ÖZGÜN ARAŞTIRMA ORIGINAL RESEARCH

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THE USE OF THORACOACROMIAL ARTERIAL TRUNK AND CEPHALIC VEIN SYSTEM WITH DIFFERENT MODALITIES INCLUDING CHIMERIZATION OF FREE FLAP IN DIFFICULT SITUATIONS AS THE RECIPIENT VESSELS

ZOR DURUMLARDA ALICI DAMAR OLARAK SERBEST FLEP KİMERİZASYONUNU İÇEREN FARKLI MODALİTELERLE BİRLİKTE TORAKOAKROMİAL ARTERYEL GÖVDE VE SEFALİK VEN SİSTEMİNİN KULLANIMI

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Öz

Amaç
Baş-boyun, kol ve gövdeye konforlu ve güvenilir olarak serbest flep transferi için, bu bölgelerin ana alıcı damarlarının önceki cerrahi, radyoterapi veya travma sonucu elverişsiz olmaları durumunda, cerrahlara Torakoakromial arter gövdesi ve Sefalik venin (TAT-CV) varlığını hatırlatmayı amaçladık.

Gereç ve Yöntem
Baş-boyun veya üst ekstremitede tümör veya travmayı içeren, bu vasküler sistemin farklı modalitelerle kullanılarak serbest doku transferi ile tedavi edilen 8 hasta retrospektif olarak incelendi.

Bulgular
Bu vasküler sistem bütün vakalarda güvenilir olduğunu kanıtladı. Pektoral flep ile kimerizasyonu mümkün kıldı. Baş-boyun rekonstrüksiyonu için 6 hastada ve 2 üst ekstremite restorasyonunda kullanıldı. Anastomozların TAT-CV bölgesine taşınması ve CV transpozisyonu, dolaşım sorunu olan flebi kurtarmak için oldukça hızlı ve güvenilir yöntemler olarak bulundu.

Sonuç
Birçok rekonstrüktif cerrah tarafından anatomik olarak iyi bilinmesine rağmen, diseksiyonunun kolaylığı, tutarlılığı, farklı çaplı dallarının sağladığı kanlanma ve stratejik lokasyonu yeterince rağbet görmemektedir. Ayrıca pektoralis majör flep transferi sırasında ek doku gereksinimi olduğunda, bu vasküler sistem alıcı olarak orada hazır bulunmaktadır.

Anahtar Kelimeler: Sefalik ven; serbest flep; Torakoakromial arter

Abstract

Objective
We aimed to remind surgeons of the presence of the thoracoacromial arterial trunk and cephalic vein (TAT-CV) for a comfortable and reliable free flap transfer to the head, arm, and trunk, in case the mainstream

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recipient vessels of these regions pose some inconveniences due to previous surgery, radiotherapy, or trauma.

Material and Methods
Eight cases of trauma or tumor involving the head and neck or upper extremity, treated with free tissue transfer in which this vascular system was used with different modalities, were reviewed retrospectively.

Results
This vascular system proved to be reliable in all cases. It enabled chimerization with the pectoral flap. It was used in six patients for head and neck reconstructions and in two upper extremity restrorations. Switching the anastomoses to TAT-CV site and cephalic vein transposition were found to be rapid and reliable methods to rescue a flap with compromised circulation.

Discussion
Although anatomically well known by many reconstructive surgeons, its ease of dissection, consistency, supply of branches of differing caliber, and strategic location is not adequately appreciated. Moreover, in cases of pectoralis major flap transfer in which additional tissue is required, this vascular system is already there to receive it.

Keywords: Cephalic vein; free flap; thoracoacromial artery.

Introduction

The neck is a rich source of recipient vessels in free tissue head and neck reconstruction. Though, scarring due to previous neck dissections and radiotherapy, absence of the external jugular vein, and proximally tied external artery branches make recipient vessel exploration a challenging task in recurring cases (1). Moreover, radiation injury is known to impair the patency of anastomoses (2,3,4). In a systematic review performed on head and neck cancers, preoperative radiotherapy was found to be associated with an increased risk of free flap failure (5). Regardless of what is known about the status of the neck vessels, the skeletonized and scarred appearance of the neck may foreshadow a blind dissection, where cleavage between tissue planes has been lost. To overcome this obstacle, a suitable recipient vessel around the cervical region is not infrequently sought (6,7). A similar situation may be faced in breast reconstruction, in which both the axillary and internal mammary vessels may be impaired due to lymph node dissection, radiotherapy, or coronary bypass surgery (8). Another source of difficulty in finding a recipient vessel around the axilla is extensive vascular injuries leading to graft interpositions that bypass major axillary artery branches.

The thoracoacromial trunk and cephalic vein (TAT-CV) are found where the lateral border of the pectoralis major muscle meets with the clavicle (Figure 1). This location can serve as a reminder of different reconstructive regions, including head and neck, upper arm, and thorax-breast sites. While TAT-CV can successfully relieve the anxiety of finding a suitable recipient vessel in some challenging cases, it tends to be ignored among usual treatment options. In the Shanghai experience of 4640 flaps for head and neck cancer, 8% of patients received radiotherapy. Although the relationship between vascular problems and preoperative radiotherapy was not addressed, vascular problems, salvaged or failed, were around 5%. A recipient vessel originating out of neck was not reported in any of these cases (9). In the present study, over the last ten years, TAT-CV was the first choice recipient site in six cases. In two other cases, surgeons rushed to this site upon circulatory failure to rescue the flaps in an urgent manner. We aimed that these vesssels will more readily be acknowledged as options in the recipient vessel selection process with different using modalities.

Materials and Methods

Eight free tissue transfers performed on the head and neck and upper extremity using TAT-CV were retrospectively reviewed. They are displayed in Table 1. This study was conducted with approval of Süleyman Demirel University Faculty of Medicine Clinical Research Ethic Commitee (Date:16.04.2020, No:113). The rules of research and publication ethics were followed in accordance with the Declaration of Helsinki. The patient age range was 18–69 years, and all were male. The follow-up period ranged from 3 months to 4 years. Four of the patients were operated due to head and neck cancers. The other patients had the extensive tissue defects because of high energy traumas with gunshot and vehicle accident.

Anatomy and Surgical Technique

TAT stems from the second part of the axillary artery. It is a relatively short branch that soon divides into its

Table 1 Demographic information of patients. Diagnoses, defect sites, flap choices, radiotherapy, and recipient vessels were reviewed.

Patients		Diagnosis	Radiation Therapy	Flap	Recipient artery/Vein
No	Age				
1	69	Larynx CA / Tracheoesophagocutaneous fistula	Yes	Groin	Deltoid branch of TAT / CoV
2	47	Larynx CA / Pharyngoesophagocutaneousfistula	Yes	Latissimus Dorsi MC	Deltoid branch of TAT / CV
3	47	Recurring larynx and floor of the mouth SCC / Pharyngoesophagocutaneous fistula	Yes	Latissimus Dorsi MC	Deltoid branch of TAT / CV
4	54	Recurring oral SCC involving also skin	Yes	DIEP Chimerized with Pectoral	Deltoid branch (for free flap) and pectoral branch of TAT / CV
5	33	Gunshot. Bone and soft tissue loss. Vascular injury of hemifacial with mandibular defect.	No	Iliac Bone	Deltoid branch of TAT only with vein graft (CV)
6	36	Gunshot. Bone, soft tissue and skin loss.	No	Iliac Bone	CV transposition Only
7	18	Traumatic Arm Amputation / Elbow and Wrist Active Motion Deficit in Replanted Arm	No	Functional Gracilis Muscle	Acromial branch of TAT / CoV
8	34	Gunshot Wound of Axilla / Axillar Artery and Brachial Plexus repairs with artificial vascular graft and sural nerve grafts.	No	Groin	Deltoid branch of TAT / CoV

TAT: Thoracoacromial trunk, CV: Cephalic vein, CoV: Comitant vein of TAT, MC: Musculocutaneous.

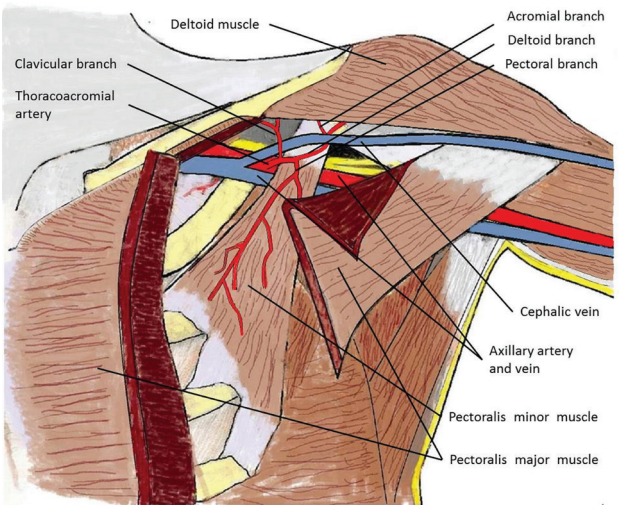

Figure 1
Anatomic illustration of the thoracoacromial trunk and cephalic vein (TAT-CV) vascular system and relationship with other structures.

own branches. It arises behind the pectoralis minor, traversing its medial border to pierce the clavipectoral fascia, and dividing into its branches. The CV is one of the main superficial veins of the upper extremity, running from the hand to the shoulder, along the outer edge of the biceps muscle. It passes between the deltoid and pectoralis major muscles, known as the deltopectoral groove, and through the deltopectoral triangle, emptying into the axillary vein (10).

For TAT-CV dissection as recipient vessels, a horizontal, curved incision 10–15 cm in length is planned just under the clavicle starting from the midclavicular point and extending through the deltopectoral groove toward the arm. Firstly, the CV is found in the deltopectoral groove under the fascia between the deltoid and the pectoral muscles. Vein dissection is continued proximally, and the deltoid branch of TAT is found medially with respect to the CV (Figure 1). The pectoral muscle is divided from the clavicle laterally, and then the deltoid branch is followed

proximally toward the root of TAT, also revealing the pectoral and acromioclavicular branches. One of the TAT branches is used as a recipient artery. If the concomitant vein is not appropriate, the CV is used as the recipient vein.

When only the CV of TAT-CV is needed, the dissection begun in the deltopectoral groove is pursued distally all the way down the arm and forearm, if required. It is subcutaneously passed to the anastomosis site. When a chimerization to the pectoral flap is required, the deltoid branch and CV in an appropriate length are comfortably chosen as recipient vessels.

Results

Laryngeal carcinoma was the primary pathology in three cases. These patients (Numbers 1, 2, and 3) had pharyngoesophagocutaneous or tracheoesophagocutaneous fistulas. Two of them had been wearing the Blom-Singer device. These fistulas were reconstructed with free latissimus dorsi musculocutaneous and free groin flaps (Figure 2). One patient had a recurrent tumor in the floor of the mouth and the neck after bilateral neck dissection and radiotherapy to the neck. The tumor was excised extensively, leaving only the common and internal carotid arteries bilaterally. The large pharyngeal defect was reconstructed with the free latissimus dorsi musculocutaneous flap (Figure 3).

In Patient 4, a recurring oral squamous cell carcinoma (SCC) involving the mental and upper cervical skin, mouth floor, and mandibular body, after bilateral neck dissections and adjoining radiotherapy, underwent an extensive excision including wide skin, subtotal mandible, lower lip, and floor of mouth. A reconstruction plate was preferred temporarily for the mandibular defect. The defect of the oral side was closed with a pedicled pectoral skin flap. The deltoid branch of the thoracoacromial artery (TA) and the cephalic vein (CV) was reserved during pectoral flap elevation for chimerization of a deep inferior epigastric artery (DIEP) skin flap (Figures 4 and 5).

Two were gunshot injuries involving the mandible and the overlying soft tissue (Patients 5 and 6). These were reconstructed using a free iliac bone flap. In both cases, the free tissue transfers were anastomosed to the neck vessels and circulatory failures occurred in the first 24 hours. In one of these cases, the external carotid artery itself was the recipient vessel, because heavily scarred tissue precluded the use of its branches. The external carotid artery was found to be trombosed and the anastomoses were switched to the deltoid branch of TAT and CV was used as a vein graft. In the other case, a long CV segment distally from the midarm was transposed to the anastomosis site instead of dissecting out a contralateral vein and interposing a vein graft in between (Figure 6).

In Case 7, which was an upper extremity amputation at an axillary artery level, accompanied by a mixture of supraclavicular and infraclavicular brachial plexus injuries, was treated with nerve allotransplantation and short-term (2 years) immunosuppression for protective sensation in the hand. Free functional gracilis muscle transfer was performed to provide elbow flexion and wrist extension. TAT and concomitant vein were used as recipient vessels. Motor supply was obtained from the accessory nerve.

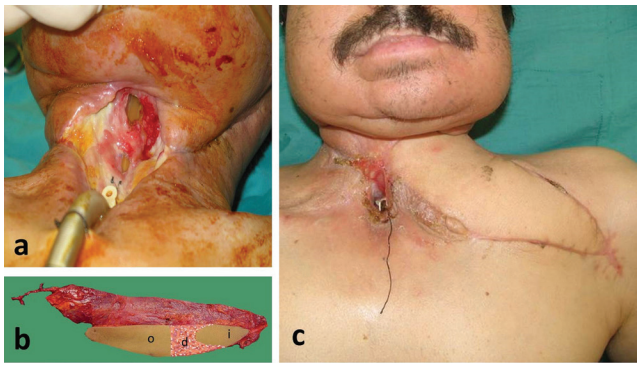

Figure 2
Case 2 had a pharyngoesophagocutaneous fistula (a). The latissimus dorsi musculocutaneous flap was planned in two layers as an inner and outer and desepithelized between both layers (b). Postoperative view after three months (c).

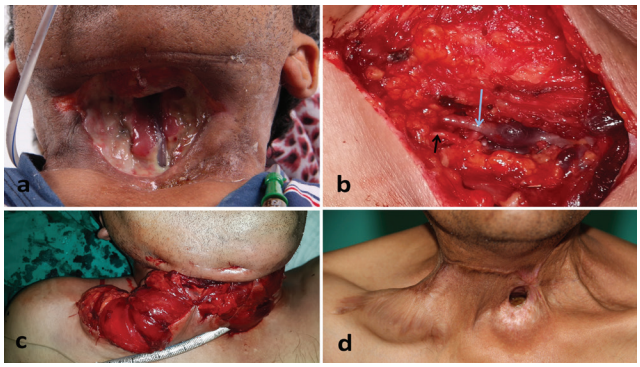

Figure 3
Recurrence of squamous cell carcinoma (SCC) and wide pharyngoesophago-cutaneous fistula with irradiated and scarred neck is seen in Case 3 (a). After excision of SCC (b). The deltoid branch of TAT and CV were used as recipient vessels (c). The defect was covered with a skin island of latissimus dorsi musculocutaneous flap. Postoperative view at the first year (d).

Case 8 was a shotgun injury in the axillary region accompanied by significant axillary skin loss, medial and posterior cord defects with ulnar and radial nerve impairments, and axillary artery injury. The cord and axillary artery injuries were repaired by interposing the sural nerve and artificial vessel grafts, respectively, and a free groin flap was utilized to cover the axillary skin defect (Figure 7). Here, the anastomoses were between the superficial circumflex iliac artery (SCIA) and the deltoid branch of TAT and between the concomitant vein of SCIA and CV.

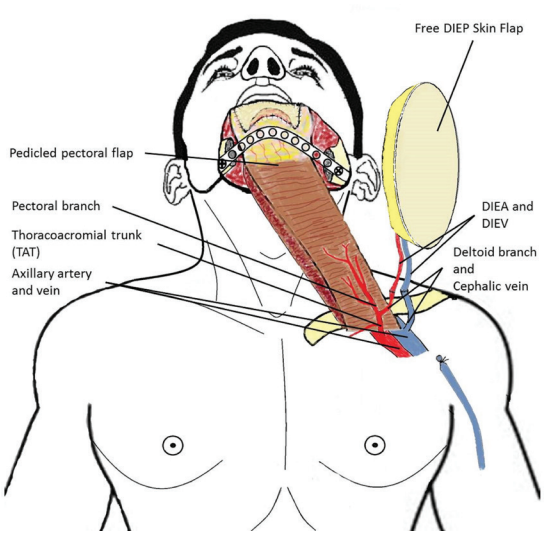

Figure 4
Schematic illustration of chimerization of a free flap with pedicled pectoral flap at the TAT-CV recipient site. While the pectoral branch of TAT supplies the pectoral flap, deltoid branch of TAT and CV are utilized as a recipient vessels for free flap.

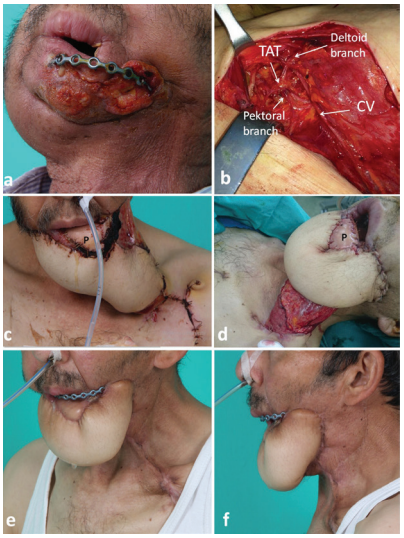

Figure 5
Case 4: Recurrence of oral SCC and hardware exposition with irradiated head and neck (a). After excision of the tumor, the defect of the oral side was closed with a pedicled pectoral skin flap. The deltoid branch of TA and CV were reserved (b) during pectoral flap elevation for chimerization of a DIEP skin flap. Early postoperative(c) and after first revision views (d). Six months later (e,f). (P: pectoral flap).

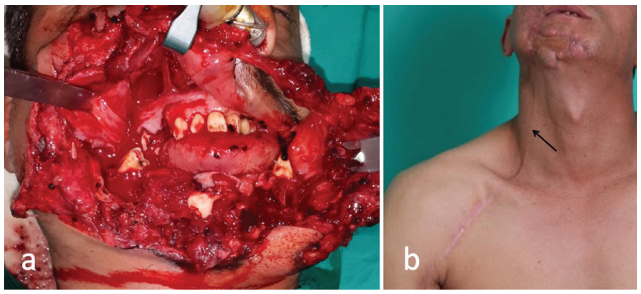

Figure 6
Case 6 was injured with a gunshot and had a mandible defect involving the body (a). The mandible defect was reconstructed with a free iliac bone flap. The free tissue transfer was anastomosed to the neck vessels and the vein anastomosis was switched to the CV in the first 24 hours due to venous circulatory problems. The CV can be traced (arrow) in the neck at the postoperative sixth month (b).

Figure 7
A shotgun injury was accompanied by large axillary skin loss, medial and posterior cord defects, with affected ulnar and radial nerves, and axillary artery injury in Case 8 (a). Cords and axillary artery injuries were repaired by interposing the sural nerve(arrow) and artificial vessel grafts(*) (b). Free groin flap was utilized to cover the axillary skin defect. Postoperative view at sixth month (c).

Discussion

All reconstructive surgeons are already familiar with the TAT-CV vascular complex. It is considered one of the second choice recipient vessels besides the circumflex scapular and lateral thoracic vessels (11) in head and neck, upper extremity, and thorax-breast reconstructions. This should not mean that it is only after first choice vessels are deemed useless that they can be used. The more this vascular site is recognized, the more it may be utilized when questions arise about the safety of dissection and anastomosis at the primary recipient sites (Figure 8). There is scarce literature describing the versatility of TAT–CV as recipient vessels (10-17). More reports that underline ease of dissection, supine patient positioning, consistent anatomy, an array of branches of different calibers, concomitant or CV alternatives, and strategic location, are needed to increase awareness about this site. Especially in emergency situations, as in the presence of circulatory problems, this site should be recalled as a fast and reliable lifeboat to rescue the flap. In particular, venous obstruction rapidly causes deterioration of flaps. If a vein graft is required, the CV would not be the first candidate because it results in a conspicuous scar in the donor area. However, CV transposition is again an unrivaled lifeboat in terms of speed and reliability (18).

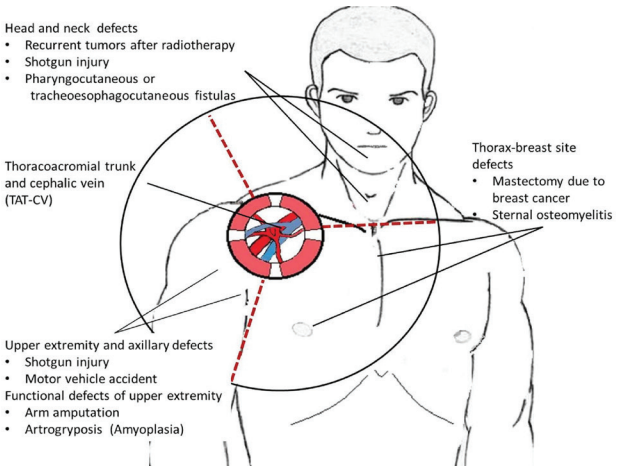

Figure 8
Indications to use the TAT-CV vascular system in three different regions as a lifeboat.

Vascular damage is considered to be the primary cause of radiofibrosis (19). Russell et al. studied radiation effects on vessels (20). Changes including intimal thickening, proteoglycan deposition, and inflammatory cell infiltrate that are consistent with early stages of atherosclerosis were observed in the tissue samples obtained from recipient arteries within a few years after irradiation. In another study, arterial thrombosis and flap failure complications were reported at rates of 50% and 25%, respectively, in microvascular reconstructions after chemoradiation therapy (21).

Other than recurrence, principal indications for secondary surgery in head and neck cancers have been fistulas, osteoradionecrosis of the mandible, and exposed carotid vessels (10,12,13). The repair of oropharyngeal, tracheal, and esophageal fistulas generally requires a vascularized tissue transferred from a distant site due to the unreliability of nearby tissues, and finding a suitable recipient vessel is usually one of the main challenges faced in these cases.

The pectoralis major has been the workhorse in many head and neck reconstructions since it was described by Ariyan in 1979 (22). A free flap in addition to the pectoralis major may be required. The vascular pedicle of the pectoralis major is easily dissected in order to use TAT-CV as the recipient vessels of the free flap. In one case in this report, the deltoid branch and CV were the recipient vessels in this chimeric design. The deltoid branch is usually the most preferred branch for anastomosis because of its long and straight orientation, and its satisfactory caliber. The pectoral branch must be left intact in all cases of TAT-CV dissection, in case the pectoral flap is required. Harris et al. successfully preserved the pectoral branch and later used the pectoralis muscle in one patient (10).

The branches arising from the third part of the axillary artery (distal to the pectoralis minor tendon) are usually utilized as recipient vessels in upper arm reconstructions. These vessels, exposed through armpit skin, are generally bypassed by the grafts used in repairs. In these circumstances, TAT-CV is found to be a suitable recipient vessel option. In the upper extremity, TAT-CV has previously been used for functional muscle transfer for elbow flexion in patients with amyoplasia (14).

In patients with sternoclavicular joint problems with pain, vascularized second toe metatarsal joint was transferred and vascular anastomoses were performed to branches of TAT (15). Kompatscher et al. studied TAT in cadaveric dissections and ultrasonographically in young female volunteers. They found the pectoral branches of the TA vessels were well-suited, with appropriate vessel size and length, to be recipient vessels for free autogenous breast reconstruction. They used pectoral branches of TAT in two breast reconstructions with DIEP flap (16). They suggested this option as a valuable addendum to the

thoracodorsal and internal mammary vessels.

The internal mammary artery and vein have also been suggested as alternative recipient vessels for a microvascular anastomosis in a vessel-depleted neck (23). TAT-CV would be unarguably more favorable when the distance, difficult dissection, complication risk, and delicate vein in the internal mammarian site is considered. In breast reconstruction, TAT-CV should always be in mind as a second choice recipient site when axillary and internal mammarian sites pose challenges and inconveniences.

In conclusion, TAT-CV dissection is easy and quick. The anatomy is very consistent, with branches of different calibers. The proximity of the CV provides an opportunity for a long venous recipient. TAT-CV is known by many surgeons, but not appreciated enough as a recipient site. TAT-CV can be utilized on the same side with a pectoral flap prior to it, or at the same session, and does not obviate the use of a future pectoral flap as long as the pectoral branch is respected.

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