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Moist-condition Training for Cerebrovascular Anastomosis: A Practical Step after Mastering Basic Manipulations

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Abstract

As cerebrovascular anastomosis is performed in moist conditions that may impede precise manipulations, surgeons must undergo extensive preoperative training. We developed a simple moist-condition training method. It involves placing a free-floating inner platform hosting an artery from a chicken wing in an outer container filled with tap water to just below the specimen. Trainees performed anastomosis under magnification. Training sessions mimicked difficulties encountered during operations such as poor visibility of the lumen and problems handling the sutures. A retrospective comparison of 100 wet- and 100 dry-condition training sessions for end-to-side anastomoses with 8 stitches showed that under moist condition the time required for the entire procedure was significantly longer (17.8 ± 2.1 vs. 15.3 ± 2.1 min, $p < 0.01$) and the incidence of wrong stitching was greater (0.38 vs. 0%, $p = 0.04$). In 8 cases after introducing moist-condition training, the time required in superficial temporal artery to middle cerebral artery bypass surgery was significantly shorter than 8 cases before introducing the training (32.3 ± 5.6 min vs. 48.3 ± 15.9 min, $p = 0.01$). Incidence of wrong stitches was less in cases after introducing moist-condition training (2.7 vs. 7.4%, $p = 0.10$). Those indicate that moist-condition training is a useful and practical step and a bridge between training for basic manipulations under dry conditions and actual surgery.

Key words: cerebrovascular anastomosis, chicken wing artery, training, moist operating condition

Introduction

Cerebrovascular anastomosis is one of the most precise manipulations in neurosurgery. As patency of the anastomosis depends greatly on the surgeons' skills, they are required to undergo preoperative laboratory training. Conventional training ranges from knotting fine threads and gauze fibers to suturing gloves, handling anastomosing materials such as silastic tubes and chicken wing arteries, live animals (mainly anesthetized rats), to manipulating raw superficial temporal arteries harvested at surgery and from human cadavers.[1–10] However, frustrating technical difficulties during actual operations are encountered even by surgeons who are well trained in the laboratory. These are mainly due to the presence of fluid from the cistern below and occasional contamination by blood, despite efforts to keep the field dry by, for example, elevation of the recipient vessel with gelatin sheets, continuous tube suction of the cistern or epidural region, and suction performed by an assistant.[11–13)]

To close the gap between training and clinical application we modified preoperative training to include moist-condition practice.

Materials and Methods

A 5 × 3 × 1-cm cuboid platform made of thin plastic sheets was prepared to hold a chicken wing artery (approximate length and diameter 3–6 cm and 1 mm, respectively).[5] Openings on two sides of the platform were used to fix the artery with aneurysm clips; the top of the platform descended upon a light touch with instruments (Fig. 1A). Then the platform hosting the artery was placed in an outer plastic container which was filled with tap water to just below the top of the platform so that it resembled a floating island (Fig. 1B). A box with a window simulating a craniotomy was then placed

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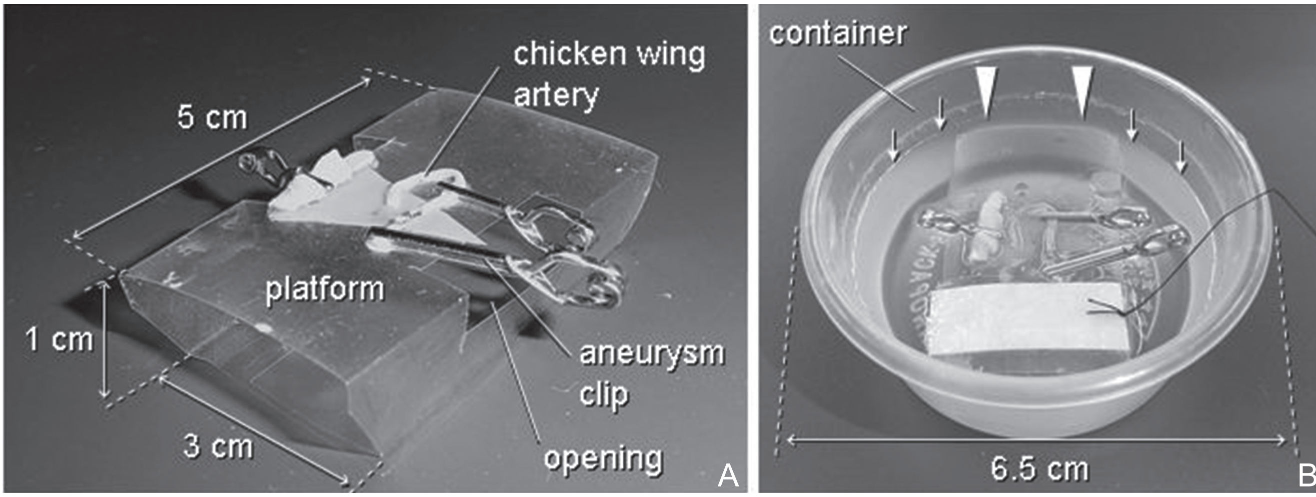

Fig. 1 Devices of moist-condition training for cerebrovascular anastomosis. Dimensions are shown in each figure. A: A cuboid inner platform made of thin plastic sheets is used to hold the chicken wing artery. Openings on two sides of the cuboid platform are used to hold the specimen with aneurysm clips. B: The outer plastic container is filled with tap water (*arrows*) that reaches to just below the top of the inner cuboid platform (*arrowheads*).

over the outer container. This made it possible to train for end-to-side-, end-to-end-, and side-to-side anastomoses. The trainees used desk-type and surgical microscopes. After each training session, the water was removed; and the platform, the artery, and the container were placed in a freezer for later use. At that time the outer container was again filled with tap water and left to sit at room temperature until the specimen was completely thawed.

Four surgeons who had performed or would perform superficial temporal artery to middle cerebral artery bypass surgery participated several times in these moist-condition training sessions. They compared their impressions acquired in moist- and dry-condition training sessions with those during actual surgery. We made video recordings of some trials.

One surgeon assessed the effect of the moist-training condition on the manipulation of the chicken wing artery by performing end-to-side anastomosis with 8 interrupted stitches (3 knots in each stitch) using a nonsterile 10-0 nylon thread (Kono Seisakusho Co. Ltd., Ichikawa, Chiba). The ostium was visualized with the aid of methylrosaniline chloride (pyoctaninum blue, crystal violet; Sigma-Aldrich Co. LLC., St. Louis, Missouri, USA).[14] The same surgeon introduced moist-condition training after performing 150–200 dry-condition training sessions per year for 3 years, and maintained the pace of the training. He reviewed and compared the records of the last 100 dry- and the first 100 moist-condition sessions, the time required from arteriotomy of the recipient artery to complete suturing, and technical difficulties encountered in the 200 training session. In addition, the time required, technical difficulties, and patency in superficial temporal artery to middle cerebral artery bypass surgery (8–10 interrupted stitches and 3 knots in each stitch) by the same surgeon was compared between 8 cases before- and 8 cases after introducing moist-condition training.

Results

The surface of the platform hosting the specimen was always moist because water in the outside container infiltrated through openings in the cuboid platform. The participants found that manipulations under moist conditions were more difficult than under dry conditions. They also reported poor depth perception due to poor focusing, poor visibility of the vessel lumen, and difficulty handling the thread due to loop formation and adhesion of the thread to the vessel or between adjacent threads (Fig. 2). These impressions obtained by the presence of water in the container mimicked situations encountered during surgery although the degree of adhesiveness was lower than in fluids contaminated by blood.

The time required in moist conditions was significantly longer than in dry conditions (17.8 ± 2.1 min vs. 15.3 ± 2.1 min, $p < 0.01$, unpaired *t*-test). Of 800 stitches 3 (0.38%) occluding the anastomosis needed correction in moist-condition sessions, no stitches had to be corrected when placed under dry-training conditions ($p = 0.04$, Chi-square test). At the final inspection after amputation of the donor artery, all anastomoses performed under moist- and dry conditions were patent. The time required in

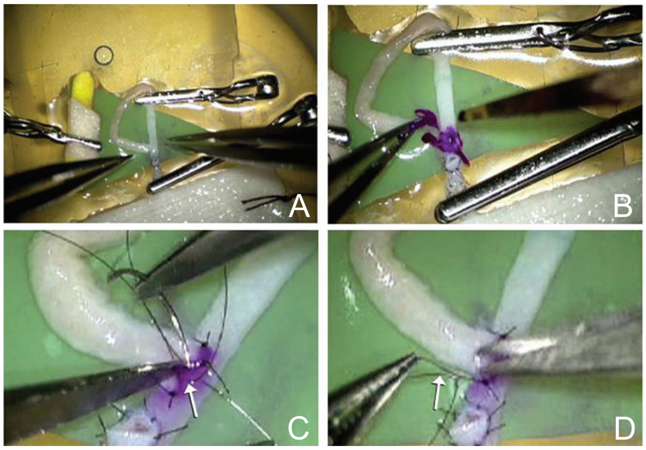

Fig. 2 Difficulties encountered at surgery are simulated during moist-condition training. A: The top of the inner cuboid platform descends upon a light touch. B: Unexpected dye diffusion. C: Inadvertent stitching to the side wall of the recipient artery upon penetration of the donor artery (*arrow*). D: Looping of the thread due to the adhesive force of the water film (*arrow*).

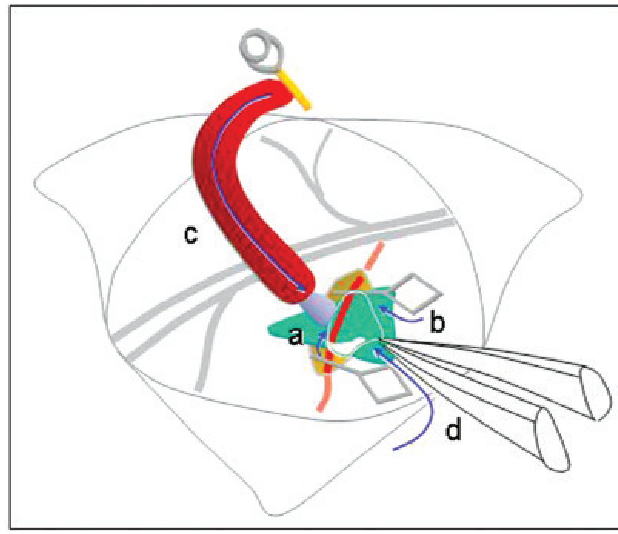

Fig. 3 Fluid infiltration into the surgical field derives from the cistern below (a), from the surface of the brain (b), the surface or the lumen of the donor artery (c), and from the epidural region via instruments (d).

cases after introducing moist-condition training was significantly shorter than cases before introducing the training (32.3 ± 5.6 min vs. 48.3 ± 15.9 min, $p = 0.01$, unpaired *t*-test). Incidence of stitches occluding the anastomosis needed correction was 2/74 (2.7%) in cases after introducing moist-condition training, and 5/68 (7.4%) in cases before introducing the training ($p = 0.10$, Chi-square test). In the follow-up periods of 24 months, patency of the anastomosis was confirmed by magnetic resonance angiography in all 16 cases.

Discussion

During cerebrovascular anastomosis procedures, the operative field must be kept in moist condition (semi-wet condition[11)]), in which the tissue is covered by thin fluid. This condition is ideal not only for avoidance of adhesion of the thread to the tissue but also for tissue protection from drying. However, visibility of the tissue and handling of the threads in moist condition are quite different from that in dry condition training, especially in cases with much fluid in the operative field (Fig. 3) despite efforts to keep the field dry by.[11–13)] Therefore, surgeons must be familiarized in practice sessions with the performance of manipulations under such challenging conditions before operating on patients.

The proposed moist-condition training simulated technical difficulties that occur during surgery, i.e., poor depth perception due to poor focusing, poor visibility of the vessel lumen, and thread adhesion. The difficulties were shown as significantly longer time required and lower accuracy of the manipulation than in dry-condition training. Introduction of the moist-condition training succeeded to shorten operating time and to improve accuracy.

As well as the environment, the choice of anastomosing materials is also important in the training. Chicken wing arteries offer several advantages over artificial vessels.[5)] Their shrinkage resembles that of the human cortical artery, they present the risk of dissection of the intima, their diameter varies, and they harbor fine branches. In addition, their surrounding fat and connective tissue requiring removal resemble those of donor arteries in the scalp. As moist conditions increase the difficulty of visualizing the lumen of shrunk vessels and the dissected intima, moist-condition training mimics situations encountered in human operations.

In conclusion, moist-condition training is a useful and practical step and a bridge between training for basic manipulations under dry conditions and actual surgery. Besides enhancing surgical skills, this training method forces surgeons to concentrate on completing the anastomosis procedure under difficult situations.

Conflicts of Interest Disclosure

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices in the article. All authors who are members of The Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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