A Simple Technique for Continuous Registration of Blood Flow[1]

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Methods used in research laboratories for recording blood flow such as thermoelectric flow meters, the rotameter, and the photographically recording differential manometer, are either too complex or too delicate for use in student laboratories. The bubble flow meter, while simple, has the disadvantage of giving point determinations rather than a continuous record. For purposes of demonstration or student laboratory experiments we have adapted a technique described by Fleisch (*1*), to permit registration on smoked paper. Although no original principle is involved, the following description is offered in the belief that others may find the instrument useful.

As first described, a closed U-tube containing dyed chloroform was used for recording the pressure drop across a stainless steel cannula (*2*). Kymographic records were obtained by following the water-chloroform meniscus manually by means of a pointer attached with thread to a recording stylus. In its present form, a membrane differential manometer is arranged to inscribe directly on the drum.

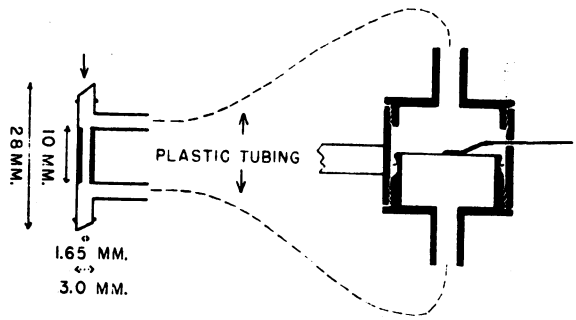

FIG. 1. Cannula and manometer drawn to same scale. Internal diameter of cannula at constriction, 1.65 mm.

The cannula is made of stainless steel; the inner surface is polished and coated with a silicone preparation. The dimensions given in the diagram (Fig. 1) are suitable for recording femoral arterial flow in dogs of 12 to 18 kg. The ends of the cannula are tied centrally and peripherally into the femoral artery; since blood is not diverted from the animal no warming device is required. The side tubes are connected through transparent plastic tubing to the brass manometer capsule. A short segment of rubber tubing attached to the distal side tube of the cannula permits introduction of a fine hypodermic needle directly into the blood stream.

The manometer capsule consists of a central cylinder threaded to receive the two end pieces, one serving as a tambour and the other as a cap. The tambour piece, fitted with dental dam tied in place with very little tension, is screwed into the cylinder. Stopcock grease applied to the threads ensures a water-tight seal. A short piece of wire is inserted through the fulcrum hole in the side of the cylinder, and the flattened end is cemented to the center of the rubber membrane with an aqueous-base latex suspension. The fulcrum is sealed off from the inside with several coats of the same cement, care being taken to obtain a water-tight joint, while allowing adequate flexibility for the movement of the lever arm. The cap is then screwed into place, and the instrument is filled with saline solution. A light pointer about 20 cm long is attached to the projecting end of the wire lever arm. In use, the capsule should be mounted cap down so that the weight of the lever presses the inner end up against the membrane.

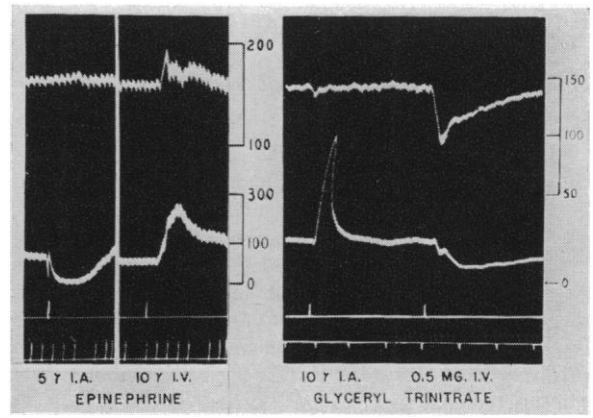

FIG. 2. Records of arterial pressure (above) and femoral arterial flow (below); two experiments. Epinephrine (left) and glyceryl trinitrate (right) were injected intra-arterially and intravenously. The upper scale represents pressure in mm Hg; the lower, blood flow in cc/min. Time signal: left tracing, 10 sec; right tracing, 1 min.

The cannula itself needs to be calibrated only once. This is done by passing blood at body temperature through the instrument and recording the pressure differential at various rates of flow by means of a closed U-tube containing chloroform under water. It should be recalled that 1 cm difference in height between the two chloroform menisci is equivalent to approximately 0.5 cm of water. The manometer capsule can then be calibrated when desired by applying a measured pressure differential to the two outlets. In our experience, at low flows the calibration curve approximates that predicted from the Poiseuille equation. At higher flows the pressure difference exceeds that predicted by the equation.

Heparinization of the animal is of course necessary. We have used a priming dose of 2 to 3 mg/kg, followed by continuous infusion of about 2 mg/kg/hr.

Records of arterial flow and pressure obtained in class demonstrations are illustrated in Fig. 2.

[1] Development of this apparatus was begun when the author was at Harvard Medical School and was completed at the University of Michigan.

References

1. FLEISCH, A. *Arch f. d. ges. Physiol.*, 1920, **178**, 31.
2. MOE, G. K., BASSETT, D. L., and KRAYER, O. *J. Pharm. exp. Therap.*, 1944, **80**, 272.