**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**

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Title. Technical note: How to manage Calcified vessels for head and neck microsurgical reconstruction.

Short running title: Microsurgery for calcified vessels in head and neck reconstruction.

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1 **Abstract**

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

13 **Keywords**

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

15 Introduction

16

17 Demographic changes and medical progresses led to increasing diagnoses and managements
18 of head and neck (HN) cancers in elderly patients with more comorbidities^{1,2}. Surgeons
19 therefore face to technical challenges such poor vascular capitals with calcified vessels which
20 may affect the success of microsurgery³. Calcified arteries lose their elasticity and are more
21 prone to thrombosis.

22

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

26

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

Technical description

30

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 history⁴.

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 traumatism 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 plaques³. 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.

58

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).

67

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 Techniques⁸. 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.

77

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

80

81 *Wound closure*

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

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

88

89 *Specific situations*

90 To avoid anastomosis with both recipient and donor calcified vessels, surgeon can choose
91 vessels more prone to microanastomosis by dissecting more proximally the recipient vessel,
92 including sometimes the "mother vessels"⁹ (external carotid) or by using alternative recipient
93 vessels such Transverse cervical vessels which are rarely in the radiation fields of HN cancers
94 and offer good vascular flow. However, this last option requires longer pedicle and sometimes
95 the use of venous graft bypass or "Chain-link" sequential flaps. In this case, forearm free flaps
96 are suitable (longer, tension-free pedicle, far from the affected zone) and should be harvested
97 during the same surgery (one-stage reconstruction). The proximal part of its pedicle is
98 branched with the alternative recipient vessels while the distal part is sequentially branched
99 with the main free flap. Another option is the interposition venous grafting between the two
100 calcified vessels¹⁰ (Figure 1). The main disadvantages are the need to perform two

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

104 **Discussion**

105

106 Calcified vessels are not a barrier to microsurgery and do not constitute a contraindication.

107 Preoperative surgical planning meticulously evaluates the pedicle length and caliber to choose

108 the best free flap type and anticipate the need for harvesting two flaps or venous graft¹².

109 During surgery, thrombosis can be avoided by respecting integrity of the vessels, choosing the

110 best location for an end-to-end anastomosis. End-to-side anastomosis increase the thrombus

111 formation risk because of more direct exposure of the atherosclerotic plaque. Vascular

112 clamps, stripping of adventitia and dilatation of vessels should be avoided given the risk of

113 traumatism and thrombus. Arterial dilatations with lidocaine, papaverine or amlodipine are

114 not performed because vasospasm is uncommon in calcified vessels. Tapered needles with a

115 cutting tip can be used to easily puncture the plaque while avoiding a laceration¹⁰. Fibrin

116 sealants are useful to ensure that the optimal pedicle position is respected during healing.

117 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.