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Original article

Training of deep microsurgical skill: Establishment of a high-volume intracranial carotid bypass model

Formation en microchirurgie profonde : création d'un modèle de pontage carotidien intracrânien à haut débit

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ABSTRACT

Objective. – To establish a model for a high-volume intracranial carotid bypass operation.
Methods. – High-volume internal carotid-middle cerebral artery bypass was performed on 9 cadaver heads with arteries of porcine forearms as grafts by 6 residents with no previous experience in vascular anastomosis on cadavers. The intima was dissected immediately after the anastomoses were completed to observe the patency of anastomosis.
Results. – After different duration periods of training using this model, 36 vascular anastomoses on 18 sides were successfully performed by the 6 residents with a self-made difficulty regulation device. As the difficulty level increased, the time needed for anastomosis lengthened and patency rate showed a decreasing trend. As the amount of training increased, the residents were able to decrease the amount of time to complete the operation with increasing patency rates.
Conclusions. – The model of high-volume internal carotid-middle cerebral artery bypass with arteries of porcine forearms has the advantages of material similarity, easy access of grafts, better simulation of intraoperative conditions, and adjustable difficulties. Our results suggest that this new procedure has a better simulation-training platform which is closer to the real surgical procedure for surgeons willing to master the technique of a high-volume bypass operation.

Mots clés :
Carotide
Haut débit
Pontage
Anastomose vasculaire

RÉSUMÉ

Objectif. – Établir un modèle d'intervention chirurgicale de pontage carotidien intracrânien à haut débit.
Méthodes. – Des interventions de pontage à haut débit entre l'artère carotide interne et l'artère cérébrale moyenne étaient réalisées sur neuf têtes de cadavres, avec des greffons d'artères d'épaule de porc, par six internes sans expérience des anastomoses vasculaires sur cadavre. L'intima était disséquée immédiatement après l'intervention afin de mesurer la perméabilité de l'anastomose.
Résultats. – Après des périodes d'entraînement de durée variable, les six internes ont réalisé 36 anastomoses vasculaires sur 18 côtés, en utilisant un dispositif sur mesure d'autorégulation de la difficulté. Les résultats montrent qu'au fur et à mesure de l'augmentation du niveau de difficulté, le temps nécessaire pour réaliser les anastomoses augmentait et le taux de perméabilité tendait à diminuer. Avec l'entraînement, les internes pouvaient réduire le temps nécessaire pour réaliser l'intervention et améliorer le taux de perméabilité.
Conclusions. – Le modèle d'intervention de pontage carotidien intracrânien à haut débit utilisant des greffons d'artères d'épaule de porc présente des avantages : similarité des tissus, facilité d'obtention

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des greffons, bonne simulation des conditions opératoires, niveau de difficulté ajustable. Nos résultats suggèrent que ce nouveau procédé correspond à une plateforme performante de formation. Il simule efficacement des interventions chirurgicales réelles pour des chirurgiens cherchant à acquérir la maîtrise de la technique de pontage à haut débit.

1. Introduction

In recent years, high-volume intra- and extra-cranial artery bypass surgery has been widely used as an effective treatment for many intracranial diseases with an improvement in the application of intraoperative angiography, advancement in neurosurgical techniques, and more appropriate selected patients. Therefore, it has become an essential technique which needs to be popularized [1–3]. However, high-volume bypass surgery is not an easy-to-master technique, requiring special training. Trainees should first practice performing sutures with gloves, on mice and cadavers in the laboratory, read books, search the literature and see videos as a reference as well as assist experienced surgeons in surgeries [4,5]. Only through these training sessions can surgeons improve their knowledge and surgical ability for this technique. Nevertheless, these training sessions are still quite different from actual practice. For example, the suture feeling of non-biological materials is greatly different from that of mammal vessels. Blood flow volume of small animals cannot meet the demand of high-volume vascular anastomosis. In order to improve surgical results, we used an easy, feasible, convenient and inexpensive model of internal carotid-middle cerebral artery bypass with arteries of porcine forearms as grafts to help trainees master and improve their performance in cerebral artery reconstruction and transit to real practice sooner.

2. Materials and methods

2.1. Cadaver heads

Nine cadaver heads (from Department of Anatomy of Tianjin Huanhu Hospital) fully fixed with 10% formaldehyde, including 6 males and 3 females, were immersed in 75% alcohol to recover tissue color and reduce stimulus by formaldehyde. Arteries and veins were perfused with red and blue silica gel after general flushing, respectively. Bilateral dissection of each cadaver head was performed.

2.2. Arteries of porcine forearms

Dissect and harvest arteries of forearms from commercially available fresh swine (Fig. 1).

2.3. Equipment

Self-made anastomotic difficulty regulation device (Fig. 2). The device was composed of three sets of removable plastic tube heads with different diameters and heights in the front and a snake-shaped part at the back to fix the tube heads and facilitate movement. The three sets of tube heads could add to the difficulty of anastomosis by narrowing the operational field and operating space as well as restricting the angle and direction of operation. At a higher difficulty level, the fixation part at the back could be easily removed to facilitate operation. The plastic tube heads were of different sizes in order to stimulate the narrow and deep surgical site of actual practice. According to difficulty levels, the diameters and heights of the three sets of tube heads were: 4 cm in diameter and 1.5 cm in height for tube I (difficulty level I), 3 cm in diameter and 3.5 cm in height for tube II (difficulty level II) and 2.5 cm in diameter and 4.5 cm in height for tube III (difficulty level III).

3. Methods

3.1. Body posture

The cadaver heads were placed at a horizontal position, rotated 20–30° toward the opposite side of surgical site and fixed onto the supporting structure.

3.2. Skin incision

A frontotemporal skin incision was made 1–2 cm below the zygomatic arch and 0.5 cm anterior to the ear (Fig. 3).

3.3. Exposure of the middle cerebral artery bifurcation

Retract the temporal muscle laterally and four bone holes were made at the processus zygomaticus ossis frontalis, corresponding frontal area of supraorbital notch, anterior to the coronal suture, and the squamous bones (Fig. 4A). Bone flaps were dissected with a milling cutter or a saw. After scissoring the dura mater, the mid anterior part of the lateral fissure was dissected in order to expose the middle cerebral artery bifurcation (Fig. 4B).

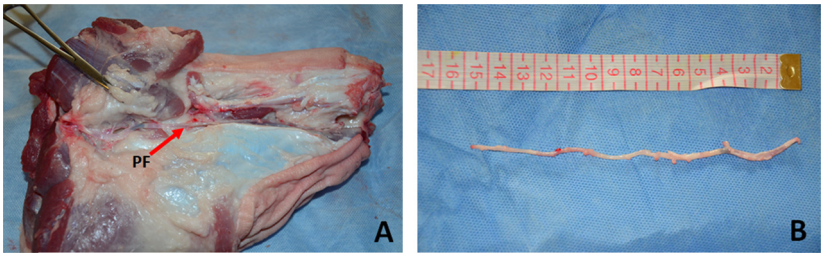

Fig. 1. A. Porcine forearm (PF). B. An artery of porcine forearm.
A. Épaule de porc (PF). B. Artère d'épaule de porc.