JPRAS Open 30 (2021) 6–12

Contents lists available at ScienceDirect

JPRAS Open

journal homepage: www.elsevier.com/locate/jpra

Original Article

Transverse cervical vessels as a recipient site for microvascular reconstruction in vessel-depleted necks: a safe option

Adriano-Valerio Schettini*, Ali Modarressi, Eva Ruegg, Daniel Kalbermatten, Brigitte Pittet-Cuenod

Department of Plastic, Reconstructive and Aesthetic Surgery, Geneva University Hospitals and University of Geneva Faculty of Medicine, Geneva, Switzerland

A R T I C L E I N F O

Article history:
Received 17 April 2021
Accepted 10 June 2021
Available online 18 June 2021

Keywords:
transverse cervical vessels
microsurgery
frozen neck
reconstruction

A B S T R A C T

Background: Free flap reconstruction is the gold standard in complex head and neck reconstruction. The branches of the external carotid vessels (ECVs) are considered the most suitable recipients, but they may be unavailable in patients presenting "frozen necks" or "vessel-depleted necks" due to previous treatments. We report our experience using the transverse cervical vessels (TCV) in these situations.

Methods: Retrospective chart review of microsurgical head and neck reconstructions from 2005 to 2017. We focused our analysis on secondary procedures and compared the complication rate according to whether the TCV or the ECVs were used.

Results: A total of 97 free flaps were performed for secondary procedures in 89 patients, mainly due to oncological recurrence and fistulae. TCV were used in 14 procedures when external carotid vessel branches were unavailable. The overall complication rate (all grade III Dindo-Clavien) was of 21% versus 35%, respectively, in the TCV and ECVs group. Grade IIIb Dindo-Clavien complications, i.e., microsurgical complications (10%) and flap loss (1%), were only recorded in the ECVs group. Other complications recorded were seroma (7% versus 1%) and hematoma (17% versus 6%) in the

* Corresponding author: Dr Adriano-Valerio Schettini, Service de chirurgie plastique, reconstructive et esthétique, Clinique Saint-Luc Bouge, Rue Saint-Luc 8, 5044 Namur, Belgique.

E-mail address: adriano.schettini@slbo.be (A.-V. Schettini).

https://doi.org/10.1016/j.jpra.2021.06.003
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TCV and ECVs groups, respectively, and corresponded to grade IIIa Dindo-Claviens.

Conclusions: The use of TCV is a safe second-line recipient site for microsurgical head and neck reconstruction in vessel-depleted necks. Major advantages are their anatomical position outside the previous surgical and radiation zone, lower affinity for atherosclerotic damage, and similar diameter to the pedicles of the most used flaps.

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Introduction

Current treatment protocols of head and neck cancer mostly include extensive surgery and/or radiochemotherapy trying to achieve complete cancer removal while preserving as much surrounding healthy tissue as possible.[1–4] There is, however, an increasing demand for salvage/secondary surgery for either primary treatment failures/complications (e.g., recurrence and/or fistulae), second primary tumors (i.e., new primary cancer in a cancer survivor) and/or treatment-related sequelae.[3–8] Repeated surgery and radiochemotherapy may leave the patient's neck in a severely scarred and fibrotic status referred to as "frozen neck" or "vessel-depleted neck" (Figure 1).[1–5,9–11] This situation is reported to occur in 7%-12% of patients receiving microvascular reconstructions.[2,5]

The challenge faced by the reconstructive team in these cases is to find appropriate recipient vessels. Conditions for vessel suitability are: 1) reliable anatomical appearance, length, and caliber (i.e., dynamic and pulsatile inflow, corresponding recipient vein, absence of atherosclerosis or intimal damage, and diameter greater than 2 mm); 2) ease and safety of dissection; 3) position in a nonradiated body part, but remaining within the range of the vascular pedicle length; and 4) matching diameter with the donor pedicle.[1,5,7,9,11–14] The transverse cervical vessels (TCVs) potentially satisfy these criteria and have been proposed as an alternative in vessel-depleted neck patients.[1–3,9,10,14–16] However,

Figure 1. Preoperative "vessel-depleted neck" status that shows heavily scarred neck with exposed osteosynthesis material and bone.

dissection is not devoid of risks, and an inexperienced approach might cause inadvertent injury to adjacent noble structures.[1–3,5,9,16]

We describe our experience using the TCV in secondary head and neck reconstruction in vessel-depleted neck patients and compare these results with secondary reconstructions using external carotid vessels (ECVs).

Patients and methods

We conducted a retrospective single-center chart review of all free flap procedures performed for head and neck reconstructions from 2005 to 2017 (171 procedures). Flaps performed in the context of primary oncological treatment for head and neck cancer were excluded (74 procedures). Only flaps performed in the context of salvage/secondary procedures were taken into consideration (i.e., oncological recurrence, second primary tumor, primary treatment failure, and primary treatment-related complications). Among these flaps, two groups were defined depending on the choice of recipient vessels: TCV versus ipsi/contralateral external carotid vessel branches. Complications documented at 30 days' postoperatively were analyzed. All were grade III Dindo-Claviens (i.e., requiring surgical, endoscopic, or radiological intervention). We distinguished between microsurgical complications needing surgical revision, corresponding to grade IIIb Dindo-Clavien (i.e., intervention under general anesthesia), and "local" complications, corresponding to grade IIIa Dindo-Clavien (i.e., intervention not under general anesthesia).

Our surgical technique was based on Yu's anatomical findings, later also confirmed by Tessler and others.[1–3,9] We approached the TCVs through a separate incision in the supraclavicular region located in the posterior cervical triangle between the dorsal edge of the sternocleidomastoid muscle, the superior edge of the clavicle, and the external jugular vein. After locating and medially retracting the sternocleidomastoid muscle, the omohyoid muscle was identified and the overlying fibrofatty tissue dissected to find the transverse cervical vein (TCV). The transverse cervical artery (TCA) was found deeply, posteriorly, and superiorly to the vein. Care was taken not to push dissection further down toward the clavicle and anterior neck once appropriate vessels' diameter was reached.

Results

A total of 97 flaps corresponding to 89 patients were performed for salvage/secondary procedures. TCVs were first used in 2005 at our institution, and they were selected for use in 14 free-flap procedures (12 patients). ECVs were used in 83 free-flap procedures (77 patients). Both groups had similar demographic (Table 2), highlighting the fragile and undernourished status of these patients and reflecting other comorbidities and systemic diseases as evidenced by the ASA (American Society of Anesthesiologists) score. In addition, most patients were (or had been) smokers, and thus, presented a potential vascular and healing risk factor.

In the TCVs group, patients previously had a free flap reconstruction in 10 of 14 procedures. Indications to use TCVs as recipient vessels included oncological recurrence (7), fistulae (4), stenosis (1), velar incompetence (1), and osteoradionecrosis (1) (Table 2). In the ECVs group, patients had already undergone free flap reconstruction in 18 of 83 procedures. Indications for surgery were oncological recurrence (61), osteonecrosis (9), velar incompetence (5), stenosis (3), chronic wound (2), previous flap necrosis (2), and fistula (1) (Table 2).

The overall complication rate was 21% and 35% in the TCV and ECVs group, respectively (Table 3). Microsurgical complications were only recorded in the ECVs group (10%), which led to complete flap failure in one case (1%). Other types of complications were seroma (7% versus 1%), hematoma (14% versus 6%), and delayed healing (0% versus 14%) in the TCV, and ECVs group, respectively (Table 3). No specific complication related to transverse cervical vessel dissection, such as the phrenic nerve, thoracic duct, or lymphatic trunk injury were observed.

Table 1
TCA position, distance to chosen anatomical landmarks, and pedicle lengths

TCA origin	Distance TCA origin – H&N landmark	Flap pedicle length	TCA diameter	Flap pedicle diameter
33 mm from midline 17 mm above the clavicle (anterior border of SCM) 20 mm above the clavicle (posterior border of SCM) 12 mm posterior to the clavicle	mandibular angle: 10 cm floor of the mouth: 9.2 cm mandibular symphysis: 12.6 cm	ALTf: 8- 13.2 cm RFF: 18.0 cm FF: 5-10 cm	2.2-2.65 [1.3-3.5] mm	ALTf: 2.1 mm RFF: 2 mm FF: 1.5 mm

ALTf, anterolateral thigh flap; FF, fibula flap; RFF, radial forearm flap; SCM, sternocleidomastoid muscle; and TCA, transverse cervical artery

Discussion

In the vessel-depleted neck, gold standard recipient vessels (i.e., ipsilateral ECVs) are no longer available, either because of their involvement in the oncological surgery and/or neck dissection (Table 4) or due to previous irradiation.[2,4,5,13] Alternatives could be contralateral neck vessels or other distant vessels. Drawbacks of such options are a more invasive approach and/or the use of venous interposition graft that might complicate the procedure and increase operating time in these already high-risk fragile patients.[1,2,5] Possible second-line recipient vessels are the superficial temporal vessels, internal mammary vessels, thoraco-acromial, and TCV.[5,10–12,15]

Advantages of the TCVs' topography over the ECVs are their position deep to the clavicle and their longitudinal direction in the neck. These two elements grant a lower exposure to radiotherapy (clavicle's protection) and an ideal alignment for anastomosis thanks to their course, thus lessening the risk of pedicle kinking and conferring an ideal blood flow and pressure.[1–3,12,14,16] Moreover, the TCVs are often outside the previously treated area, unless a very aggressive neck dissection (i.e., also involving zone V) has been performed.[1,3,4,9,10,13,14,16] There is also little anatomical variation of the TCVs as compared to superficial temporal vessels, for example, where the vein might be absent and vessel caliber small.[11]

Previous reports identified the mean distances between the TCA's origin and the mandibular angle (10 cm), the floor of the mouth (9.2 cm), and the mandibular symphysis (12.6 cm).[1,2,9,12,16] As these distances are shorter when compared with the contralateral ECVs and ipsilateral alternatives, and also shorter than the pedicle length of commonly used flaps, the need for an "extra-long" flap pedicle and/or the use of an interposition vein graft is reduced.[1,5,9,12,16,17] Moreover, the similarity of diameter between the TCA and the flap pedicles (Table 1) allows to consider this vessel as a suitable recipient in 96% of patients.[1,9,12]

Preparation of the TCVs also seems to be less traumatic than dissecting the ECVs in highly scarred tissue (e.g., risk of carotid artery rupture) or the internal mammary vessels (e.g., cartilage removal with the risk of pneumothorax, intercostal nerve injury, and chest wall herniation).[2,5,7,11] Despite the precise anatomical landmarks allowing a straightforward and safe approach, exposure of the TCVs is not devoid of risks. An inexperienced extensive dissection might cause inadvertent injury to the phrenic nerve, the thoracic duct on the left side, and/or the right lymphatic trunk as they enter the venous system at the junction of the subclavian and internal jugular veins.[1–3,5,9,16] It is thus suggested to stop dissection once the appropriate vessels' diameter is reached to avoid injuring noble adjacent structures.[1,2,12]

Many reports have also pointed out that the TCA has a much lower affinity for atherosclerotic deposit as compared to the ECVs.[1,9,14] This advantage, combined with the lower exposure to radiotherapy, is of relevance, given that the fibrosis of recipient vessels is the greatest adverse predictive factor as reliability of patency of microvascular anastomoses performed on irradiated vessels decreases in time due to progressive intimal fibrosis.[7,9,10,18]

Since their first use in our institution, we have always found the TCVs in the above-mentioned posterior cervical triangle. We did not experience unsuitable TCVs as reported by Yu (23%) and Tessler

Table 2
Study population characteristics

	TCVs	ECVs
Patients, n°	12	77
Procedures, n°	14	83
Sex ratio (male/female)	8/4	60/17
Mean age (years)	56 [41 – 71]	62 [41 – 87]
Mean BMI (kg/m^2)	21.6 [18.4 – 29]	23 [13 – 33]
Mean ASA score	2.5 [1 – 3]	2.5 [2 – 4]
Smoking, no. of patients	• 5 active smoking • 7 stopped smoking	• 27 active smoking • 34 stopped smoking
Previous treatments		
RCT, no. of procedures (no. of patients)	12 (10)	59 (64)
Free flap, no. of procedures (no. of patients)	10 (9)	18 (15)
Pedicled flap, no. of procedures (no. of patients)	4 (4)	3 (3)
Indication for surgery, no. (%)	• 7 oncological recurrence (42%) • 4 fistulae (33%) • 1 osteoradionecrosis (8%) • 1 velar incompetence (8%) • 1 stenosis (8%)	• 61 oncological recurrence (74%) • 9 osteoradionecrosis (11%) • 3 stenosis (4%) • 5 velar incompetence (5%) • 2 chronic wound (3%) • 2 flap necrosis (2%) • 1 fistula (1%)

ASA, American Society of Anaesthesiologists; BMI, body mass index; ECVs, external carotid vessels; RCT, radio-chemotherapy; and TCVs, transverse cervical vessels

Table 3
Postoperative complications at 30 days

	TCVs	ECVs
Procedures, no.	14	83
Complications, no. (%)		
Overall	3 (21%)	29 (35%)
Microsurgical	0	8 (10%)
Hematoma	2 (14%)	5 (6%)
Seroma	1 (7%)	1 (1%)
Infection	0	3 (4%)
Delayed healing	0	12 (14%)

ECVs, external carotid vessels and TCVs, transverse cervical vessels

(32% unsuitable TCV).[1,2] Both artery and vein were in all our cases free of disease. This finding is in line with Yu's experience, where if the TCA was present, it had no sign of injury.[2]

Despite the external jugular vein being usually larger and close by the TCA, we did not have to choose this alternative venous recipient when the transverse cervical pedicle was chosen: the TCV was of appropriate diameter for anastomosis. In the external carotid system group, the chosen venous recipient was in the decreasing order of frequency of the external jugular vein, the superior thyroid vein, the lingual vein, and the facial vein.

We did not observe any complications due to the dissection of the TCVs. The overall complication rate at 30 days postsurgery was 21% and 35% in the TCVs and ECVs groups, respectively (Table 3). Microsurgical complications (grade IIIb Dindo-Clavien) were only recorded in the ECVs group for a total of eight cases (10%), thus representing the second most frequent complication (Table 3). In one of the eight cases, complete flap failure and removal was necessary. In the seven remaining cases, flaps were saved with only partial tissue necrosis. On the other hand, in the TCVs group, only "minor" complications (i.e., Dindo-Clavien IIIa) were recorded: two hematomas (14%) and one seroma (7%)

Table 4
Neck dissection levels and vascular involvement

Level		Sacrificed blood vessel
I	Submandibular and submental	• Lingual pedicle
II	Superior spinal accessory, superior jugular, and jugulo-epigastric	• Lingual pedicle • Facial pedicle
III	Mid-jugular	• Superior thyroid pedicle
IV	Jugulo-omohyoid and inferior jugular	• Inferior thyroid pedicle
V	Inferior spinal accessory and transverse cervical	• Transverse cervical vessels

(Table 3). We consider these to be linked to heavily scarred tissues and surgical dissection during recipient vessel preparation. Nevertheless, despite a more fibrotic local situation in transverse cervical vessel patients, no microsurgical complications were recorded.

A limitation of our study is the small size of the transverse cervical vessel patient population. Although a statistical analysis was not possible, a trend showing the absence of microvascular complications probably reflects the better quality of these vessels as located outside of the field of previous treatment. These findings still suggest the safe use of TCV in complex salvage/secondary procedures in vessel-depleted necks. They may even suggest that TCV could be a better alternative than remaining ECVs in the case of secondary procedures, but this assessment needs further studies with a larger number of patients to confirm this hypothesis.

Conclusions

Our complication rate using TCV is lower than when using ECVs, despite the fact that the former patients presented a higher degree of neck fibrosis and a less common area of dissection. No microsurgical or recipient vessel preparation adverse outcome was observed using the TCV and all our microsurgical reconstructions were successful as compared to the external carotid vessel group.

Compared to other options, the TCVs seem to satisfy all criteria for suitable recipient site. Their major advantages are the anatomical position outside the previous surgical and radiation zone, the lower affinity for atherosclerotic damage, and the similar diameter to the pedicles of the most commonly used flaps. A good knowledge of anatomical landmarks can avoid extensive dissection and the risk of causing damage to the adjacent noble structures, thus making the choice of TCV as recipient vessels a reliable and safe choice.

Ethical Approval

Not required.

Funding

None.

Declaration of Competing Interest

None.

Acknowledgments

The authors would like to thank Ms. Sudan Rosemary for her writing assistance.

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