THE EFFECT OF SURGICAL OPERATION UPON CAPILLARY RESISTANCE

By HAROLD SCARBOROUGH

From the Clinical Laboratories, The Royal Infirmary, Edinburgh

THE structure, functions and physiological behaviour of the capillaries in man are not easy to investigate. The capillary resistance (fragility) —that is the ease or difficulty with which the capillary walls rupture when a pressure is applied to them—can, however, be measured with a satisfactory degree of accuracy provided that certain standard conditions be observed. The capillary walls may be subjected to a pressure strain by an increase of pressure within them or, alternatively, by a negative pressure (suction) directed through the skin. Upon the latter procedure a method for the accurate determination of capillary resistance has been based (Scarborough, 1941a). The resistance of the capillary walls to suction is assessed in terms of the least amount of negative pressure (suction), measured in mm. Hg. required to rupture a single capillary in the area under examination. Since normally there is variation between the results in different areas, the capillary resistance is usually measured in three standard areas on the front of the forearm. The nature of the differences between results in the standard areas is shown in Table I. There is a high degree of correlation between results in similar areas in the two arms and between the several standard areas of the same arm. The method possesses the great advantage that relatively frequent determinations can be made; by a suitable arrangement the capillary resistance may be assessed every four hours. The procedure does not necessarily measure capillary permeability; there are at present no experimental data on the relationship, if any, between capillary resistance and capillary permeability. Moreover, it does not necessarily give any information, or permit anything to be inferred, about the resistance of the capillary walls in organs and tissues within the body.

It has previously been recorded (Scarborough, 1941b) that the extravascular suffusion of blood into the body tissues or alimentary tract is immediately followed by a marked but temporary rise in capillary resistance. The increase frequently amounts to over 100 per cent. It is evident within 12 hours after the injection of as little as 4 ml. of blood into a muscle, or the experimental introduction of blood into either the upper or lower end of the alimentary tract. The intramuscular injection of whole fresh blood, whole stored blood, fresh and stored plasma, reconstituted dehydrated serum, and, particularly, concentrated red cell suspensions have all been followed by highly significant elevations of capillary resistance. Similar increases in capillary resistance have been reported after blood and
### TABLE I

Showing the Increase in Capillary Resistance which followed Surgical Operation in 23 Cases. The Capillary Resistance is determined before and after Operation in each of three Standard Areas designated I, III and V. The figures represent mm. Hg. Suction.

| Sex | Age | Diagnosis                        | Operation                             | Anesthetic                          | Result | Capillary Resistance |
|-----|-----|----------------------------------|---------------------------------------|-------------------------------------|--------|----------------------|
|     |     |                                  |                                       |                                     |        | Before:               | After:                |
|     |     |                                  |                                       |                                     |        | I. III. V.           | I. III. V.           |
| F.  | 62  | Tuberculosis of cecum            | Ileo-transverse-colostomy             | G.O.E.                              | R.     | 150 : 150 : 225      | 300 : 350 : 400      |
| F.  | 28  | Toxic goitre                     | Subtotal thyroidectomy                | Intra-tracheal gas and oxygen        | C.     | 150 : 200 : 250      | >500 : >500 : >500   |
| M.  | 29  | Empyema                          | Drainage                              | G.O.E.                              | C.     | (150 : 250 : 350)    | >450 : >450 : >500   |
| F.  | 40  | Menorrhagia                      | Dilatation and curettage              | Avertin                             | R.     | (175 : 200 : 300)    | 400 : 450 : 500 (Lt.)|
| M.  | 77  | Prostatic hypertrophy. Retention of urine | Supra-pubic cystostomy | Local (1 per cent. " novocaine") | R.     | (200 : 225 : 350)    | 400 : 450 : 500 (Lt.)|
| F.  | 51  | Biliary fistula                  | Cholecystenterostomy                  | G.O.E.                              | R.     | 200 : 200 : 250      | >500 : >500 : >500   |
| M.  | 59  | Carcinoma pancreas. Jaundice     | Cholecystenterostomy                  | Spinal ("stovaine")                 | R.     | 200 : 250 : 350      | >450 : >500 : >500   |
| M.  | 29  | Carcinoma colon                  | Laparotomy                            | Pentothal                            | R.     | 200 : 250 : 350      | >450 : >500 : >500   |
| M.  | 62  | Subphrenic abscess               | Partial gastrectomy                   |                                     | ...    | 200 : 250 : 350      | >450 : >500 : >500   |
| F.  | 59  | Carcinoma stomach                | Subtotal thyroidectomy                |                                     | R.     | 200 : 250 : 350      | >450 : >500 : >500   |
| F.  | 32  | Toxic goitre                     | Eck's fistula                         | Intra-tracheal gas and oxygen        | C.     | 200 : 350 : 450      | >500 : >500 : >500   |
| M.  | 26  | Splenic anemia                   | Laparotomy. Biopsy of liver           | Intra-tracheal gas and oxygen        | D. 4   | 250 : 250 : 300      | >500 : >500 : >500   |
| F.  | 50  | Subacute hepatitis. Jaundice     | Cholecysto-jejunoscopy                 | G.O.E.                              | R.     | 250 : 300 : 400      | >450 : >500 : >500   |
| M.  | 66  | Carcinoma pancreas. Jaundice     | Drainage                              | G.O.E.                              | R.     | 250 : 350 : 450      | >450 : >500 : >500   |
| M.  | 54  | B. coli septicemia. Subcapsular abscess | Laparotomy and drainage | G.O.E.                              | R.     | 300 : 375 : 450      | >450 : >500 : >500   |
| F.  | 67  | Abcess cystic duct               | Removal of cysts from scalp          | G.O.E.                              | R.     | 300 : 350 : 350      | >450 : >500 : >500   |
| M.  | 74  | Hemophilia. Sebaceous cysts      | Cholecystosotomy                      | G.O.E.                              | D. 15  | 300 : 300 : 400      | >400 : >450 : >500   |
| F.  | 33  | Petic ulcer                      | Cholecystotomy                        | Cyclopropane                         | C.     | 300 : 350 : 450      | >500 : >500 : >500   |
| M.  | 49  | Carcinoma stomach                | Gastro-enterostomy. Ligation of gastric vessels | Laparotomy                            | ...    | 350 : 400 : 450      | >450 : >500 : >500   |
| M.  | 70  | Carcinoma stomach                | Laparotomy                            | Ethyl chloride and ether             | ...    | 300 : 450 : 450      | >500 : >500 : >500   |
| M.  | 64  | Carcinoma pancreas. Jaundice     | Cholecystodudenostomy                 | G.O.E.                              | R.     | 400 : 450 : 450      | >450 : >500 : >500   |

Note.—G.O.E. = Gas, oxygen and ether; R. = Relieved; C. = Cured; D. = Died (D. 4 = died 4 days after operation); Rt. = Determinations on right arm; Lt. = on left arm.
plasma transfusions, but they are not found after infusions of saline or glucose-saline (Scarborough, 1941a).

In this paper are reported the results of exploratory capillary resistance determinations made before and after certain surgical procedures. “Before” signifies within 3 hours of the operation being started; “after” means approximately 24 hours later. No case received a transfusion during the interval between these two observations. The figures in 23 cases are given in Table I arranged in order of the level of capillary resistance before operation. The results are definite, the changes being considerable and all in the same direction. No statistical treatment of the data is therefore required to support the conclusion that in 23 investigated cases a remarkable increase in capillary resistance followed surgical operation.

**TABLE II**

Showing the Increase in Capillary Resistance which followed Simple Fracture in 6 Cases. The Capillary Resistance is determined in each of three Standard Areas (I, III and V) within 24 hours of the Fracture being sustained and again between 5 and 7 days later. The figures represent mm. Hg. suction

| Sex. | Age. | Fracture. | Capillary Resistance. |
|------|------|-----------|-----------------------|
|      |      |           | Within 24 Hours.       | 5-7 Days Later. |
|      |      |           | I. III. V.            | I. III. V.     |
| M.   | 24   | Tibia and fibula | 350 >450 >500 | 200 250 300 |
| M.   | 16   | Femur     | 450 >450 >500       | 250 300 350 (Rt.) |
| F.   | 67   | Scapula   | 450 >500            | 250 300 400 (Lt.) |
| F.   | 55   | Femur     | 400 >450 >500       | 200 250 300 (Rt.) |
| M.   | 30   | Ribs      | 350 >450 >500       | 150 175 200 (Lt.) |
| M.   | 54   | Radius    | 400 >550 >650       | 200 225 250 (Lt.) |

At the suggestion of Professor J. R. Learmonth certain cases were investigated to determine whether similar increases in capillary resistance could be observed after internal injuries—injuries in which there was no break in the continuity of the skin surface. In Table II are set forth the results obtained in 6 cases of simple fracture. Determinations of capillary resistance were made within 24 hours of the fracture being sustained and between 5 and 7 days later. Two cases (the first and fourth in the table) were seen after first-aid treatment only and before reduction of the fracture. No case was operated upon or received blood or plasma transfusions between the two observations on capillary resistance. In all cases the capillary resistance was significantly higher at the first observation as compared with the second, a finding which supports the results already described and which shows that similar increases in capillary resistance follow injuries which do not involve the skin surface.

In these experiments the increases in capillary resistance were similar to those found after the experimental introduction, or extra-
vasation, of blood into the tissues referred to above. This increase appears to be independent of the age and sex of the patient, of the anaesthetic employed and of the nature of the operation performed. It is observed after traumata which involve the surface of the skin and after those which do not and is independent of the level of capillary resistance. No information is provided by this investigation as to the mechanism of this striking phenomenon, for which at present no physiological explanation is available.

REFERENCES

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