

**A SIMPLE METHOD OF SHORT-CIRCUITING THE
PORTAL CIRCULATION. BY H. H. DALE AND P. P.
LAIDLAW.**

*(From the Department of Biochemistry and Pharmacology of the Medical
Research Committee, and the Department of Pathology, Guy's Hospital.)*

IN some recent experiments on the mechanism of certain shock-like conditions we wished to observe the effect of excluding the liver alone from the circulation. The available methods for doing this were unsuitable for our purpose. Complications which we wished to avoid would be introduced by the use of hirudin and the exposure of the blood to injurious contact with artificial tubes. The making of Eck's fistula did not seem to be a practicable procedure in cats, on which most of our experiments were made; in any case it involves a relatively severe and prolonged operation, which was especially undesirable for our purpose. The simple procedure here described requires no special surgical dexterity, is easily carried out in the cat, and can be completed so rapidly that the animal is immediately in satisfactory condition for the main purpose of the experiment. It was demonstrated to the Physiological Society in October 1917.

The essential feature of the method is the use of an excised vein for making an anastomosis between the portal vein and the inferior cava. Apposition of endothelium to endothelium, so that the blood touches nothing but the uninjured lining of the veins, is secured by the use of Crile's anastomosis-cannulæ. The vein which we have used is the external jugular vein, which can be obtained from the same cat or from another. The only part of the procedure demanding time and patience is the attachment of a Crile's cannula to each end of this vein after its excision, and it is an advantage of the method that this can be done beforehand, without hurry, by using the vein from another cat.

The vein is exposed along its whole length in the neck and tied at each end. Small tributaries are tied or twisted and the vein is then dissected free and cut out. It is immediately transferred to a dish of

solution containing 0.9 p.c. sodium chloride and 1 p.c. sodium citrate in distilled water.

In this all traces of blood are carefully washed from the interior of the vein. It is important at this stage not to lose the identification of the cephalic from the thoracic end of the vein, since valves are often present, and it is therefore essential that the flow of blood eventually established through it shall be in the normal direction.

The cannulæ should not be so large as to cause undue stretching of the vein wall in reflecting the cuff over the outside; on the other hand they must be large enough not greatly to restrict the lumen where the vein passes through the cannula. For cats we used small silver cannulæ intended for uniting artery to vein for direct transfusion in man, the internal diameters being about 1.5 to 2 mm. The method was used in dogs on a few occasions, and for these we turned some larger cannulæ (3 mm. diameter) out of short segments of an old silver catheter.

Each end of the vein in turn is drawn through a cannula of appropriate size and the cuff reflected and tied in position. It is desirable to use coloured silk for tying the cuff of the cephalic end, so that it can easily be recognised. The freedom of flow through the vein is tested by holding it up by the cephalic cannula and squirting a jet of saline into this end from a fine nozzle. If a shred of clot is detected at either orifice it can be removed with fine forceps, great care being taken not to touch the endothelial lining. The vein on its cannulæ is now laid in Ringer's solution until it is required. It is quite probable that it could be so kept on ice for some days, but we have not tested the point.

The animal in which the short circuit is to be made is now prepared. Under deep ether anæsthesia the abdomen is opened along the middle line, and the intestines packed aside with warm swabs. The systemic end of the anastomosis is first prepared. We have used either the right renal vein or the vena cava itself. In the former case the renal artery is first tied. The vein is tied close to the hilus of the kidney, a loose ligature is laid round it for tying in the end of the jugular vein, and a clamp is applied close to the vena cava. The kidney can then be removed, to give greater freedom of manipulation. If the anastomosis is made directly with the lower end of the vena cava, the aorta is tied below the origin of the renal arteries. The cava is then doubly ligatured above the entry of the iliac veins and cut between the ligatures. Lumbar branches are then tied and cut, so that the cava can be dissected free for two or three centimetres and turned forward. A loose ligature is laid ready and a clamp applied above it as in the case of the renal vein.

The portal vein is now prepared, being dissected clear from the point of entry of the splenic vein up to the portal fissures. One or two small tributaries from the pancreas and duodenum are double-ligatured and cut, so that the portal vein can be completely freed between the splenic vein and the liver. Two loose ligatures are then laid round it.

The renal vein or lower end of the cava, whichever has been chosen, is now incised distally to the clamp and the blood carefully washed out of the occluded segment with citrated saline. The *thoracic* end of the prepared jugular vein on its cannula is then inserted through the incision, pushed well into the lumen and tied in by means of the loose ligature laid ready. This systemic end of the anastomosis can be completed deliberately, but the insertion of the cephalic end of the jugular into the portal vein must be carried out with speed, since the portal vein must be clamped during its completion. Cooperation of two trained workers is useful at this stage, though not essential. The first holds the cephalic end of the jugular vein on its cannula ready for insertion and applies a clamp to the portal vein between the splenic vein and the lower ligature, while the second draws the upper ligature tight, close up to the portal fissure, incises the portal vein and holds the incision open. The first immediately inserts the end of the jugular vein on its cannula and the second ties it in position by means of the lower ligature, laid ready round the portal vein. The clamps on the portal and renal vein (or cava) are immediately removed, and the flow through the inserted jugular is at once established. It is advisable then to complete the cut through the portal vein above the anastomotic junction, so that it is no longer attached to the liver; any additional small dissection is made which may be necessary to allow the jugular vein and its junctions at both ends to be disposed without liability to kinking. The hepatic artery can then be tied or clamped, and the intestines carefully replaced, so as to avoid pressure on or twisting of the anastomotic path. The abdomen can then be closed.

The whole operation, from the first abdominal incision, should not take more than 15 to 20 minutes, and the clamp need not be on the portal vein more than about 20 seconds. If the arterial blood-pressure is recorded while the connexion is being established it will be seen to fall, perhaps, 60 mm. during the portal obstruction, but it quickly recovers when the anastomosis is completed and then maintains a good high level. A failure of recovery or renewed fall of the pressure probably indicates obstruction, the existence of which can be verified by the colour of the bowels. The only likely sources of this trouble are the

formation of clot in the jugular vein at one end or the other, where its lumen is slightly constricted by passage through the cannulæ, or obstruction by kinking. The latter trouble is easily adjusted, but a clot denotes injury of the endothelium, and even if the obstruction caused in this way can be temporarily removed by manipulation, it is certain to recur, and it is better to abandon the experiment. We have not often met with this difficulty, and a little practice in the attachment of the vein to the cannula should eliminate it altogether. When once the circulation has been established and has remained satisfactory for ten minutes or so, it may be expected to continue so during the course of an ordinary experiment.

The method is quite as suitable for dogs as for cats.

Professor Bainbridge, who wished to observe the effect of temporarily diverting the blood from the liver, asked us to test the possibility of using the splenic instead of the main portal vein. We had no difficulty in doing this in a medium-sized dog. The splenic artery was tied and the cephalic end of the jugular was inserted into the splenic vein close to its opening into the portal, the thoracic end into the renal vein as usual. By clamping the interposed jugular, or the portal vein above the splenic orifice, the portal blood could be alternately sent through the liver or diverted into the vena cava.

It is possible that with absorbable cannulæ (say of thin ivory) and strictly aseptic procedure, the operation could be used for permanently short-circuiting the portal circulation. The renal vein would have to be used and one kidney removed. If the operation proved to be a practical alternative to the Eck fistula, the cat would become available for investigations of a kind hitherto restricted to dogs. We have not tested this possibility of making the connexion permanent. We suspect that kinking of the jugular vein would be liable to occur if its middle portion were left hanging free; probably it would be advisable to fix it to the back of the abdominal cavity by a few stitches through the adventitia of the vein and the parietal peritoneum.