Circulation VII

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Title: BYPASS BLOOD FLOW DURING CAROTID ENDARTERECTOMY

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Introduction. The minimal lower level of cerebral blood flow during carotid endarterectomy has been reported to range from 50 to 60 ml/100 gm/min (1). A carotid flow bypass tubing (shunt) is frequently inserted during carotid endarterectomy to provide adequate blood flow. However, the amount of blood flow through the shunt has not been determined and the appropriate size of tubing needed to provide an adequate flow without interfering with the operation procedure is not known. The present investigation was designed to assess the flow through the shunt (Qs) and its relationships with related hemodynamic parameters.

Methods. Nine normal patients (46 to 73 years of age) scheduled for carotid endarterectomy were anesthetized with 0.3-1% halothane plus nitrous oxide. The arterial pressure (AP) was measured with a radial arterial catheter connected to a Statham transducer. Another transducer was used to record the stump pressure (SP) and distal shunt pressure (DSP) after a flow bypass shunt had been inserted. These pressures represented the internal carotid arterial pressure either when the shunt was occluded (SP) or kept open (DSP). The length (L = 15.2 cm) and the radius (r = 0.08 cm) of this bypass shunt, the pressure difference (∆Pb) between AP and DSP, and the blood viscosity (η) measured with a viscometer were used to calculate the blood flow (Qb) across the shunt by the use of Poiseuille's law.

\[ Q_b = \frac{\Delta P_b \times \pi \times r^4}{8\eta L} \]

The Qb was then compared with the ∆Pb and the slope of AP increase (Sb) after the occlusion of carotid artery. Same measurements were made after 100 ml of 10% low molecular weight Dextran (LMD) had been infused intravenously. An in vitro study was also conducted to compare the blood flow measured with electromagnetic flow probe with that obtained by calculation with the use of Poiseuille's law.

Results. In vitro, the calculated shunt flow was in good agreement with that measured with electromagnetic flow meter (r = 0.96, P < 0.05). In vivo, the Qb showed a significant correlation with the ∆Pb before and after 100 ml LMD infusion (Fig. 1). The Qs following the carotid artery occlusion also correlated well with the Qb (r = 0.76). Although the whole blood viscosity was decreased by 13%, the infusion of 100 ml LMD caused no significant changes in the AP, ∆Pb, and Qb from those of control state.

Discussion. The close correlation between shunt flow and the ∆Pb and Sb demonstrates that the magnitudes of ∆Pb and Sb can help to delineate the necessity of a bypass shunt. In the presence of low ∆Pb and Sb, the shunt provides minimal flow (as low as 12 ml/min), and hence the insertion of a shunt became unnecessary. Higher values of ∆Pb and Sb indicate the importance of an adequate shunt to alleviate the possible cerebral ischemia following carotid artery occlusion. Therefore, it is feasible to determine the need of a shunt and the size of a shunt by the evaluation of ∆Pb and Sb. The administration of 100 ml 10% LMD solution, although decreases blood viscosity, does not seem to improve the hemodynamic condition in the present investigation.

References.

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![Graph](image)

Fig 1. Correlation of the shunt flow determined by the use of Poiseuille's law (see text) with the difference between arterial P and stump P.