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Vascular microanastomosis through an endoscopic approach: Feasibility study on two cadaver forearms

Microanastomose vasculaire sous abord endoscopique : étude de faisabilité sur deux avant-bras de cadavre

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Abstract

The size of the incisions for free muscle flaps is often very large, and a source of deep adhesions and unaesthetic scars. But it is justified by performing the microsurgical step comfortably. In the hopes of shortening the size of incisions, the goal of this work was to study the feasibility of vascular microanastomoses through an endoscopic approach. The material consisted of two cadavers, a telemanipulator, and a vascular clamp. The antebrachial skin was detached then distended by gas insufflation. Four incisions, 1 cm each, allowed the insertion of four trocarts connected to the telemanipulator. The artery was dissected (radial or ulnar) and the vascular clamp was introduced under the skin through one of the trocarts, and then installed on the dissected artery. The vascular anastomosis was performed with the use of a 10/0 nylon suture. The anastomosis lasted 2 hours under insufflation without any leak. The two arteries were identified then dissected without difficulty. The anastomosis was performed in good conditions. The assembling and disassembling of the clamp were time consuming. The main difficulties were caused by a long suture and a very fragile needle. Our results demonstrate the feasibility of vascular microanastomosis through an endoscopic approach. The next step is to perform the first clinical case for example on a *latissimus dorsi* free muscle flap.

Keywords: Anastomosis; Endoscopy; Microsurgery; Robot; Telesurgery

Résumé

La taille des incisions des lambeaux musculaires libres est souvent très grande, source d'adhérences profondes et de cicatrices inesthétiques. Elle est justifiée pour réaliser le temps microchirurgical confortablement. Pour la diminuer, le but de ce travail était d'étudier la faisabilité de microanastomoses vasculaires par voie endoscopique. Le matériel comprenait deux cadavres, un télémanipulateur, un clamp vasculaire démontable. La peau antébrachiale a été décollée, puis distendue par insufflation de gaz. Quatre incisions d'1 cm permettaient d'installer quatre trocarts reliés à un télémanipulateur. L'artère était disséquée (radiale ou ulnaire) et le clamp démontable était introduit par un trocart sous la peau, puis installé sur l'artère qui était sectionnée. L'anastomose était réalisée avec des points de 10/0. L'anastomose durait deux heures sous insufflation, sans fuite. Les deux artères ont été repérées, puis disséquées sans difficulté. L'anastomose était réalisée dans de bonnes conditions. Le montage et démontage du clamp étaient chronophages. Les difficultés principales ont été causées par un fil trop long et une aiguille trop fragile. Nos résultats démontrent la faisabilité de microanastomoses vasculaires par voie endoscopique. Reste à réaliser le premier cas clinique, par exemple sur un lambeau de grand dorsal (*latissimus dorsi*).

Mots clés : Anastomose ; Endoscopie ; Microchirurgie ; Robot ; Chirurgie à distance

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1. Introduction

Plastic and reconstructive surgery often uses free muscle flaps that necessitate large incisions not only to harvest the muscle flap itself but also to perform the microsurgical vascular anastomoses [1]. These large surgical approaches are looked down upon for esthetic and functional reasons [2–4]. For those reasons, some authors have developed minimally invasive techniques of raising those muscle flaps such as the *rectus abdominis* [5], robot-assisted [6] or by endoscopic approach [7], and of the *latissimus dorsi* [8]. To our knowledge, no study has been done on achieving microsurgical vascular anastomoses through a minimally invasive endoscopic approach.

The purpose of our work was to study the feasibility of vascular microanastomoses through an endoscopic approach on a radial and ulnar artery model in a fresh cadaver forearm.

2. Materials and methods

2.1. Material

The material consisted of two fresh cadaver forearms, a Da Vinci SI® robot (Intuitive Surgical™, Sunnyvale, CA, USA) and specific and non-specific instruments.

The non-specific instruments consisted of forceps (Black Diamond®, Cadiere®, Maryland) and scissors (Pott®, curved).

The specific instruments consisted of prototypes of annular devices (iin medical™, Besancon, France) used to ensure the airtightness of the trocarts and avoid their expulsion from the antechamber during the surgical intervention (Fig. 1). It also consisted of a prototype of vascular clamps that can be taken apart (Arex™, Palaiseau, France).

2.2. Technique

The surgical technique consisted of six steps.

The first stage consisted in preparing the portals of entry (Fig. 1). Starting with four 1-cm-long cutaneous incisions, a dissection with Metzenbaum scissors allowed forming the work chamber. The camera trocart (12 mm diameter) was then installed on the ulnar side (to approach the radial artery) or from the radial side (to approach the ulnar artery). Two instrument trocarts (8 mm diameter) were placed on each side of the camera. The third instrument trocart was placed on the opposite side of the camera. Each trocart was introduced 2 cm deep and held to avoid its expulsion thanks to an annular device (iin medical™, Besancon, France) fixed to the skin with a 3-0 Vicryl® suture.

The second stage consisted in linking the arms of the robot to the trocarts. The third instrument arm was placed opposite to the camera arm in an original configuration (Fig. 2). An insufflation of carbon dioxide at a pressure of 8 mmHg allowed maintaining the working chamber open.

After introducing and locating the instruments in the working chamber, the third stage consisted in dissecting the different layers of soft tissue until the radial or ulnar artery was located (Fig. 3).

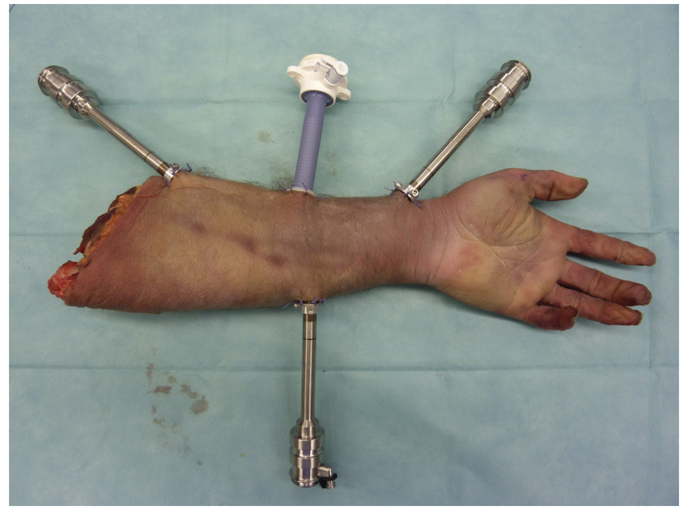

Fig. 1. Positioning of the trocarts for the ulnar artery approach. The optical trocart and two instrument trocarts were placed on the radial side, the third instrument trocart on the opposite side. The expulsion of the trocarts was prevented by annular devices fixed to the skin.

The fourth stage consisted in introducing the device to anastomose through the instrument trocart opposite to the camera. The vascular clamp that can be taken apart (Arex™, Palaiseau, France) was introduced piece by piece: two simple clamps and a metallic bar (Fig. 4). It was then put back together with the aid of forceps and then fixed to the artery. The 10-0 suture was then introduced.

The fifth stage consisted in the anastomosis. The artery was first sectioned with Pott's scissors, then anastomosed with separate sutures (Fig. 5).

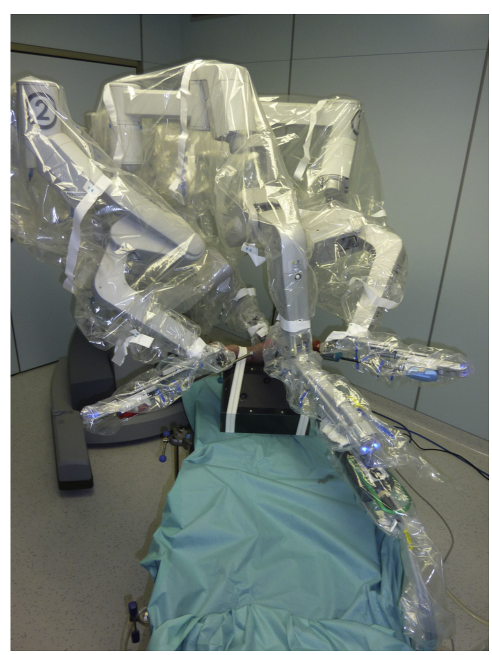

Fig. 2. Installation of the telemanipulator. The arms of the Da Vinci® robot were linked to the trocarts in which the instruments and the camera were introduced.