Abstract

Background: Microsurgical technique and anatomical knowledge require extensive laboratory training. Human cadaver models are especially valuable as they supply a good microsurgical training environment simultaneously providing authentic brain anatomy. We developed the “skull infusion model” as an extension of our previous “brain infusion model” taking it a step further maintaining simplicity but enhancing realism.

Methods: Four human cadaveric brains donated for educational purposes were explanted at autopsy. The specimens were prepared cannulating carotid and vertebral arteries with plastic tubings, flushed with abundant water and fixed for 1 month in formaldehyde. They were then enclosed with white silk clothing (emulating the dura mater) and inserted into human skulls cut previously into two pieces. Tap water at a flow rate of 10 L/h was infused through the arterial tubings.

Results: Diverse microsurgical procedures were performed by two trainees, including craniotomies with microsurgical approaches and techniques such as sylvian fissure exposure, extra-intracranial and intra-intracranial bypass, approaches to the ventricles and choroidal fissure opening. The water infusion fills the arterial system, leaking into the interstitial and cisternal space and finally moistening the whole specimen. This makes vascular microsurgical techniques become extremely realistic, increasing its compliance making manipulations easier and more authentic.

Conclusions: Standard microsurgical laboratories frequently have difficulties to work with decapitated human cadaver heads but could have human brains readily available. Using the infusion model and inserting it in a human skull makes the environment much more realistic. Its simplicity and inexpensiveness make it a good alternative for developing microsurgical techniques.

Key Words: Bypass, cadaver, cerebrovascular, infusion model, skull, surgical training
INTRODUCTION

Microsurgical technique and anatomical knowledge require extensive laboratory training. Human cadaver models are especially valuable as they supply a good microsurgical training environment with authentic brain anatomy. The main disadvantage of standard human cadaver models is the lack of hemodynamic factors, as well as low compliance and ductility of the specimens making dissection seemingly artificial.

The first human cadaveric circulation model was described by Garret followed by Aboud et al., both creating the dynamic pulsating cerebral model. In a previous report the authors developed a simpler alternative “human cadaver brain infusion model”. The present “skull infusion model” is an extension of that previous model taking it a step further and maintaining its simplicity but enhancing the realism.

MATERIALS AND METHODS

Four human cadaveric brains donated for educational purposes were explanted at autopsy. The specimens were prepared as described by Olabe, cannulating both the carotid and vertebral arteries with plastic tubings. They were then flushed with abundant water and fixed for 1 month in formaldehyde.

After fixation period, each specimen was washed with water, enclosed with white silk clothing (emulating the dura mater) and encased into human skulls cut previously into two pieces and reattached using “velcro” fixings. Tap water at a flow rate of 10 L/h was infused through the arterial tubings.

RESULTS

Various craniotomies were carried out using a drill (Dremel 400 Series Digital). The artificial dura mater was opened and tented in a realistic fashion with leakage of clear liquid similar to cerebrospinal fluid.

Diverse microsurgical procedures were performed by two trainees including sylvian fissure opening and exposure, extra-intracranial high flow bypass to middle cerebral artery, intra-intracranial from carotid artery to middle cerebral artery “jump” bypass, subtemporal approach and bypass to the posterior cerebral artery, approaches to the ventricles and choroidal fissure opening. Explanted porcine carotid arteries (of 3-5 mm diameter) preserved in glycerine and immersed in warm water 5 minutes before use were employed as bypass grafts. They are similar in diameter and texture to radial arteries and can be used many times if they are preserved in glycerine. In the bypass models control angiography was executed to test patency.

The water infusion fills the arterial system finally leaking into the interstitial and cisternal space, so vascular microsurgical techniques become extremely realistic. In addition, the whole moistened specimen increases its compliance and makes manipulations easier and more authentic. The water also fills the ventricular system what makes working in the ventricles emulation of live surgery.

CONCLUSIONS

Standard microsurgical laboratories frequently have difficulties to work with decapitated human cadaver heads, although human brains may be readily available. Using the infusion model and inserting it in a human skull makes the environment much more realistic. Its simplicity and inexpensiveness make it a good alternative for developing microsurgical techniques.

This model provides the trainee with an adequate setting for microneurosurgical training. The most important properties are the reality of the microvascular dissection, moist texture and increased compliance of the brain.
similar to live surgery. This offers the possibility of opening completely the anatomical corridors such as the sylvian fissure without damaging the specimen.

The present model is especially beneficial for training bypass techniques as they can be emulated in the anatomical corridors in a realistic fashion. The main disadvantages with respect to the in vivo situation are: 1) the difficulty to measure the chance of vessel thrombosis; and 2) suture leakage is greater, so the trainee tends to place extra unnecessary sutures.

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