Porcine model

A large craniotomy survival porcine model is useful for scientific research. The surgical approaches and craniotomy complications in pigs have not been published before. This study describes how large craniotomies were performed in 46 pigs and how the risk of complications was minimized. The major complications were direct postoperative epidural hematomas (n = 3) and sagittal sinus rupture (n = 4). The measures taken to prevent postoperative epidural hematomas consisted of optimizing anesthesia, using bone wax to stop trabecular bleeding, increasing blood pressure before bone flap replacement, tranexamic acid administration, and postoperative recovery of the pigs in the prone position in a dedicated hammock. After these measures, no pig died from a postoperative epidural hematoma. Iatrogenic sagittal sinus rupture occurred in cases where the dura shifted into the craniotome during craniotomy. The dura was detached from the skull through drill holes with custom elevators before craniotomy to minimize the risk of a sagittal sinus rupture. In conclusion, pigs can undergo craniotomy and survive if the right measures are put in place [1].

A study proposes a practical model for a new approach to the posterior fossa in common domestic pigs. Several surgical procedures can be simulated in the nonliving pig model, including soft tissue dissection, drilling of temporal bone, dural incision, access to the cerebellopontine angle, exposure of cranial nerves and drilling of the internal auditory canal. The pig model perfectly simulates standard otological and neurosurgical procedures, and we highlight the feasibility of our approach for further experiments in a living pig model with the possibility of reproducing the model for research on cranial nerves in pigs to study their electrophysiological behavior [2].

Arikan et al. present a proof-of-principle study describing an alternative animal model of malignant middle cerebral artery infarction (MCA) in the common pig and illustrate some of its potential applications. They report on metabolic patterns, ionic profile, brain partial pressure of oxygen (PtiO2), expression of sulfonylurea receptor 1 (SUR1), and the transient receptor potential melastatin 4 (TRPM4).

A 5-hour ischemic infarct of the MCA territory was performed in 5 2.5-to-3-month-old female hybrid pigs (Large White x Landrace) using a frontotemporal approach. The core and penumbra areas were intraoperatively monitored to determine the metabolic and ionic profiles. To determine the infarct volume, 2,3,5-triphenyltetrazolium chloride staining and immunohistochemistry analysis was performed to determine SUR1 and TRPM4 expression.

PtiO2 monitoring showed an abrupt reduction in values close to 0 mmHg after MCA occlusion in the core area. Hourly cerebral microdialysis showed that the infarcted tissue was characterized by reduced concentrations of glucose (0.03 mM) and pyruvate (0.003 mM) and increases in lactate levels (8.87mM), lactate-pyruvate ratio (4202), glycerol levels (588 µM), and potassium concentration (27.9 mmol/L). Immunohistochemical analysis showed increased expression of SUR1-TRPM4 channels.

The aim of the present proof-of-principle study was to document the feasibility of a large animal model of malignant MCA infarction by performing transcranial occlusion of the MCA in the common pig, as an alternative to lisencephalic animals. This model may be useful for detailed studies of cerebral ischemia mechanisms and the development of neuroprotective strategies [3].

2015

Supplemental education is desirable for neurosurgical training, and the use of human cadaver specimen and virtual reality models is routine. An in vivo porcine training model for cranial neurosurgery was introduced in 2005, and our recent experience with this unique model is outlined here. For the first time, porcine anatomy is illustrated with particular respect to neurosurgical procedures. The pros and cons of this model are described. The aim of the course was to set up a laboratory scenery imitating an almost realistic operating room in which anatomy of the brain and neurosurgical techniques in a mentored environment free from time constraints could be trained. Learning objectives of the course were to learn about the microsurgical techniques in cranial neurosurgery and the management of complications. Participants were asked to evaluate the quality and utility of the programme via standardized questionnaires by a grading scale from A (best) to E (worst). In total, 154 residents have been trained on the porcine model to date. None of the participants regarded his own residency programme as structured. The bleeding and complication management (97%), the realistic laboratory set-up (89%) and the working environment (94%) were favoured by the vast majority of trainees and confirmed our previous findings. After finishing the course, the participants graded that their skills in bone drilling, dissecting the brain and preserving cerebral vessels under microscopic magnification had improved to level A and B. In vivo hands-on courses, fully equipped with microsurgical instruments, offer an outstanding training opportunity in which bleeding management on a pulsating, vital brain represents a unique training approach. Our results have shown that education programmes still lack practical training facilities in which in vivo models may act as a complementary approach in surgical training [4)].

2014

Several neurosurgical procedures could be simulated in the nonliving pig model, including transcallosal approach to the lateral ventricle, lateral sulcus and middle fossa dissection, and posterior fossa surgery.

The swine model perfectly simulates standard microneurosurgical procedures, and is a useful tool for developing and refining surgical skills [5)].

2011

Olabe et al. developed a simple reproducible technique for aneurysm creation and adapted it to mimic intracranial dissection conditions using glue application as a pseudo-arachnoid type layer. Ten 1-2-month-old healthy domestic swine were employed under general anesthesia. A novel technique for bifurcation aneurysm creation was developed using two arteries and a vein. After aneurysm creation, diluted sulfuric acid was applied on the dome with a micropipette to increase aneurysm fragility in selected zones. The surgical field was then dried and contact glue was applied around the vascular complex in a circular manner so as to emulate arachnoidal connection fibers. Microsurgical dissection of the aneurysm and surrounding vessels was performed by delicately removing the adhesive substance. Diverse aneurysm clipping techniques, emergency rupture situations and vascular reconstruction procedures were trained. Twenty-two aneurysms were created at several vascular sites, one aneurysm dome ruptured during application of sulfuric acid, two aneurysm models were proved to be thrombosed, two aneurysms ruptured during the dissection and no intraoperative deaths occurred. All aneurysms were clipped in an acceptable manner. This bifurcation aneurysm model provides a novel training system to be used not only by neurosurgeons but also by neurovascular interventionists [6].

1)

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