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Original article

Learning of supermicrosurgical vascular anastomosis: MicroChirSim® procedural simulator versus Anastomosis Training Kit® procedural simulator

Apprentissage d'une anastomose vasculaire supermicrochirurgicale : simulateur procédural MicroChirSim® versus simulateur procédural Anastomosis Training Kit®

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ABSTRACT

Many biological and non-biological simulators have been developed to reduce the length of the learning curve for supermicrosurgery. All of them have disadvantages. The goal of this study was to evaluate the feasibility of the new MicrochirSim® (0.5 mm) non-biological procedural simulator by comparing it to the Anastomosis Training Kit® (2 mm). After viewing a video of end-to-end anastomosis of a rat-tail artery, 10 residents in surgery reproduced the same technique on a procedural simulator: 5 on the MicroChirSim® (group 1) and 5 on the Anastomosis Training Kit® (group 2). The 10 residents then each performed five end-to-end anastomoses of the rat-tail artery on which they were evaluated. The average length of the procedure was 33 minutes in group 1 and 45 minutes in group 2. The average number of suture points was 3.7 in group 1 and 5.4 in group 2, which suggests training with a 0.5 mm simulator improves suturing. The anastomosis was patent in 25 cases in group 1 and in 22 cases in group 2. The anastomosis was free of leaks in 25 cases in group 1 and in 19 cases in group 2. In conclusion, the MicroChirSim® procedural simulator accelerates the learning curve for vascular supermicrosurgery.

Mots clés :
Simulation
Anastomose vasculaire
Microchirurgie
Supermicrochirurgie
MicroChirSim™

RÉSUMÉ

Pour diminuer la durée de la courbe d'apprentissage de la supermicrochirurgie, de nombreux simulateurs biologiques vivants ou non vivants et non biologiques procéduraux ou virtuels ont été mis au point. Tous comportent des inconvénients. Le but de ce travail était de tester la faisabilité d'un nouveau simulateur non biologique procédural, le MicrochirSim® (0,5 mm), en le comparant à l'Anastomosis Training Kit® (2 mm). Après avoir visionné une vidéo d'anastomose termino-terminale de l'artère de la queue de rat, 10 internes en chirurgie ont reproduit la même technique sur un simulateur procédural, 5 sur MicroChirSim® (groupe 1) et 5 sur Anastomosis Training Kit® (groupe 2). Les 10 internes ont ensuite réalisé 5 anastomoses termino-terminales de l'artère de la queue de rat sur lesquelles a porté l'évaluation. La durée moyenne de la procédure était de 33 min dans le groupe 1 et de 45 min dans le groupe 2. Le nombre moyen de points de suture était de 3,7 dans le groupe 1 et de 5,4 dans le groupe 2. L'anastomose était perméable 25 fois dans le groupe 1 et 22 fois dans le groupe 2. L'anastomose était étanche 25 fois dans

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le groupe 1 et 19 fois dans le groupe 2. En conclusion, le simulateur procédural MicroChirSim® accélère la courbe d'apprentissage en supermicrochirurgie vasculaire.

1. Introduction

The conventional learning curve for supermicrosurgery implies performing microsurgical vascular anastomoses on living rats [1]. End-to-end anastomosis of the rat-tail artery has widespread use [2]. The ethics applied to animal experiments require us to abide by the three Rs: reduce the number of animals for the experiment, refine the methodology, and replace animal models [3]. In order to reduce the length of the learning curve before starting on animal models, many biological procedural simulators – living and non-living – have been designed. All of them have disadvantages [4,5]. Some non-biological procedural simulators, such as the Anastomosis Training Kit®, are available on the market. However, its 2 mm outer diameter is too large for supermicrosurgery training.

The goal of this study was to compare two non-biological procedural simulators, the MicrochirSim®, with a 0.5 mm outer diameter and the Anastomosis Training Kit®, with a 2 mm outer diameter.

2. Material and methods

This study was performed in a certified microsurgery laboratory, in accordance with the Helsinki's convention regarding animal experimentation. Ten residents in plastic or orthopaedic surgery with no previous microsurgery experience were involved in the study. Our materials included: one demonstration video, one operating microscope with 40 × magnification (ASOM18-4B®, Carl Zeiss GmbH, Oberkochen, Germany), two types of procedural simulators: MicroChirSim® (Créaplast™, Verton, France), Anastomosis Training Kit® (Biomet™, Jacksonville, Florida, USA), and 50 adult Sprague Dawley rats weighing 400 grams on average.

All anastomoses were performed with the operating microscope. The learning protocol entailed three steps.

The first step consisted in viewing a video in which a senior microsurgeon performs microsurgical vascular anastomosis on a rat-tail artery.

The second step consisted in reproducing the same technique on a procedural simulator, either a MicroChirSim® (5 residents, group 1) or an Anastomosis Training Kit® (5 residents, group 2). The main difference between the two simulators was the outer diameter. With the MicroChirSim® (Fig. 1A), the technique consisted in setting a flexible silicone tube, 0.5 mm in outer diameter and 0.25 mm in inner diameter on step 2 of a dedicated mount, placing a double microvascular clamp in the middle of the tube (Biover®, Arex™, Palaiseau, France), transecting the tube completely using microsurgical scissors, and repairing the tube by an end-to-end anastomosis using 10/0 nylon suture (Surgipro® Covidien™, Mansfield, MA, USA). The patency and tightness of the anastomosis were then assessed (Fig. 1B). With the Anastomosis Training Kit® (Fig. 2A), the technique consisted in setting a 2 mm flexible silicone tube on a dedicated mount, placing a double microvascular clamp in the middle of the tube (Biover®, Arex™, Palaiseau, France), transection the tube completely using microsurgical scissors, and repairing the tube by an end-to-end anastomosis using 10/0 nylon suture (Surgipro® Covidien™, Mansfield, MA, USA). In both groups, each resident performed five anastomoses for which the patency was assessed (Fig. 2B).

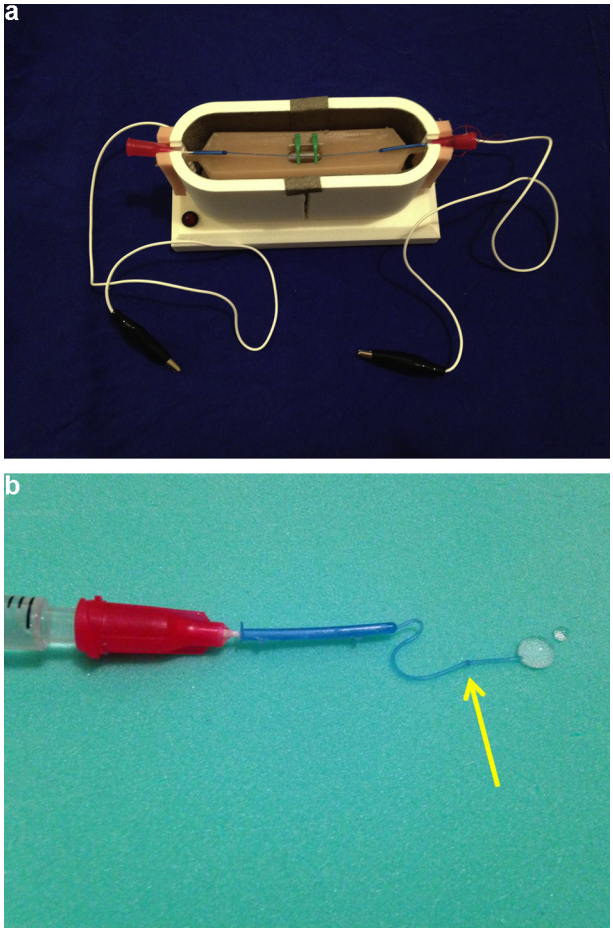

Fig. 1. MicroChirSim® procedural simulator. A. Set up: a double vascular clamp (green) is placed in the middle of a flexible silicone tube on a dedicated mount (white). B. Assessment of the patency and tightness of the anastomosis: after cutting one end of the silicone tube (blue), saline is injected at the other end by a syringe inserted in the catheter (red); the absence of leaks and discharge of the saline at the other end is checked (yellow arrow).

The third step consisted in performing five end-to-end microsurgical anastomoses of the rat-tail artery by each resident in both groups. The rats were anaesthetized by an intraperitoneal injection of 0.1 mL/100 g of sodium pentobarbital, with an additional dose of 0.1 mL every hour. After shaving the area, the rat-tail artery was dissected. The average diameter after adventicectomy was 0.5 mm. A double vascular clamp (Biover® Arex™, Palaiseau, France) was used before the artery was cut completely with microsurgical scissors. The artery was repaired by an end-to-end anastomosis using 10/0 nylon sutures (Surgipro® Covidien™, Mansfield, MA, USA). The patency was assessed and potential leaks determined.

An independent observer evaluated four variables (two quantitative and two qualitative) for each group on all 50 rat-tail artery anastomoses. The two qualitative variables were the patency of the anastomosis (yes or no) and the presence of leaks (yes or no). The two quantitative variables were the length of the procedure in minutes and the number of suture points.

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