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 Title : BYPASS BLOOD FLOW DURING CAROTID ENDARTERECTOMY  
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**Introduction.** The critical lower level of cerebral blood flow during carotid endarterectomy has been reported to range from 18 to 24 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 ( $Q_s$ ) and its relationships with related hemodynamic parameters.

**Methods.** Nine informed 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 ( $\Delta P_B$ ) between AP and DSP, and the blood viscosity ( $\eta$ ) measured with a viscometer were used to calculate the blood flow ( $Q_s$ ) across the shunt by the use of Poiseuille's law.

$$Q_s = \frac{\Delta P_B \times \pi \times r^4}{8\eta L}$$

The  $Q_s$  was then compared with the  $\Delta P_B$  and the slope of AP increase ( $S_A$ ) 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 flowmeter ( $r=0.96$ ,  $P<0.05$ ). *In vivo*, the  $Q_s$  showed a significant correlation with the  $\Delta P_B$  before and after 100 ml LMD infusion (Fig. 1). The  $S_A$  following the carotid artery occlusion also correlated well with the  $Q_s$  ( $r=0.76$ ). Although the whole blood viscosity was decreased

by 13%, the infusion of 100 ml LMD caused no significant changes in the AP,  $\Delta P_B$  and  $Q_s$  from those of control state.

**Discussion.** The close correlation between shunt flow and the  $\Delta P_B$  and  $S_A$  demonstrates that the magnitudes of  $\Delta P_B$  and  $S_A$  can help to delineate the necessity of a bypass shunt. In the presence of low  $\Delta P_B$  and  $S_A$ , the shunt provides minimal flow (as low as 12 ml/min), and hence the insertion of a shunt became unnecessary. Higher values of  $\Delta P_B$  and  $S_A$  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  $\Delta P_B$  and  $S_A$ . 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.**

1. McKay RD, Sundt TM, Michenfelder JD et al.: Internal carotid artery stump pressure and cerebral blood flow during carotid endarterectomy. *Anesthesiology* 45: 390-399 1976
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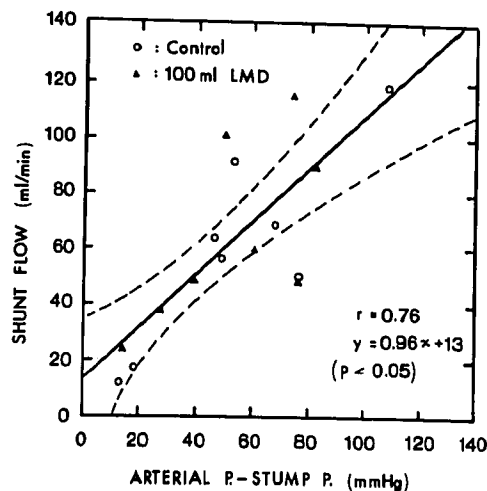


Fig 1. Correlation of the shunt flow determined by the use of Poiseuille's law (see text) with the difference between arterial P and stump P.