 32 cm with the tips 10 cm apart (Fig. 1a). Both tips were cut at 45° to facilitate insertion, and holes were cut through the sides near each tip with a sharpened, 10-gauge needle shaft. The injection tip was plugged to effect a spray-like injection through the holes in the sides (to enhance mixing of dye with blood); the collection tip was not plugged. To prevent occlusion of the tip by clot and sheath formation, some catheters were coated with graphite (5), benzalkonium chloride, and heparin (6) (GBH) (8). A tight, movable collar was fitted over the catheter for suturing it to the adjacent mesentery.

In later experiments, separate silicone rubber tubes (0.16 cm id by 0.32 cm od) were used. The injection catheter (Fig. 1b), established by way of the anterior mesenteric vein, had a tight, movable collar for suturing it to the adjacent mesentery. The collection catheter (Fig. 1c), inserted directly through the portal vein wall, had a collar cemented 4 cm from the tip. The collar was cut at 45° so that, when the catheter was secured in place, the tip was not butted directly against the opposite wall of the vein. To facilitate insertion, a sharpened point of bone was fitted into the tip of the collection catheter (Fig. 1c). This point was
milled from autoclaved, bleached bovine bone so that the stem (6.5 mm long) fit snugly into the lumen and the outside diameter of the shoulder was the same as that of the tubing.

Each animal was fasted 36 to 72 hours to allow sufficient emptying of the gastrointestinal tract. Anesthesia was induced by administering 3% Surital sodium\(^6\) by way of the jugular vein. Immediately, the calf was placed on the surgical table in left lateral recumbency, and the trachea was intubated. The endotracheal tube was connected to a closed-circuit anesthesia machine, and anesthesia was maintained with 2 to 3% Fluothane\(^7\) in oxygen.

Double-lumen catheters were established by way of the anterior mesenteric vein with the collection tip in the portal vein (2). This position was determined by palpation. Usually about 30 cm of catheter resided in the vein. The catheter was exteriorized by the procedure of Dougherty et al. (4).

To establish the silicone rubber catheters, an incision 40 cm long was made over the 12th rib and its costal cartilage, the periosteum was stripped from the rib, and the rib was removed along with its cartilage. Entrance to the peritoneal cavity was through the rib resection. Care was exercised to avoid penetrating the diaphragm at the dorsal aspect of the incision. The incision was retracted, and the portal vein was located by tracing the fissure between the caudate and dorsal lobes of the liver medially and ventrally to its base. The dorso-lateral surface of the vein close to the liver was dissected free of surrounding tissue for about 5 cm. With the sharpened bone in place, the catheter was forced cranially, at a 45° angle, through the portal vein wall; the elasticity of the wall prevented blood loss. The catheter was fixed in place by suturing the collar to adjacent connective tissue with 0 silk and then was flushed with physiological saline to dislodge the sharpened bone. Continuous infusion of anti-coagulant (subsequently described) was begun. The injection catheter was established in the same manner as the double-lumen catheter (2). The objective was to position the catheter tips 10 to 15 cm apart. The catheters were exteriorized by the method of Dougherty et al. (4) after 30 cm of each catheter was left free in the peritoneal cavity.

After exteriorization of either type catheter, antibiotic oblets were placed in the peritoneal cavity, and the incision was closed. The catheters were attached to needle hubs and two-way valves (B-D MS09-TI, with handles removed to prevent accidental opening). The valve assembly was secured to the skin with stay sutures,

---

\(^6\) Parke Davis and Co., Detroit, Michigan.

\(^7\) Bromochlorotrifluoroethane. Ayerst Laboratories, New York City.
and the wounds were dusted with an antibiotic powder.

During both methods of catheterization, 150 to 250 ml of 5% dextrose in 0.9% saline solution containing 20 units of Varizyme and 20 units of heparin per milliliter were infused through the catheters. Infusion started as the catheter was inserted into the vein and ended when the valve assembly was attached.

Strict asepsis was maintained throughout surgery. A penicillin-streptomycin combination was injected intramuscularly after surgery and on the three succeeding days to prevent general infection.

Anticoagulant was used postoperatively to maintain catheter patency. Twenty milliliters of saline were flushed through the catheter, blood was withdrawn if the catheter was open, 20 ml of saline were again flushed through the catheter, and the catheter was filled with a saline solution containing 500 units heparin and 5,000 units Varizyme per milliliter. For two days after surgery catheters were flushed at 8-hour intervals. Subsequently the catheters were flushed at 12-hour intervals for five days and then at 24-hour intervals. No Varizyme was used after the second day.

**Results and Discussion**

Portal catheters were established in 28 calves (24 double-lumen). Post-operative recovery was rapid and no infection or other undesirable effects resulted from surgery. Many of the catheters had a short functional life (catheters were considered functional only if blood could be withdrawn) despite early therapy and periodic flushing with anticoagulant. With the double-lumen catheters, the injection tubes remained functional from 1 to 45 days (15 of 24, less than 14 days), while the collection tubes were functional from 1 to 56 days (11 of 24, less than 14 days). In 10 the injection tube and in 7 the collection tube became nonfunctional first while in the remaining catheters both tubes became nonfunctional at the same time. The silicone rubber catheters remained functional longer (injection, 10 to 52 days; collection, 12 to 88 days) than the double-lumen catheters, and the injection tubes always became nonfunctional first.

When catheters became nonfunctional, the calf was sacrificed and the catheters and ad-

---

8 Courtesy of American Cyanamid Co., Princeton, New Jersey. Varizyme contains streptokinase, streptodornase, and human plasminogen; the level indicated here and in other parts of the text is that of the streptokinase activity.

---
tips should be no farther apart than is necessary to assure thorough mixing of dye with blood, or the dye-dilution curve will be difficult to analyze.

The use of sharpened points of bone provides a unique, highly successful technique for inserting catheters into the blood vessels of experimental animals, particularly in instances where intimal damage must be kept to a minimum and extravascular bleeding might obscure the field of vision. No undesirable effects have been observed from dislodging points into the circulation. Of those located at autopsy, all have been in the liver.

Catheterization procedures described in this study have been used successfully in the determination of portal blood flow by the dye-dilution technique.

A. D. McGILLIARD, Department of Animal Science, Iowa State University, Ames, 50010 and J. W. THORP, Armed Forces Radiological Research Institute, National Naval Medical Center, Bethesda, Maryland 20014

References