ARQUIVOS DE NEURO-PSIQUIATRIA

Volume 38 - Nº 2

Junho de 1980

INTERCAROTID ANASTOMOSIS WITH A VEIN GRAFT IN THE RAT

A MODEL FOR MICROSURGICAL TRAINING

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The application of the operating microscope to neurosurgery has a short history, but the development of microneurosurgery has been so fast and successful that it is applied in almost all neurosurgical fields [6,7,9,12]. The operating microscope, bipolar coagulation and microsurgical instruments have become a *conditio sine qua non* of contemporary neurosurgery.

However, successful application of these new technical aids requires skilled performance and presuposes adequate training in order to fulfill the main scope of magnification: an atraumatic technique. Several months of preliminary practice on laboratory animals are usually essential in order to master these techniques.

Various models have been described for microsurgical training [1,2,4,11,13] and it is the scope of this brief communication to present a new animal model used with sucess in our training laboratory.

MATERIAL AND METHODS

Twenty male albino Wistar rats, weighing between 180 and 270 g, were selected and divided into two groups.

In the experimental group, one common carotid artery (CCA) was anastomosed to the contralateral one by means of a venous graft obtained from the external jugular vein. In the control group both CCA were ligated. The animals in the experimental

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Work supported by the Stiftung Volkswagenwerk as part of the research project: Die Mikroneurochirurgische Anatomie des Basalen Hirnstrukturen.

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group were sacrificed by hemodilution with saline solution, 2 days to 3 months after operation, and subsequently perfused with 10% formalin. The neck, including the anastomosis, and the brain, were removed and immersed in 10% formalin for several days. The same procedure was also applied to the control group following the animals death.

TECHNIQUE

The experimental animal is anesthetized with 60 mg/kg of pentobarbital sodium (Nembutal) intraperitoneally, and anesthesia is maintained with ketamine hydrochloride (Ketanest) as required.

Following anesthesia, the animal is turned on its back, and properly placed on a cork plate. A midline skin incision is made from the laryngic protuberance to sternal manubrium (Fig. 1). The external jugular vein, main cranial venous drainage in the rat, is dissected on the left side (Fig. 2). A segment of vein of 1 cm is removed and immersed in saline solution. Thereafter, mobilization and displacement of the thyroid gland upwards exposes the jugular fossa, bordered by the sternocleidomastoid muscles (Fig. 3). Lateral retraction of the sternocleidomastoid muscles and section of the infrahyoid muscles, allows bilateral exposure of the neurovascular bundle of the neck (vagus, CCA and internal jugular vein) (Fig. 4). Both CCA are isolated from the surrounding structures and a piece of rubber glove is placed beneath them.

The intercarotid bridge with the vein graft includes two anastomoses: one on the left and the other on the right side.

Procedure on the left side: The left CCA is temporarily clipped with two microclips (Fig. 5). A small (2 mm long) eliptic ventral arteriotomy is performed. A small polyethylene tube (outer diameter 0.8 mm) is temporarily inserted into the

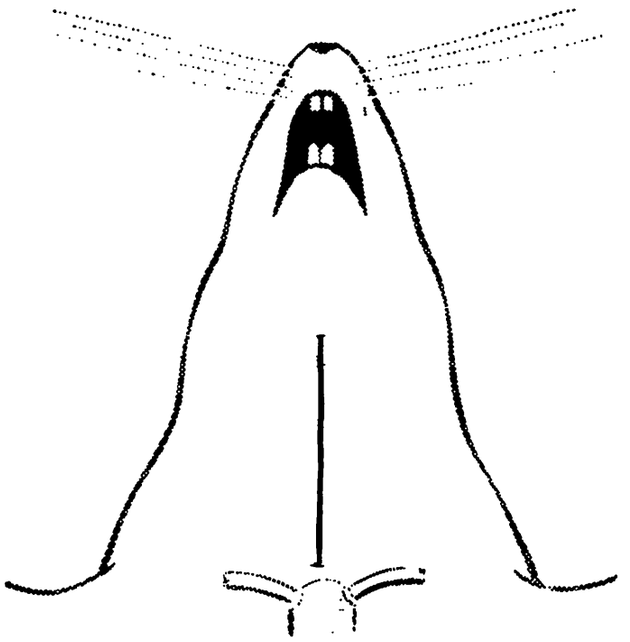

Fig. 1 — Midline skin incision from the protuberantia laryngica to the manubrium sterni.

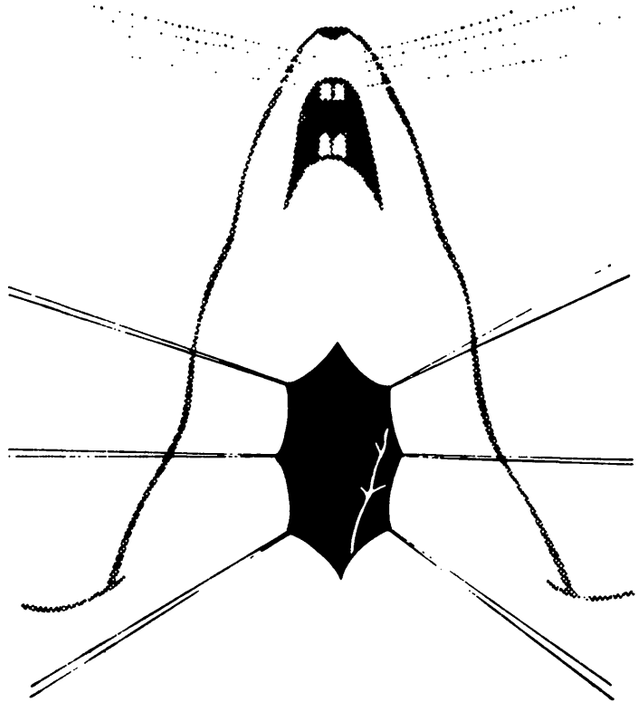

Fig. 2 — The external jugular vein is dissected on the left side.

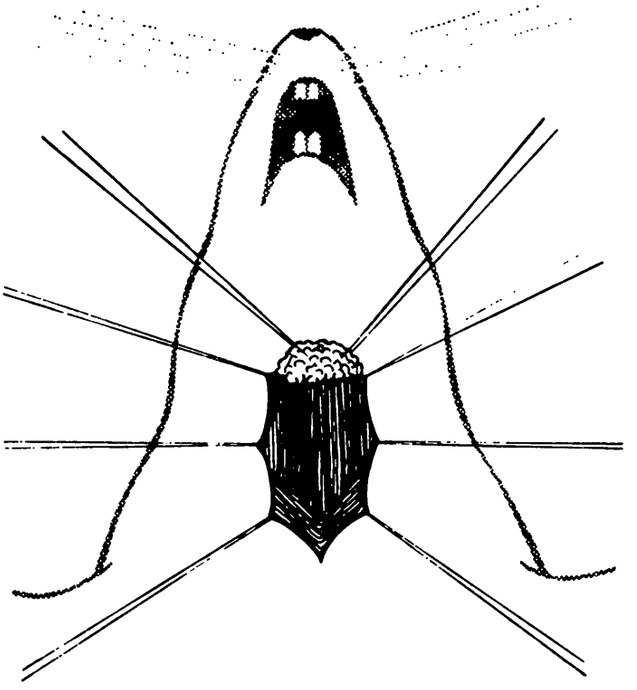

Fig. 3 — Cranial mobilization of the thyroid gland exposes the jugular fossa bordered by sternocleidomastoid muscles.

lumen of the artery to prevent vessel-collapse (Fig. 6), and an end-to-side anastomosis between the free vein graft and the right CCA is made with single stitches using 10x0 thread (Fig. 7 and 8). The vein graft is temporarily clipped, the clips are removed from the artery (Fig. 9).

The procedure on the right side is the same as on the left (Fig. 10).

At the end of the operation the left CCA is ligated above, and the right CCA beneath the anastomosis (Fig. 11).

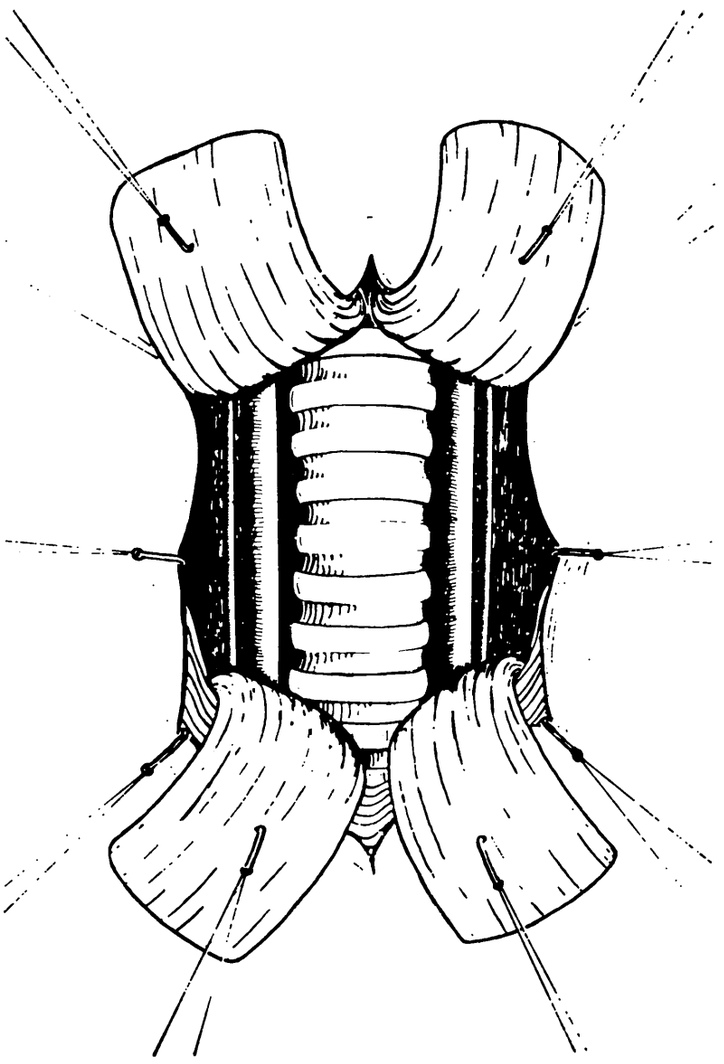

Fig. 4 — Lateral retraction of the sternocleidomastoid muscles and section of the infrahyoid muscles allows bilateral exposure of the neurovascular bundle of the neck.

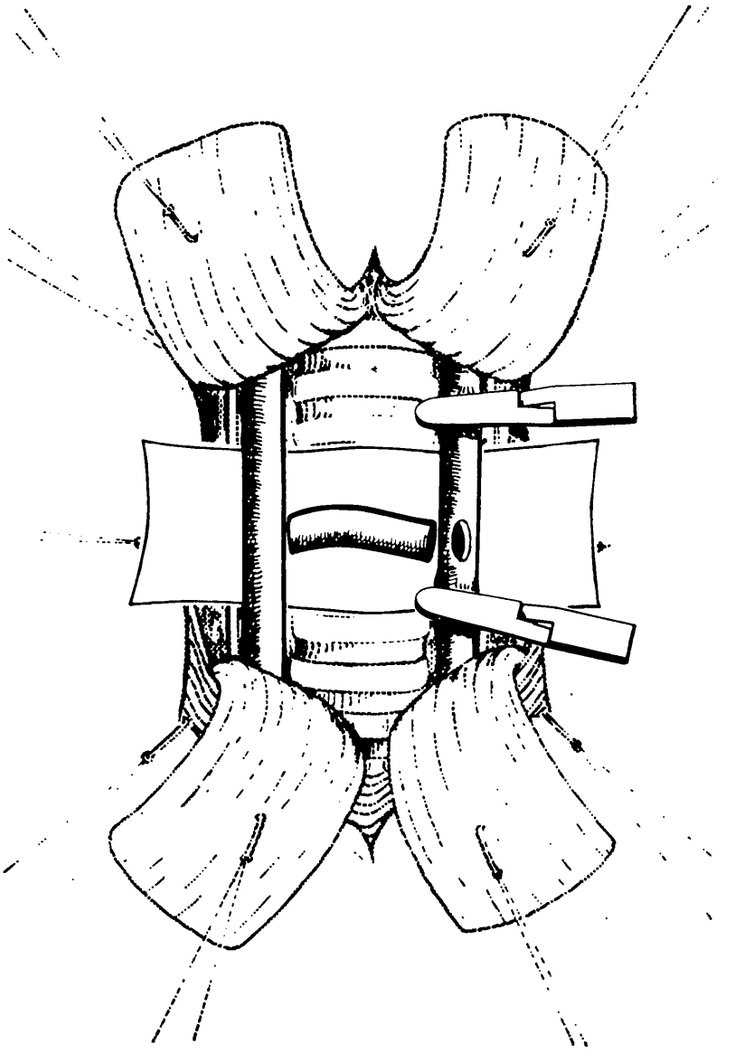

Fig. 5 — Small (2 mm long) ventral eliptic arteriotomy of the left CCA. Transiet clipping of the artery.

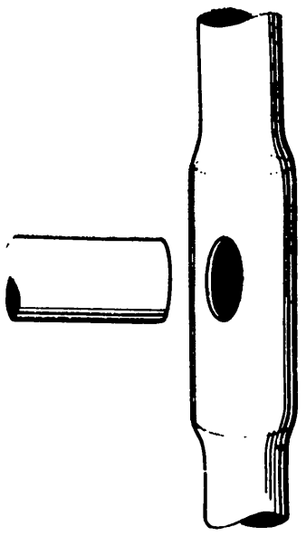

Fig. 6 — A small polyethylene tube (outer diameter 0.8mm) is inserted into the lumen of the artery.

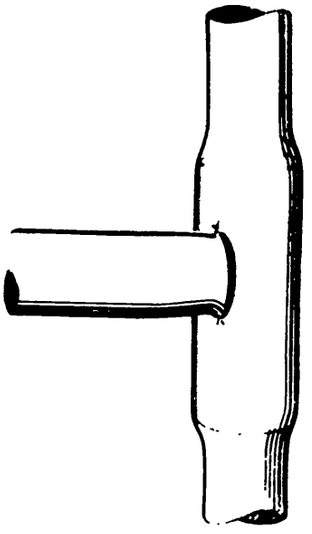

Fig. 7 — End-to-side anastomosis on the left, starting with one suture on each edge of the incision.

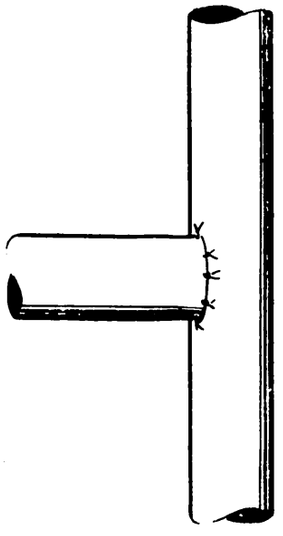

Fig. 8 — Completed end-to-side anastomosis on the left. The polyethylene tube is removed prior to concluding the suture.

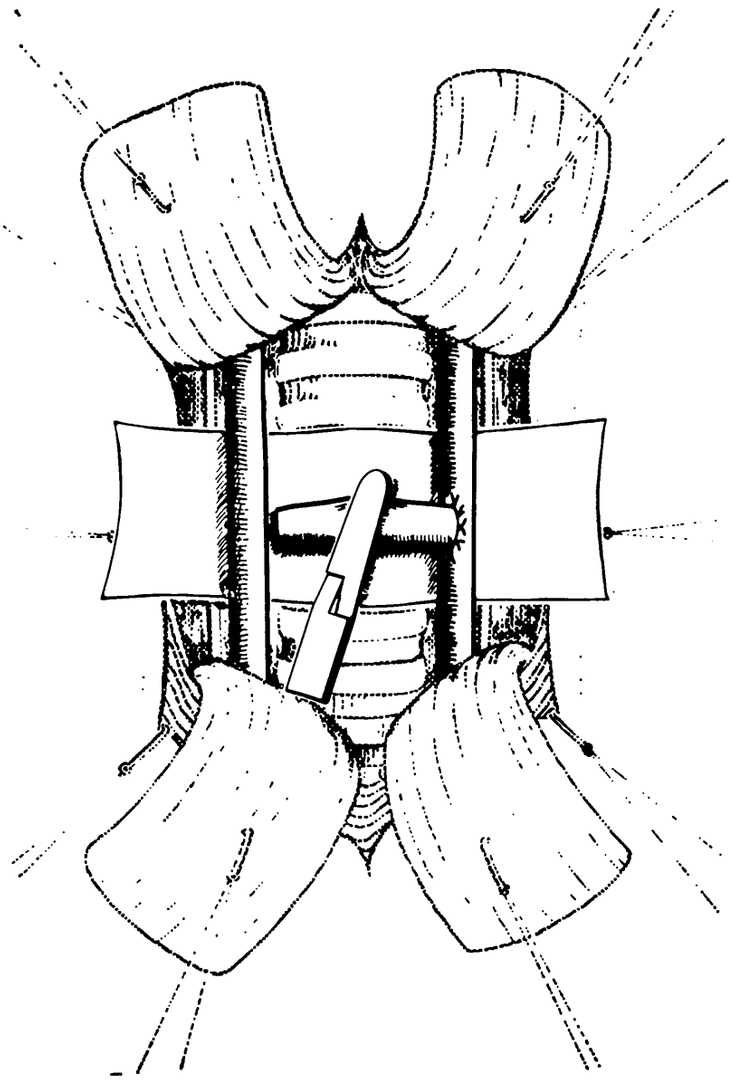

Fig. 9 — The vein graft is temporarily clipped following removal of the clips from the left CCA.

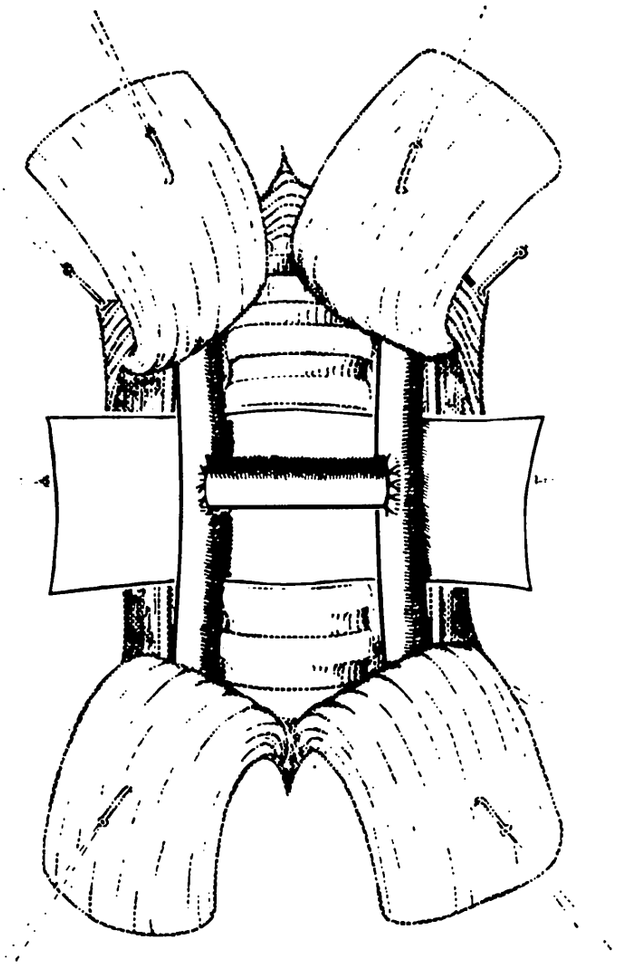

Fig. 10 — End-to-side anastomosis on the right side is completed.

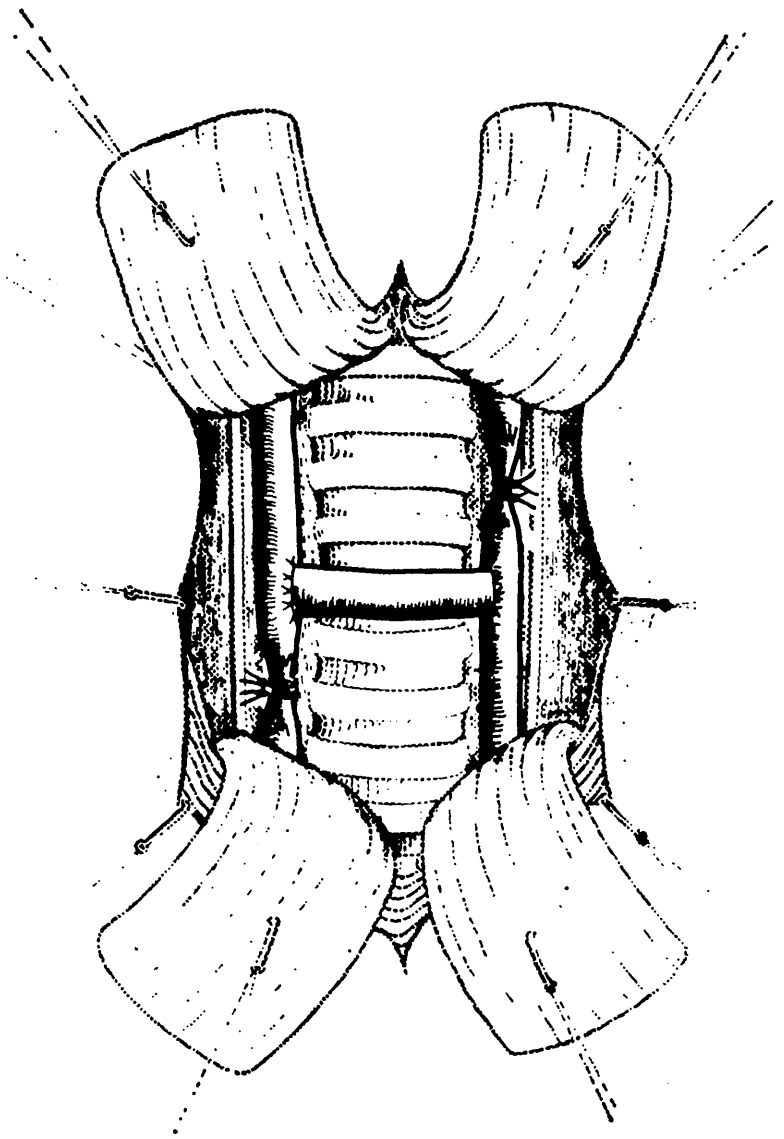

Fig. 11 — The left CCA is ligated above, and the right CCA beneath the anastomosis

RESULTS

All animals of the experimental group survived surgery without any neurological deficit. They were sacrificed between 2 days and 3 months after operation. Light microscopy showed good patency of the anastomoses, and no histological brain damage in any case (Table I).

The animals of the control group died spontaneously between 2 hours and 11 days after operation. Clinical evaluation showed that these animals had marked neurological deficit, with slow and incomplete reactions to any external stimuli. Feeding was impaired, and dystrophy occurred. Histologic examination showed frontal ischemic lesions (Table II).

CONCLUSIONS

Our results show that short vein grafts can be applied successfully for microvascular anastomose.

The model presented here is convenient for microsurgical training, since the rat is an ideal animal for this purpose, due to its availabil'ty and inexpensiveness. Evaluation of patency of the anastomose is simple since the survival of the animal depends on it.

TABLE I

Number	Age (months)	Sex	Weight	Postoperative survival (days)	Neurological findings	Macroscopic findings	Histological findings
1	6	male	250	2	normal	normal	anastomose patent; no pathological changes in the brain
2	6	male	240	7	normal	normal	anastomose patent; no pathological changes in the brain
3	6	male	270	21	normal	normal	anastomose patent; no pathological changes in the brain
4	6	male	250	30	normal	normal	anastomose patent; no pathological changes in the brain
5	6	male	200	39	normal	normal	anastomose patent; no pathological changes in the brain
6	6	male	260	46	normal	normal	anastomose patent; no pathological changes in the brain
7	6	male	260	48	normal	normal	anastomose patent; no pathological changes in the brain
8	6	male	270	50	normal	normal	anastomose patent; no pathological changes in the brain
9	6	male	230	79	normal	normal	anastomose patent; no pathological changes in the brain
10	6	male	250	90	normal	normal	anastomose patent; no pathological changes in the brain

Table 1 — Neurological and anatomic findings in animals with anastomosis.

TABLE II

Number	Age (months)	Sex	Weight	Postoperative survival	Neurological findings	Macroscopic findings	Histological findings
1	6	male	270	4 hours	coma; weak response to pain	no clearcut macroscopic changes	no detectable histologic changes
2	6	male	230	5 days	impairement of feeding; slow reactions	brain edema	bifrontal ischemic lesion
3	6	male	220	2 hours	coma; no response to pain	no clearcut macroscopic changes	no clearcut histologic changes
4	6	male	240	11 hours	somnolent to soporous	brain edema	bifrontal ischemic lesion
5	6	male	210	7 days	impairement of feeding; slow reactions	no clearcut macroscopic changes	bifrontal ischemic lesion
6	6	male	220	11 days	impairement of feeding; slow reactions	no clearcut macroscopic changes	bifrontal ischemic lesion
7	6	male	200	5 days	impairement of feeding; slow reactions	no clearcut macroscopic changes	bifrontal ischemic lesion
8	6	male	220	2 hours	coma; weak response to pain	no clearcut macroscopic changes	no clearcut histologic changes
9	6	male	210	1 day	somnolent to soporous	brain edema	bifrontal ischemic lesion
10	6	male	230	2 days	impairement of feeding; slow reactions	brain edema	bifrontal ischemic lesion

Table 2 — Neurological and anatomic findings in animals without anastomosis (control group).

SUMMARY

The common carotid arteries were anastomosed through a venous graft in a group of ten rats. The right common carotid artery was ligated below and the left above the anastomosis. In a control group both common carotid arteries (CCA) were ligated. While the animals of the experimental group survived without neurological deficit, those in the control group died 2 hours to 11 days after operation. The anastomoses and brains were studied by light microscopy.

The model described is convenient for practising microsurgery, and should constitute part of the routine training program of young neurosurgeons.

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