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Chapter 14

Microsurgical Reconstruction for Defects of the Oral Cavity

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Abstract

Squamous cell carcinoma is the most prevalent cancer histology pattern in oral cavity. The resections of oral squamous cell carcinoma result in defects involving various functional units and size. Before the reconstruction, an evaluation of each functional unit involved in the defect helps the surgeon to choose the most suitable reconstructive option for every single patient.

Free flap transfer is now the standard surgical procedure for oral cavity reconstruction. The availability of flaps, the robust blood supplies to the flap and the freedom it provides for flap inset are advantages of free flap transfer. There are many free flaps available for oral cavity reconstruction, among which the free anterior lateral thigh (ALT) and fibula flaps are the two most commonly applied ones. In this chapter, the detailed surgical procedures in transferring free anterolateral thigh (ALT) or fibula flaps and the perioperative management in oral cavity reconstruction are reviewed.

Keywords: Oral cancer, buccal cancer, tongue cancer, squamous cell carcinoma, marginal/ segmental mandibulectomy, oral reconstruction, anterolateral thigh flap, free fibula flap

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Introduction

Most of the etiologies resulting in oral defects are cancer-originated. Tumor ablation surgery leave defects in the oral cavity ranging from a small shallow mucosa defect to a huge soft tissue defect, even a through and through defect from inside the oral cavity to the external cheek skin or an exposed bony segment, or even a missing of a segment of bone.

Squamous cell carcinoma is the most prevalent cancer histology pattern in the oral cavity, counting for more than 90 % [1]. The other pathologies are cancers from salivary glands, basal cell carcinoma, melanoma, sarcoma and benign aggressive tumors, such as ameloblastoma. Oral cavity cancer is one of the common cancers in Southeast Asia countries, mainly because of the culture of betel nut chewing [2]. Buccal mucosa is the most commonly involved area, following by tongue, mouth floor and lower gum.

Cancer ablations result in various defects and reconstruction methods range from simple wound closure, skin graft, local flap, distant flap, to one or even two free flap transfers. Most of the defects are, however, requiring a free tissue transfer to enhance the reconstruction regarding function and cosmetics results.

Symptoms

Clinical symptoms of premalignant and malignant changes of the oral mucosa are various and in early state could be painless and asymptomatic, which makes early diagnosis difficult.

In general the following signs can be observed:

- Loss of the reflecting shines of the mucosa-surface
- Tendency to cornification of the lesions (white lesions/leukoplakia)
- Loss of the surface integrity (red lesions/erythroplakia)
- Swelling
- Erosion
- Ulceration
- Exophytic growth
- Formation of blisters / desquamation
- Induration
- Pigmentation
- Burning pain sensations
- Halitosis / foetor
- Swelling of neck lymph nodes

Risk Factors

- Consuming of tobacco
- Consuming of alcohol [3, 4,5, 6, 7]
- Betel nut chewing (main factor in Asian population) [2]
- Human papillomavirus [8, 9].

- Poor oral hygiene
- Mechanical injury / sharp teeth

Management

Specific Considerations in Each Functional Unit of the Oral Cavity

The oral cavity is bounded by the wet-dry border of the lips anteriorly, hard and soft palate superiorly, pharyngeal wall posteriorly, buccal mucosa laterally, tongue and mouth floor mucosa inferiorly, whereas the posterior third of the tongue, the soft palate and the pharyngeal wall are in the oropharynx. These structures maintain the oral compentence and play important roles for directing saliva, eating and speaking. Inside the oral cavity, the tongue functions for speech, deglutition, articulation and airway protection. The mandible bone works for mastication/chewing, swallowing, smiling and speech. In addition it keeps the aesthetic appearance of the lower face. The surgical resection affects the postoperative function; yet, a well preoperative surgical plan and well performed reconstruction can help to restore the function and aesthetic outcome [10]. A well understanding of the functional role of each unit in the oral cavity and the relationships in between helps to select the best option for reconstruction. Preoperative considerations should focus on the functional unit resected during the surgery. In general the choice of the tissue used for reconstruction should match the character of the defect and should replace like with like in order to achieve the best aesthetic and functional result.

Buccal Mucosa

The buccal mucosa is commonly affected in oral cancer. The soft and pliable buccal mucosa tissue provides function regarding swallowing, speech and emotional expression in daily life. Reconstruction should focus on restoration of the integrity and the original thickness of the buccal mucosa and maintain maximal mouth opening with soft tissue flap. If the defect involves only the buccal mucosa, the reconstruction is relatively simple. With the mouth fully opened, the size of the defect could be measured. The authors prefer to tailor a template before designing the flap to make sure the flap is adequately raised from the donor site. The thickness of the defect and available flaps could be judged with pinch test and flap selection can be based accordingly.

Buccal mucosa reconstruction requires a flap that is soft and pliable to achieve satisfactory function after flap transfer [11]. In most of the cases, solitary buccal mucosa defect is best reconstructed with free radial forearm or ulnar foreram flaps [12]. The medial sural artery perforator flap is another alternative in patients who are not good candidates for forearm flap harvesting. In selected patients who are thin, the anterolateral thigh perforator flap can be used as well and its role in oral reconstruction is expanding [13]. However, a bulky flap may diminish the cosmetic result. It also affects mouth opening and closing, disturbing tongue movement, and prone to be bited by the teeth resulting in chronic

ulceration. On the other hand, a flap that is too thin to recreate the facial contours can cause cosmetic problems.

Sometimes the defect extends from the buccal mucosa to the buccogingival sulcus that connects to the lower gum. Although the defect between the sulcus and lower gum could be closed primarily, the closure causes dimple of the cheek and function loss of the sulcus. A thin soft tissue flap is required to be folded to create the sulcus [14]. In more advanced staged buccal cancer, tumor resection may result in exposure of the mandible or maxilla or even defects in the mandible or maxilla. In these situations, the exposed bone should be covered with adequate soft tissue, such as anterolateral thigh flap or even a myocutaneous flap, such as anterolateral thigh myocutaneous flap, rectus abdominis myocutaneous flap, or latissimus dorsi myocutaneous flap, not only to prevent post-operative bone exposure but also to replace the soft tissue volume. [15]. Once the mandible bone is partially involved in the resection, it is common that the resection margin is close to or even include the tongue. In this situation, special attention should be carried out to inset the flap in a more redundant way in the mouth floor. It gives space for the mouth opening as well as a free tongue movement to improve swallow function.

Tongue

Tongue is an essential functional unit in the oral cavity with unique natural intrinsic anatomy and musculature. The tongue is not replaceable by any other tissue transferred from other part of the body [16, 17]. After reconstruction, the tongue can only move passively, driven by the residual tongue. It is impossible to replicate the motion of the native tongue which acts to enhance contact with the palate for propulsion of food [18, 19]. Therefore, attempts to restore the tongue shape and utilize the residual tongue to help on postoperative tongue function are the key to a successful tongue reconstruction.

Tongue defects can be classified as partial tongue defect, hemi-tongue defect, and total tongue defects. For defects less than 50 % of the tongue, the residual tongue can still function well for tongue movement. A thin and pliable soft tissue flap is preferred to allow a more freely tongue movement along with the native tongue. A free radial forearm flap or an ulnar forearm flap is the flap of choice. However, when the defect is larger than 50 %, a bulky flap is required. For these tongue defects, a thicker fasciocutaneous flap, such as free ALT fasciocutaneous flap is suitable for reconstruction. In more advanced defect, a myocutaneous flap is required to reconstruct the tongue, which may function in such a case at least as a counterweight for chewing and swollowing [20, 21].

Soft and Hard Palate

The soft and hard palate separate oral cavity from the nasal cavity. Once the tissue is missing, the separation is destroyed, creates a free communication and results in oronasal fistula. The sequele of an oronasal fistula include food regurgitation into nasal cavity and nasopharynx during oral intake and hypernasality in speech. To avoid these symptoms a complete reconstruction of the palate should be considered. [22]. Usually a soft tissue component is enough to fulfill the reconstruction goals. For smaller defects local mucosal

flaps and palatal flaps may be suitable [23]. Larger defects or combined defects require a free microsurgical tissue transfer. However, the flap should be relatively thin and pliable. A forearm flap or an ultrathin anterolateral thigh flap would meet the requirements in skinny patients [24, 25]. Also a fascia only flap combined with a skin graft can be used to achieve a thin coverage of palate defect. A bony component is not always necessary. Depending on the extent of the defect and the thickness of the flap, complete coverage of the nasal side and the oral side of the palate with epithelialized tissue is sometimes not possible. In such cases, secondary epitheliazation of the nasal side may be allowed.

Mandibula

In treatment of oral cancer the mandibular bone plays a crucial role in maintaining the oral competence and aesthetic appearance [26, 27]. In general the mandibular periosteum is very resistant to tumor spread. However bone invasion can occur as infiltrative spread through the soft tissue, as embolic spread along lymphatic channels, as perneative spread along nerves and through the occlusal surface following tooth extraction. In addition, radiotherapy disrupts periosteal integrity causing it to lose its resistance to tumor spread [28]. Dependent on the grade of invasion, different resection types have to be performed. In cases with only limited bony invasion a rim resection of the alveolus with preservation of the body of the mandible is indicated. Deeper bony invasion has to be treated by a marginal resection and a segmental resection is appropriate in cases with significant bony invasion.

The rim and marginal resections doesn`t require a bone reconstruction. To cover the defect with soft tissue is the priority, however in certain cases the defect of a marginal mandibulectomy can be filled with a muscle component of the free tissue transfer to prevent the injuried bone from osteoradionecrosis.

In segmental resections there are three possible ways of reconstruction [28].

No Bone Reconstruction

Segmental bony defects can be spanned by contoured reconstruction plates in order to maintain the outer alignment. They are rigidly fixed to bone at both ends of the defect. This form of reconstruction is best for patient with a poor prognosis and is not suitable for long microsurgical operation, or who has not received and will not receive radiotherapy or not suitable for other reconstruction methods.

Reconstruction with Non-Vascularized Tissue

In cases with limited bony defects with a sufficient soft tissue coverage and good perfusion of the wound bed, the use of non-vascularized free bone grafts is a possibility. The bone grafts are usually harvested from iliac crest, but autogenous mandible or alloplastic materials or biomaterials could be another choice. Non-vascularized tissue should be avoided in cases with planned radiotherapy.

Vascularized Tissue

The optimal method for bone reconstruction is the vascularized tissue. It has the advantage of being osseoinductive as well as osseoconductive. Sources of the free

vascularized bone are the iliac crest with the deep circumflex iliac artery flap (DCIA), part of the radial bone with the radial forearm flap, part of the scapula margin with the scapular flap and the fibula in the free fibula flap [15]. All flaps have the advantage of combining osseous and cutaneous components, but the flap with the longest bone and the largest possible skin island as well as the best freedom of arrangement for the inset is the free fibula flap. Furthermore the fibula has a dense cortical structure and is supplied by several perforators from the peroneal artery. This permits the creation of multiple osteotomies to contour accurately the bone to the dimensions of the mandibular defect.

In the following discussion, we concentrate on the two most important flaps for oral reconstruction: the anterolateral thigh flap and the free fibula flap.

Preoperative Markings

Anterolateral Thigh Flap

- Spina iliaca anterior superior
- Lateral proximal angle of the patella
- Connection line between this two points with help of a tape to draw a straight line
- Mark the midpoint of this distance
- In a 3 cm circle around this midpoint the perforators are mainly located and can be detected by a Doppler probe.
- After considerations of the necessary length of the pedicle, the flap can be designed and drawn with the perforators in its center or more eccentric, in its proximal part to achieve more length.
- The flap size should be determined together with the “resection team”, usually ENT-colleagues. Design the flap a little larger rather than too small. A widths of approximately 8 cm allows usually a primary closure of the defect.

Free Fibula Flap

- Anterior and posterior border of the fibula
- Fibula head and malleolus lateralis
- Mark a distance of 6 cm of the proximal and distal bone, which should be preserved.
- Divide the fibula in thirds
- Along the posterior border of the fibula, 1 – 3 perforators are located around the distal third and can be detected with a Doppler probe.
- Flap-design according to the resection plan of the ENT-colleagues, a width of 4 cm can usually be closed primarily

Intraoperative Details

Anterolateral Thigh Flap

In medical literature there are many different approaches described to harvest the ALT-flap. We prefer the medial approach, because it allows a better overall view on the anatomical situation of the pedicle and perforators after opening the intramuscular septum. In addition an adjustment of the flap design is easily possible from this approach. Furthermore we prefer to harvest the ALT-flap in a subfascial plane. The advantages of a suprafascial preparation (thinner, softer flap) are inferior to the safety of including the vessel-carrying fascia.

Harvesting

- The patient is placed in a supine position, the leg has to prepared circumferentially up to the Spina iliaca anterior superior which should be exposed for orientation.
- The drawing should be renewed.
- Skin incision along the medial marking of the flap and dissection of the subcutaneous tissue down to the fascia with the monopolar cauter to achieve a clean field.
- Incision of the fascia and exposure of the rectus muscle.
- Careful elevation of the fascia and scissors dissection to the lateral direction until the intramuscular septum between the recut femoris muscle and the vastus lateralis muscle is visible.
- From this point on a careful and meticulous dissection of the subfascial plane has to follow, identifying the perforator vessels.
- Once they are located, the intramuscular septum can be exposed by retracting the rectus femoris muscle to medial with help of selfretracting skin hooks.
- Following the septum into the deep leads to the descending branch of the lateral circumflex femoral artery (LCFA), coursing over the vastus lateralis muscle.
- At this time point the anatomical situation of the relation between the pedicle and the perforators can be seen. The perforators may have a direct septocutaneous course or a partial or complete intramuscular course before entering the skin.
- Septocutaneous vessels can be dissected easily from their surrounding tissue. Branches should be clipped or cautered with the bipolar forceps.
- Intramusculular courses are more difficult to dissect. At first an “unroofment” of the perforator is essential to clarify the course and not accidentaly damage the vessel. The unroofment can be performed best using a dissection scissors, elevating the muscle tissue and cutting it with a monopolar cauter. The whole length of the perforator has to be shown in this manner.
- In dependency whether a part of the vastus lateralis muscle is needed or not, the further dissection differs. If muscle should be included, a preservation of muscular branches, coming from the perforator is essential. The vessel is not more dissected, but elevated as a whole package together with the required muscle part. If there is no muscle tissue needed, the perforator can be dissected completely from the surrounding tissue. Branches should be clipped or cautered by bipolar forceps very

carefully. Special care has to be taken not to manipulate the vessel too much, which may result in spasm or intima lesions. An ongoing control of the pulsation movement is important,

- After reaching the descending branch of the LCFA, the dissection proceeds to proximal. The descending branch has several large branches to the rectus femoris muscle or to the deep plane, which should be ligated carefully. Once, they are cut, they retract and make a control of the bleeding extremely difficult. The descending branch should be dissected up to its origin (the LCFA) dependent on the required pedicle length.
- The proximal three centimeters of the pedicle (1 artery, 2 veins), should be dissected from each other to allow more freedom during the later inset.
- At this time point, the lateral margin of the flap can be redesigned (if needed) and cut to the fascia. While dissecting through the fascia, care has to be taken to protect the perforators, which lay sometimes very close and may be injured.
- Now, the flap is completely raised and should be checked for subcutaneous stable bleeding on all 4 "corners".
- To adapt the flap on the new perfusion pattern, it should be left at this position for approximately 30 minutes. After that time, redo the bleeding check.
- The flap can be ligated, when the recipient side and –vessels are completely prepared and are ready for the inset.

Inset

- The inset of the flap into the oral defect varies from case to case and cannot be described in general. But some key points have to be considered for all types of defect.
- The inset of the flap should be performed and almost completed before doing the microanastomoses [14]. Otherwise the bleeding and welling of the flap would make the inset very difficult.
- The inset should begin with the most inaccessible / deepest part and should progress toward the more superficial and easy to reach location of the defect [14]. The inset can be partially or largely completed before microsurgical repair of the vessels. Use mouth opener and tongue retractor to have a clear field.
- When a folding of the flap is necessary, e.g. for simultaneous reconstruction of the tongue and the mouth floor, special care has to be taken not to kink the perforators. They have to have always a smooth course. Better fold the flap in its longitudinal axis rather its transverse axis, if possible.
- Tension, twisting and kinking of the pedicle has to be avoided.
- When a filling of a dead space is required, parts of the flap can also be deepithelialized and used for this purpose.
- This technique is also very useful for the finetuning along the lips and mouth angles.
- Keep always some redundant tissue to allow a later mouth opening.
- Intraoral the flap can be sutured with single stitches of a resorbable, braided material (e.g. Dexon, Vicryl). Extra orally Nylon or Prolene can be used.

- Due to the postoperative oozing of the flap tissue and the wound bed, the use of drains is crucial. Vacuum drains, as well as Penrose drains are useful and can also be combined. They should not compromise the pedicle they have to be placed in the dependent portions of the wound, away from the site of the microanastomoses, usually in the posterior triangle of the neck.
- After finishing the inset, the mircoanastomoses can be performed. A smooth and tension free course of the pedicle is necessary. Avoid any kinking and pressure. We recommend doing one venous anastomosis at first to allow drainage of the flap after arterial anastomosis and prevent the flap from congestion. A second vein is not always necessary but gives the situation more safety.
- In our experience, the most used recipient vessels are the superior thyroid artery with a commitant vein or internal jugular vein, the superficial temporal artery and vein or the facial artery and vein.

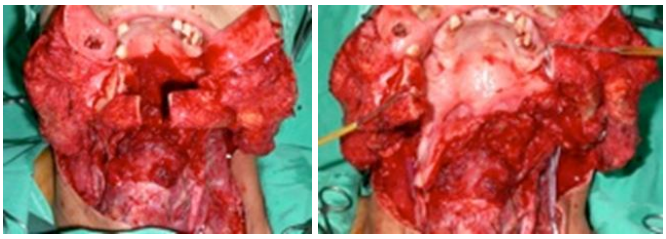
Free Fibula Flap

Harvesting

Before harvesting of the free fibula flap all conditions that could indicate unreliability of the peroneal artery should be excluded. Next to periphere vascular disease, deep vein thrombosis, trauma or arteritis a peronea-magna-situation should be excluded by the foot Allen`s test. In up to 8 % of the population this vascular variation consists of a hypoplasia or absence of the anterior and posterior tibial arteries with the peroneal artery as the sole arterial supply to the foot. In suspicious cases an angiography or CT angiography is justified [Wei].

- Supine position of the patient and preparation of the complete leg in a circumferential manner. An elevation of the ipsilateral hip and pelvis region is achieved with a towel roll or pillow underneath.
- The leg is positioned in an upright position, with the hip and knee joints flexed and is secured with another towel roll under the foot.
- Completion and redo of the drawing again.
- With an Esmarch bandage an almost complete exsanguination is performed and surgery is performed with this tourniquet.
- The dissection of the flap starts with the anterior incision along the designed skin paddle and stops on the fascia. Preparation is proceeded in the posterior direction in the suprafascial plane until the peroneal tendons are reached. Care has to be taken not to damage the superficial peroneal nerve branches in this layer.
- Along the posterior border of the peroneal tendons the muscle fascia is incised and secured to the skin paddle with temporary 30 Vicryl sutures. With this technique a transplantable wound bed is preserved even along the tendons.
- The flap is carefully elevated and the intermuscular septum separating the anterior from the posterior superficial and deep compartments is exposed.
- The perforators can now be identified within the septum.

- The flap is then turned back and the posterior incision is made. Dissection start again in the suprafascial plane to the anterior direction until the margin of the soleus muscle is reached.
- The muscle fascia is then incised to proceed with subfascial dissection.
- Carefully the same intermuscular septum is now exposed from the posterior side and the perforators are visualized. Take care not to shear the septum and the containing perforators.
- To identifiy the course of the perforators, they have to be dissected free from their surrounding tissue and followed up to the peroneal vessels. In some cases, they have an intramuscular course through the soleus and flexor halluces longus muscle and may be accidentaly confused with muscular branches.
- Once the perforators are dissected, the muscular branches can be ligated.
- Complete the dissection under dissecting the lateral soleus, flexor halluces longus and tibialis posterior muscle off the fibula, preserving an approximately 3mm muscular cuff for periosteal nutrition and circulation of the fibula.
- Then the flap is turned to posterior again to proceed with the anterior dissection.
- The peroneus longus and brevis muscles are dissected over the whole length from the anterior surface of the fibula, leaving again an approximately 13 mm muscular cuff on the muscle to protect the periosteum and its containing blood supply. Muscular branches are clipped and care is taken for meticulous bleeding control.
- Incision of the anterior intermuscular septum separating the peroneal compartment from the anterior compartment.
- The extensor digitorum and extensor halluces longus muscle are then dissected off the fibula, again under preservation of a thin muscle layer.
- Now the interosseous membrane can be identified in its whole length.
- After that the fibula is prepared for osteotomy: at the planned osteotomy sides the periosteum is scraped of over a 1cm width and the fibula is tunneled with sharp and blunt elevators. These instruments are also used to protect the underlying vessels from the saw.
- With a reciprocating or oscillating saw, or even a Gigli saw, the proximal and distal osteotomies are performed and the fibula segment is then retracted with a proximal and distal bone plier.
- Under retraction and posterior rotation the interosseous membrane is exposed under a light tension and can then be incised.
- The dissection of the peroneal vessel bundle proceeds now from distal to proximal under careful ligation of all branches. Dissection is easier when ligation of the distal peroneal vessels is performed directly.
- The remaining parts of the deep posterior muscle compartiment are dissected.
- The vascular pedicle is dissected up to its origin at the level of the bifurcation from the posterior tibial artery.
- The tourniquet can be released at this point, perfusion of the skin paddle can be confirmed and hemostasis can be performed.
- The flap can be ligated, when the recipient side and –vessels are completely prepared and are ready for the inset.



(a) (b)

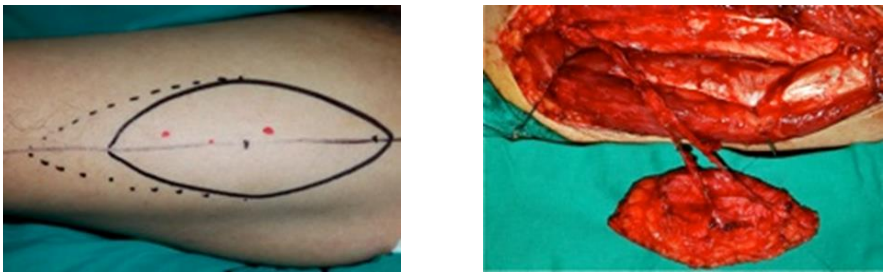
Figure 1. A 58- year- old male patient with malignant neoplasm of the tongue underwent subtotal glossectomy and bilateral marginal mandibulectomy. Left internal jugular vein was also resected during neck dissection. 1a: Front view, 1b: The split mandibles were retracted laterally.

(a) (b) (c)

Figure 2. 2a: Left anterolateral thigh flap with identification of one myocutaneous perforator by pencile Doppler. 2b: intraoperative view on the undersurface of the harvested anterolateral thigh perforator flap, the pedicle is isolated completely out of its intramuscular course. 2c: The anterolateral thigh perforator flap was harvested with only one perforator.

Figure 3. 3a: Inset of the flap, beginning with the most dependent part of the tongue. The mandible was reduced and fixed using two miniplates at the lower margin of the mandible. 3b: Completed inset of the flap. The neo-tongue can be clearly seen, the distal part of the flap was deepithelialized in order to augment the mouth floor. The pedicle was anastomosed to the right superficial thyroid artery and internal jugular vein.

Figure 4. 47- year- old male patient was a left buccal verrucous carcinoma T4N0M0 patient, with facial skin invasion 3 x 2 mm in size. The defect was 13 x 6 cm after wide excision.



(a) (b)

Figure 5. 5a: An anterolateral thigh perforator flap 16 x 7cm with two dominant perforators was designed on left thigh. 5b: The pedicle with the two perforators was dissected out. The pedicle was anastomosed to the left superior thyroid artery and vein.

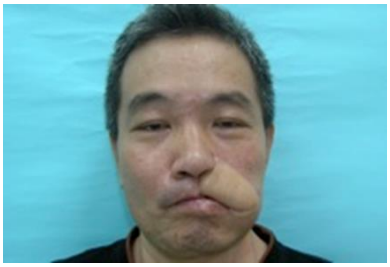


Figure 6. 12 months after surgery.

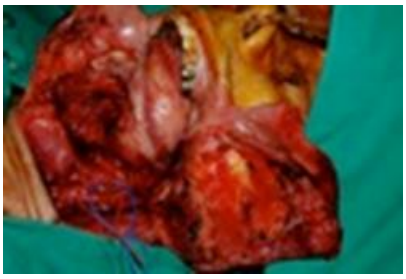
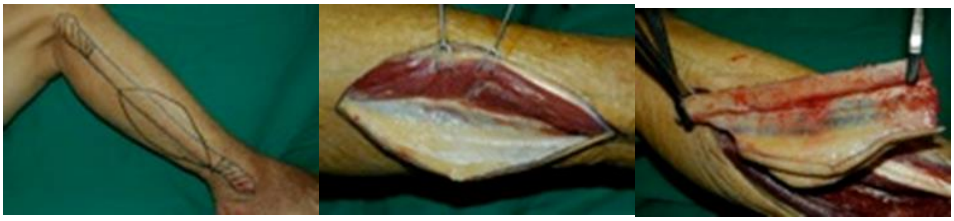
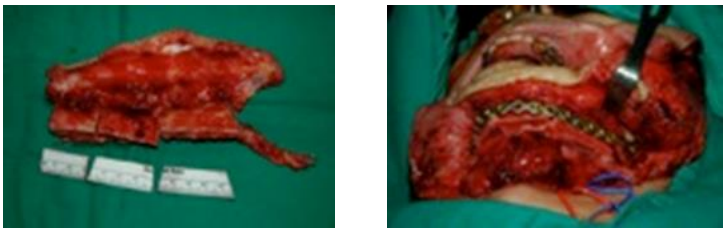


Figure 7. A 74- year- old patient presented with lower gingival squamous cell carcinoma T4aN0M0 with rapidly progression and painful ulceration. Wide excision, segmental mandibulectomy (angle to angle) and left supraomohyoid neck dissection were performed.



(a) (b) (c)

Figure 8. 8a: Designing of a fibula flap with 17 x 7 cm skin flap and 11 cm in length fibula bone. 8b: The skin incision was started from the anterior approach with 2 perforators preserved in the septum. 8c: The osteotomy was performed proximally and distally to expose the osseous membrane and extensor halluces longus and then to dissect the peroneal vessels.



(a) (b)

Figure 9. 9a: The fibula was osteotomied in three segments in the back table. B: A reconstruction plate was used to bridge the residual mandibles. The new mandible could be shaped and reconstructed. The skin paddle was used to cover the buccal defect. The pedicle was anastomosed to the left superior thyroid artery and vein.

(a) (b)

Figure 10a, b: At a follow-up of 8- months, the patient satisfied the functional and cosmetic outcome. 10a: front view, 10b: lateral view.

Table 1. Special equipment for anterolateral thigh flap

Surgical loupes with at least magnification of 2.5x
Hemoclips at least 2 sizes
Self-latching skin retractors (fish-hooks)
Heparin-irrigation
Surgical microscope
Single and double micro vessel clamps
Microsurgical instruments (4 forceps, 1 needleholder, 1 dilatator, 2 scissors – smooth and toothed)
Suture material nylon 9-0
Mouth opener
Tongue retractor
Suction
Headlight

Table 2. Additional special equipment for free fibula flap

Tourniquet-bandage
Bone-saw
Elevators for protection of the vessels
Bone pliers for retraction of the fibula
Strong sharp skin hooks
Extra table for shaping of the bone
Reconstruction plate system (2.0-2.5, self-locking)

Inset

- The inset of the flap into the oral defect varies from case to case and cannot be described in general. But some key points can be outlined for all types of defect.
- The inset of the flap should be performed and almost completed before doing the microanastomoses. Otherwise the bleeding and welling of the flap would make the inset very difficult.
- With help of a prebent reconstruction plate a kind template for shaping of the bone can be formed.
- The shaping of the bone bone should be performed on an extra sterile table to have a stable situation.
- Dependent on the defect location and size one or two osteotomies have to be performed to reconstruct the natural rectangle of the mandibular. For this, the osteotomy levels should be measured and marked precisely and periosteum should be scraped of over a 5mm width. Consider to perform oblique osteotomies or even wedge resections to obtain a full contact between both surfaces.
- There are two ways of inset now: some surgeons fix the bone to the reconstruction plate on the table side and transfer the whole construction into the defect; some surgeons fix the plate first into the defect and assemble the fibula flap in situ. Both ways work well.
- After fixation of the plates and bone and taking care for a smooth and tension free course of the pedicle, the skin paddle is sutured into the defect.
- After finishing the inset, the mircoanastomoses can be performed. Again, a smooth and tension free course of the pedicle is necessary. Avoid any kinking and pressure. We recommend doing the venous anastomosis at first to allow drainage of the flap after arterial anastomosis and prevent the flap from congestion.
- In our experience, the most used recipient vessels are the superior thyroid artery with a commitant vein or internal jugular vein, the superficial temporal artery and vein or the facial artery and vein.

Postoperative Details

The postoperative care of free flap reconstruction cases always requires an intensive monitoring of the flaps and the patients. This can be achieved best at an intensive care unit but this is not absolutely necessary. Also a normal ward can perform a sufficient care when the nursing staff is very experienced. The following details are of great importance to assure the best outcome:

- A strict bed rest for at least 5 days is mandatory to avoid tension and shearing of the flap, to keep a stable blood pressure and perfusion of the transferred tissue.
- The head should be maintained in a neutral position to avoid kinking and tension on the pedicle. This is particularly important in patients with tracheostomies, the tubes tubes should be secured with sutures, ties and oxygen mask elastic bands that encircle the neck must be strictly prohibited [14].

- A sufficient pain management according to the WHOguidelines is mandatory.
- To maintain a sufficient perfusion special care has to be taken on the circulation management. First the hemoglobin level should be kept over 10 g/dl to assure oxygen saturation of the tissue. Blood transfusions have to be considered for this purpose. Second, the hematocrit should stay under the level of 47 % to decrease the viscosity and increase the perfusion. Thus patients should be kept well hydrated, different kinds of haemodilutant fluids such as NaClsolution, Ringer lactatsolution, Dextrane, Haessolution are reported to be used. Third, the use of anticoagulants is frequent after free flap transfer, however there are different approaches from hospital to hospital. Although the use of such agents has not been conclusively demonstrated to increase anastomotic patency, it does not seem to increase perioperative bleeding and hematomas [29, 30]. It should be used in selected case with compromised coagulation history, such as when anastomotic patency is threatened, when a clot appears intraoperatively, or in salvage cases after revision of the venous or arterial anastomosis [31].
- The flap should be monitored at least every hour for the first 5 days. Flaps mostly fail within the first 5 days [69]. Clinical examination is our primary modality of monitoring. Due to the sometimes deep inset, the perfusion of the skin in these regions can only be controlled by repeated stitching and observation of the bleeding. We consider monitoring devices like implantable or percutaneous Doppler and laser Doppler probes to be always inferior to the clinical testing, because they are less reliable.
- Special care has to be taken on the oral hygiene. Due to the often impaired swallowing function some debris and saliva can aggregate in the mouth and can cause infections easily. Cleaning with disinfectant mouthwash and cottonbuds multiple times a day is necessary.
- Wound infection rates between 26 and 48 % have been reported for reconstruction in the aerodigestive tract under prophylactic antiobotics [32, 33]. The incidence of infections in cleancontaminated head and neck cancer surgery without preoperative antibiotics has been reported at 30–80 % [34]. But, in the pretreated mucosa (e.g., with radiation or chemotherapy), the immune defense seems to be reduced. Penel et al. [32] described five significant variables for wound infection: tumor stage, previous chemotherapy, duration of preoperative hospital stay, permanent tracheotomy, and presence of hypopharyngeal and laryngeal cancers. Concerning the length of antibiotic ingestion, shortterm (24–48 hours) seems to be as efficient as longterm [35]. A standardized antibiotic regime with a combination of amoxicillin 2 g and clavulanate potassium 0.2 g i.v. for 5 days is sufficient in most cases.
- Concerning the patients nutrition, the “oral” feeding is important to maintain the bacterial flora of the stomachgut system, assuring a stable immunologic status of the patient. The feeding should be performed over a nasogastric tube as long as the wound healing is not yet completed. But drinking of clear water or unsweetened tea in single sips should be encouraged after 7 days for oral hygiene purposes. After achievement of a stable healing of the flap the oral feeding can start with fluid diet and increased to normal diet from day to day. In case of mandibular reconstruction eating of hard food requiring intensive chewing should be permitted until the healing of the bone transplant is assured by xray. In case of persisting swallowing problems

due to tongue resections or in case of reduced oral competence due to an incomplete closure the help of specialized physiotherapists or speech therapist should be provided.

Notes

- For the intraoral part of the flap inset special care has to be taken to perform so called "watertight" wound closure. Otherwise the risk of developing orocutaneous fistulas is increased.
- For extensive defects including a segmental mandibulectomy a combination procedure, consisting of a free osteocutaneous fibula flap and an anterolateral thigh flap is a good choice.
- At the end of the dissection of a free fibula harvesting, the flexor hallucis longus and tibialis posterior muscles are routinely sutured to the interosseous membrane, as described by Wei et al. [36] to provide a new insertion of the muscles and prevent clawtoe deformity.
- To facilitate microsurgical repair at the neck side, the head can be turned slightly to the contralateral side.
- After microanastomoses the neck should be passively moved through its functional range of motion to ensure that the pedicle is tension-free.
- During microanastomoses suction can be applied over the drains to prevent blood pooling in the working field.
- The high rate of tumor recurrence, respectively secondary primary tumors is a challenge for the plastic surgeon in order to save possible future flaps from one donor area. For example when harvesting an ALTflap, the most distal perforator should be used and the dissection should be stopped before the origin of the oblique branch. If a second flap is needed in the future, a second ALTflap may be raised based on a perforator from the oblique branch. In our experience we particularly see more and more patients requiring 3 or 4 free flaps for oral reconstruction.
- The artery and the veins of the most proximal 3 cm of the pedicle should be separated while being still in situ in the donor site. With this, the separation is easier and the arrangement of the vessels after the inset has more freedom.
- Before ligation of the flap, all 4 corners of the flap should be checked separately for perfusion. With this, the best perfused part can be identified and used for the inset in the most dependent and most crucial part of the defect.

Conclusion

Cancer ablation surgery result in various defects in the oral cavity. An detailed assessment of defects of each functional unit/area involved, and consideration of the availability of different flaps are important for microvascular surgeons to select and offer the best reconstruction to the patients. Although there are many free flaps availbe to reconstruc the oral cavity defect, the ALT flap and fibula flap present as the workhorse flaps because of

the availability of larger flap volume, long vascular pedicle, easy 3-D inset and better functional and cosmetic outcome.

References

[1] American Cancer Society. *Global Cancer Facts & Figures 2nd Edition*. Atlanta: American Cancer Society; 2011. http://www.cancer.org/acs/groups/content/%40 epidemiologysurveilance/documents/document/acspc-027766.pdf

[2] Chen, YJ; Chang, JT; Liao, CT; Wang, HM; Yen, TC; Chiu, CC; Lu, YC; Li, HF; Cheng, AJ. Head and neck cancer in the betel quid chewing area: recent advances in molecular carcinogenesis. *Cancer Sci*., 2008 Aug, 99(8),1507-14. doi: 10.1111/j.1349-7006. 2008.00863.x.

[3] Baan, R; Straif, K; Grosse, Y; Secretan, B; EI, Ghissassi, F; Bouvard, V; Altieri, A, Cogliano V. Carcinogenicity of alcoholic beverages. *Lancet Oncol*, 2007, 8, 292-293.

[4] World Cancer Research Fund and American Institute for Cancer Research: Food, nutrition, physical Activity, and the prevention of cancer: a global perspective. *AICR*, Washington DC; 2007.

[5] Znaor, A; Brennan, P; Gajalakshmi, V; Mathew, A; Shanta, V; Varghese, C; Boffetta, P. Independent and combined effects of tobacco smoking, chewing and alcohol drinking on the risk of oral, pharyngeal and esophageal cancers in Indian men. *Int J Cancer*, 2003, 105, 681-686.

[6] Talamini, R; Bosetti, C; La Vecchia, C; Dal Maso, L; Levi, F; Bidoli, E; Negri, E; Pasche, C; Vaccarella, S; Barzan, L; Franceschi, S. Combined effect of tobacco and alcohol on laryngeal cancer risk: a case-control study. *Cancer Causes Control*, 2002, 13, 957-964.

[7] Do, KA; Johnson, MM; Doherty, DA; Lee, JJ; Wu, XF; Dong, Q; Hong, WK; Khuri, FR; Fu, KK; Spitz, MR. Second primary tumors in patients with upper aerodigestive tract cancers: joint effects of smoking and alcohol (United States). *Cancer Causes Control*, 2003, 14, 131-138.

[8] Pintos, J; Black, MJ; Sadeghi, N; Ghadirian, P; Zeitouni, AG; Viscidi, RP; Herrero, R; Contlee Fand Franco, EL. Human papillomavirus infection and oral cancer: a case-control study in Montreal, Canada. *Oral Oncol*, 2008, 44(3), 242-250.

[9] Haddad, R; Crum, C; Chen, Z; Krane, J; Posner, M; Li, Y; Burk, R. HPV16 transmission between a couple with HPV-related head and neck cancer. *Oral Oncol*, 2008, 44(8), 812-815.

[10] Cordeiro, PG; Hidalgo, DA. Conceptual considerations in mandibular reconstruction. *Clin Plast Surg*, 1995, 22(1), 61–69.

[11] Ma¨ kitie, AA; Beasley, NJ; Neligan, PC; Lipa, J; Gullane, PJ; Gilbert, RW. Head and neck reconstruction with anterolateral thigh flap. *Otolaryngol Head Neck Surg*, 2003, 129, 547–555.

[12] Sinha, UK; Young, P; Hurvitz, K; Crockett, DM. Functional outcomes following palatal reconstruction with a folded radial forearm free flap. *Ear Nose Throat J*, 2004, 83, 45–48.

[13] Park, CW; Miles, BA. The expanding role of the anterolateral thigh free flap in head and neck reconstruction. *Curr Opin Otolaryngol Head Neck Surg*, 2011 (19), 263-268.
[14] Wong, CH; Wei, FC. Microsurgical Free Flap in Head and Neck Reconstruction. *Head Neck*, 2010, 32(9), 1236-1245.
[15] Lin, PY; Lin, KC; Jeng, SF. *Oromandibular Reconstruction: The History, Operative Options and Strategies, and Our Experience*. ISRN Surgery 2011:824251. doi: 10. 5402/2011/824251. Epub 2011 Dec 12.
[16] Yu, P. Reinnervated anterolateral thigh flap for tongue reconstruction. *Head Neck*, 2004, 26, 1038–1044.
[17] Kimata, Y; Uchiyama, K; Ebihara, S; et al. Comparison of innervated and noninnervated free flaps in oral reconstruction. *Plast Reconstr Surg*, 1999, 104, 1307–1313.
[18] Kimata, Y; Sakuraba, M; Hishinuma, S; et al. Analysis of the relations between the shape of the reconstructed tongue and postoperative functions after subtotal or total glossectomy. *Laryngoscope*, 2003, 113, 905–909.
[19] Lyos, AT; Evans, GR; Perez, D; Schusterman, MA. Tongue reconstruction: outcomes with the rectus abdominis flap. *Plast Reconstr Surg*, 1999, 103, 442–449.
[20] Yu, P. Characteristics of the anterolateral thigh flap in a Western population and its application in head and neck reconstruction. *Head Neck*, 2004, 26, 759–769.
[21] Chana, JS; Wei, F-C. A review of the advantages of the anterolateral thigh flap in head and neck reconstruction. *Br J Plast Surg*, 2004, 57, 603–609.
[22] Harreus, U. Malignant neoplasms of the oropharynx. In: Flint PW, Haughey BH, Lund VJ, et al., editors. *Cummings otolaryngology-head and neck surgery*. 5th ed. Philadelphia: Mosby; 2010. 1365–1368.
[23] Gillespie, MB; Eisele, DW. The uvulopalatal flap for reconstruction of the soft palate. *Laryngoscope*., 2000, 110, 612–615.
[24] Tezel, E. Buccal mucosal flaps: a review. *Plast Reconstr Surg*., 2002, 109, 735–741.
[25] Lacombe, V; Blackwell, KE. Radial forearm free flap for soft palate reconstruction. *Arch Facial Plast Surg*. 1999, 1, 130–132.
[26] Schliephake, H; Neukam, FW; Schmelzeisen, R, et al. Long-term quality of life after ablative intraoral tumor surgery. *J Craniomaxillofac Surg*, 23, 243, 1995
[27] Wilson, KM; Rizk, NM; Armstrong, SL; et al. Effects of hemimandibulectomy on quality of life. *Laryngoscope*, 108, 1574, 1998
[28] Richards, AM. *Key Notes on Plastic Surgery*. 1st Edition, Blackwell Science Ltd., 2002.
[29] Chien, W; Varvares, MA; Hadlock, T; Cheney, M; Deschler, DG. Effects of aspirin and low-dose heparin in head and neck reconstruction using microvascular free flaps. *Laryngoscope*, 2005, 115, 973–976.
[30] Kroll, SS; Miller, MJ; Reece, GP; et al. Anticoagulants and hematomas in free flap surgery. *Plast Reconstr Surg*, 1995, 96, 643–647.
[31] Conrad, MH; Adams, WP, Jr. Pharmacological optimization of microsurgery in the new millennium. *Plast Reconstr Surg*, 2001, 108, 2088–2096.
[32] Penel, N; Lefebvre, D; Fournier, C; Sarini, J; Kara, A; Lefebvre, JL. Risk factors for wound infection in head and neck cancer surgery: A prospective study. *Head Neck*, 2001, 23, 447–455.

[33] Girod, DA; McCulloch, TM; Tsue, TT; Weymuller, EA, Jr. Risk factors for complications in clean-contaminated head and neck surgical procedures. *Head Neck* 1995, 17, 7–13.

[34] Penel, N; Lefebvre, D; Lefebvre, JL. Wound infection in head and neck cancer surgery. *Bull Cancer*, 1999, 86, 985–995.

[35] Kruse, AL; Luebbers, HT; Grätz, KW; Obwegeser, JA. Factors influencing survival of free-flap in reconstruction for cancer of the head and neck: a literature review. *Microsurgery*, 2010, 30(3), 242-8. doi: 10.1002/micr.20758.

[36] Wei, F; Seah, C; Tsai, Y; et al. Fibula osteoseptocutaneous flap for reconstruction of composite mandibular defects. *Plast Reconstr Surg*, 93, 294, 1994