How to manage Calcified vessels for head and neck microsurgical reconstruction. Short running title: Microsurgery for calcified vessels in head and neck reconstruction. Author names and affiliations

Jebrane Bouaoud, Jean-François Honart, Yasmine Bennis, Nicolas Leymarie

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Author names and affiliations:

Jebrane Bouaoud[1, 2], Jean-François Honart[1], Yasmine Bennis[1], Nicolas Leymarie[1]

1. Plastic and Reconstructive Surgery Department, Gustave Roussy Cancer Campus, 114 Rue Edouard Vaillant, Villejuif 94805, France.

2. Department of Maxillo-facial Surgery and Stomatology, Pitié-Salpétrière Hospital, Pierre et Marie Curie University Paris 6, Sorbonne Paris Cite University, AP-HP, Paris, 75013, France

Corresponding author:

Jebrane Bouaoud, M.D

Plastic and Reconstructive Surgery Department, Gustave Roussy Cancer Campus, 114, Rue Edouard Vaillant, Villejuif 94805, France.

E-mail jebrane.bouaoud@gmail.com

Phone# +33142161049

Financial Disclosure Statement: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Abstract

Head and neck reconstructive microsurgery in patients with calcified vessels (atherosclerosis or radiotherapy) is challenging. Preoperative reconstruction planning should meticulously evaluate the pedicle length and caliber aiming to select the most adapted free flap type and to plan the need for harvesting two free flaps or a venous graft. During surgery, end-to-end microanastomosis should be preferred, without artery clamps on calcified vessels and using open-loop sutures, a limited number of microsutures and a round needle with inside-outside directed bites (no atherosclerotic plaque removal). Before declamping, fibrin sealants are used to prevent minor leakage around the anastomosis as well as before wound closure to fix the optimal position of the pedicle avoiding pressure on the vessels or pedicle kinking. Calcified vessels are not a barrier to microsurgery and do not constitute a contraindication. Several options are useful to safely perform microsurgical head and neck reconstruction.

Keywords

Microsurgery, reconstruction, free flap, calcification, atherosclerosis, radiotherapy

Introduction

Demographic changes and medical progresses led to increasing diagnoses and managements of head and neck (HN) cancers in elderly patients with more comorbidities[1,2]. Surgeons therefore face to technical challenges such poor vascular capitals with calcified vessels which may affect the success of microsurgery[3]. Calcified arteries lose their elasticity and are more prone to thrombosis.

HN reconstructive microsurgery is characterized by anatomical and technical specificities. Inferior limb free flaps are useful, but their vessels are often affected by atherosclerosis. Furthermore, recipient vessels can be calcified due to atherosclerosis or radiotherapy.

We provide specific advice for safe HN microsurgical reconstruction based on our experience with calcified vessels.

Technical description

Patients should be evaluated thoroughly before, during and after the surgery. The microsurgical technique should be meticulous.

Pre-operative

A thorough vascular assessment is crucial, especially for patients with cardiovascular history[4]. Physical examination (palpable pulses) and evaluation of the vascular flows (echography doppler) are mandatory. We recommend CT-Scans for angiographic study of free flap and recipient vessels to specify the presence/size of atheroma plaque and the stenosis degree, especially for the external carotid arteries. Some authors privileged the Magnetic resonance angiography (MRA) because it is effective and less invasive [5]. Anyway, in case of common carotid artery stenosis > 80%, an endarterectomy is realized prior to reconstruction. If three of the four carotid/vertebral axes are stenosed, the procedure is contraindicated.

For lower limb free-flaps, vessels of “leg tripod” (anterior tibial, posterior tibial and fibular arteries) are investigated.

Perioperative

Free flap harvesting and recipient vessels preparation

To limit ischemia of the limb operated, flap harvesting is realized quickly (< 1 hour) or if possible, without pneumatic tourniquet.

Careful dissection of vessels is crucial to avoid traumatisms and to allow a safe anastomosis.

To choose the best location for the anastomosis, surgeon inspect and palpate the recipient vessel checking for the presence of calcifications, thrombus or atherosclerotic plaques[3]. As far

as possible, get away from the major vascular axes to preserve them and avoid excessive atheromatous infiltrations. The arterial anastomosis is generally performed on one of the terminal branches of the external carotid artery, away from all side branches (avoiding flow modifications) that should be ligated. In all cases, vessels diameter should be as equal as possible since the rigidity of the walls does not allow correction of diameter incongruences.

Anastomosis

We privilege end-to-end anastomoses[3,6,7]. To avoid traumatisms of vessels, we recommend to not flush the flap, not use artery clamps for flap vessels, not strip the adventitia and not dilate vessels. To visualize the vessels lumen, we limit irrigation with heparinized saline and prefer careful drying with gauzes. Surgeons should not put instruments into the lumen blindly and should use a round needle while limiting the number and the tension of microsutures. The bites are directed from the inside to the outside for the atherosclerotic arteries (avoiding removal of atherosclerotic plaque).

We privilege the open-loop suture technique[6,7] for more secure anastomosis with clear visualization of the vessels lumen during every pass of the needle (better eversion and elevation of the edges using the tips of the forceps). We vary the size of loops to easily identify loops that should successively be cut and tied. To improve the microvascular anastomosis efficiency, experienced surgeons combine Open-Loop and Airborne Suture Techniques[8]. The anterior and the back sides of the anastomosis are successively sutured.

Once the microsuture is completed, apply fibrin sealant around the anastomosis (tubulization of the anastomosis) and wait until it dries before declamping. The objective is to prevent any minimal leakage.

The use of an anastomotic coupler device is not recommended for atherosclerotic microanastomoses (vessels rigidity, traumatism risk).

Wound closure

After declamping, we avoid manipulation of the pedicle (no permeability tests) to not create turbulence and/or damage the vessel walls.

Before wound closure, we replace the patient head in physiological position (no neck extension/rotation) and fix the pedicle optimal position using fibrin sealant ensuring that there is no pressure or kinking of the pedicle. Kinking of the pedicle with calcified vessels is more frequent than usual due to its length or difference in vessels walls rigidity.

Specific situations

To avoid anastomosis with both recipient and donor calcified vessels, surgeon can choose vessels more prone to microanastomosis by dissecting more proximally the recipient vessel, including sometimes the ''mother vessels''[9] (external carotid) or by using alternative recipient vessels such Transverse cervical vessels which are rarely in the radiation fields of HN cancers and offer good vascular flow. However, this last option requires longer pedicle and sometimes the use of venous graft bypass or “Chain-link” sequential flaps. In this case, forearm free flaps are suitable (longer, tension-free pedicle, far from the affected zone) and should be harvested during the same surgery (one-stage reconstruction). The proximal part of its pedicle is branched with the alternative recipient vessels while the distal part is sequentially branched with the main free flap. Another option is the interposition venous grafting between the two calcified vessels[10] (Figure 1). The main disadvantages are the need to perform two

anastomoses, increasing the operating time and the risk of thrombosis (venous graft blockages due to different pressure regimes with calcified arteries)[11]. In all situations, double needle sutures are useful.

Discussion

Calcified vessels are not a barrier to microsurgery and do not constitute a contraindication. Preoperative surgical planning meticulously evaluates the pedicle length and caliber to choose the best free flap type and anticipate the need for harvesting two flaps or venous graft[12].

During surgery, thrombosis can be avoided by respecting integrity of the vessels, choosing the best location for an end-to-end anastomosis. End-to-side anastomosis increase the thrombus formation risk because of more direct exposure of the atherosclerotic plaque. Vascular clamps, stripping of adventitia and dilatation of vessels should be avoided given the risk of traumatism and thrombus. Arterial dilatations with lidocaine, papaverine or amlodipine are not performed because vasospasm is uncommon in calcified vessels. Tapered needles with a cutting tip can be used to easily puncture the plaque while avoiding a laceration[10]. Fibrin sealants are useful to ensure that the optimal pedicle position is respected during healing. Several options are useful when encountering both flap and recipient calcified vessels.

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Figure legends

Figure 1 Illustration of a venous grafting between two vessels (not calcified in this case). A. Interposition of the venous grafting (blue arrow); B. The two end-to-end anastomoses are performed simultaneously to avoid increasing the ischemia time.

Figure 1

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