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Original article

Multiple adjustable vascular clamp prototype: Feasibility study on an experimental model of end-to-side microsurgical vascular anastomosis

Prototype d'un clamp vasculaire multiple orientable : étude de faisabilité sur un modèle expérimental d'anastomoses vasculaires microchirurgicales termino-latérales

A. Pereira [a], S. Ichihara [a,b], S. Collon [c], F. Bodin [d], A. Gay [e], S. Facca [a], P. Liverneaux [a,*]

[a] *Department of Hand Surgery, Strasbourg University Hospital, FMTS, University of Strasbourg, Icube CNRS UMR7357, 10, avenue Baumann, 67403 Illkirch, France*
[b] *Department of Orthopaedic Surgery, Juntendo University, Tokyo, Japan*
[c] *Department of Orthopaedic Surgery, Caen University Hospital, 14000 Caen, France*
[d] *Department of Plastic Surgery, Strasbourg University Hospital, FMTS, University of Strasbourg, 67000 Strasbourg, France*
[e] *Department of Hand Surgery, La Timone Teaching Hospital, Aix Marseille University, 13000 Marseille, France*

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Abstract

The aim of this study was to establish the feasibility of microsurgical end-to-side vascular anastomosis with a multiclamp adjustable vascular clamp prototype in an inert experimental model. Our method consisted of performing an end-to-side microsurgical anastomosis with 10/0 suture on a 2-mm diameter segment. In group 1, the end-to-side segment was held in place by a double clamp and a single end clamp. In group 2, the segment was held in place with a single multiclamp adjustable clamp. The average time for performing the anastomosis was shorter in group 2. The average number of sutures was the same in both groups. No leak was found and permeability was always positive in both groups. Our results show that performing end-to-side anastomosis with a multiclamp adjustable vascular clamp is feasible in an inert experimental model. Feasibility in a live animal model has to be demonstrated before clinical use.

Keywords: Vascular clamp; End-to-side anastomosis; Microsurgery

Résumé

Le but de ce travail était d'étudier la faisabilité d'anastomoses vasculaires microchirurgicales termino-latérales avec un prototype de clamp vasculaire multiple et orientable sur un modèle expérimental non vivant. La méthode consistait à réaliser une anastomose microchirurgicale termino-latérale avec des fils de 10/0 sur un modèle de diamètre 2 mm. Dans le groupe 1, le modèle latéral était maintenu par un clamp double et le terminal par un clamp simple. Dans le groupe 2, les modèles étaient maintenus par un seul clamp vasculaire multiple et orientable. Le temps moyen pour réaliser l'anastomose était plus rapide dans le groupe 2. Le nombre moyen de points était proche dans les deux groupes. Aucune fuite n'a été constatée dans aucun des deux groupes et la perméabilité a toujours été positive dans les deux groupes. Nos résultats montrent que la réalisation d'anastomoses termino-latérales avec un clamp vasculaire multiple et orientable est faisable sur un modèle expérimental. Reste à le démontrer sur un modèle vivant, puis de le mettre en pratique sur des applications cliniques.

Mots clés : Clamp vasculaire ; Anastomose termino-latérale ; Microchirurgie

* Corresponding author.
E-mail address: philippe.liverneaux@chru-strasbourg.fr (P. Liverneaux).

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1. Introduction

To perform microsurgical vascular anastomosis, most surgeons use a clamping system that puts both vascular lumens in front of each other with the blood flow stopped. Numerous vascular clamps are on the market, both single-clamp and double-clamp designs [1].

Among microsurgical anastomoses, the end-to-side ones are the most difficult to perform [2]. The hardest part is keeping the terminal blood vessel in the appropriate position in front of the lateral vessel without damaging it. Most authors use a double clamp to hold the lateral vessel and a single clamp for the terminal vessel. In most cases, the terminal vessel is unstable since the clamps are not connected; this leads to repeated manipulations and thus risks of vascular lesions and/or increase in procedure time.

The aim of this study was to determine the feasibility of microsurgical vascular end-to-side anastomosis using a multiclamp adjustable vascular clamp prototype on an inert experimental model.

2. Material and methods

2.1. Material

The material used was a 2-mm exterior diameter blood vessel segment made out of polyvinyl alcohol (Anastomosis training kit®, Biomet microfixation™, Jacksonville, FL, USA), nylon 10/0 suture (Ethilon®, Ethicon™, Sommerville, NJ, USA), and a surgical microscope (Wild®, Leica™, Wetzlar, Germany). A single surgeon performed all the anastomosis procedures.

The adjustable vascular clamp prototype (Fig. 1) includes a bendable, 0.8-mm diameter metal connection bar that can bear as many single clamps as needed (multiclamp design). Each single clamp is designed with a transfixing tunnel to permit the placement of a connecting bar with a rectangular cross-section (0.6 × 1 mm) to avoid unwanted rotation around the bar. Both peripheral ends of the connection bar have a squared cross-section (1-mm cross-section rod stamped to reach a 0.8 mm depth) that is bendable enough to allow for on-demand shaping (adjustable clamp). The central part of the connection bar has a round cross-section, which is more bendable than the squared section. This central part will not pass through the clamp tunnel. The lateral segment is held by a double vascular clamp and the terminal segment by a single clamp. The connection bar is shaped to improve access to the anterior and posterior planes. Both clamps are connected to one another; the terminal segment is stable regardless of its angle relative to the lateral vessel.

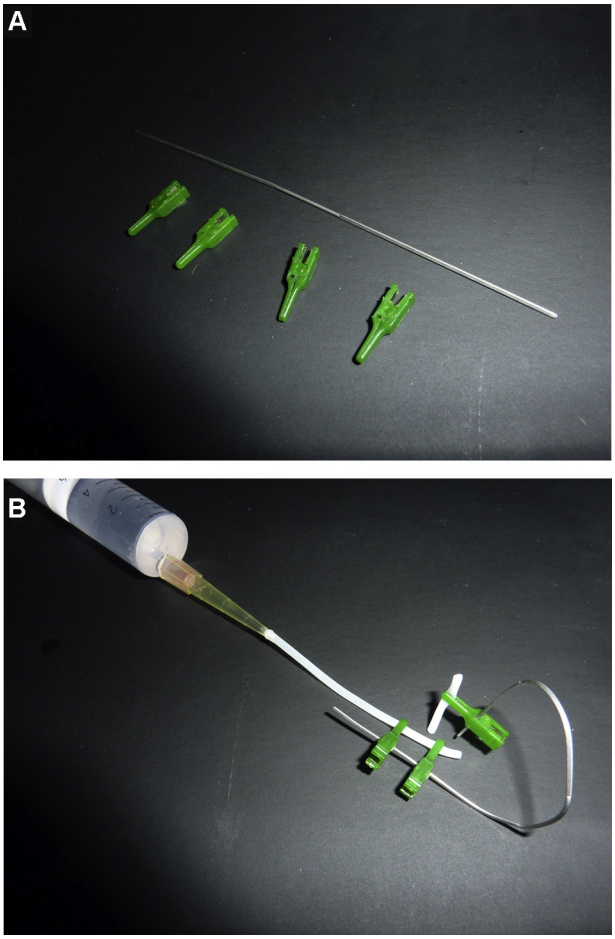

Fig. 1. Preparation of a microsurgical vascular anastomosis model in group 2. The adjustable vascular clamp prototype includes a bendable, 0.8-mm diameter metal connection bar that can bear as many single clamps as needed (multiclamp design). Each single clamp is designed with a transfixing tunnel to permit the placement of a connecting bar with a rectangular cross-section (0.6 × 1 mm) to avoid unwanted rotation around the bar. Both peripheral ends of the connection bar have a squared cross-section (1-mm cross-section rod stamped to reach a 0.8 mm depth) that is bendable enough to allow for on-demand shaping (adjustable clamp). The central part of the connection bar has a round cross-section, which is more bendable than the squared section. This central part will not pass through the clamp tunnel (A). The lateral segment is held by a double vascular clamp and the terminal segment by a single clamp. The connection bar is shaped to improve access to the anterior and posterior planes. Both clamps are connected to one another; the terminal segment is stable regardless of its angle relative to the lateral vessel (B).

2.2. Methods

The method consisted of preparing two vascular segments, one main or lateral, another secondary or terminal intended for connection to the former through an end-to-side anastomosis. Preparation of the lateral segment consisted of creating a breach by excising a parietal fragment with microscissors.

In group 1, the lateral segment was held in place with a double vascular clamp (Biover®, Arex™, Palaiseau, France) and the terminal segment was held in place by a single vascular clamp (Biover®, Arex™, Palaiseau, France) (Fig. 1). Both clamps were not connected to one another. In group 2, the lateral and terminal segments were held in place by the single multiclamp adjustable vascular clamp prototype described above (Fig. 2).