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ORIGINAL MEMOIRS.

THE TECHNIQUE OF DIRECT TRANSFUSION OF BLOOD.

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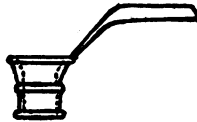
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THIS paper is based on 225 experiments upon animals and 32 clinical cases. The major part of the work was done in the Laboratory of Surgical Physiology, Western Reserve University. The experimental part was undertaken in conjunction with Profs. Macleod and Haskins and Drs. Dolley, Hitchings, Cole, Lenhart, and Eisenbrey; the clinical part with Dr. W. E. Lower.

Experimental research into the technique included the availability of vessels by which blood could be transferred from one individual to another with the greatest certainty and under the best control. Transference of blood from vein to vein, though easy of technique, was uncertain in the rate of flow and had little power of overcoming resistance. By using an artery of the donor the blood was driven across under a certain amount of pressure, with a uniform rate of flow, readily overcoming a certain resistance and supplying fresh oxygenated blood. In using the peripheral artery of the recipient, it was found that the back pressure and peripheral resistance interfered with the free flow, and the valves of the peripheral veins

interfered with the flow from the artery of the donor. The proximal vein of the recipient, therefore, being the direct channel to the right heart, seemed the natural and most available route. The question of clotting at the site of anastomosis was eliminated by the use of a mechanical device in place of the Carrel suture. Dr. S. J. Mixter presented us with an ingenious device, in principle not unlike a Murphy button. From this and from the original method of Payr was developed our present instrument, shown in the cut, and now made by Messrs. J. C. Ulmer & Company, of Cleveland. By means of this tube anastomosis may be made so that intima is in contact with intima alone, without damage to this structure and without the possibility of any foreign body coming in contact with the blood stream. The tube has proved as successful in the clinic as in the laboratory.



Twice actual size.

In the clinical transfusions we have utilized the radial artery of the donor and the proximal end of any superficial vein of the arm of the recipient. The radial artery was chosen because it is easily isolated and may be readily adjusted to the position of the vein of the recipient. Unless contraindicated the donor and the recipient are each given a hypodermic injection of morphin twenty minutes before the transfusion. Before they enter the operating room, after their arms are prepared, and for the purpose of minimizing the psychic factor, a nurse places over their eyes a wet towel with the diverting explanation that the eyes must be protected from the bright light to prevent headache. The donor is placed upon an operating table of the Trendelenburg type so that should he faint the head may be readily lowered. The recipient is also placed upon an operating table with his head in the opposite direction from the donor. By the use of an infiltration anæsthesia of 0.1

per cent. solution of cocain, about 3 c. m. of the radial artery is exposed, and the smaller branches tied with very fine silk; a "Crile" clamp is applied to the proximal end of the artery and the distal end is ligated; the artery is then divided; the adventitia is pulled over the free end as far as possible and closely snipped off; a moist saline sponge now covers this field. Three or four cm. of a superficial vein of the recipient is then likewise freed; the distal part ligated, the proximal closed with a "Crile" clamp; the distal part is divided with scissors, the adventitia drawn out as far as possible and closely snipped off; the vessels are then inspected and a cannula whose bore is larger than the actual tissue thickness of either vein or artery is selected. The vein may then be pushed through this tube, after which the freed end is turned back like a cuff and snugly tied in the second groove. During this time the handle of the cannula is steadied and manipulated by means of a forceps. If the artery is small or atheromatous and, therefore, firmly contracted or if it is contracted for any other reason, its lumen may be dilated by means of a mosquito hemostat, pushed into the lumen and gradually opened. The artery is then drawn over the vein and is snugly tied with a small linen ligature in the first groove. This completes the anastomosis.

The clamp is then removed from the vein, afterward gradually from the artery, when the blood stream will be seen to pass from the artery across to the vein, dilating the latter. However, the exposure and manipulation of the vessels, especially the artery, causes sharp retraction. The artery may contract so firmly as to obliterate its lumen. The constant application of warm saline solution and protection from the air will help materially in bringing about relaxation and, hence, a larger stream of blood. The pulse wave may be palpated in the vein. It is best to introduce the blood very slowly, watching carefully the result.

From our clinical and experimental research into technique we have reached the following conclusions: that the vascular systems of two individuals may be united so that intima comes in contact only with intima; that this may be

accomplished by the Carrel suture or by a special anastomosis tube, which is the method of choice; that blood may be transferred without clotting; that the use of the radial artery of the donor and any superficial vein of the recipient yields the best results; that the operation may be done painlessly; that the blood lost by the donor is regained in from four to five days; that the amount transferred is under the immediate control of the operator; and that the rate of transference should be carefully gauged because of the risk of overcharging the pulmonary circulation.