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ORIGINAL ARTICLE

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A laboratory training model for interhemispheric-transcallosal approach to the lateral ventricle

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Abstract Laboratory training models are essential for developing and refining surgical skills before clinical application of microneurosurgery. Our aim is to train residents of neurosurgery to be familiar with a basic microneurosurgical technique in access to the lateral ventricle via a transcallosal approach. The training material consists of a 2-year-old fresh cadaveric cow cranium. A four-step approach was designed to simulate microneurosurgical dissection along the falx to visualize cingulated gyri, callosomarginal and pericallosal arteries in order to perform callosotomy and access to the lateral ventricle, and finally to the foramen of Monroe. We conclude that the model perfectly simulates standard microneurosurgical steps in interhemispheric-transcallosal approach to the lateral ventricle and to the area of the foramen of Monroe.

Keywords Training model · Cow brain · Transcallosal approach · Cadaver dissection · Third ventricle

Introduction

The practice of surgical skills and gaining experience by neurosurgery residents on an animal model prior to exposure to patients is useful [6]. Several models have been developed to gain experience with neurosurgical and microsurgical procedures; the majority use tissue of cadaveric or animal origin, or use synthetic materials [1, 2, 4–6, 8]. Our aim is to present a practical model of a cow cranium simulating the interhemispheric-transcallosal approach, which we use in the Laboratory of Microneurosurgery for training residents of neurosurgery in basic intracranial microneurosurgical procedures.

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Materials and methods

The model presented in this report is an advanced step of the basic microneurosurgery training program that we use in our Laboratory of Microneurosurgery. Trainees are 2nd to 5th year neurosurgery residents, who have already had a basic laboratory training in microsurgery under an operating microscope.

The material for the model was obtained from a local butcher, and consisted of a 2-year-old cow cranium with the scalp and the anterior part of the head removed, including nasal and buccal structures. The cow cranium was kept in the refrigerator at 4°C for 6 h after the specimen had been obtained.

Techniques

Before the beginning of the microsurgical procedure, the large air sinus overlying the cranium is removed. The cranium is positioned in the vertical plane and stabilized with a self-retaining retractor system (Budde Halo Retractor, Codman, USA). One burr hole is placed 1 cm to the right of the midline. The paramedian frontal bone was rongeured to make a 3×3 cm right paramedian craniectomy, to simulate the standard anterior paramedian frontal craniotomy [9, 10] (Fig. 1). The microneurosurgical training steps begin under magnification (×6–×10) in an operating microscope (OpMi 99 Zeiss Inc., Germany). After the craniectomy, a triangular dural flap is draped across the superior sagittal sinus.

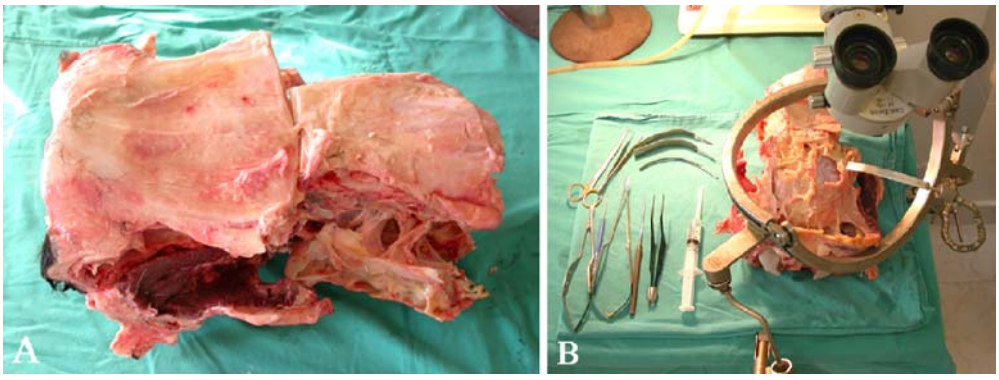

Fig. 1 **a** Preparation of the cow cranium training model with the anterior nasal and buccal area being removed. **b** Self-retaining retractor system stabilizing the specimen. (Note that the large area of the air sinus overlying the cranium is removed)

The first step consists of retracting the right frontoparietal lobe with a self-retaining retractor. The medial surface of the frontal lobe is retracted away from the falx and a small tunnel thus established. Entrance into the interhemispheric fissure is made in stepwise fashion, using cotton balls of increasing sizes, placed at the anterior and posterior extent of the dissection to provide noninjurious retraction.

The second step consists of identification and gentle dissection of callosomarginal arteries. Care must be taken not to confuse the ipsilateral cingulate gyrus with the corpus callosum (Fig. 2).

The third step consists of gentle separation of the cingulate gyri to reveal the upper surface of the corpus callosum, and identification and dissection of pericallosal arteries.

The fourth and final step consists of making an opening into the corpus callosum (about 10–15 mm) with bipolar forceps to enter into the lateral ventricle (Fig. 3), then the identification of choroid plexus, septal and thalamostriate veins, and finally the identification of the foramen of Monroe (Fig. 4).

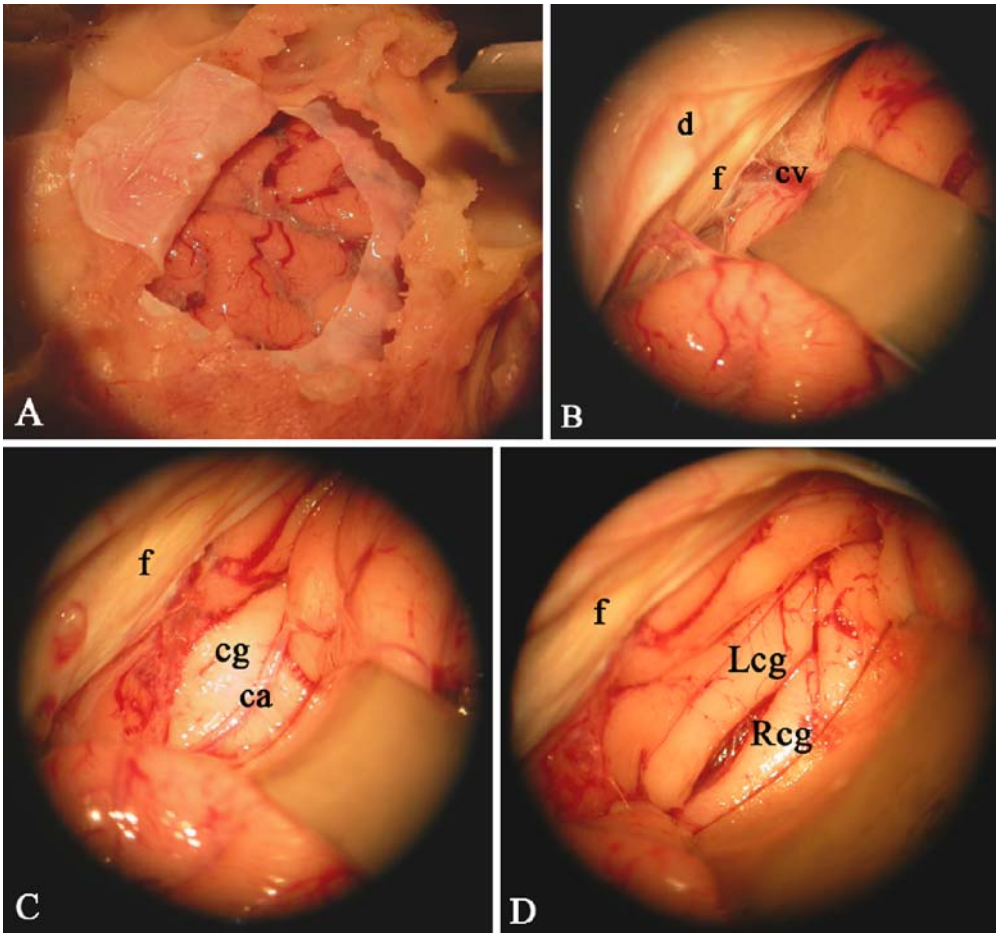

Fig. 2 **a** Brain surface as it appears upon beginning of microsurgery with the dura reflected medially. **b** Parasagittal dissection along the falx with retraction of the mesial frontoparietal lobe. **c** Visualization of the callosomarginal artery and cingulate gyrus. **d** Visualization of the right and left cingulate gyri

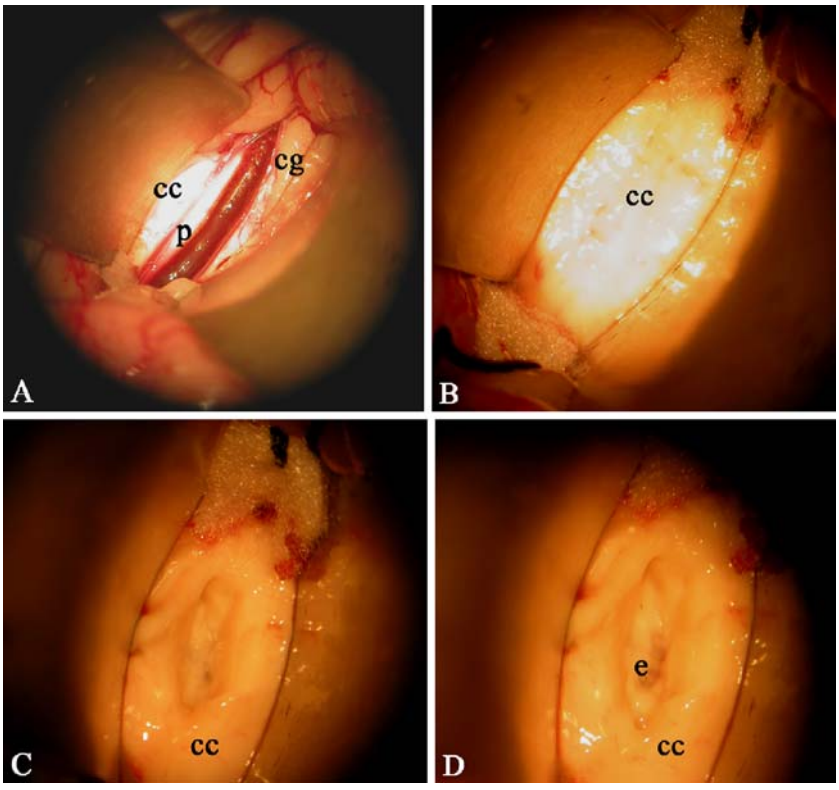

Fig. 3 **a** Separation of the cingulate gyri and visualization of the upper surface of the corpus callosum, and identification and dissection of pericallosal arteries. **b** Upper surface of the corpus callosum. **c** Making an opening into the corpus callosum. **d** Callosotomy and the ependymal wall of the lateral ventricle

Discussion

Laboratory training models are essential for developing and refining surgical skills, and before clinical application of microneurosurgery, training in the laboratory in order to gain familiarity with techniques of microsurgery and to acquire skills in handling microinstruments is fundamental [1]. Several models have been developed for gaining

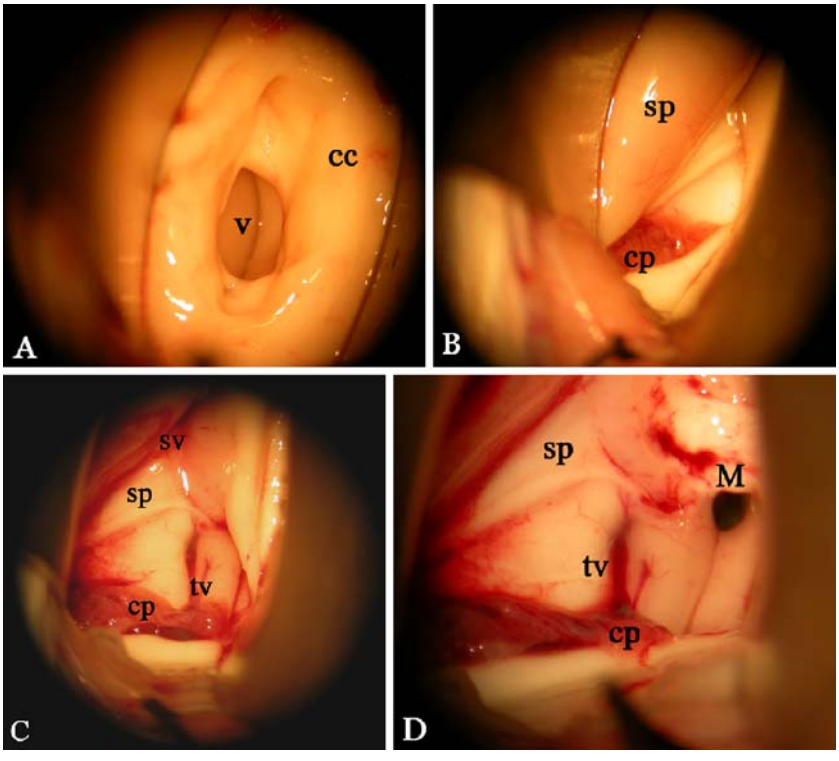

Fig. 4 **a** Access to the right lateral ventricle. **b** Identification of choroid plexus and the septum pellucidum. **c** Identification of the septal vein, and the thalamostriate vein. **d** Identification of the foramen of Monroe

experience with neurosurgical and microsurgical procedures; the majority use tissue of cadaveric or animal origin, or synthetic materials [1, 2, 4–6, 8].

The cow brain is readily available and is an attractive alternative to human cadavers. Practice on a cadaveric cow brain has several advantages; the material is cheap, convenient to manage, and easy to obtain, and neither a specific facility to maintain living animals nor anaesthesia is required. This is far more cost-effective than using cadavers and live experimental animals. In addition, the use of cadaveric cow brains raises fewer ethical objections. One disadvantage is that the model is hemodynamically non-functional. When compared to dissections in human patients, the most important deficiency in the model we propose is the absence of bleeding. Although the medical risk of contracting animal diseases is low, manipulating cow brain is not exempt from a minimal risk of dissemination of a number of transmissible spongiform encephalopathies [3]. The specimen should be provided from a known source, and from animals under veterinary control. We also recommend that surgical instruments used in the study should not be used on human subjects, and that all sterilization measures should be absolutely rigorous.

The cow brain is similar to that of a human being, but there are some differences. For instance, the volume of a cow brain is nearly half that of a human brain, and the topographic anatomy of the lateral and inferior surfaces of hemispheres, and the circle of Willis of a cow brain are slightly different from that of a human brain [7]. In our model, however, we found that the differences in volume and anatomy were negligible in the context of microsurgery, especially when the mesial surface of brain hemisphere and the topography of the lateral ventricle are considered. However, working with long surgical instruments in a narrow surgical field makes this deep approach technically demanding. For this reason, and the cow cerebral hemispheres being only half the size of their human counterpart, the trainee must consider actually deeper ventricular access in human subjects. Furthermore, we have also to mention that the cadaveric cow brain model presented here is intended only for laboratory training, and is not an anatomic study of the cow brain in the context of veterinary medicine. Therefore, except for the microneurosurgical similarities to corresponding structures of the human brain, other definitions, localizations, actual dimensions, and variations of vessels and neural structures mentioned in this report are not the subject of the training model and are beyond the scope of this study.

Varieties of intraventricular approaches are used to access tumours in the third and lateral ventricles. These are frontal and parieto-occipital median interhemispheric approaches to access tumours within the third and lateral ventricles [10]. Yasargil classified interhemispheric approaches to supratentorial ventricles as anterior frontal, posterior frontal, parieto-occipital, parieto-occipital and transtentorial approaches [10]. Depending on the target, interhemispheric fissure approaches to intraventricular pathologies vary. In our laboratory, the presented training model that we use to access the lateral ventricle involves the anterior frontal and/or posterior frontal approaches. It provides a standard interhemispheric-transcallosal approach to lateral ventricles, and to the foramen of Monroe. This model does perfectly satisfy our aim to provide residents of neurosurgery with familiarity with a basic microneurosurgical technique in access to the ventricular system via a transcallosal approach under an operating microscope in the earlier years of their neurosurgical residency program.

Conclusion

In conclusion, this model of cadaveric cow brain perfectly simulates the standard microneurosurgical steps of the interhemispheric-transcallosal approach to the lateral ventricle and to the area of the foramen of Monroe, and is a useful method for accustoming neurosurgery residents to intracranial microneurosurgical procedures performed in the human brain.

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