CEREBRAL BLOOD FLOW FOLLOWING UNILATERAL CAROTID ARTERY OCCLUSION : An Experimental Study

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SUMMARY :

The effects of unilateral carotid occlusion for one hour on cerebral blood flow were investigated in normotensive and hypotensive anaesthetized rabbits.

Cerebral blood flow was found to be 29.2+2.44 ml/100g/min. in the normotensive control group, 17.55+3.52 ml/100g/min. in the normotensive occlusion group, 24.52+2.56 ml/100g/min. in the hypotensive control group and 8.89+2.32 ml/100g/min. in the hypotensive occlusion group. It was significantly lower in the normotensive occlusion group than the normotensive control group (p<0.01), also significantly lower in the hypotensive group than all the other groups (p<0.01). It was concluded that unilateral carotid occlusion especially when associated with hypotension brings about significant changes in cerebral blood flow.

KEY WORDS :

Cerebral blood flow, hypotension, unilateral carotid occlusion.

The haemodynamic effects of carotid artery occlusion are not well known. Therefore occluded carotid artery causes some anxiety in various conditions, for example during carotid endarterectomy, and some surgeons prefer to use internal shunt. Some other preventive methods are the measurement of stump pressure and monitoring of cerebral blood flow (CBF) by EEG (11,12). Occlusion of the carotid artery for 15 minutes is thought to be well tolerated by patients, and the period might even be lengthened to 30 minutes (1). The results are not known well in longer occlusion than this.

The haemodynamic effects of unilateral carotid occlusion have been studied in various animals (8,14,16). In general, unilateral carotid occlusion alone has no significant effect on CBF (3), which shows a close relation not only with collateral circulation but also with systemic blood pressure and hypoxia.

In this study, unilateral carotid occlusion was produced in normotensive and hypotensive rabbits and its effects on CBF were investigated.

MATERIAL AND METHOD

In this study, 26 white New Zealand rabbits weighing between 2-3.5 kg were used. Anaesthesia was induced with 1.5 g/kg urethane intraperitoneally. The ear vein was canulated and an intravenous supply was provided. The femoral artery was catheterized and used to monitor blood pressure.

Arterial blood samples were withdrawn for the measurement of PaCO2 and PH and to produce hypotension. Continuous blood pressure measurement was obtained with a polygraph (NEC San-ei Instruments Ltd. Tokyo-Japan).

The rabbits were placed in supine position and their cervical regions were prepared. An incision from the mandibule to the jugular fossa was made and tracheostomy was performed. Then the left common carotid artery (CCA) was found and dissected. [In rabbits the internal carotid artery (ICA) rises from the dorsal part of the CCA and first lies dorsolaterally then dorsomedially (13)]. The ICA and external carotid artery (ECA) were separeted after bifurcation and branches of the ECA were seen and ligated and the ECA was catheterised for radioisotope administration. Following these procedures, 40-60 uCi/0.1ml 133Xe was injected in bolus into the ECA in the normotensive control group. The colimator of the blood flow apparatus (SR 8 scaler, Nuclear Enterprise Technology Ltd. Berkshire-England) was placed to the left side of the brain, and the change in 133Xe activation was measured graphically and one minute counts were recorded at the same time. T 1/2, the half time of peak value was calculated from the exponential curve provided, and CBF was found with accepting blood/brain partition coefficient for 133Xe as λ :1.1.

$$\text{CBF (ml/100g/min)} = \lambda \times \frac{0.693}{T\ 1/2} .100$$

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Then the CCA was occluded with a temporary vessel clip (Yasargil temporary clip FD 753 Aesculap-Werke A.G., Tuttlingen, Federal Republic of Germany). During the 1 hour occlusion with administration of 133Xe in the same amount through the ECA, measurements were made again.

In the hypotensive control group, the mean arterial blood pressure (MABP) was stabilized between 35-55 mmHg by withdrawal and reinfusion of blood through the femoral artery and CBF measurements were made.

In the hypotensive occlusion group, 1 hour CCA occlusion was performed with the same technique in the rabbits whose MABP was 35-55 mmHg and CBF measurements were obtained.

During the procedure, arterial blood samples were withdrawn from the rabbits in all groups and PaCO2 and HP were measured (Stat Profile Analyzer, Nove Biomedical-Waltham, Massachusetts).

Statistical analysis was done by Student's t-test.

RESULTS

PaCO2 was found to be between 29.14-38.75 the rabbits. PH ranged between 7.295-7.444.

The blood pressure was 85-106 mmHg in both the normotensive control and occlusion groups, and 35-55 mmHg in the hypotensive control and occlusion groups.

CBF was 29.02+2.44 ml/100g/min. in the normotensive control group and 24.52+2.56 ml/100g/min. in the hypotensive control group (Table 1). The difference between these two groups was not statistically significant.

Table 1 : CBF and physiological variables in rabbits (BP: Blood Pressure) PaCO2: arterial partial of carbondioxide PH: Arterial PH, CBF: Cerebral blood flow, Mean ± SEM)

	BP (mmHg)	PaCO2 (mmHg)	PH	BCF (ml/100g/min)
Normotensive control (n=6)	91.16+5.74	34.00+1.27	7.371+2.628	29.02+2.44 (25.58–32.38)
Hypotensive control (n=6)	43.16+6.08	31.91+0.99	7.335+5.096	24.52+2.56 (20.59–26.94)
Normotensive occlusion (n=7)	95.23+7.57	34.60+1.54	7.397+1.297	17.55+3.52 (12.77–21.73)
Hypotensive occlusion (n=7)	43.83+6.65	36.00+1.22	7.423+2.312	8.89+2.32 (5.21–12.08)

CBF was 17.55+3.52 ml/100g/min. in the normotenvise occlusion group which was significantly lower than in the normontensive control group (p<0.01).

CBF was 8.89+2.32 ml/100g/min. in the hypotensive occlusion group. This was significantly lower than in all the other groups (p<0.01). (Fig. 1)

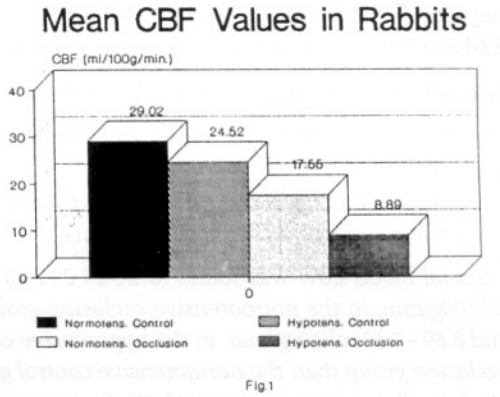

Fig.1 : Mean CBF values in rabbits (CBF: Cerebral blood flow, normotens: normotensive, hypotens: hypotensive).

DISCUSSION

Unilateral carotid occlusion does not significantly affect CBF in many mammals (rat, baboon) (3,14), because in these animals CBF is provided by many arteries rising from the CCA and the vertebral artery. But in rabbits, the brain is supplied by the ICA without much effect of ECA, and the ICA reaches the circle of Willis without any important branch after leaving the CCA (10,13). Therefore carotid occlusion may have different haemodynamic results. Similarly, different results were reported with unilateral carotid occlusion in gerbils (5,6). Crockard et al. reported a significant decrease in CBF in the ischaemic hemisphere of gerbils following 1 hour occlusion (2). Xie et al. also reported similar results (16). Hasegawa and Weinberger observed ischaemia in only some part of the ipsilateral hemisphere (4,15). Also hypotension alone does not produce significant changes in CBF (8).

In this study, although a decrease in CBF was obtained in the hypotensive control group when compared with the normotensive control group, the difference was not statistically significant. In general, lower values of CBF in the control groups were remarkable and might be related to the anesthesia technique particularly with uncontrolled ventilation through a mechanical ventilator. In addition it might be related to the method of measuring CBF. PaCO2 affecting CBF was reported also (3,14). But in this study, the probability of PaCO2 affecting CBF seems to be slight. On the other hand, PaCO2 values might have been influenced by the necessity of preserving the arterial blood samples in +4°C for 1-4 hours. The decrease in CBF seems to have more relation with the measurement method. Crockard et al. used the hydrogen clearance method and mentioned about the same lower results, they also emphasized that differences in methods affected the results (2).

CBF was found to be significantly lower in the normotensive occlusion group when compared with the normotensive control group. This was probably because the rabbit's brain supply being mostly from the ICA had insufficient collateral circulation.

Mendelow and Sengupta have shown that carotid occlusion in association with hypotension resulted in an important decrease of CBF (8,9,14). We found CBF was significantly lower in the hypotensive occlusion group when compared with the other groups.

In conclusion, unilateral carotid occlusion especially when associated with hypotension brings about significant changes in CBF in rabbits. This may indicate that hypotension resulting from blood loss during surgery, anaesthesia or antihypertensive therapy might increase the risk of ischaemia in patients in which carotid occlusion is needed.

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