# SELECTION OF RECIPIENT VESSELS IN MICROSURGICAL FREE TISSUE RECONSTRUCTION OF HEAD AND NECK DEFECTS

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The development of microsurgical techniques has facilitated proper management of extensive head and neck defects and deformities. Bone or soft tissue can be selected to permit reconstruction with functional and aesthetic results. However, for free tissue transfer to be successful, proper selection of receipient vessels is as essential as the many other factors that affect the final result. In this article selection strategies for recipient vessels for osteocutaneous free flaps, soft tissue free flaps, previously dissected and irradiated areas, recurrent and subsequent secondary reconstructions, simultaneous double free flap transfers in reconstruction of extensive composite head and neck defects, and the selection of recipient veins are reviewed in order to provide an algorithm for the selection of recipient vessels for head and neck reconstruction. © 2007 Wiley-Liss, Inc. Microsurgery 27:588–594, 2007.

Extensive head and neck defects are most often the result of surgical treatment of T3 and T4 tumors. Satisfactory outcomes of reconstructive surgery in terms of function and esthetics continue to challenge reconstructive surgeons. If these composite defects are inadequately reconstructed, in addition to the undesired esthetic appearance, the patient may subsequently have difficulties in eating, speaking, breathing, and retaining saliva.[1]

The development of microsurgical techniques has facilitated proper management of extensive head and neck defects and deformities. Bone or soft tissue can be selected to permit reconstruction with functional and esthetic results superior to those of many of the local and pedicled flap options.[2] However, for free tissue transfer to be successful, proper selection of recipient vessels is as essential as many other factors that affect the final result.[3–8]

The head and neck region has an extensive bilateral vascular network, which when selected using the appropriate strategy is readily accessible[8,9] for single free flap transfer in primary carcinoma patients, for subsequent free tissue transfer in recurrent patients or patients with complications, and even for simultaneous double free flap transfers. The two major sources of recipient arteries in the head and neck are the branches of the external carotid system; superior thyroid artery, facial artery, occipital artery, posterior auricular artery, superficial temporal artery, and maxillar artery, and the branches of the thyrocervical trunk; inferior thyroid artery, suprascapularis artery, transverse cervical artery, and dorsalis scapular artery.[10] However, the usual preferred bilateral four pairs neck and temporal recipient vessels are[1]; superficial temporal vessels,[2] facial vessels,[3] superior thyroid vessels, and[4] transverse cervical vessels.[3] These vessels are illustrated in Figure 1.

In this article, selection strategies for recipient vessels for osteocutaneous free flaps, soft tissue free flaps, previously dissected and irradiated areas, recurrent and subsequent secondary reconstructions, simultaneous double free flap transfers in reconstruction of extensive composite head and neck defects, and the selection of recipient veins are reviewed to provide an algorithm for the selection of recipient vessels for head and neck reconstruction.

## Recipient Vessel for Osteocutaneous Free Flap

Several osseous flaps offer options for the repair of extensive composite bone defects of the head and neck including the rib, scapula, radius, iliac crest, and most recently, the fibula.[11–16] The fibula osteoseptocutaneous free flap has been widely used for reconstruction of segmental oromandibular defects because of its long, dense, straight cortical bone, and a reliable skin flap for simultaneous soft tissue reconstruction for defects that are either intraoral, extraoral, or both intra and extraoral, and postoperative monitoring.[17,18] Although it has a longer pedicle than other osteocutaneous flaps, and additionally the pedicle can be lengthened by designing the required bone graft distally on the fibula with the proximal bone removed subperiosteally, the pedicle length still has its limitations. The pedicle length of this flap also depends on the bone lengths needed to repair the defect. The pedicle may not be sufficient in length when longer segments are needed, but for shorter segments the pedicle may suffice.

The osteocutaneous flaps generally require shaping and stable placement into the deep plan of the composite head and neck defects, therefore the flap pedicle positioning is less flexible. For these reasons, the recipient vessels should be selected either for their proximity to the defect or for their more suitable length and diameter with respect to the pedicle. For composite defects located on

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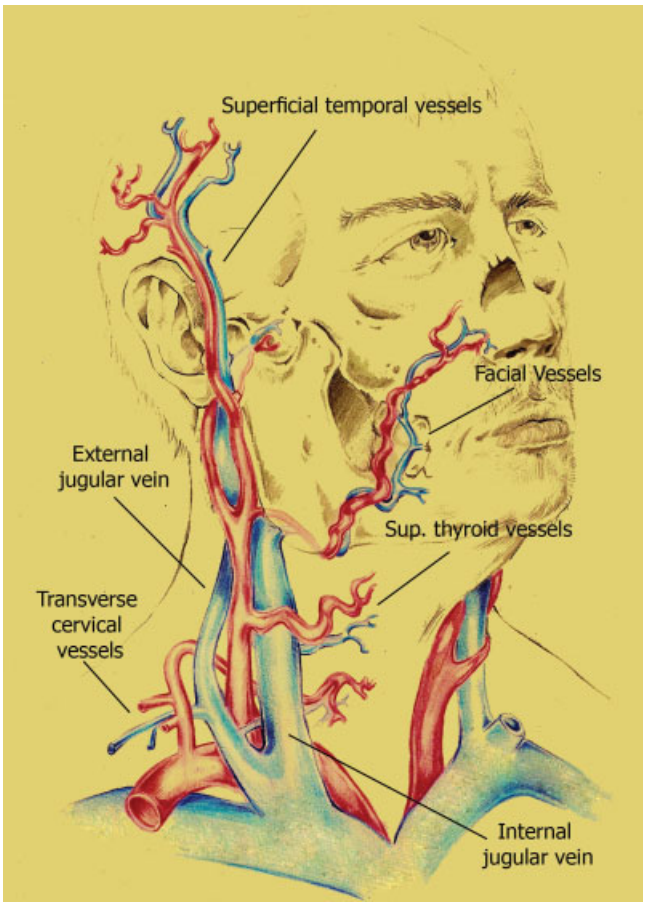


*Figure 1. The usual preferred bilateral four pair neck and temporal recipient vessels. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]*

the upper third of the face, or the skull the first choice for a recipient vessel is the ipsilateral superficial temporal vessels and the second one is the ipsilateral facial vessel. For composite defects located mid-face, selection of recipient vessels depends on the three-dimensionality of the defect, inset direction of the bone flap, and the length of the flap pedicle. For example, when the patient requires only alveolar ridge reconstruction the needed bone segment will be short and thus, the length of the pedicle should be sufficient to reach the neck recipient vessels (see Fig. 2). The closest ipsilateral facial vessels are usually the first choice, followed by the superior thyroid vessels. When the patient requires alveolar ridge and infraorbital bone reconstruction, the required bone length is longer than the length of the pedicle and less flexible therefore, the geometrical configuration of the pedicle becomes more difficult. In such defects, the osteotomised distal fibular bone segment may be inset at the infraorbital defect and the second proximal bone segment inset at the alveolar ridge so the direction and the location of the pedicle should be close to either the ipsilateral facial vessels or to the superficial temporal vessels.

Although, the recipient vessel alternatives are limited in upper third and middle face defects, there are more choices for recipient vessels in defects located in the oromandibular, or neck area. The first choice recipient artery is usually the ipsilateral facial artery, and the superior thyroid artery is usually preferred second (see Fig. 3). However, when the first and second choice vessels are not available, the contralateral facial vessels are the next alternative as they are located near the mid-line of the neck. The submandibular gland can be removed to increase the length of the recipient vessels.[5] For more centrally located defects, or for those with extended pedicles, the contralateral superior thyroid artery is another alternative.

## Recipient Vessels for Soft Tissue Flap

Although the recipient vessel selection strategy for soft tissue flaps is similar to that of the osteocutaneous flaps, the soft-tissue free flaps have some advantages. The anterolateral thigh, radial forearm, and rectus abdominis flaps are the most frequently used flaps for intraoral lining, external surface coverage, and soft tissue reconstruction. These flaps provide consistent, vascular pedicles with adequate length and diameter.[3,4,6,7,19] As soft-tissue defects are usually superficial, the direction and pedicle of these flaps can more easily be changed during inset so as to reach the vessels more easily (see Fig. 4). For these reasons, the recipient vessel alternatives for the soft-tissue free flaps are greater and if needed, the distant located recipient vessels could also be accessed. Therefore, for oromandibular defects the more distant ipsilateral transverse cervical vessels or even the contralateral recipient vessels are acceptable first choice recipient vessels.

## Recipient Vessel in Previously Dissected and Irradiated Areas

A history of previous surgery and/or radiotherapy to the head and neck did not prevent ipsilateral vessel exploration and successful anastomosis.[4,5,7,9,20,21] In previously irradiated necks the recipient vessel identification and dissection was a rather tedious procedure but it is not as difficult as was once imagined. It does however require more delicate dissection and in some cases must be performed using a surgical microscope. In patients who had previously undergone surgery and/or radiotherapy a spurt test from the recipient artery prior to anastomosis can ensure adequate blood flow.[3,5] If a neck dissection has been carried out on the ipsilateral side or a dense scar has resulted due to previous extensive surgery or radiotherapy, the ipsilateral superficial temporal vessels or transverse cervical vessels can be evaluated and considered first before exploring the possibility of using a recip-

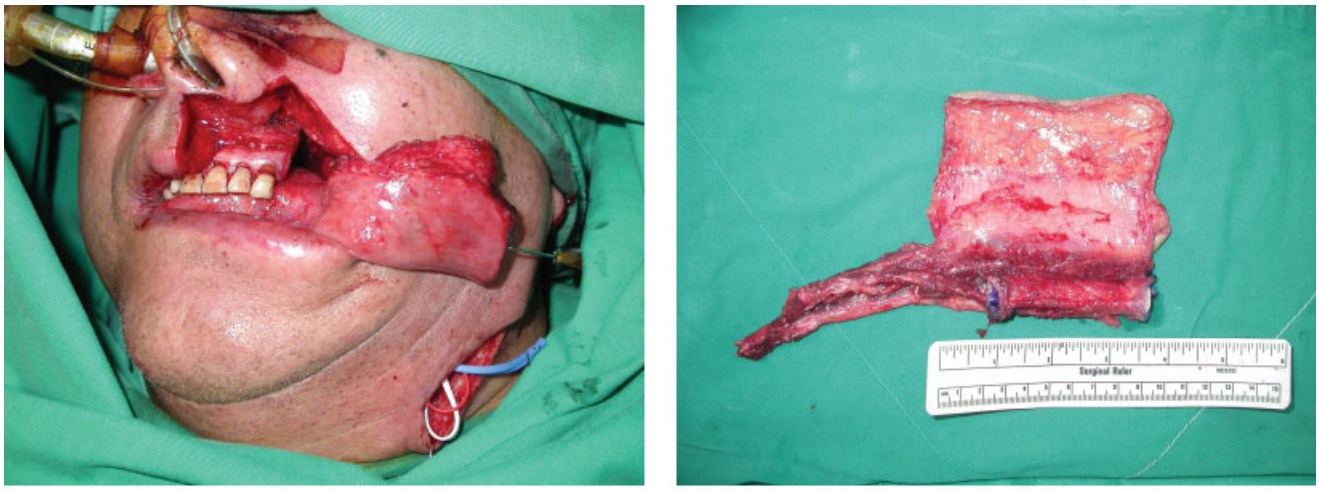


*Figure 2. (**A**) Composite maxillary defect after tumor ablation surgery. (**B**) The fibula osteoseptocutaneous flap was used for reconstruction. The anastomosis was performed between the pedicle of the flap and the left facial artery and the branch of the internal jugular vein. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]*

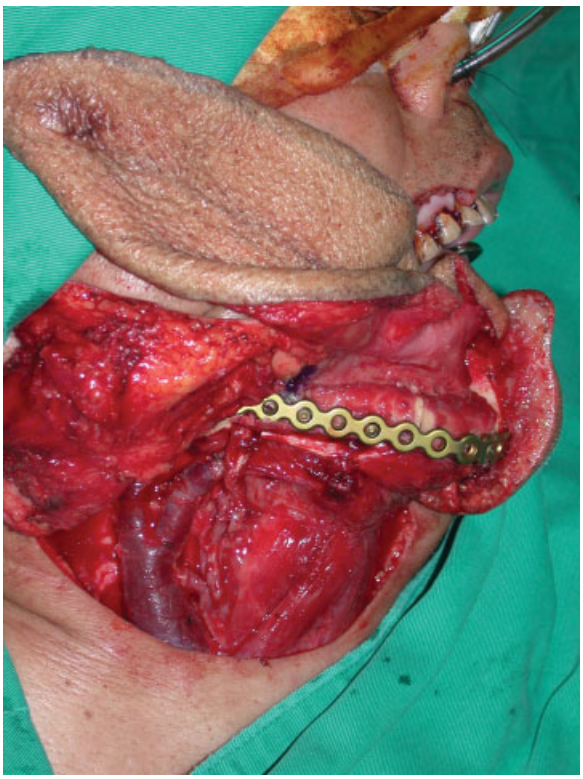

*Figure 3. Inset of osteotomized fibula osteoseptocutaneous flap for oromandibular defect reconstructions. The ipsilateral facial and superior thyroid vessels are available for anastomosis. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]*

ient vessel from the contralateral neck because these ipsilateral recipient vessels are usually not injured in previous dissections. However, by choosing flaps with longer pedicles and arranging them carefully at the time of inset, a pair of recipient vessels could easily be located without interpositional vein grafts on the ipsilateral side.

### Recipient Vessel for Recurrence and Subsequent Secondary Reconstructions

Secondary free flap reconstructions may be needed after initial free flap transfers for a number of reasons including; failed flaps, local recurrence, second primary cancer, trismus release, or osteoradionecrosis. Arterial and/or venous thromboses are the most common reasons for early stage free flap failures. These patients usually require reexploration and revision of anastomosis for flap salvage or early secondary free flap transfers for reconstruction of the remaining defect. For revision of anastomosis or second free flap transfers the primary recipient vessels used should first be examined and evaluated with regards to suitability for secondary usage. If the blood flow of the used recipient vessels is inadequate or unavailable for secondary anastomosis, the second choice for recipient vessels should be those located close to the primary anastomosis or they should be on the ipsilateral side. In this way the need for vein grafts can be minimized or avoided. New recipient vessels from the contralateral neck should only be considered as a last option.

As reoccurrences usually occur at the margin of the previous free flap, with each resection the defect shifts somewhat either laterally or medially making the approach to new recipient vessels easier.[5,9] However, during the transfer of the second free flap the ipsilateral superficial temporal vessels or transverse cervical vessels, and the contralateral facial vessels are the most frequently selected recipient vessels for micro-vascular anas-

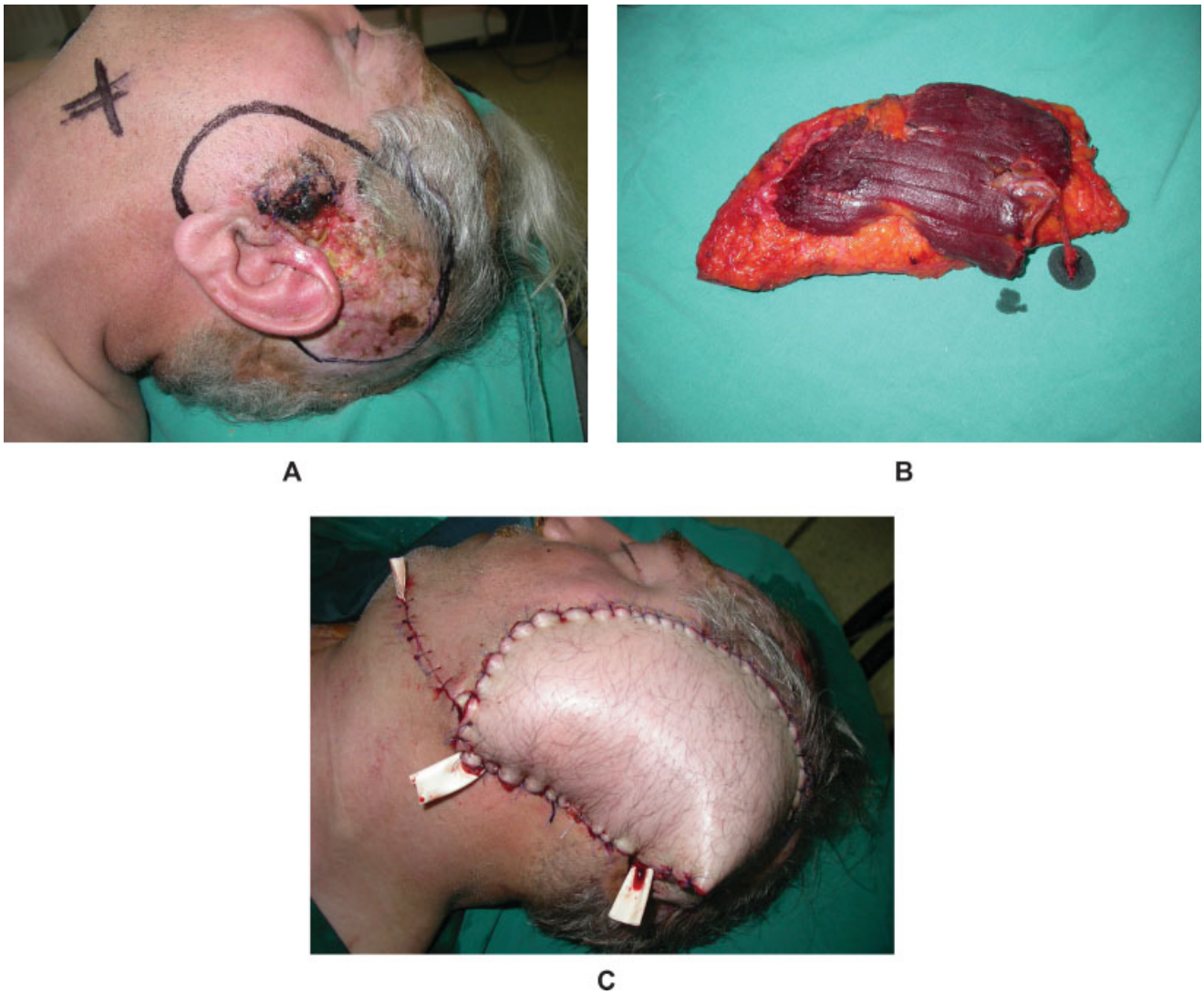


*Figure 4. (**A**) Recurrent squamous cell carcinoma on temporal region. (**B**) The defect was reconstructed with rectus abdominis flap. (**C**) The ipsilateral facial vessels are used for anastomosis. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]*

tomosis. The superficial temporal and transverse cervical vessels are valuable options as they are usually not injured in previous surgery and dissection. For more centrally located defects the contralateral superior thyroid artery may be an alternative choice.[3,5,9]

Several salvaging techniques have been described for micro-vascular access in the head and neck region including; Corlett arteriovenous loop,[22] cephalic vein transposition,[23] thoracodorsal transposition,[20] and use of the pedicle of the previous free flap.[24] However, the need for vein grafts or salvage techniques for micro-vascular access in the head and neck region can be minimized or avoided if a positive strategy is employed in recipient vessel selection, there is sufficient knowledge of suitable flaps with longer pedicles, and proper flap inset procedures in patients who had challenging head and neck defects or deformities. The anterolateral thigh, radial forearm, and fibula flaps are the workhorse flaps in the head and neck, which have contributed to this because of adequate vascular pedicles length and diameter.

## Recipient Vessel for Simultaneous Double Free Flap Transfers

Simultaneous use of two free flaps may arguably involve some technical difficulties. One of these is finding two adequate pairs of recipient vessels, and performing two pairs of anastomosis especially in patients who have had previous surgery and/or radiation. At the earlier

stage of development the sequentially linked flaps (distal run-off free flaps) were considered as a solution for simultaneous double free flap transfers. However, this was a complicated technique. In previous reports, this type of flap connection has resulted in increased partial or total flap loss.[4,25,26] This more than likely stems from the inadequate control and protection of the intermediary pedicle during insetting.[25] The other speculated cause is the distant effects of the proximal anastomosis on the thrombogenicity of the second anastomoses.[26–28] Hemodynamically a steal phenomenon might also play a role in impeding the perfusion of the distal pair.[4] Recently, when possible, sequentially linked flaps have not been preferred for double free flap transfers, due to a higher rate of complications.[3,4,29]

For the simultaneous microvascular anastomosis, five types of recipient vessels can be used: (1) Two separate pairs of ipsilateral neck or temporal vessels. (2) One ipsilateral and one contralateral pair of neck or temporal vessels. (3) One pair of ipsilateral neck or temporal vessels and the distal run-off of the first free flap vessels. (4) One pair of contralateral neck vessels and distal run-off of the first free flap vessels. (5) Two separate pairs of contralateral neck or temporal vessels.

In one study 130 complicated head and neck composite defects were reconstructed with 262 simultaneous double free flap transfers.[3] In this wide and varied sample for simultaneous double flap reconstruction 208 ipsilateral vessels (83.9%), and 40 contralateral vessels (16.1%) were used as recipient vessels.[3] Only four patients had one pair of contralateral neck vessels as recipient vessels and distal run-off of the first flap as the recipient vessels of the second flap. In the remaining patients at least one pair of ipsilateral neck or temporal vessels were available for simultaneous two free-flap transfers. There is usually no difficulty in finding two adequate pairs of recipient vessels even in previously operated or irradiated necks on the ipsilateral side when a good strategy in recipient vessels selection is planned pre-operatively. Such a strategy avoids unnecessary destruction of potential vessels during tumor ablations, which can be achieved with preoperative and intra-operative collaboration between the ablative and reconstructive surgeons, competence in the knowledge of suitable flaps, and proper flap inset.

### Recipient Veins

The head and neck region has an extensive bilateral venous network, which is also readily accessible for venous anastomosis. The branches of the internal jugular vein and the ability to direct anastomosis to the internal and external jugular vein provide a range of choices[30] (see Fig. 1). In the majority of previous reports the internal jugular vein and its branches have been recognized as superior recipient veins for free tissue transfer in head and neck reconstruction because of their easy accessibility and close proximity to the recipient arteries.[3,8,20,30–32] However, the external jugular vein is preferred as the recipient vein in other reports.[6,33]

There are some controversies about the selection of recipient veins after neck dissection. In radical or modified radical neck dissections in which the internal jugular vein is sacrificed, the external jugular vein may be the only readily available recipient vessel on the dissected side. During neck dissection, the external jugular vein is routinely ligated. However, the external jugular vein has many risk factors for thrombosis, including relatively low flow, small caliber, and considerable manipulation during neck dissection and ligation that could lead to serious intimal damage.[30]

Recently, with the increasing use of selective or modified neck dissection techniques in which the internal jugular vein is spared, several studies have been performed to determine the patency rates of the internal jugular vein after neck dissection.[30] The studies have shown internal jugular vein thrombosis rates of 14–33% shortly after functional neck dissection.[34–36] Despite this consistently high rate of internal jugular vein thrombosis, microvascular flaps anastomosed to the internal jugular vein system have an exceedingly high success rate.[30] Several of the preceding studies have shown flap survival despite internal jugular vein thrombosis.[36,37] The mechanism by which the flap maintains venous drainage in the presence of apparent internal jugular vein occlusion is not clear.[30]

Finally, a branch of the internal jugular vein at the ipsilateral side is usually the first choice of recipient vein. The recipient veins should be prepared close to the recipient artery to prevent excessive separation on pedicle vessels and to prevent kinking or pulling the artery and vein in different directions with changes in head position.[3,6]

## SUMMARY

The head and neck region has an extensive bilateral vascular network, which is readily accessible,[3,8,9,30] for free flap transfers. However, as head and neck cancer have an inherent complexity of reconstruction resulting from flap failures, radiotherapy complications, local tumor recurrence or second primary tumors, and increased concerned about esthetic and function, subsequent flap reconstruction may become necessary.[3,5,9]

Therefore, the following considerations and precautions are important for recipient vessels preparation and selection in head and neck reconstruction with free flap transfers (1) Avoiding unnecessary destruction of potential vessels during tumor ablations and neck dissection, which can be achieved with preoperative and intraopera-

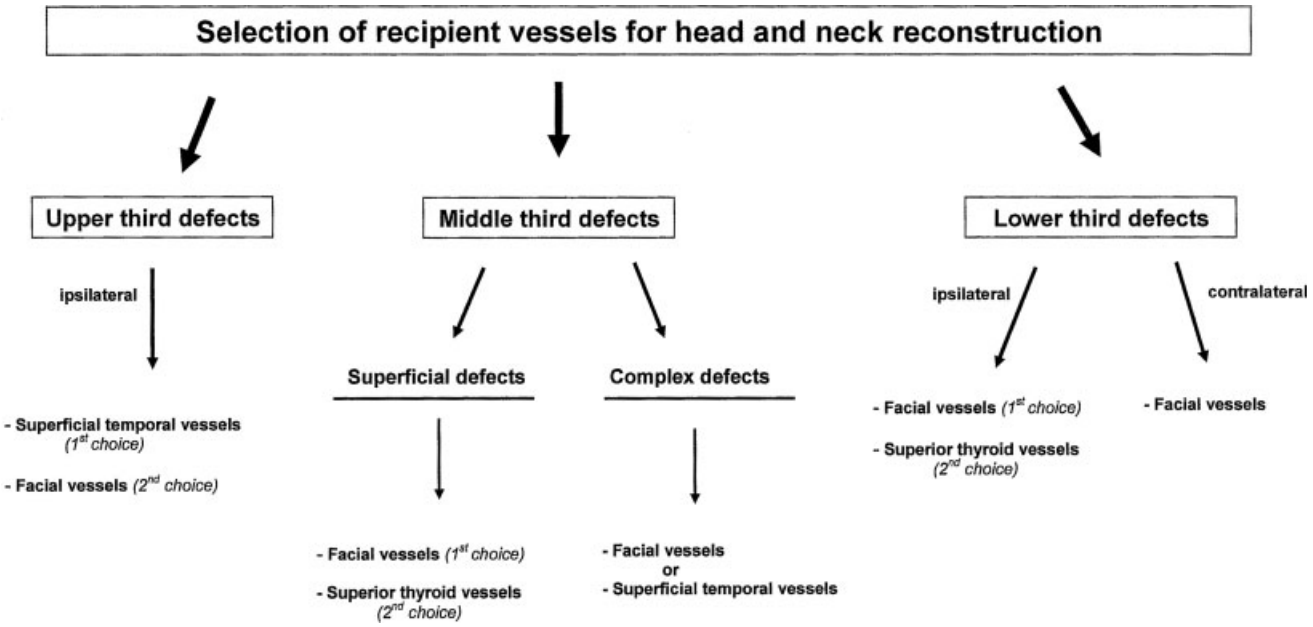


*Figure 5. The algorithm is recommended by the author for selection of recipient vessels in microsurgical free tissue reconstruction of head and neck defects.*

tive collaboration between the ablative and reconstructive surgeons. (2) After primary tumor excision, there is usually more than one pair of vessels available. Therefore, the selection should not be made without taking into consideration the possible need of subsequent free flap reconstruction for flap failure, complications, or even second primary cancers. Instead of using random easily accessible pairs of vessels on either the ipsilateral or contralateral side, the vessels should selected bearing the following points in mind. In primary cancer operations, the vessels in the ipsilateral neck should always be considered first and should be located close to the defect. An algorithm is given in Figure 5. For oromandibular defect reconstructions, the ipsilateral superficial temporal vessels should not be used needlessly as this vessel should be preserved for potential use in secondary reconstruction, which is often required in free tissue transfers. It is therefore important to take both the reliability and economics of the recipient vessels into equal consideration.

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