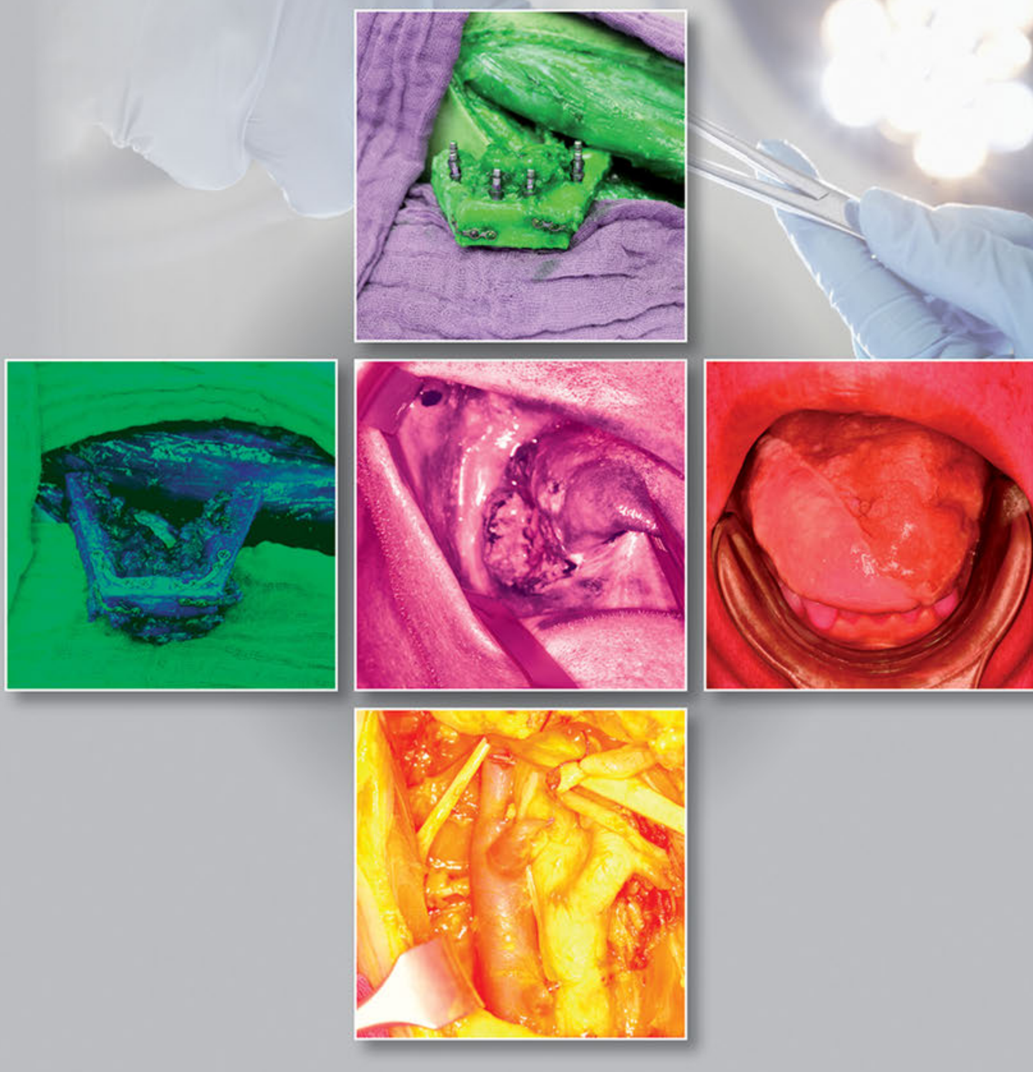
Oral Cancer Surgery: A Visual Guide

Marco Kesting



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Oral Cancer Surgery: A Visual Guide

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Inter omnes partes medicinae chirurgiae effectus evidentissimus

–Aulus Cornelius Celsus (Roman encyclopaedist)

Contents

Preface

Operative treatment for oral cancer is one of the most challenging fields in whole surgery. The perioral region is the only area of the body containing all types of tissue: muscle, bone, cartilage, skin, and mucosa. Because of this unique anatomy, ablative tumor surgery and reconstructive surgery remain very complex. On the one hand, the surgeon has to possess elaborate skills in handling the soft tissue, dealing with microvascular techniques and managing bone treatment including osteosynthesis. On the other hand, the surgeon has to prepare defined strategies to anticipate any upcoming surgical problem. Because there is an overwhelming repertoire of ablative and reconstructive procedures, it is hard for students, residents and young surgeons to find the right way to "survive in the operative jungle."

This book concentrates on key procedures that offer young surgeons the possibility to solve almost any case of oral cancer. Basic principles are didactically edited in series of pictures and/or diagrams. Traditional approaches are combined with innovative techniques. Anatomical introductions connect previous knowledge with the surgical procedures. Additionally, historic landmarks and recommendations regarding to the techniques are given in an informational, sometimes anecdotic style. The compact and concise character of the book should enable the resident to study, prepare, and recapitulate all issues regarding oral cancer surgery in a short time.

Marco Kesting, MD, DMD, FEBOMFS, Priv.-Doz.

Acknowledgments

This book would not have been possible without the support, discussion, and advice that I received from my most highly respected and honored academic teacher, Professor Klaus-Dietrich Wolff, over all the years that we have worked together. Thanks are also due to Dr. Dr. Florian Bauer, Dr. Andreas Fichter, Dr. Aakshay Gulati, cand. med. Daniela König, Dr. Dr. Kilian Kreutzer, Ali Kurt, Priv.-Doz. Dr. Dr. Thomas Mücke, Dr. Markus Nieberler, cand. med. Christopher-Philipp Nobis, Dr. Niklas Rommel, Dr. Dr. Nils Rohleder, Priv.-Doz. Dr. Elias Scherer, and Dr. Dr. Jochen Weitz for their inspiration, contributions, and proofreading.

Chapter 1

Airway Management

1.1 Tracheotomy

The success of oral cancer surgery depends on appropriate airway management; therefore, tracheotomy is a key procedure.

1.1.1 History

2950 to 2800 BC

The first images of a tracheotomy may date as far back as Ancient Egypt. On two stone plates dated to the first dynasty (2950–2800 BC), two people are depicted sitting or kneeling next to each other, one of them touching the upper thorax of the other with a knifelike object. Whether these images in fact depict a tracheotomy is, however, highly controversial.

128 to 60 BC

From the writings of Galen (129–199 AD), we know that Asclepiades (128–60 BC), Cicero's personal physician who practiced medicine in Rome, suggested opening the trachea as a measure of last resort to avoid asphyxiation. Via the Arab world, the knowledge of this technique was eventually brought to the Occident under the name of "subscannatio," meaning "cutting the throat."

1546

Antonio Musa Brassavola from Ferrara (1500–1555) performed and published the first documented case of a successful tracheotomy in 1546. The patient was on the verge of death from "an abscess in the windpipe."

19th Century to Today

Tracheotomy became a routine operation at the beginning of the 19th century for the treatment of diphtheria. The French physician Pierre Bretonneau (1778–1862) and his apprentice Armand Trousseau (1801–1867) established a standardized procedure, which was later adapted throughout Europe. However, this procedure was still considered controversial, as can be seen in the circumstances of George Washington's death in 1799. The first president of the United States of America presumably suffered from a severe case of laryngitis. His personal physician, who had heard of tracheotomy but had not actually performed the procedure himself, decided not to perform his first tracheotomy on a person of such high rank, instead relying on traditional techniques. George Washington died, perhaps not surprisingly, after losing about 2.5 L of blood from four bloodlettings within 12 hours. Chevalier Jackson (1865–1958), professor for laryngology at Pittsburgh University, achieved the next breakthrough in tracheotomy. He departed from the tradition of high tracheostomy, which was performed to preserve the thyroid gland and pretracheal vessels. By implementing the new technique of the "cricoid cartilage should never be cut," the problem of laryngeal stenosis was solved.

Whereas, at the beginning of the last century, tracheotomy was basically an emergency procedure used in cases of upper airway obstruction, this indication is the exception nowadays. Tracheotomy today is the most common surgical procedure performed in long-time ventilated intensive care patients.

1.1.2 Relevant Anatomy for Tracheotomy

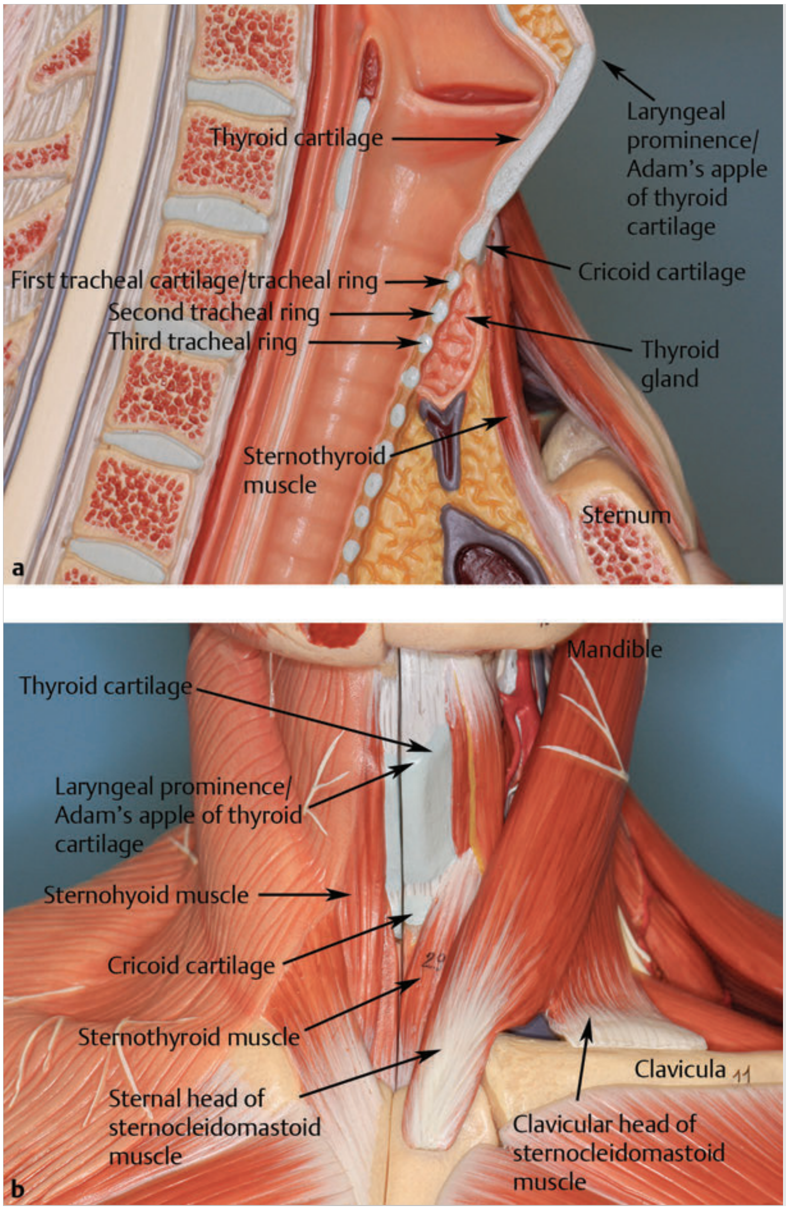

Fig. 1.1a, b Anatomy of the infrahyoid region and the jugular notch (sagittal and frontal view), shown on anatomic torso model (SOMSO, Coburg, Germany). Keep to the dogma "cricoid cartilage should never be cut" and cut between the second and the third tracheal ring.

1.2 Technique of Tracheotomy

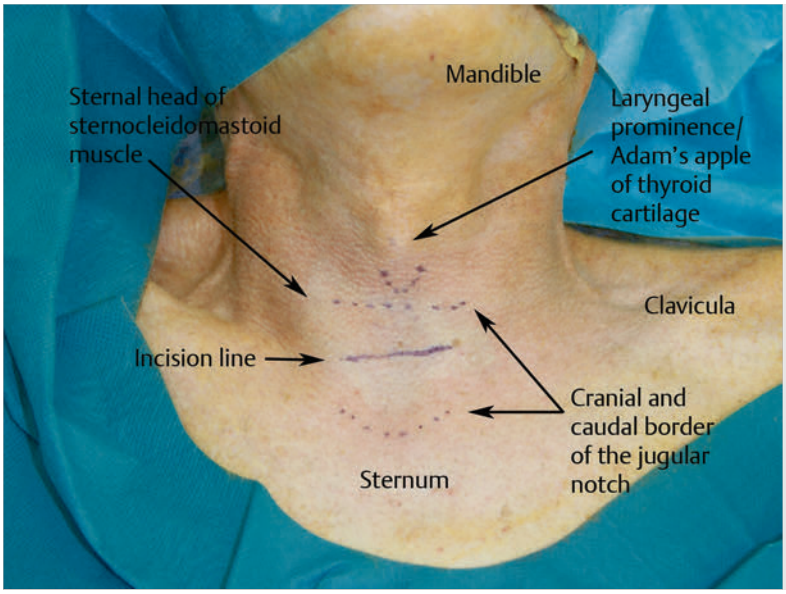

Fig. 1.2 Anatomic landmarks for skin incision. The leading landmarks are the laryngeal prominence of the thyroid cartilage and the jugular notch. The incision is made halfway between the laryngeal prominence and the caudal border of the jugular notch.

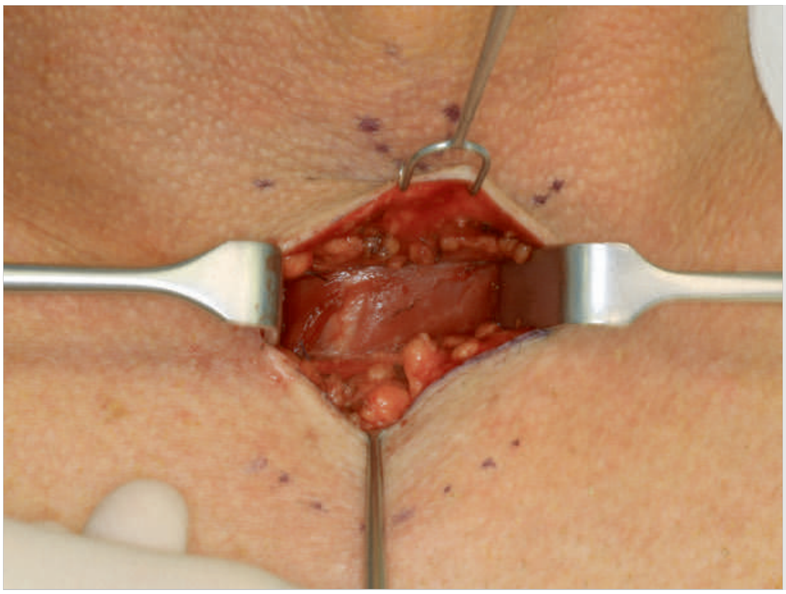

Fig. 1.3 Incision of skin, subcutaneous fatty tissue down to the sternothyroid muscle.

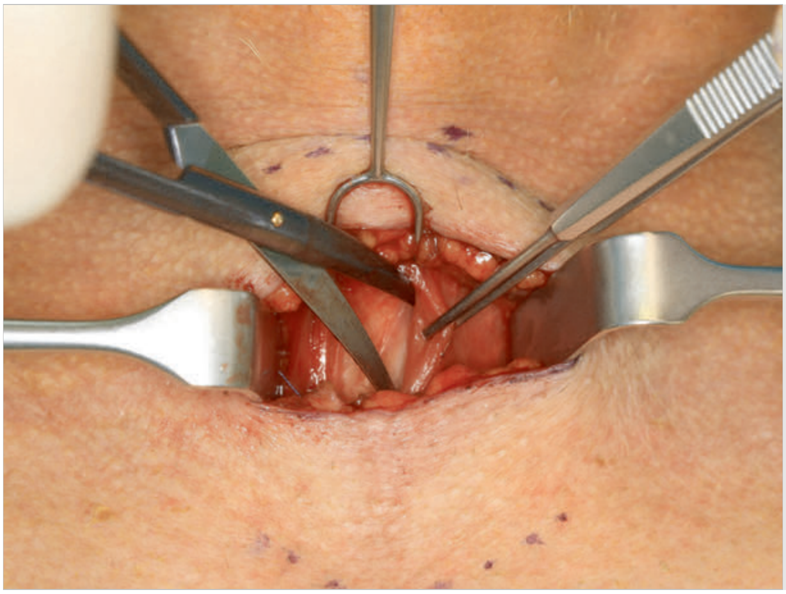

Fig. 1.4 Midline division and undermining of the sternothyroid muscle.

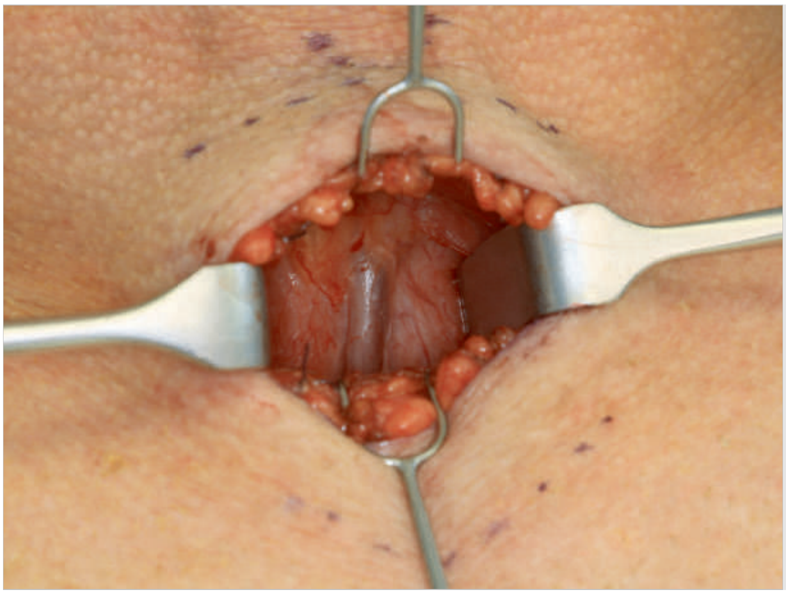

Fig. 1.5 Thyroid gland with overlying vein becomes visible.

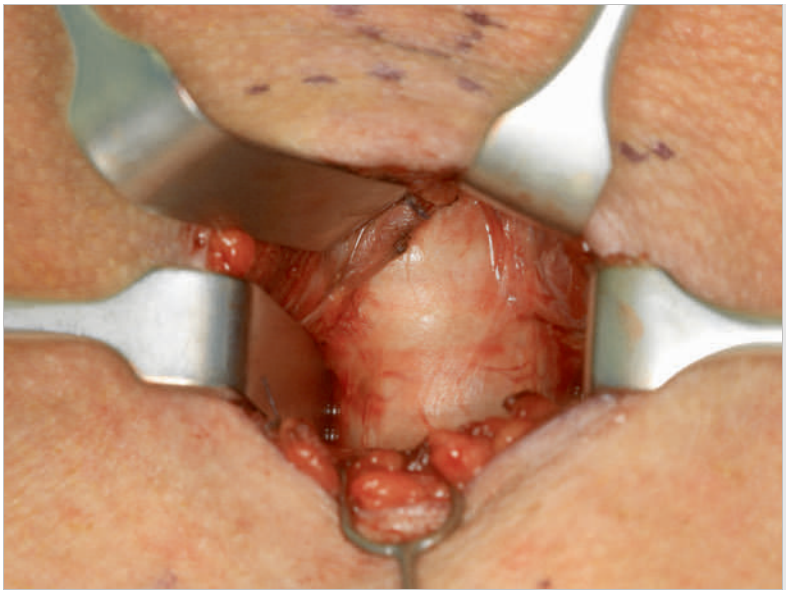

Fig. 1.6 Thyroid gland is retracted in cranial direction, trachea becomes visible.

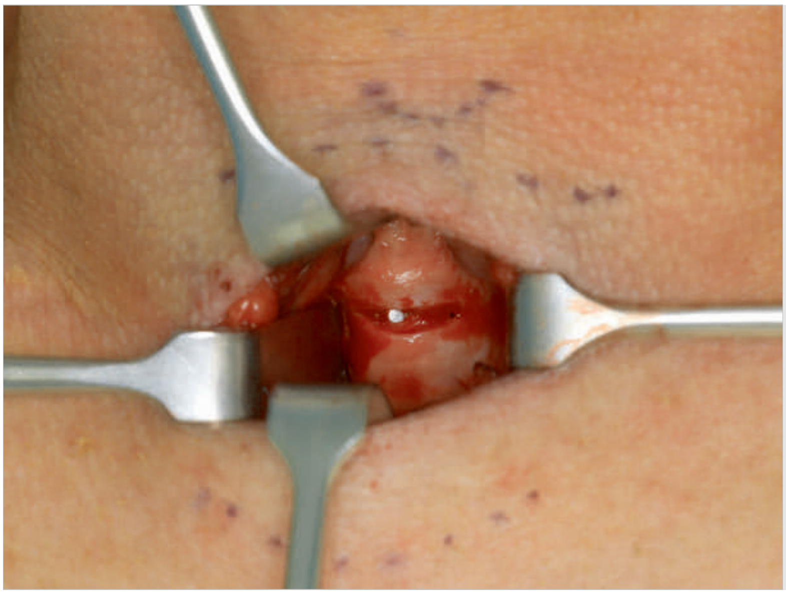

Fig. 1.7 Transverse incision of the trachea between the second and third tracheal rings.

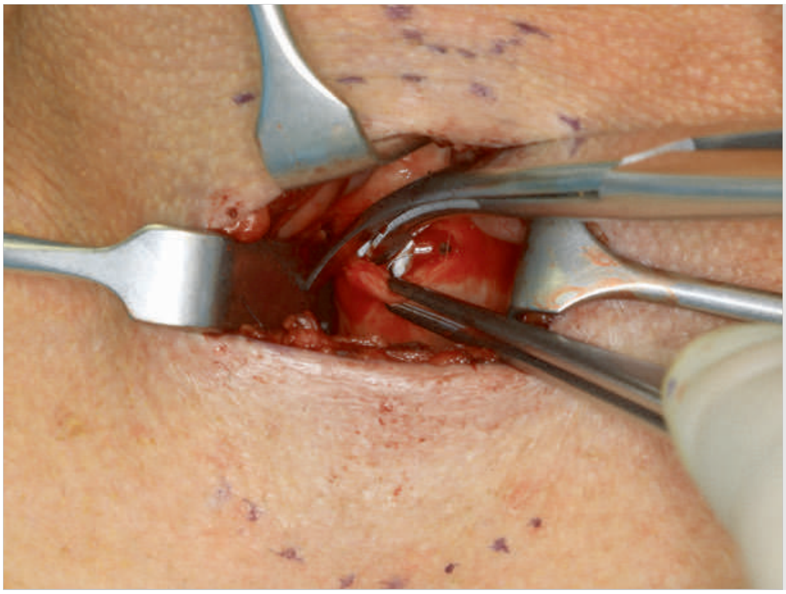

Fig. 1.8 Vertical lateral incisions of the trachea in caudal direction.

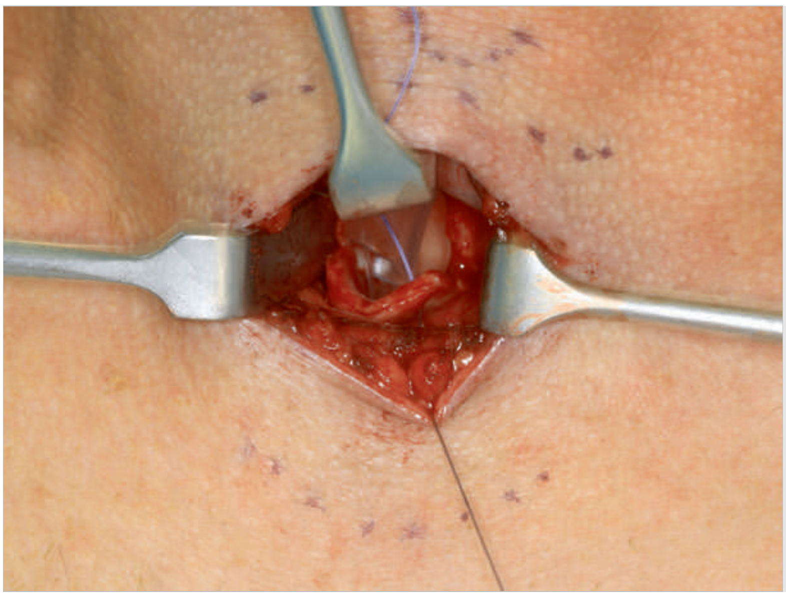

Fig. 1.9 The inversely U-shaped tracheal plate is fixed with two 2–0 Vicryl sutures (Ethicon, Somerville, NJ) to the subcutaneous tissue.

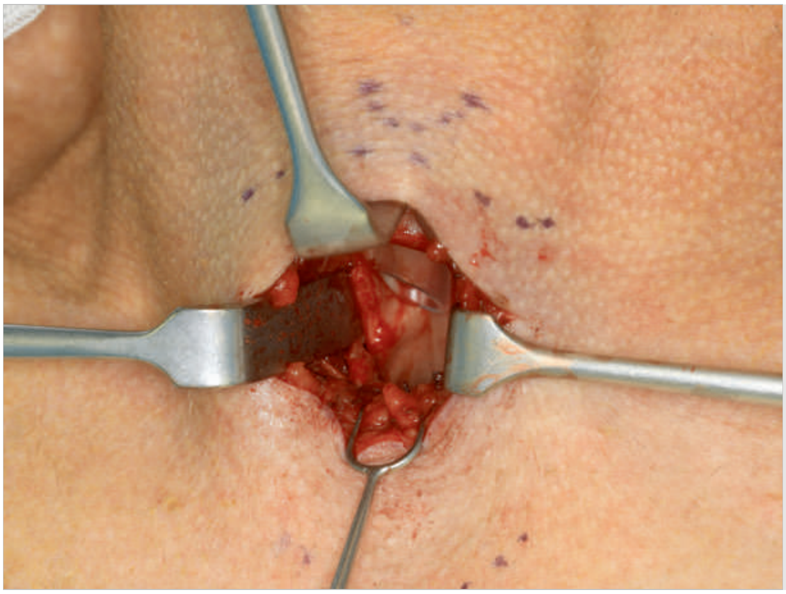

Fig. 1.10 The nasopharyngeal tube is pulled out.

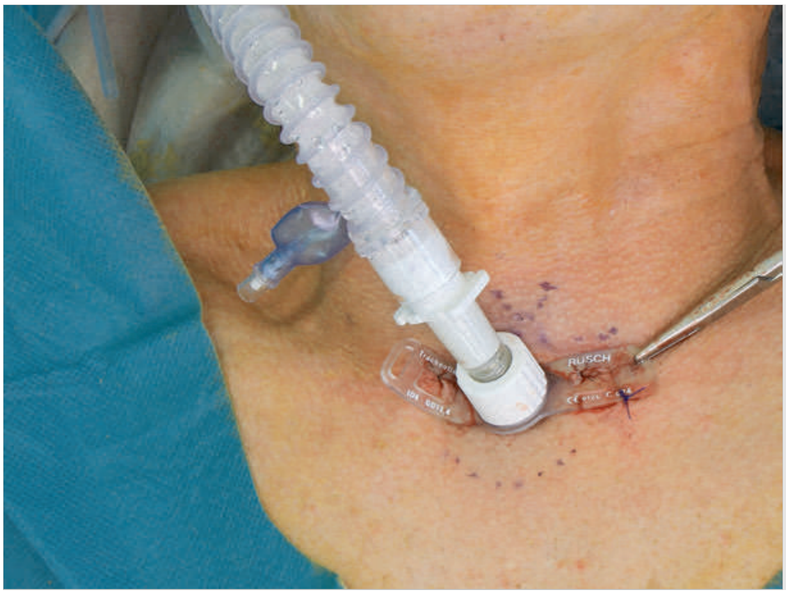

Fig. 1.11 Insertion of the tracheal tube and lateral fixation of the tracheal tube to the skin.

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Chapter 2

Lymph Node Management

2

2.1 General Overview of Neck Dissection

2.1.1 History

1888

Franciszek Jawdynski (1851–1896), a surgeon from Warsaw, was the first to perform a neck dissection in metastasizing head and neck carcinomas. He described an en bloc resection of the lymph nodes together with the carotid artery, the internal jugular vein, and the sternocleidomastoid muscle; unfortunately, because his description was in Polish, it did not gain much popularity.

1906

George Washington Crile (1864–1943), from Cleveland, Ohio, described his experience with 132 cases of radical neck dissection in head and neck carcinomas.

1962

Argentinian Osvaldo Suarez (1912–1972), from Cordoba, introduced in the Spanish literature his concept of the modified neck dissection with preservation of one or more nonlymphatic structures. It was reported that he did a modified neck dissection in an astonishing 20 minutes. After some visits to Argentina, Ettore Bocca (1914–2003), from Ferrara, Italy, popularized the modified neck dissection in English language publications.

2.1.2 Classification and Clinical Management

As a basic principle, ipsilateral neck dissection of levels I to III is performed in all carcinomas of the oral cavity that have not been operated on previously. Bilateral neck dissection of levels I to III is categorically done when the intraoral malignancy extends over the midline. Neck dissection is started with dissection of the ipsilateral level II and III lymph nodes, which are immediately sent to a pathologist who performs instantaneous sections from the tissue. If lymph node metastasis is found, neck dissection is extended to levels IV and V on the ipsilateral side and levels I to III on the contralateral side.

Management of the clinical and radiological negative neck includes a functional neck dissection. Strict focus has to be paid to preserving the spinal accessory nerve (SAN), the sternocleidomastoid (SCM) muscle, and the internal jugular vein (IJV). Even in positive necks, these structures should be preserved when the lymph nodes can be dissected clearly off these structures.

Management of lymph node–positive necks with clear adherence of lymph node metastases to one of the mentioned structures includes a modified radical neck dissection. The adhered structure (SAN, SCM muscle, or IJV) has to be included in the dissection.

Management of the lymph node–positive neck with adherence of the lymph node metastasis to all three structures (SAN, SCM muscle, and IJV) includes a radical neck dissection.

There is no evidence-based clinical benefit in resecting the neck dissection specimen en bloc. Therefore, splitting the neck dissection levels in stages is preferred as shown in the following techniques of neck dissection. This approach facilitates the postoperative tumor board review discussion. The exact pinpointing of cervical metastasis for adjuvant radiotherapy is alleviated.

2.1.3 Relevant Anatomy of the Neck

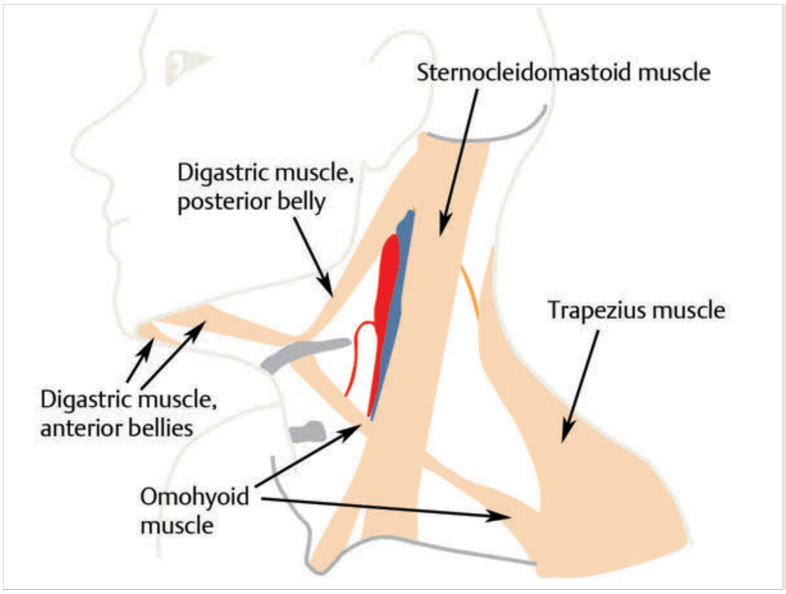

Fig. 2.1 Important muscular landmarks.

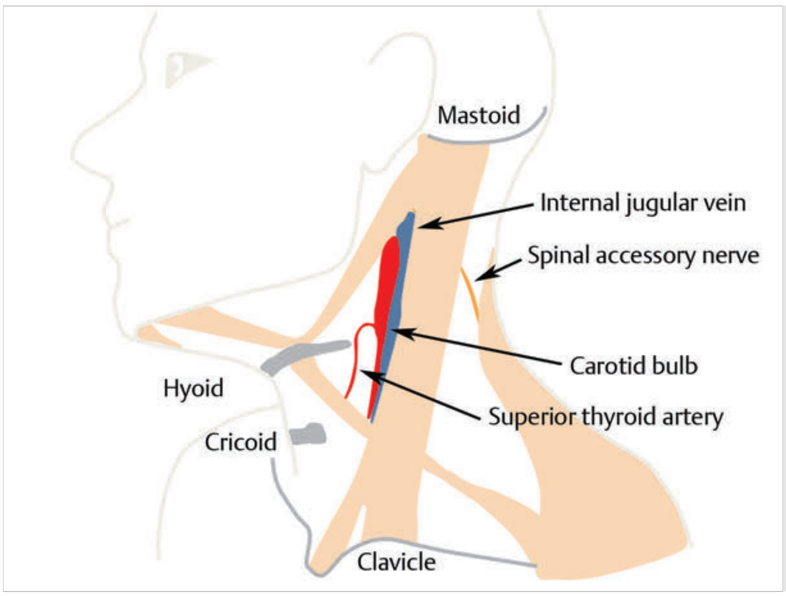

Fig. 2.2 Important vascular, nerval, and bony landmarks.

2.1.4 Definition and Description of the Cervical Lymph Node Groups: Levels and Sublevels of the Neck

I. Submental and submandibular nodes
  Ia) Submental triangle
  Ib) Submandibular triangle
II. Upper jugular nodes
  IIa) Nodes located medial to the vertical plane defined by the SAN
  IIb) Nodes located lateral to the vertical plane defined by the SAN
III. Middle jugular nodes
IV. Lower jugular nodes
V. Posterior triangle group
  Va) Nodes above the cricoid
  Vb) Nodes below the cricoid

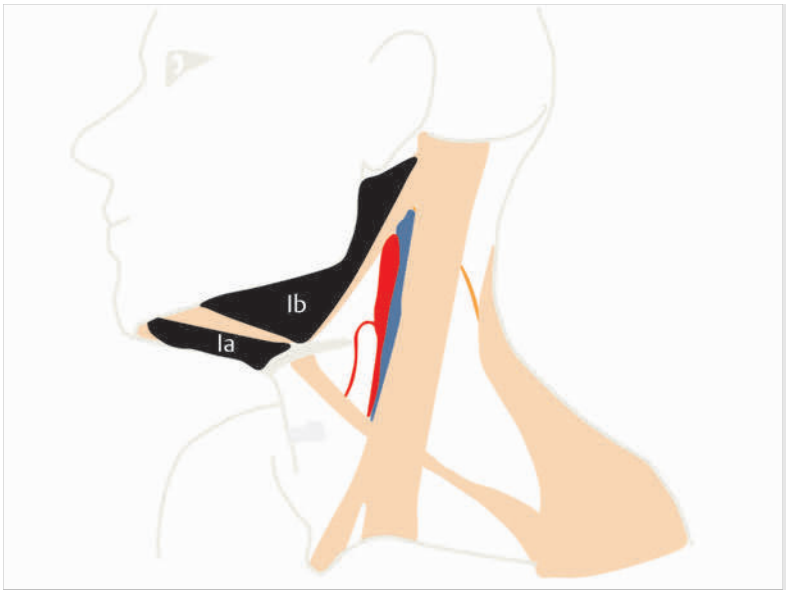

Fig. 2.3 Level I is bound by the body of the mandible superiorly, posterior belly of the digastric muscle posteriorly, and the anterior belly of the digastric muscle on the contralateral side anteriorly. Level Ia is bound by the anterior bellies of the digastric muscles laterally, by the mylohyoid at its base, and by the hyoid bone caudally. Level Ib is formed by the anterior and posterior bellies of the digastric muscle and the body of the mandible.

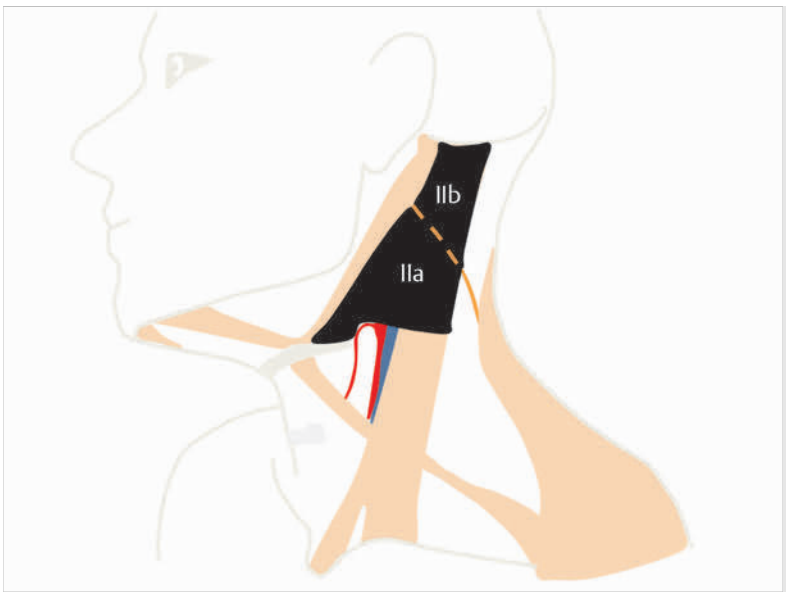

Fig. 2.4 Level II includes nodes of the upper third of the jugular vein, extending from the skull base to the inferior border of the hyoid bone. The region is defined by the digastric muscle superiorly and the hyoid bone and the carotid bifurcation inferiorly. Level II is divided into IIa and IIb by the SAN.

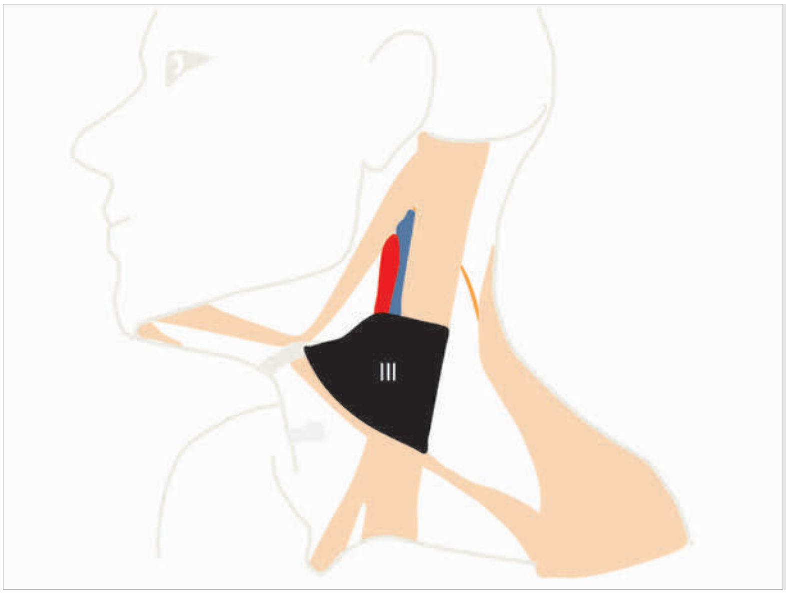

Fig. 2.5 Level III includes the middle third of the jugular nodes. The region extends from the carotid bifurcation and the hyoid bone superiorly to the omohyoid muscle inferiorly.

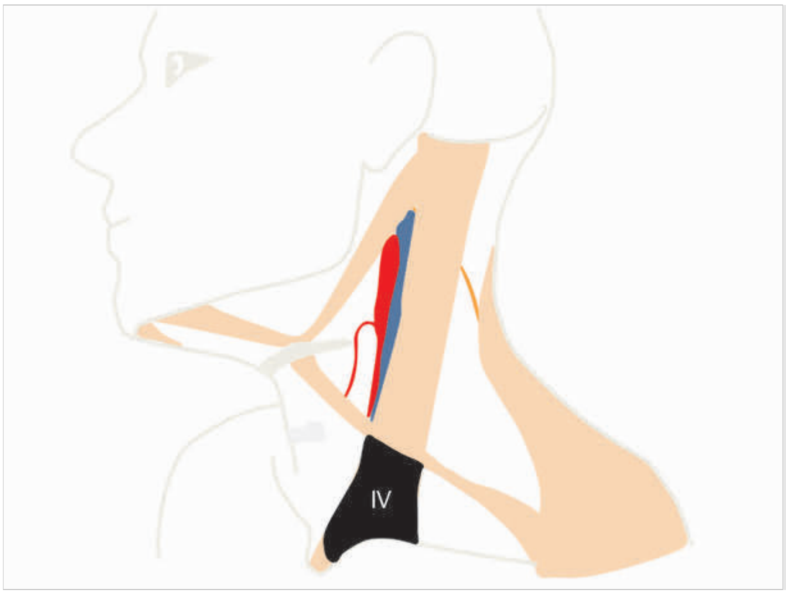

Fig. 2.6 Level IV includes lower jugular nodes extending from the omohyoid muscle superiorly to the clavicle inferiorly.

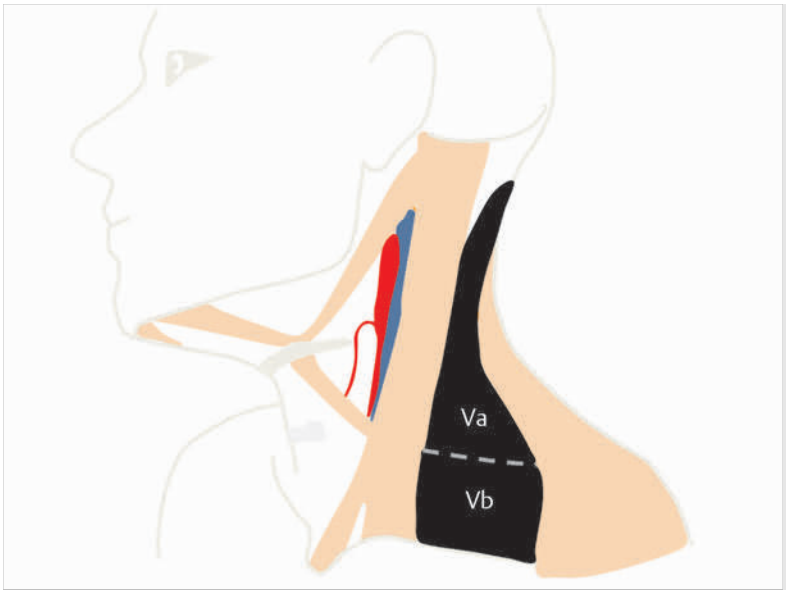

Fig. 2.7 Level V includes lymph nodes located along the lower half of the SAN and the transverse cervical artery, as well as the supraclavicular nodes. The region's posterior boundary is the anterior border of the trapezius muscle, the anterior boundary is the posterior border of the SCM muscle, and the inferior boundary is the clavicle. Level V is divided into Va and Vb by the cricoid.

2.2 Neck Dissection Levels I to III (Supraomohyoid Dissection)

2.2.1 Preliminary Considerations and Recommended Procedure

There is no evidence-based clinical benefit in resecting the neck dissection specimen en bloc. Splitting the neck dissection levels into stages A to E is therefore preferred, as illustrated in Fig. 2.8 and the following photo series "Technique of neck dissection" (Fig. 2.9 to 2.26). This approach facilitates the postoperative tumor board review discussion, especially with the pathologist. Exact pinpointing of cervical metastasis for adjuvant radiotherapy is alleviated.

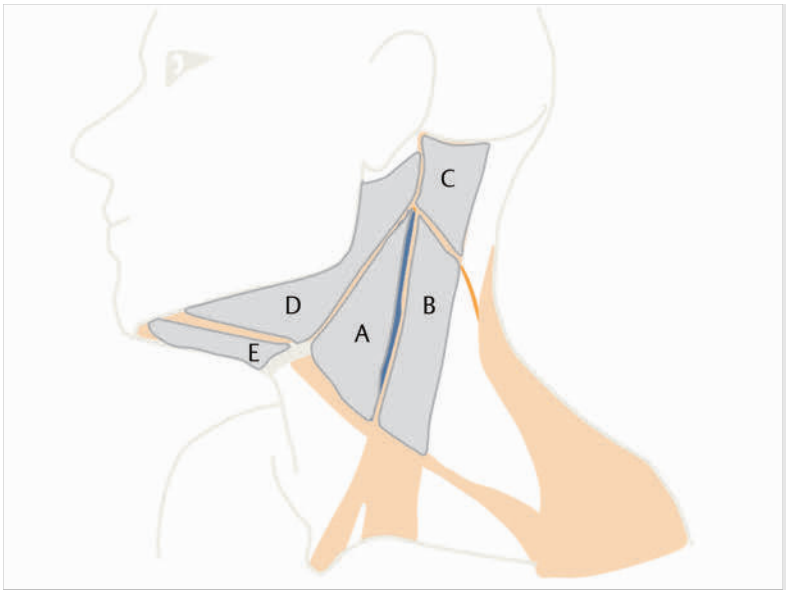

Fig. 2.8 Stages A to E of neck dissection levels I–III.

2.2.2 Technique of Neck Dissection Levels I to III

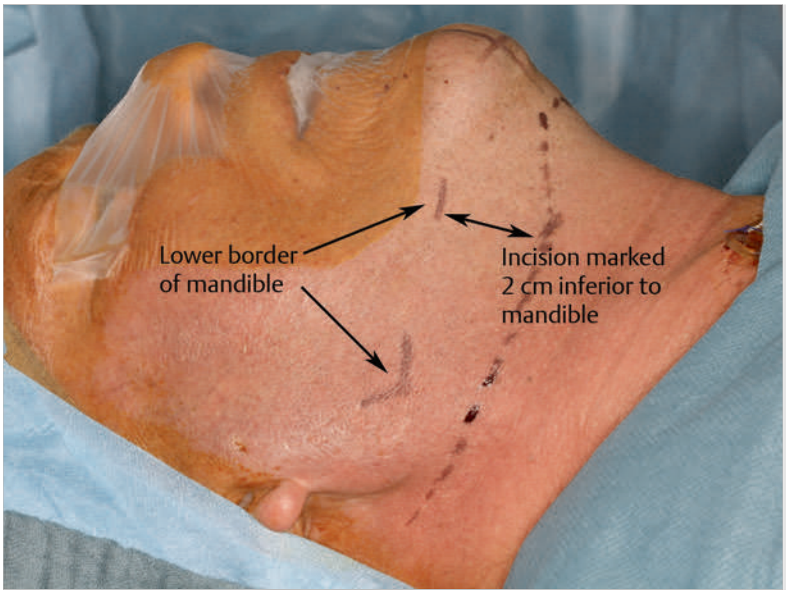

Fig. 2.9 Patient positioned with neck extended, appropriate draping, and antiseptic skin preparation. Incision line is marked 2 cm caudal to the mandibular margin.

Fig. 2.10 Infiltration of 5 mL local anaesthetic with 1:200,000 adrenaline.

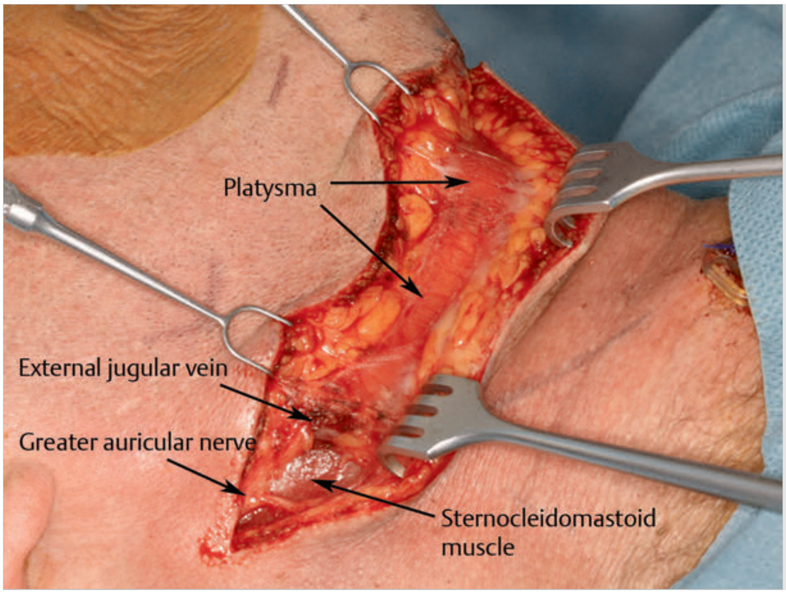

Fig. 2.11 Incision of skin and subcutaneous fatty tissue down to the platysma muscle. Posterior extent of the incision: point at which the greater auricular nerve crosses the posterior border of the SCM muscle. Anterior extent of incision: contralateral anterior belly of the digastric muscle.

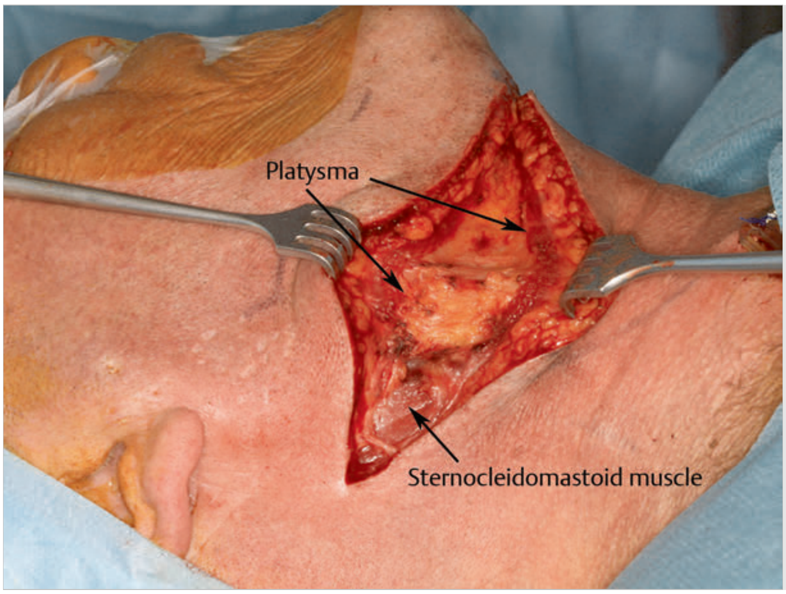

Fig. 2.12 Division of the platysma muscle and definition of the anterior margin of the SCM muscle.

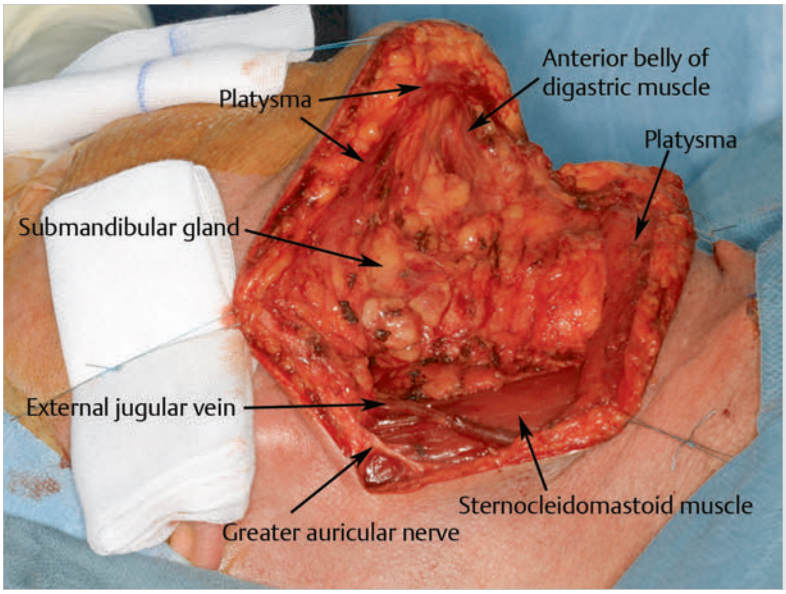

Fig. 2.13 Reflection of the platysma muscle cranially and caudally. Fixation of the skin–platysma flaps with sutures superiorly and inferiorly. Exposure of the ipsilateral anterior belly of digastric muscle down to the hyoid bone.

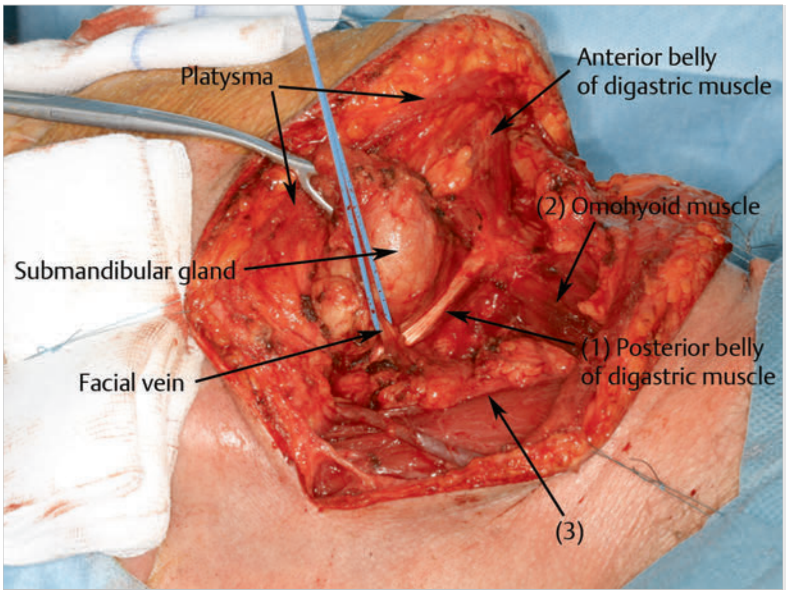

Fig. 2.14 Definition of the muscle landmarks: (1) Exposure of the posterior belly of the digastric muscle in anteroposterior direction to the point at which it is crossed by the facial vein; (2) exposure of the omohyoid muscle from the hyoid bone to the point at which it reaches the SCM muscle; and (3) exposure of the anterior border of the SCM muscle from its cranial origin to the point at which it is crossed by the omohyoid muscle.

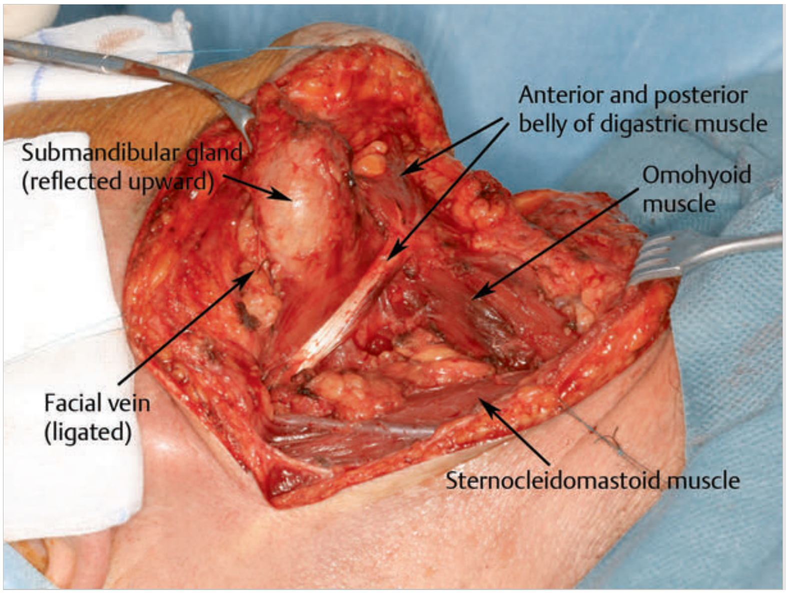

Fig. 2.15 Ligation of the facial vein and exposure of the posterior belly of the digastric muscle to the mastoid process.

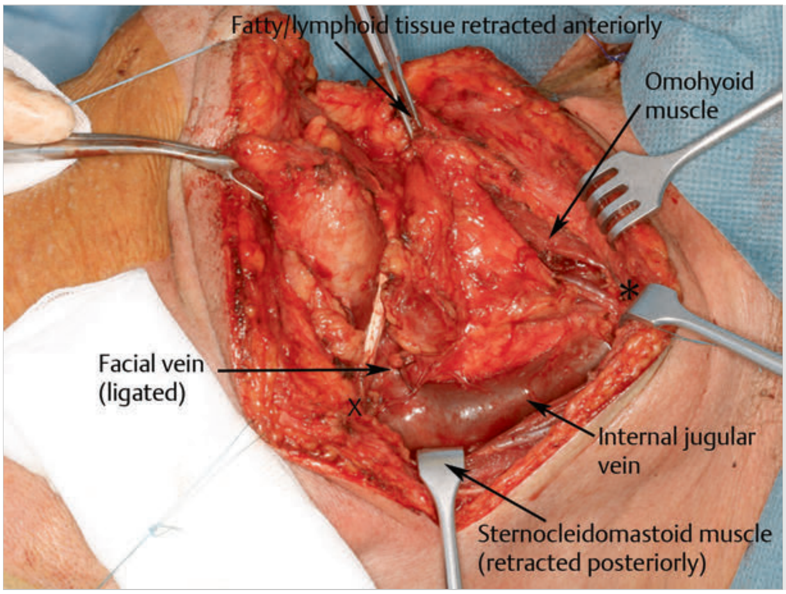

Fig. 2.16 Start removal of block A (Fig. 2.8). Facultative circumferential dissection of the IJV (lateral, anterior, and medial surfaces have to be dissected necessarily). Inferior limit of dissection of the IJV: the level of omohyoid and SCM muscle crossing (*). Superior limit of dissection of the IJV: the point at which the IJV is crossed by the posterior belly of the digastric muscle (X).

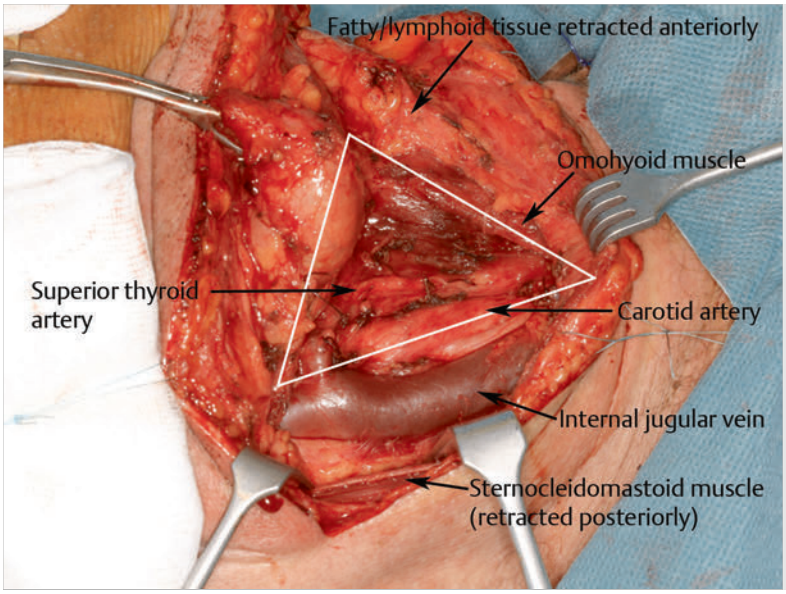

Fig. 2.17 Block A (Fig. 2.8)—the fatty/lymphoid tissue overlying the carotid artery and the superior thyroid artery—is removed. The tissue block is bounded by an anatomic triangle formed by the IJV, the omohyoid muscle, and the posterior belly of the digastric muscle.

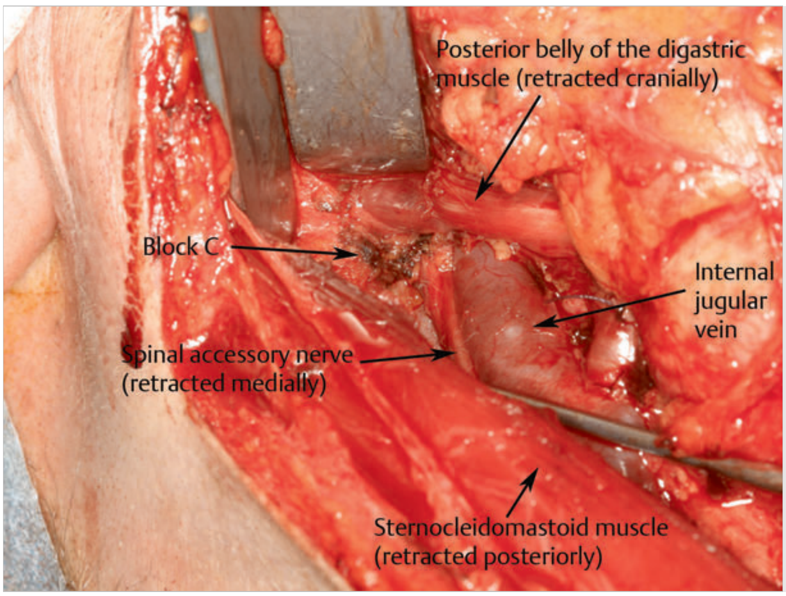

Fig. 2.18 Identification of the SAN, which can be found in close proximity to the meeting point of the IJV and the posterior belly of the digastric muscle. The nerve runs along the line, bisecting the right angle formed by the IJV and the posterior belly of the digastric muscle. Dissection of the SAN deep to the SCM muscle.

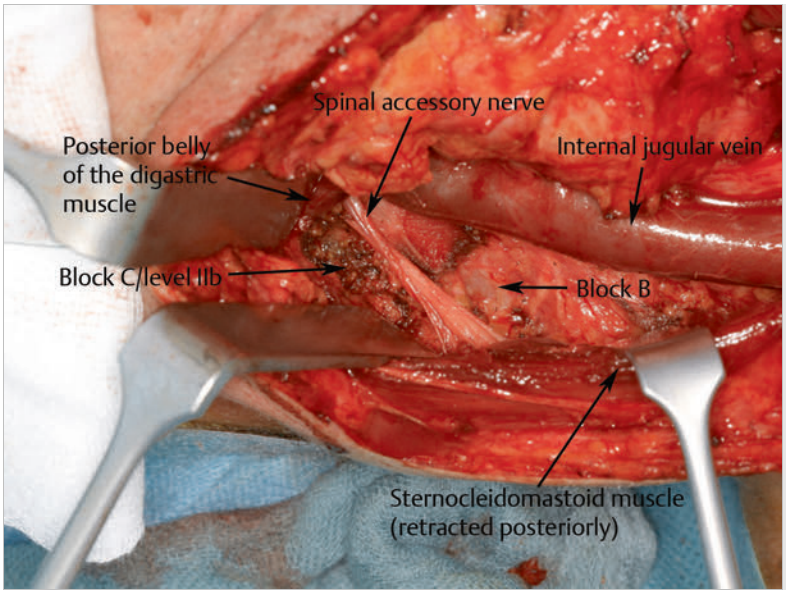

Fig. 2.19 Removal of block B (Fig. 2.8), the fatty/lymphoid tissue located caudal to the SAN, posterior of the IJV, and cranial to the crossing point of the omohyoid/SCM muscles. Removal of the fatty/lymphoid tissue located caudal to the mastoid process, cranial to the SAN, and anterior to the SCM muscle (block C, Fig. 2.8); beware of bleeding from the occipital artery.

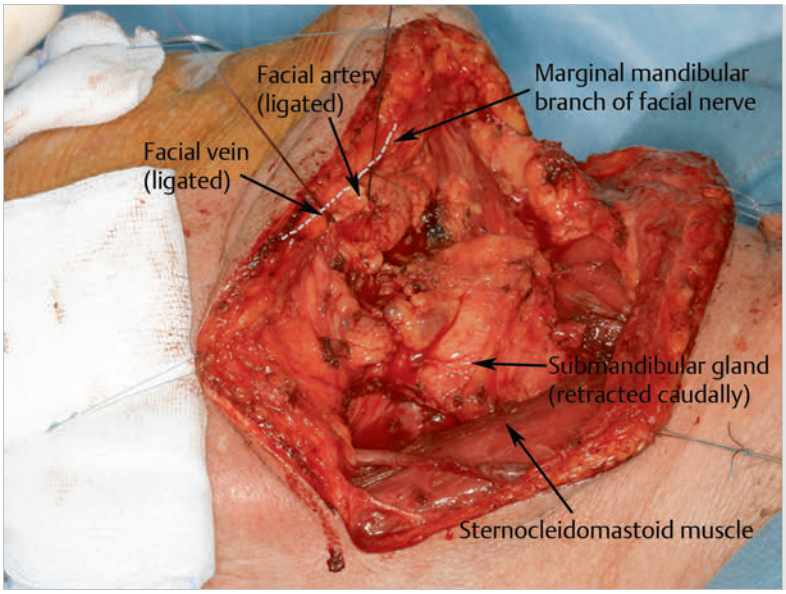

Fig. 2.20 Ligation of the facial vein and artery (can be palpated at the mandibular margin). The mandibular marginal branch (highlighted by dotting) of the facial nerve can be protected by retracting the ligated facial vessels in a cranial direction. Dissection of the contents of the submandibular triangle (block D, Fig. 2.8) from the periosteum of the mandible.

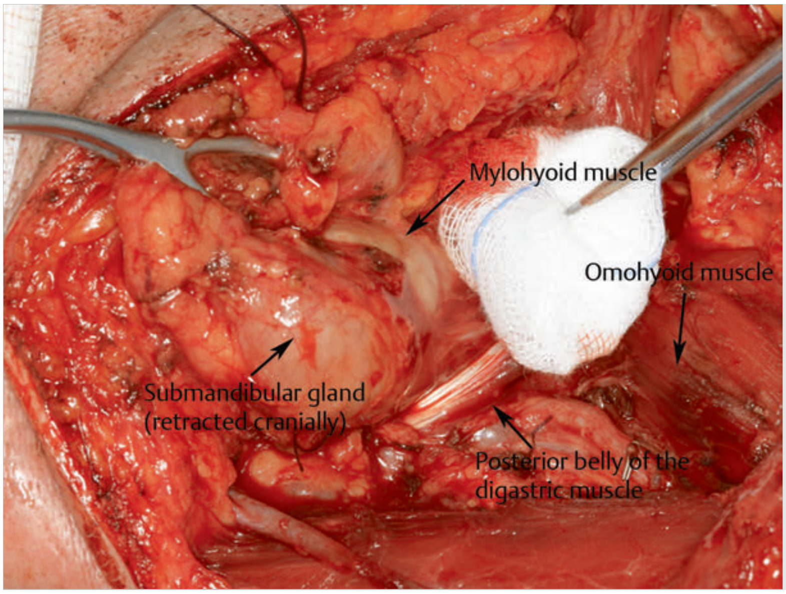

Fig. 2.21 Blunt dissection of the submandibular triangle contents from the mylohyoid muscle anteriorly and from the posterior belly of the digastric muscle caudally.

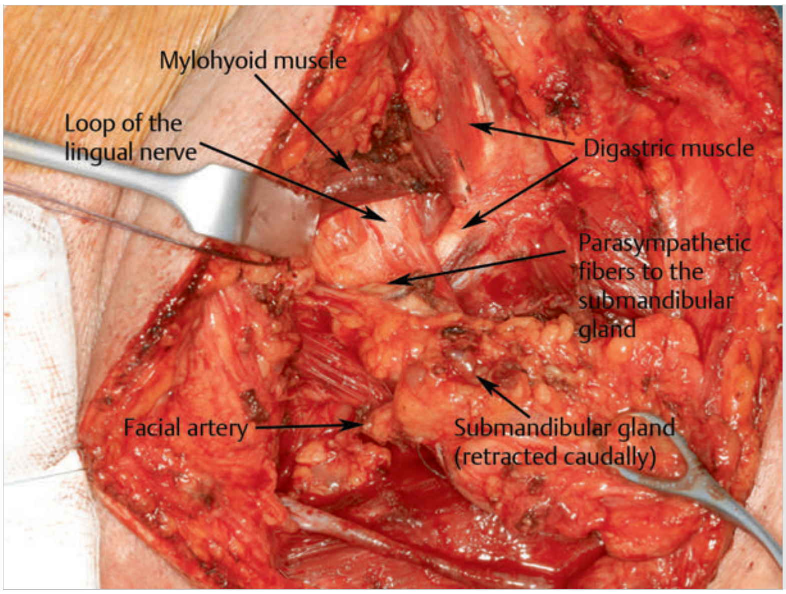

Fig. 2.22 Dissection of the loop of the lingual nerve and identification of the parasympathetic fibers to the submandibular gland.

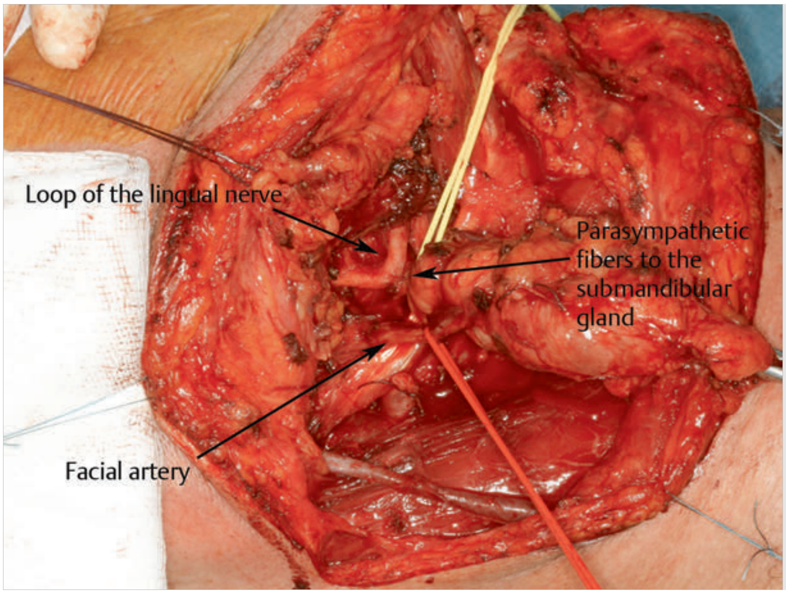

Fig. 2.23 Parasympathetic fibers to the submandibular gland are highlighted by a yellow vessel loop. The proximally pedicled facial artery is highlighted by a red vessel loop. Ligation of both of the structures and removal of the block D (Fig. 2.8) contents.

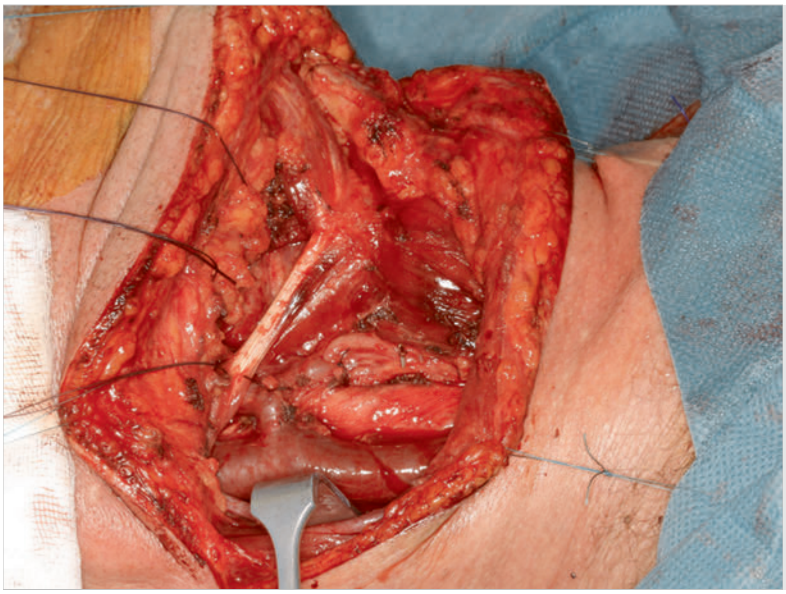

Fig. 2.24 Appearance following removal of levels Ib, II, and III (blocks A to D, Fig. 2.8) contents.

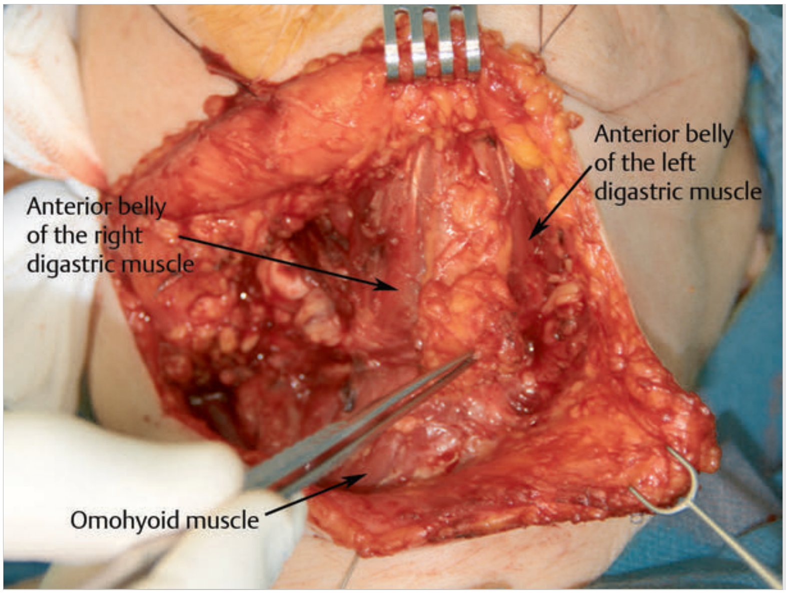

Fig. 2.25 Finally, block E (Fig. 2.8), which is located between the anterior bellies of the digastric muscles, the mylohyoid muscle, and the hyoid bone, is resected.

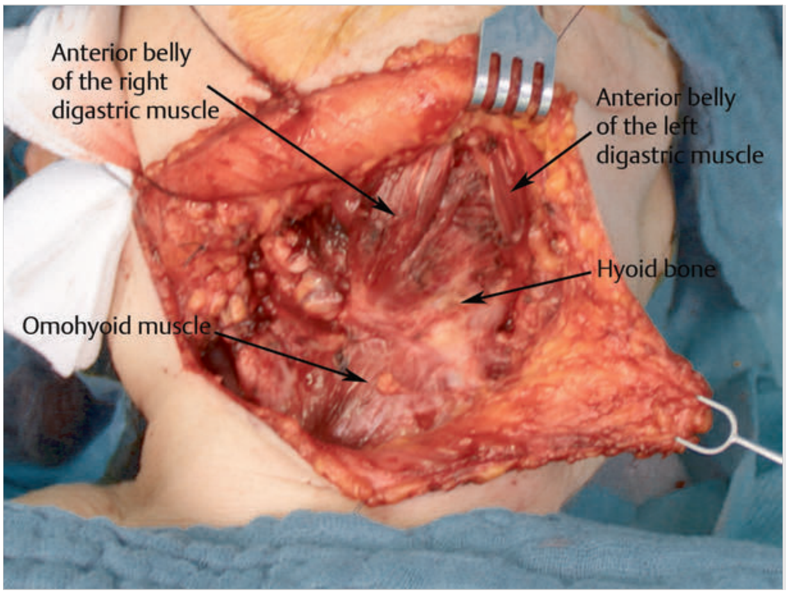

Fig. 2.26 Final appearance after resection of lymphatic and fatty tissue block E (Fig. 2.8).

2.3 Neck Dissection Levels IV and V

2.3.1 Preliminary Considerations and Recommended Approaches

- Level IV dissection is possible by gaining the same access as recommended for levels I to III; please be aware of the thoracic duct on the left side as there is limited access in the caudal region.
- The horizontal access to levels I to III generally allows two variations for extended access to level IV and V nodes: MacFee and a modified Schobinger approach (Fig. 2.27).
- Irradiated neck: the MacFee approach leads to less wound healing disturbances.
- Modified Schobinger incision: better access to the posterior triangle and the complete course of the accessory nerve.
- Modified Schobinger incision: angle of the cranioposterior tip has to be at least 90°; therefore, take care that the posterior incision for the level I to III dissection is not extended cranially to the mastoid/ear lobe region—otherwise, tip necrosis may occur. Downward incision follows the anterior border of the trapezius muscle.
- Recommendation: use modified Schobinger approach, but discuss MacFee incision in irradiated patients and patients with a short neck.

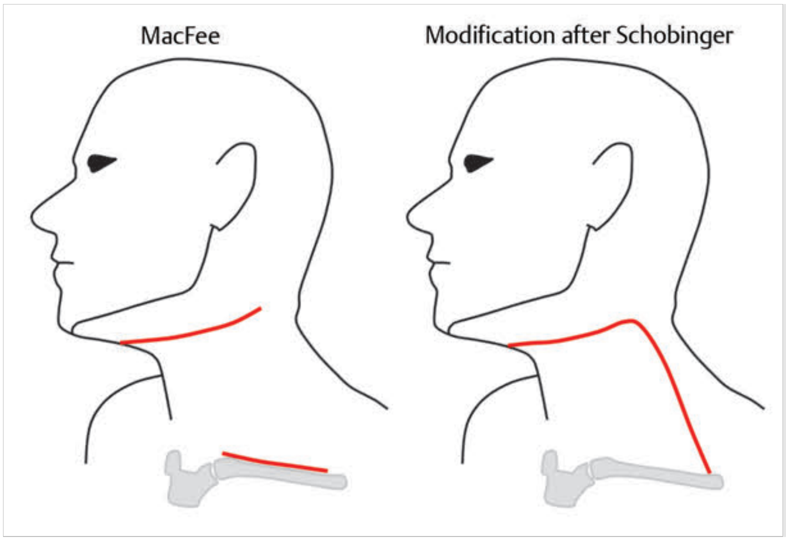

Fig. 2.27 MacFee incision and modified Schobinger approach to levels IV and V.

2.3.2 Relevant Anatomy for Level V Dissection

- The leading landmark for dissection of level V is the greater auricular nerve.
- The most severe malpractice that can occur during dissection of level V is injury of the SAN.
- Location of the SAN: 1 cm cranial of the point where the greater auricular nerve fades away behind the posterior border of the SCM muscle (Fig. 2.28).

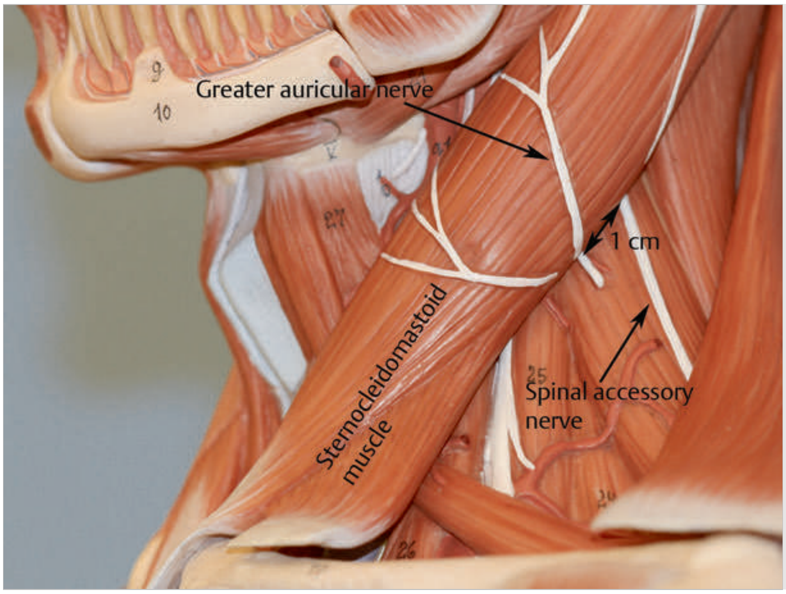

Fig. 2.28 Anatomy of the lateral posterior triangle (landmarks: SCM muscle, trapezius muscle, clavicle), shown on anatomic torso model (SOMSO, Coburg, Germany).

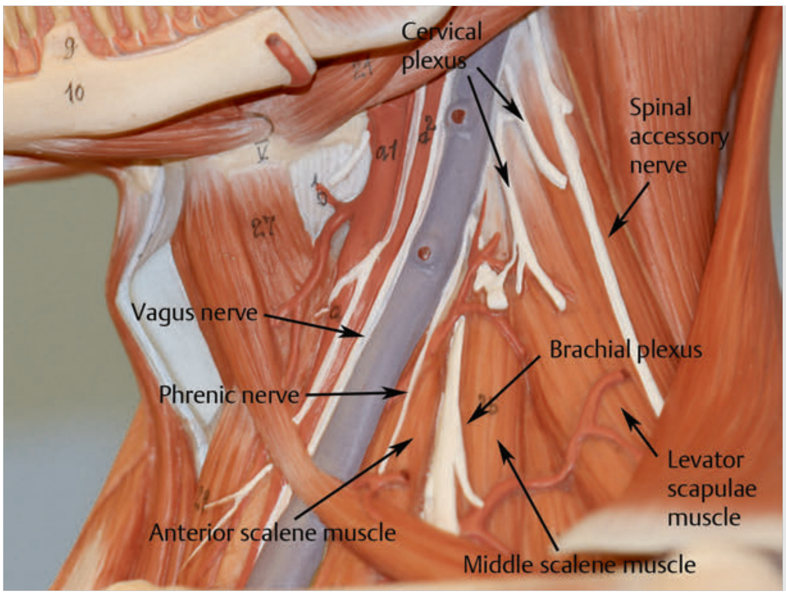

Fig. 2.29 Anatomy of the lateral posterior triangle after removal of the SCM muscle, shown on anatomic torso model (SOMSO).

2.3.3 Technique of Posterior Neck Dissection (MacFee Approach)

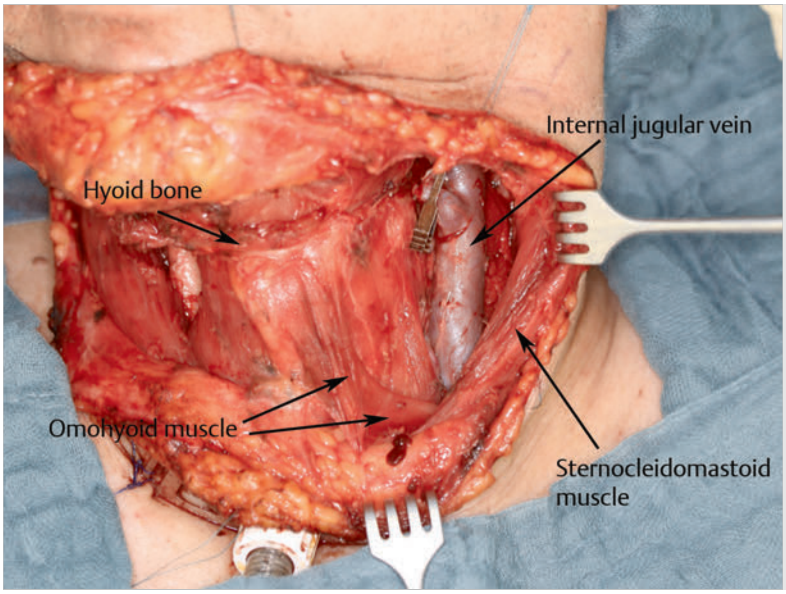

Fig. 2.30 View following neck dissection of levels I to III, anterior view.

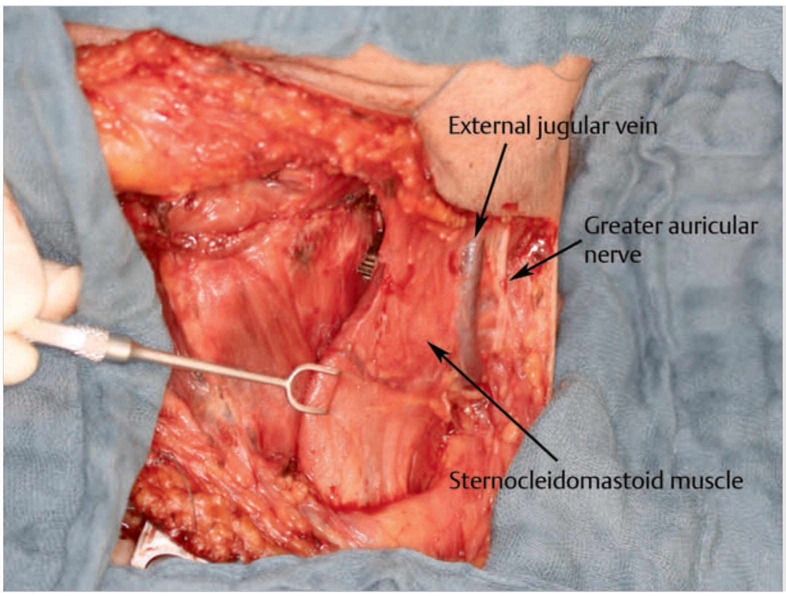

Fig. 2.31 Visualization of the external jugular vein and the greater auricular nerve on the SCM muscle surface, anterolateral view.

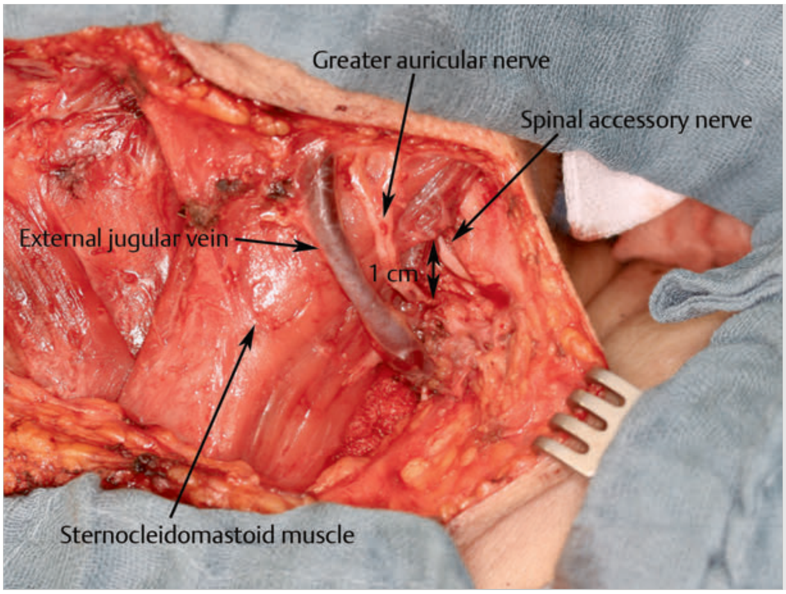

Fig. 2.32 Preparation of the posterior border of the SCM muscle and exposure of the point at which the greater auricular nerve disappears behind the SCM muscle. Following the posterior border from that point 1 cm superiorly to the mastoid, the SAN becomes visible.

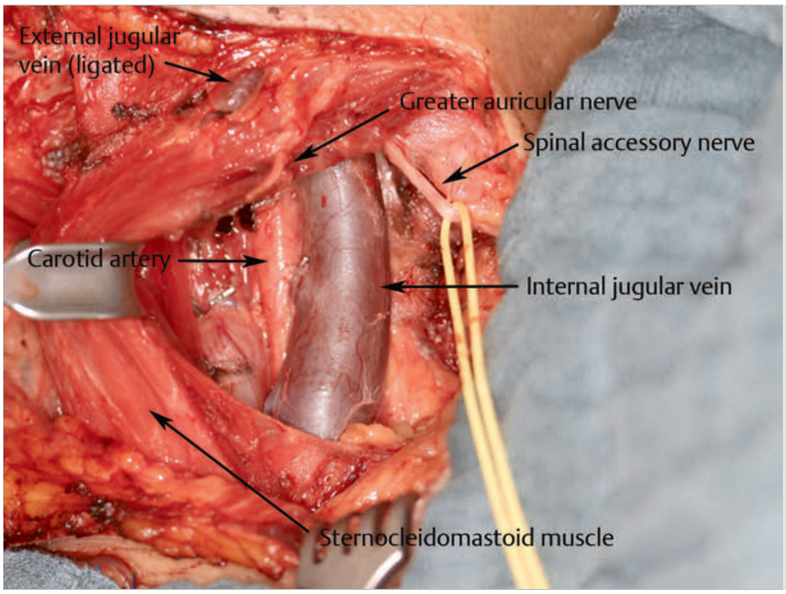

Fig. 2.33 Dissection of the SAN in distal direction, resulting in visualization of the anterior border of the trapezius muscle. Dissection of the fat and lymphoid tissue located caudally and anteriorly of the SAN from the deep cervical fascia. Do not cut the deep cervical fascia.

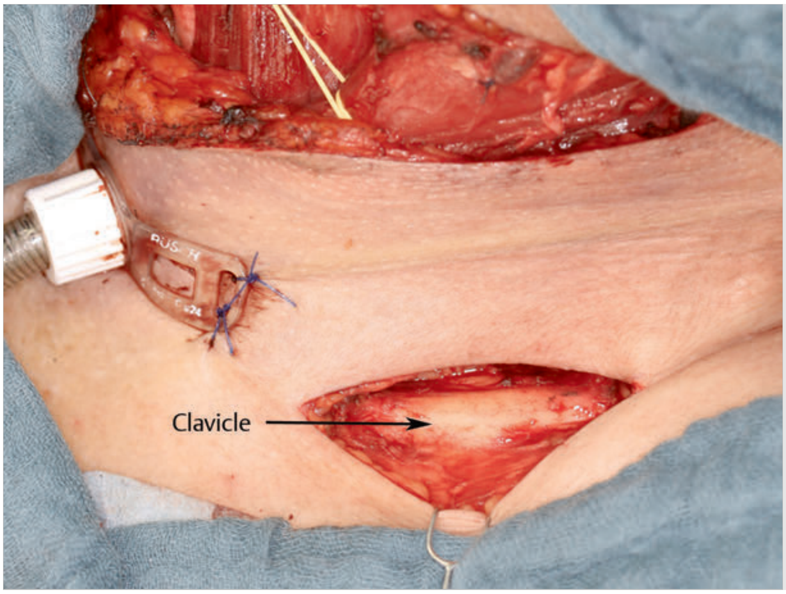

Fig. 2.34 In short necks: second incision at the level of the clavicle (MacFee incision). Subcutaneous dissection in cranial direction to preserve a skin bridge.

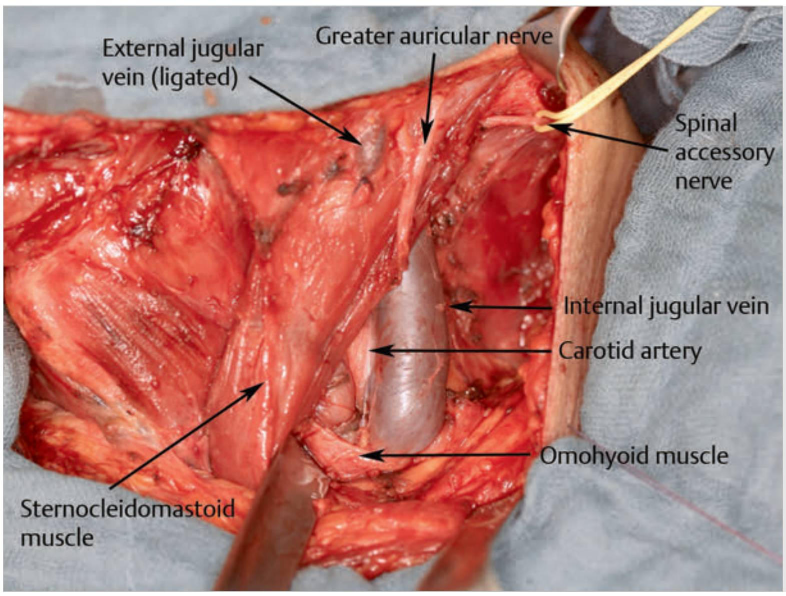

Fig. 2.35 Retraction of the SCM muscle in an anterior direction and the skin bridge in a caudal direction. Preparation of the IJV in a caudal direction and visualization of the intermediate tendon of the omohyoid muscle crossing the IJV. Exposure of the inferior part of the omohyoid muscle to the point at which it is crossed by the clavicle.

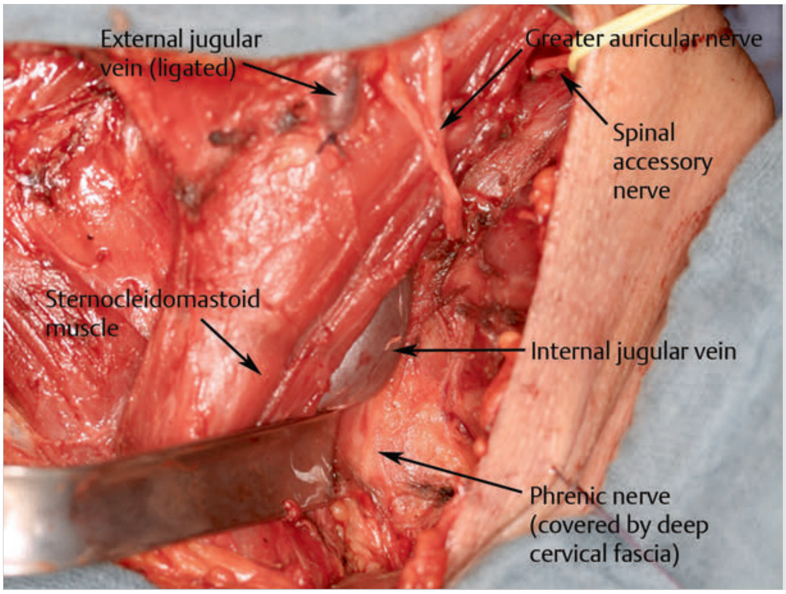

Fig. 2.36 Removal of the fatty and lymphoid tissue package from an anterior (IJV) to posterior (trapezius muscle) direction; avoid cutting the deep cervical fascia. Ligation of the transverse cervical artery and its comitant vein, which runs through the above-mentioned package. Avoid subclavicular preparation which may cause thoracic duct injury on the left side. Avoid injury of the phrenic nerve running anteriorly of the anterior scalene muscle and of the brachial plexus passing between the anterior and middle scalenes.

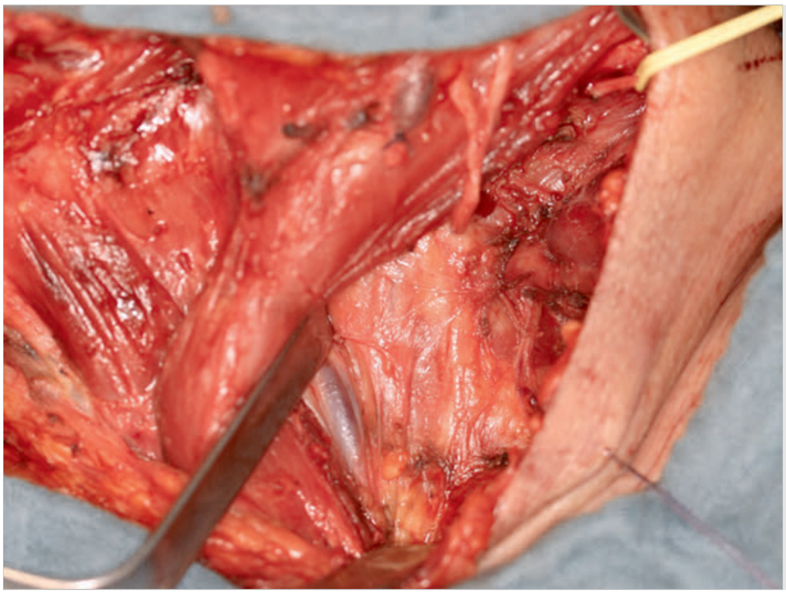

Fig. 2.37 Status after removal of levels IV and V.

2.3.4 Alternative Approaches for Levels I to V

Modified Schobinger Approach

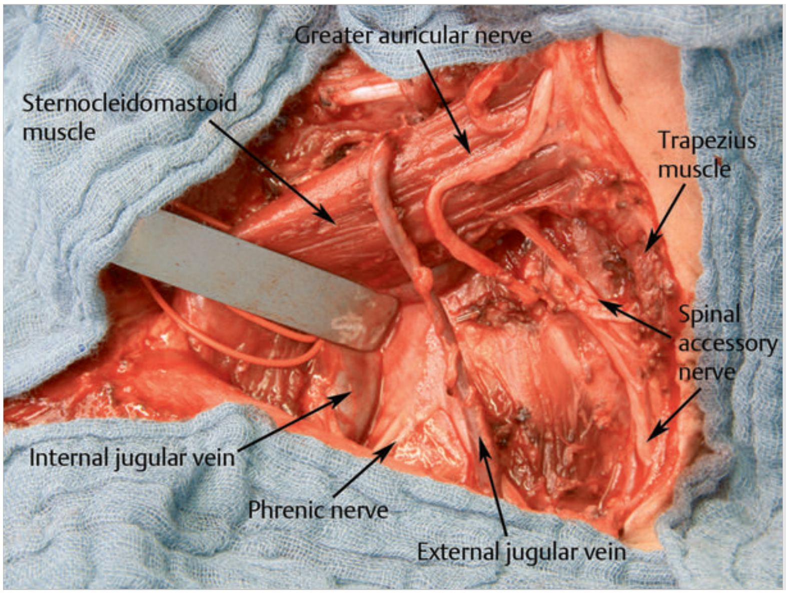

Fig. 2.38 Overview after posterior neck dissection via modified Schobinger approach.

Fig. 2.39 Results on the 12th postoperative day after removal of sutures; the vertical incision of the cranioposterior tip of the skin flap has to be at least 90° to avoid tip necrosis.

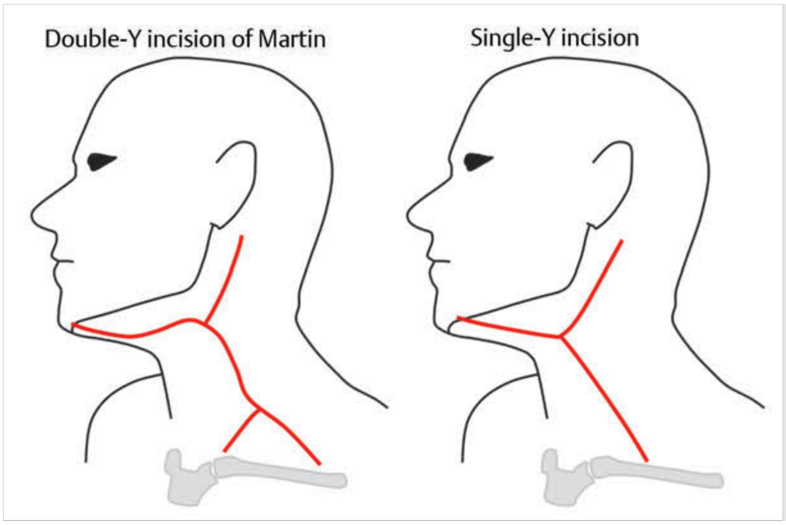

Fig. 2.40 Double-Y incision of Martin: good overview, but problematic blood perfusion at the crossing points. Single-Y incision: difficult overview on levels IV and V.

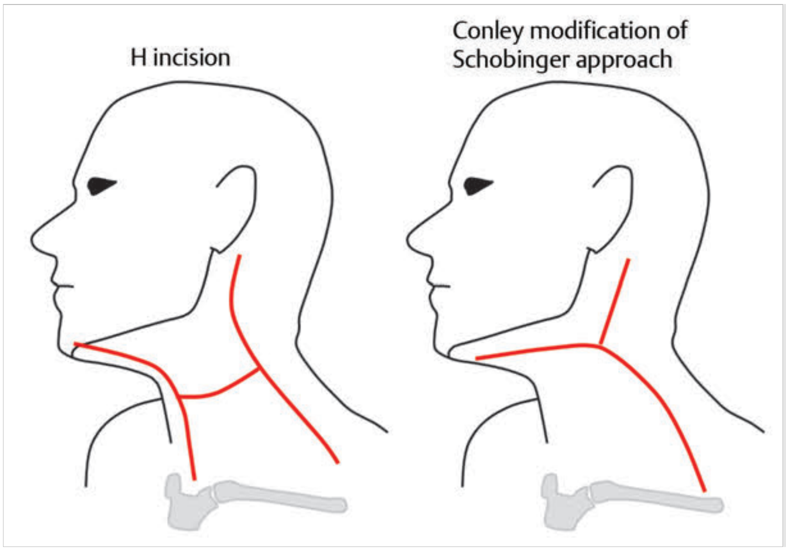

Fig. 2.41 H incision: excellent overview on levels I to V. Conley modification of Schobinger approach: protects the carotid artery.

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Chapter 3

Ablative Tumor Surgery

3.1 Access to the Tumor and Tumor Resection

3.1.1 Overview and Accessibility

Obtaining clear margins is the single most important factor in ablative tumor surgery. The anatomy of the oral cavity and its neighboring tissues does not provide ideal conditions to approach all types of tumors in their whole circumference. Tumors of the tongue base and the soft palate region and extended neoplasms with infiltration of the skull base, the sinus region, or the pterygopalatine fossa may not be removed completely via an intraoral approach. Alternative procedures are recommended in the following section.

3.1.2 Alternative Approaches and Indications

Lip-split Mandibulotomy Access

Neoplasms of the pterygomandibular region, the tongue base, and the oropharynx.

Weber-Fergusson-Dieffenbach Approach

Extended neoplasms of the maxilla, the maxillary sinus, and the adjacent anatomical structures.

Midfacial Degloving

Extended neoplasms of the maxilla with infiltration into the central midface and nasal cavity.

Le Fort I Osteotomy

Neoplasms of the maxilla including the anterior and middle parts of the maxillary sinus.

3.2 Lip-split Mandibulotomy Access

3.2.1 History

In 1836, the French surgeon Philibert Joseph Roux introduced one of the most important procedures for oral cancer surgery: the division of lip and mandible to gain access to the floor of the mouth and the tongue. Born in 1780 in Auxerre, he not only influenced oncologic surgery, but also cleft surgery. Roux was probably the first to establish a successful technique for soft palate closure. Although Albrecht von Graefe carried out his first soft palate closure in 1816, the technique was successful in only one patient because he cauterized the cleft margins. Roux did not cauterize the margins but performed surgical debridement before suturing and achieved excellent results by using his own technique in 1819.

3.2.2 Modifications

Modifications were suggested regarding the soft tissue incision and the osteotomy line.

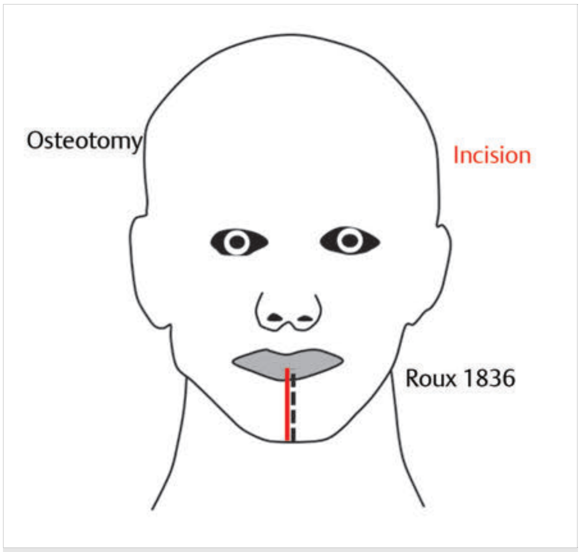

Fig. 3.1 Original incision by Roux, 1836. Roux cut a straight line vertically through the lip midline and the chin.

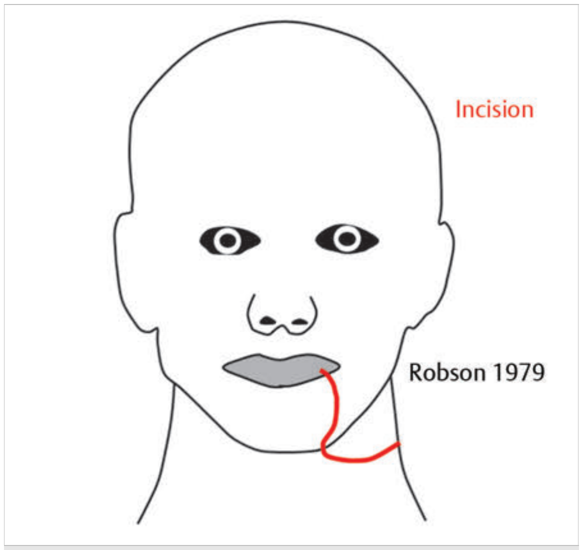

Fig. 3.2 After Robson, 1979. Martin Robson (Chicago) does not start in the lip midline, but medial of the oral commissure, touches the lateral aspect of the chin, and runs downward to the neck incision.

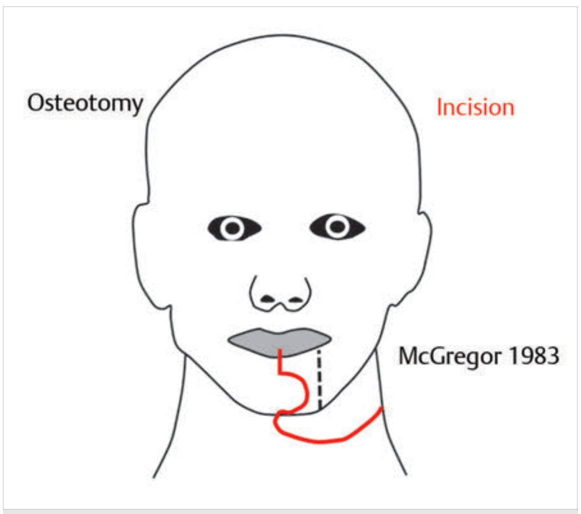

Fig. 3.3 After McGregor, 1983. Ian McGregor (Glasgow) incises the lip midline extending in a vertical fashion toward the chin, then circulating the chin and running downward into the neck incision.

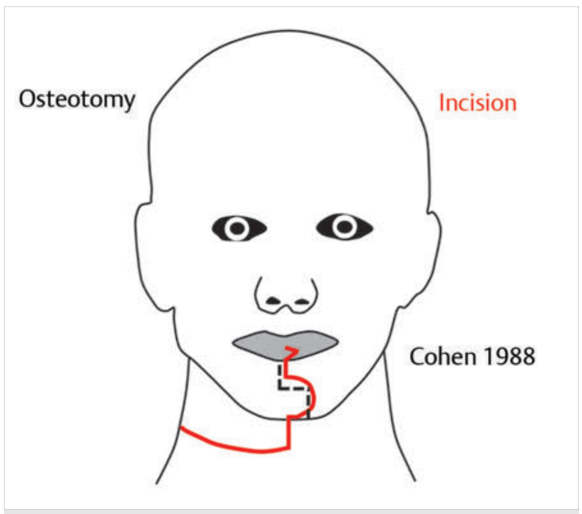

Fig. 3.4 After Cohen, 1988. James Cohen (Minneapolis) suggested the stairstep osteotomy, which allows exact repositioning of the mandibular segments.

3.2.3 Technique

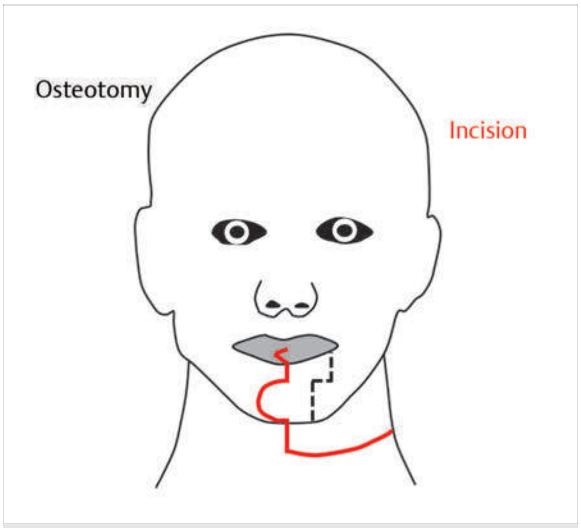

Fig. 3.5 Schematic drawing of skin incisions and stairstep osteotomy line. Note: triangular incision in the lip vermillion for exact repositioning.

Fig. 3.6 Marking the skin incision.

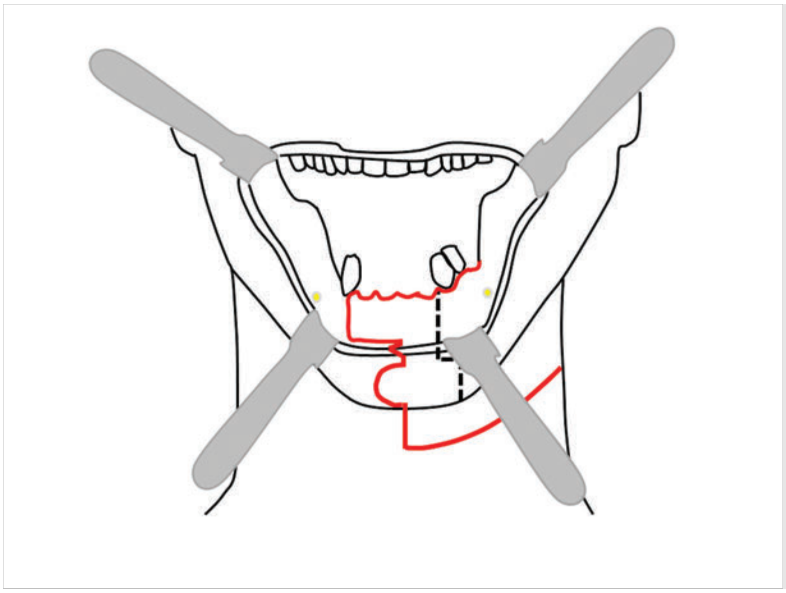

Fig. 3.7 Schematic drawing of intra- and extraoral incision line.

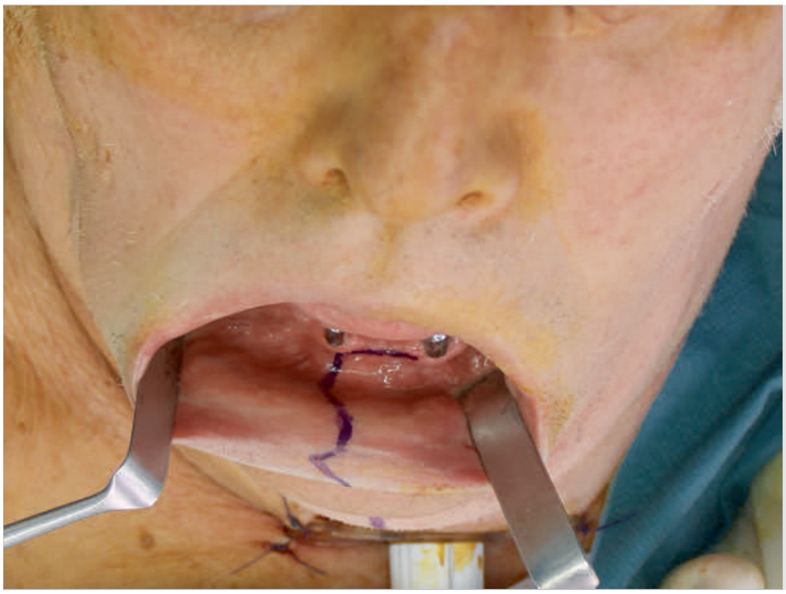

Fig. 3.8 Cut the attached mandibular gingiva paramedially on the contralateral side of the osteotomy to gain more soft tissue coverage for the osteosynthesis material.

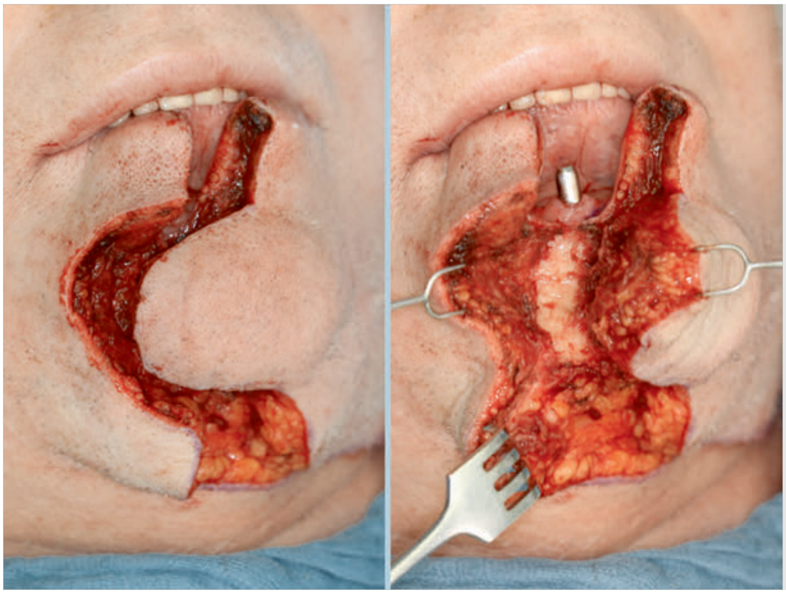

Fig. 3.9 Extraoral and intraoral soft tissue incision, exposure of the mandibula.

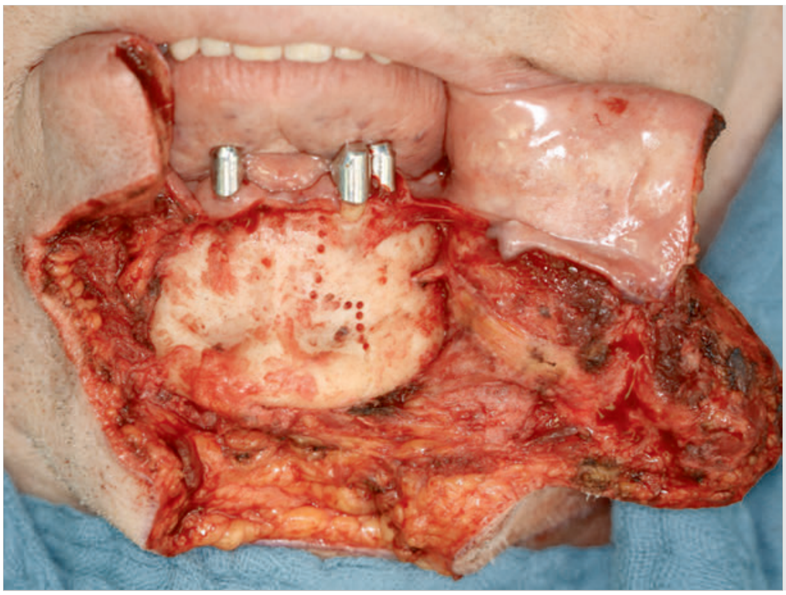

Fig. 3.10 Mark the paramedian stairstep osteotomy line.

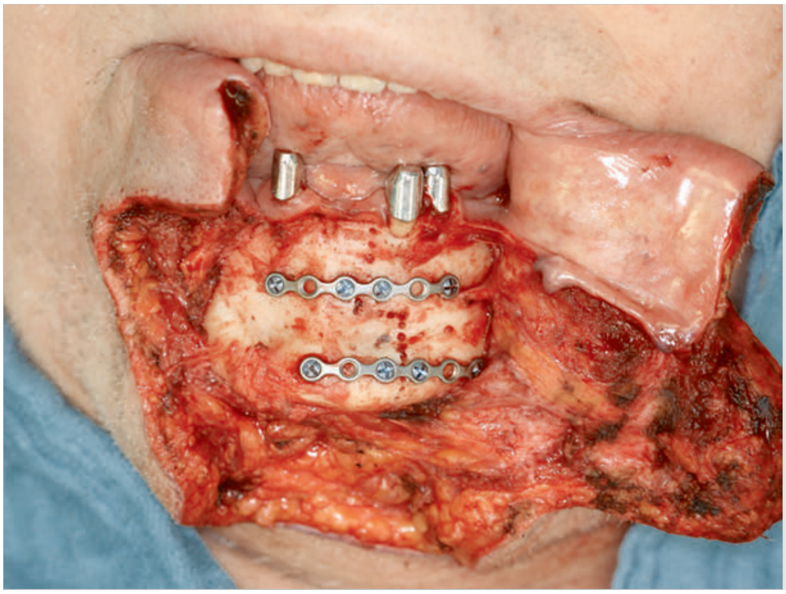

Fig. 3.11 Perform the osteosynthesis before osteotomy, then remove plates and screws.

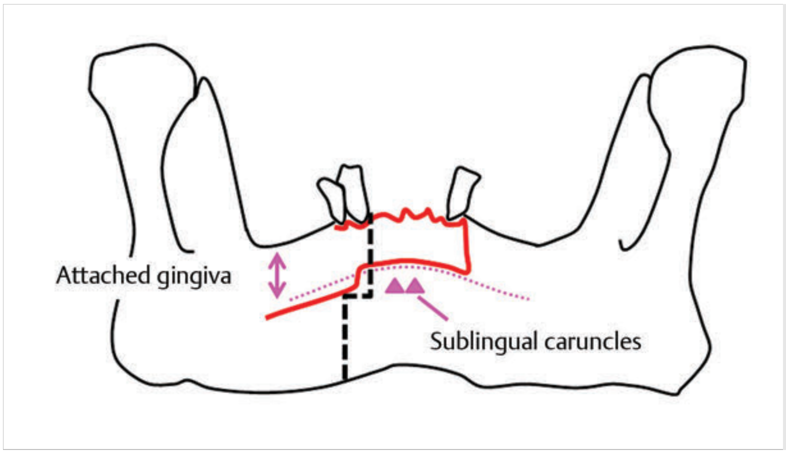

Fig. 3.12 Schematic drawing of the lingual incision. Make the lingual incision on the caudal border of the attached gingiva, save the sublingual caruncles, and extend the incision from the lateral floor of the mouth to the tumor region.

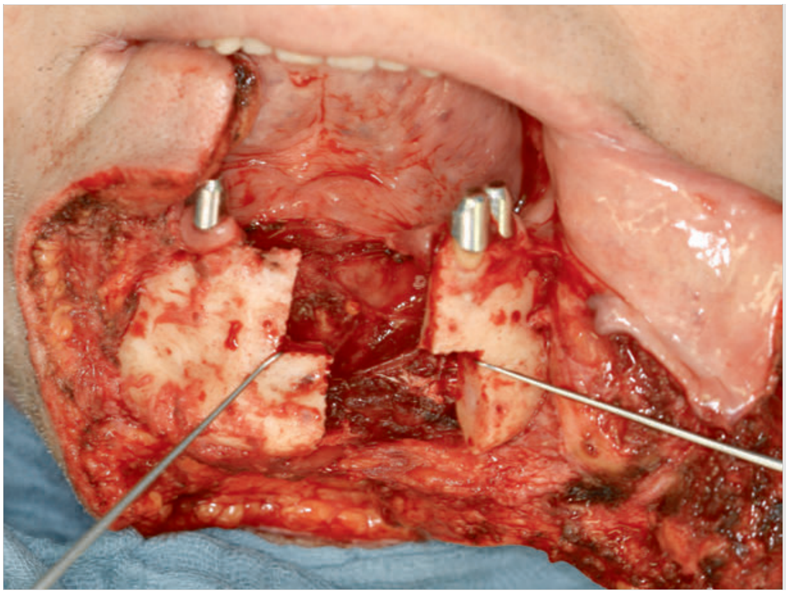

Fig. 3.13 Scrape lingual soft tissue off bone. Protect lingual soft tissue with orbital spatula. Carry out the stairstep osteotomy with a saw.

3.3 Weber-Fergusson-Dieffenbach Approach

3.3.1 History

The history of this approach remains puzzling. After taking many sources into account, Sir William Fergusson (1808–1877), a Scottish surgeon, described an approach to maxillary resection in his book *A System of Practical Surgery* in 1845. Karl Otto Weber, who was born in 1827 in Frankfurt am Main, became head of the surgical department of Heidelberg University in 1865. Some sources attribute the first description of the midfacial approach to his publication from Heidelberg "Vorstellung einer Kranken mit Resection des Unterkiefers" in 1845. With respect to Weber's date of birth, that seems quite illusory. Later, Weber described access to the midface in Pitha and Billroth's surgical handbook, which was published in 1866—one year before he died from diphtheria at the age of 39. Johann Friedrich Dieffenbach's (1792-1847) contribution appears to rely exclusively on the lateral extension to the lower eyelid. A closer look at his contributions to oral cancer surgery can be found in section 4.2.

3.3.2 Technique

Fig. 3.14 Patient in supine position with entire face prepared and appropriate draping around the surgical area. Start with a zigzag incision of the lip vermillion to the white roll followed by an extraoral skin incision following the ipsilateral philtrum. Then, proceed around the base of the nose and incise along the nasal vestibule to the medial canthus.

Fig. 3.15 Intraoral incision from the lip vermillion in a vertical direction to the upper mucolabial fold and transverse cut in the mucolabial fold to the maxillary tuberosity. If anterior wall of the maxillary sinus is not affected by the tumor, then use epiperiostal preparation; otherwise, use subcutaneous preparation of the cheek flap. Subciliary incision extraorally through the orbicularis oculi muscle down to the bone extending to the lateral canthus followed by lateral fixation of the cheek flap with sutures.

Fig. 3.16 Cheek flap turned back in medial direction.

3.4 Midfacial Degloving

3.4.1 History

1974

John Marquis Converse (1909–1981) established the procedure at the New York University Medical Center. He was born in San Francisco, went to school in Paris, and obtained his medical degree in France. Then, he moved back to the United States to do his residency. His further life as a surgeon was characterized by specializing in craniofacial reconstructive surgery. In 1963, he took over the direction of the Institute of Reconstructive Plastic Surgery at New York University. Interestingly, he was married from 1964 until his death to Veronica Cooper, the widow of film legend Gary Cooper.

3.4.2 Technique

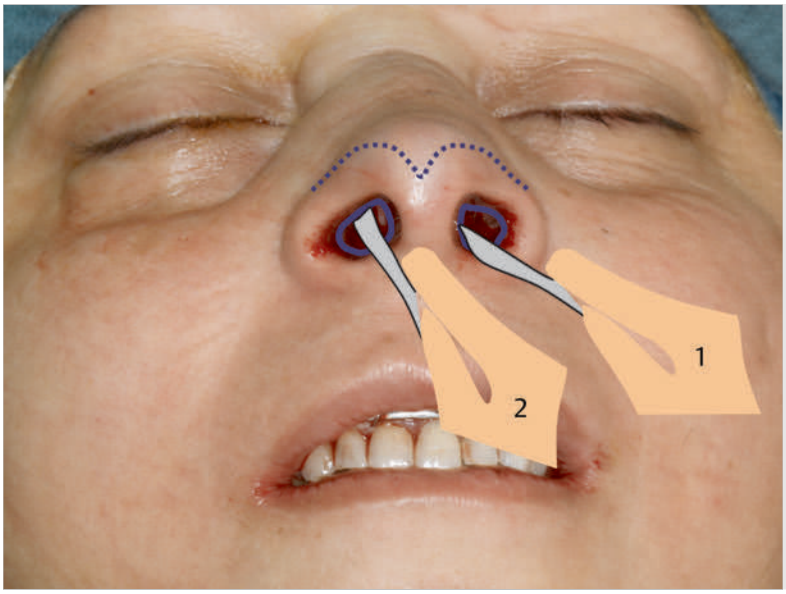

Fig. 3.17 Incision through the nasal mucosa (1) posterior to the greater alar cartilage (2) and anterior of the lateral cartilage (intercartilaginous incision). Similar procedure on the contralateral side. Mandibulomaxillary fixation with trauma splints to retain a correct jaw relationship postoperatively is mandatory.

Fig. 3.18 Dissection of the soft tissue overlying the lateral cartilages as far as the nasal bone.

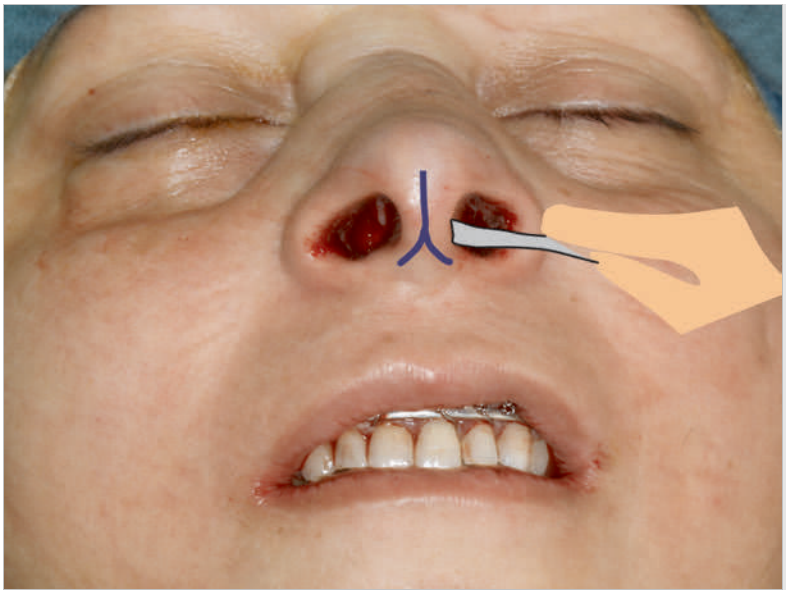

Fig. 3.19 Cut the septal cartilage dorsally and anteriorly.

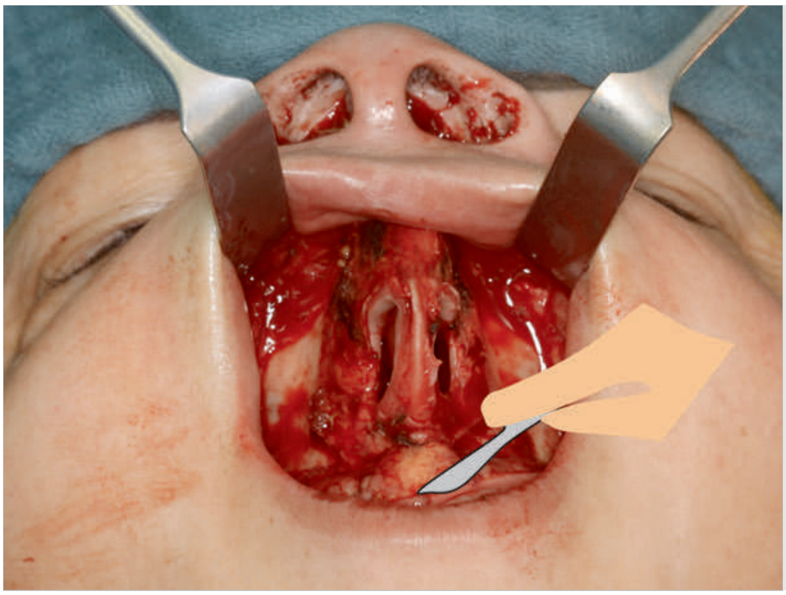

Fig. 3.20 Intraoral incision of the vestibulum.

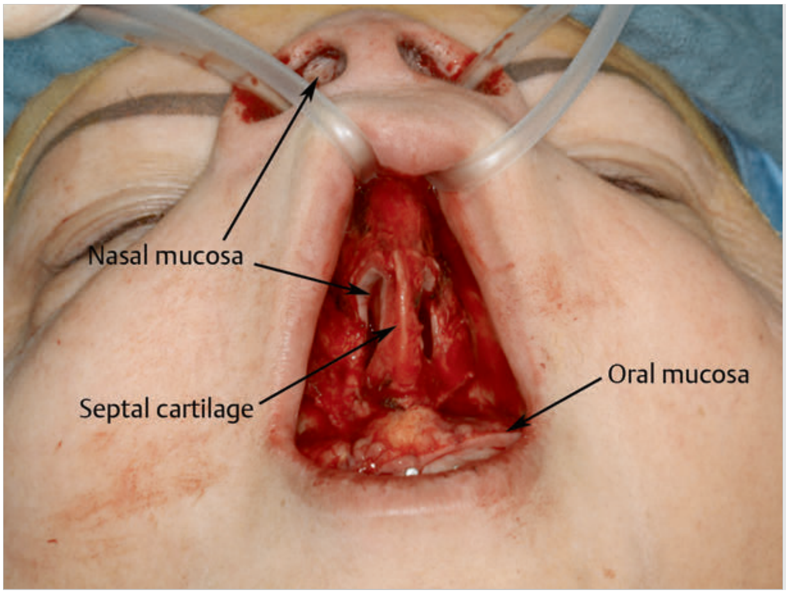

Fig. 3.21 Completed dissection with anatomic landmarks.

3.5 Le Fort I Osteotomy Approach

3.5.1 History

1859

Bernhard von Langenbeck (1810–1887) succeeded Dieffenbach as head of surgery and ophthalmology at the Charité in Berlin. In 1859, he carried out the pioneer procedure for osteotomy and temporary mobilization of the maxilla in the horizontal plane. After removing a nasopharyngeal polyp via this approach, he observed subsequent healing of the upper jaw in its original position.

1965

As a routine procedure for orthognathic repair, the Le Fort I osteotomy was introduced by Hugo Obwegeser (born in 1920 in Hohenems, Austria) in 1965. From 1964, he was head of Zurich University's department for maxillofacial surgery until his retirement in 1989.

Late 1980s

In the late 1980s, nearly 130 years after von Langenbeck's description, the technique was readapted for tumor surgery of the skull base by a group of British maxillofacial and neurosurgeons led by Daniel Archer and David Uttley. American otolaryngologist Judson R. Belmont also described the use of this technique in 1988. In 1990, Clarence T. Sasaki (born in 1941 in Honolulu), at Yale School of Medicine, reported about six patients with tumors of the central skull base who were operated on via Le Fort I osteotomy.

3.5.2 Technique

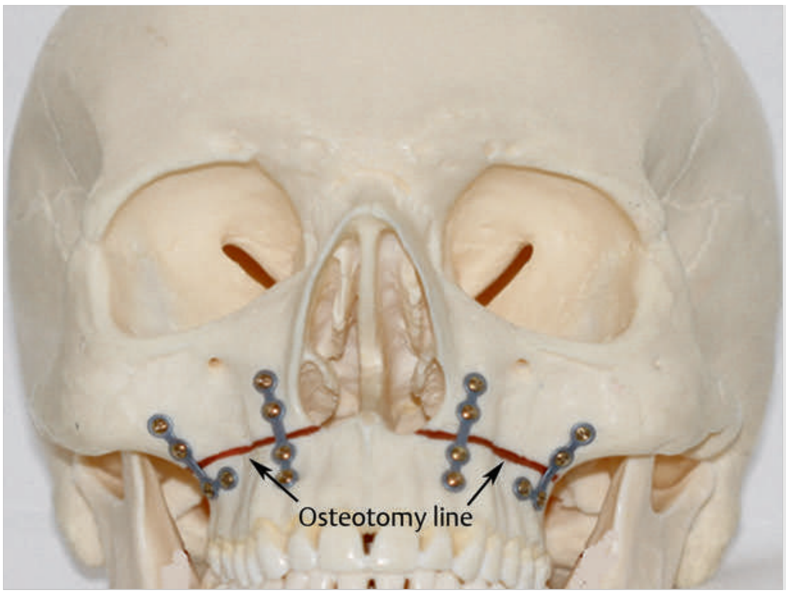

Fig. 3.22 Anatomic model of the Le Fort I osteotomy line.

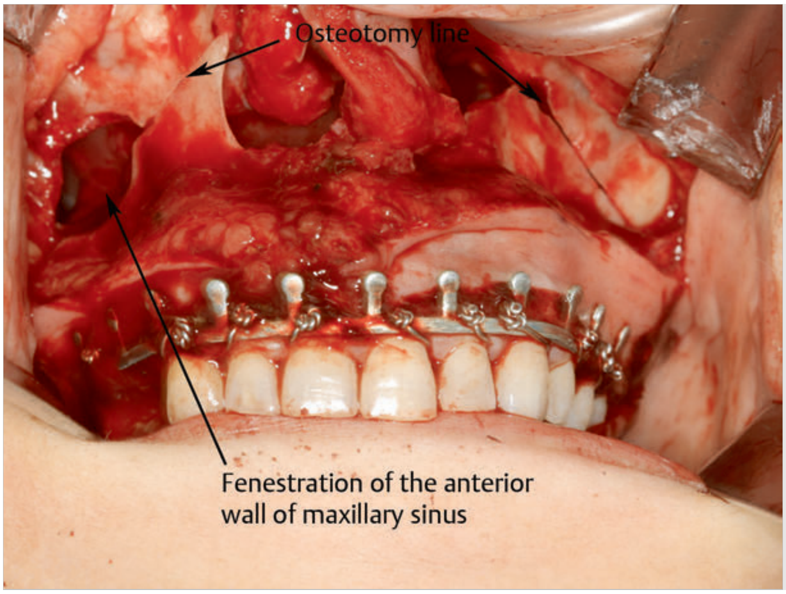

Fig. 3.23 Intraoperative view of osteotomized maxilla with fenestration of the right maxilla for flap pedicle.

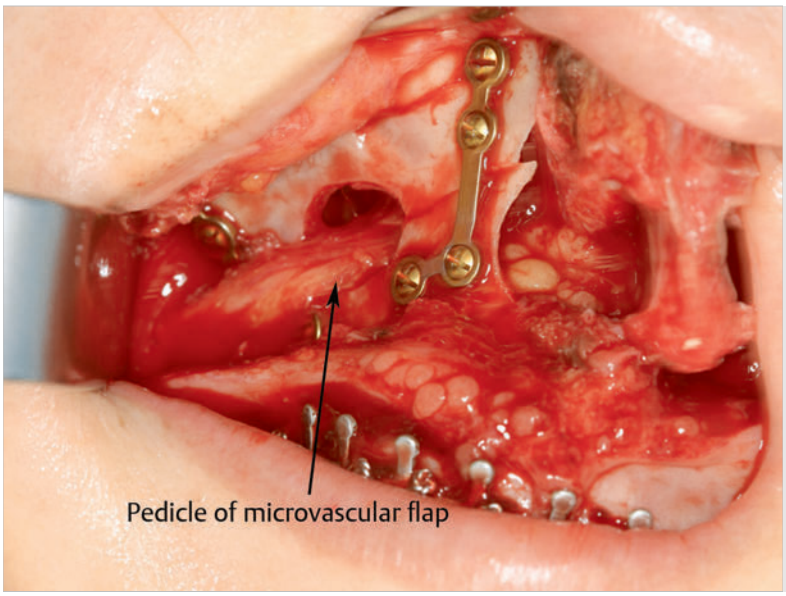

Fig. 3.24 Osteosynthesis of the maxilla after resection and reconstruction of a palatal malignancy including the central midface. Pedicle of a radial forearm flap running through the maxillary window.

3.6 Tumor Access: Further Approaches

3.6.1 To the Upper Part of the Oral Cavity and the Midface

- Posterior maxillary approach
- Anterolateral corridor approach

3.6.2 To the Lower Part of the Oral Cavity

- “Pull-through” technique/mandibular lingual releasing access
- Visor flap

3.7 Tumor Resection

Obtaining tumor-free margins is the single most important factor in ablative tumor surgery. A margin of 5 mm of uninvolved tissue around the tumor is in accordance with an R0 status in oral squamous cell carcinoma.

3.7.1 Technique

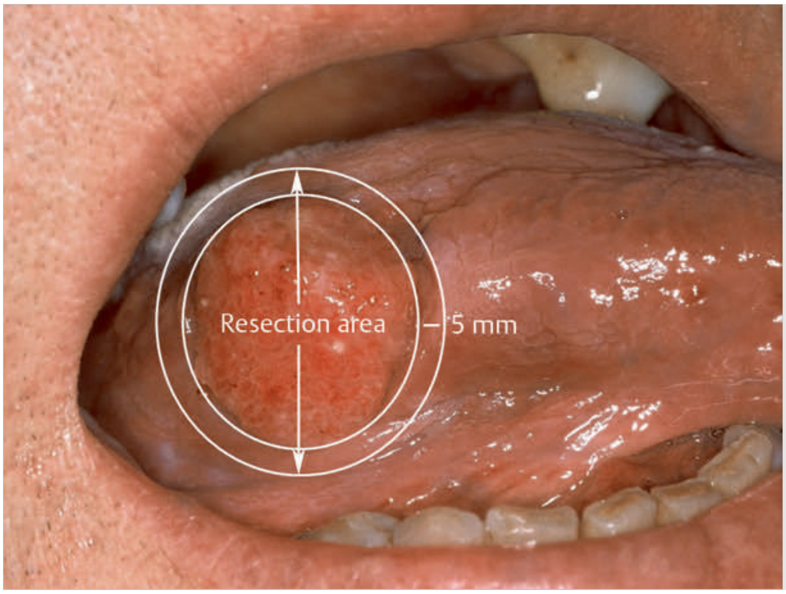

Fig. 3.25 Palpation of the tumor. Excision of the primary tumor by utilization of a 5-mm margin around the visible and palpable tumor in the transverse and vertical dimensions.

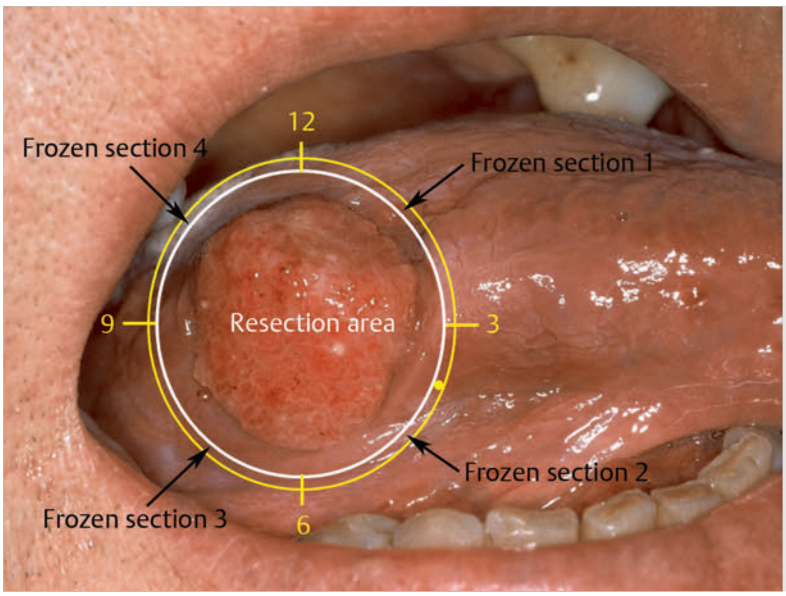

Fig. 3.26 Clockwise mapping of the tumor in the horizontal dimension. Excision of four random tissue pieces of 2-mm width for frozen sectioning.

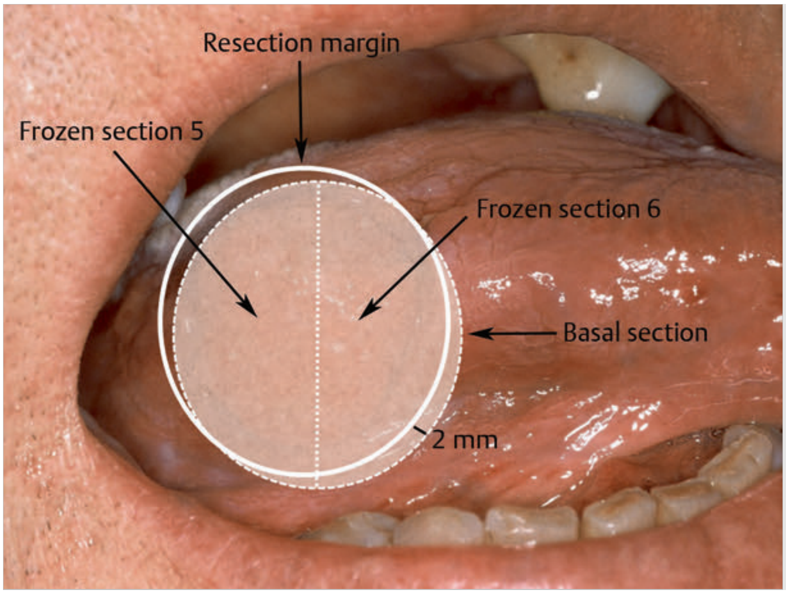

Fig. 3.27 Excision of another two semilunar basal random tissue pieces of 2-mm thickness.

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Chapter 4

Reconstructive Surgery

4.1 Considerations on Reconstructive Procedures

Ablative tumor surgery in the oral cavity results in loss of tissue and function. Except for some minor cases, which can be closed primarily, reconstruction is a pivotal aspect of oral cancer surgery. To regain sufficient speech, deglutition, and mastication, transfer of suitable tissue into the oral cavity is unavoidable. The reconstructive ladder is a valuable tool for the proper planning of intraoral restoration. With a significant number of patients suffering from serious comorbidities, the surgeon has to consider the reconstructive procedure carefully. Reconstructive procedures themselves are accompanied by significant donor site morbidity. Thus, one step down the reconstructive ladder may yield far better overall results in elderly and comorbid patients.

4.2 Suggestions for Reconstructive Algorithms

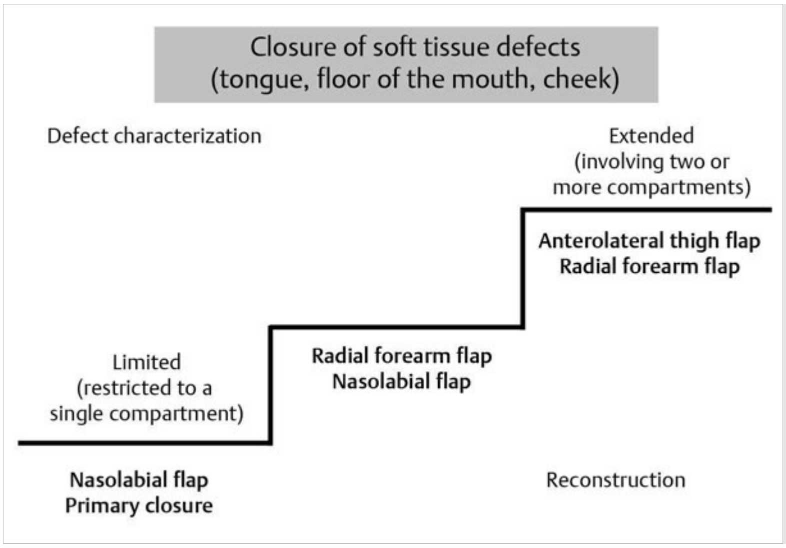

Fig. 4.1 Concise algorithm for intraoral soft tissue defect coverage.

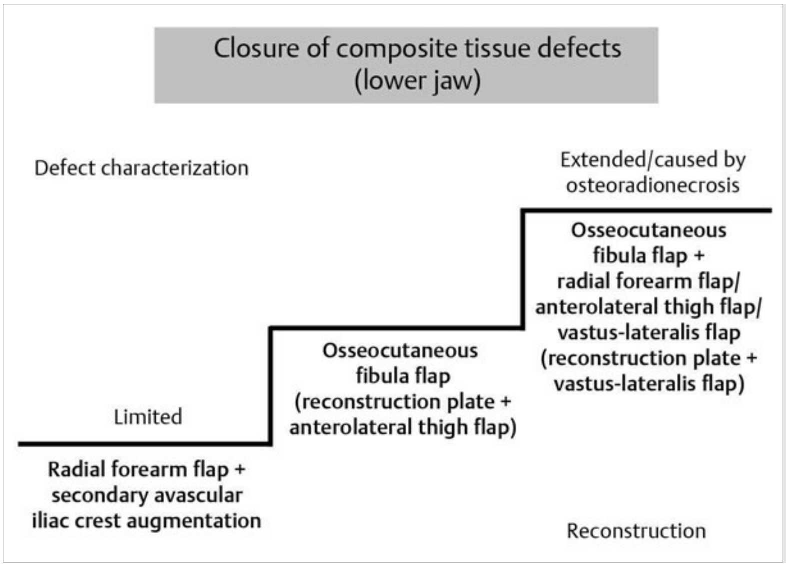

Fig. 4.2 Concise algorithm for the closure of lower jaw defects; backup procedures for patients with comorbidities or insufficient vessels for free fibular flap transfer in parentheses.

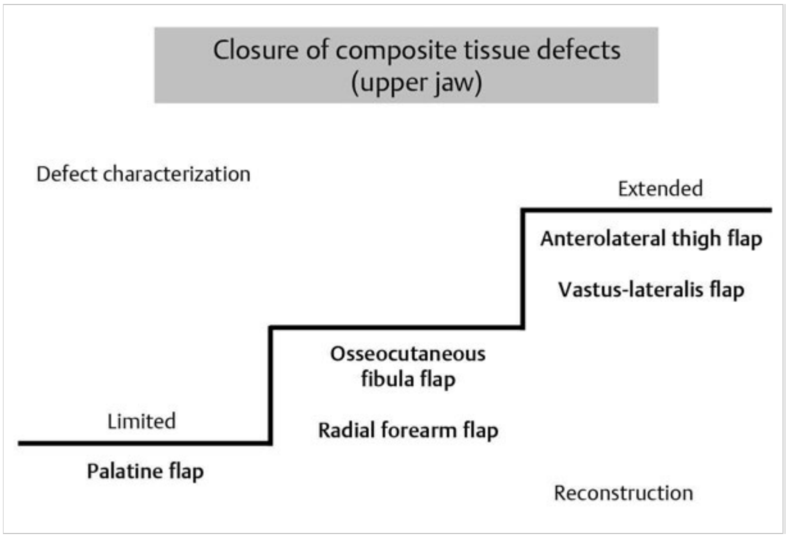

Fig. 4.3 Concise algorithm for the closure of upper jaw defects.

4.3 Nasolabial Flap

4.3.1 History

700/600 BC

Sushruta, an ancient Indian surgeon, described more than 300 operative procedures. His work not only included the famous “Indian forehead flap” to reconstruct the nose, but also the nasolabial flap.

1830

Johann Friedrich Dieffenbach was born in 1792 in Königsberg/East Prussia and was the head of the surgical department at the Charité in Berlin by the time he died in 1847. He described the use of the superiorly based nasolabial flap to reconstruct the nasal alae.

1864

Bernhard von Langenbeck (1810–1887) succeeded Dieffenbach as director of the Clinical Institute for Surgery and Ophthalmology at the Charité in Berlin and remained there until 1882. Langenbeck used the nasolabial flap to reconstruct the nose.

1918

Johannes F. S. Esser (1877–1946) was one of the first "global players" in surgery. After undertaking his medical and surgical education, mainly in the Netherlands, August Bier (1861–1949), the pioneer in anesthesiology, strongly advised Esser to practice in Berlin. During his time in Berlin, he described the nasolabial flap for intraoral reconstruction, in particular the closure of palatal fistulae.

4.3.2 Flap Anatomy

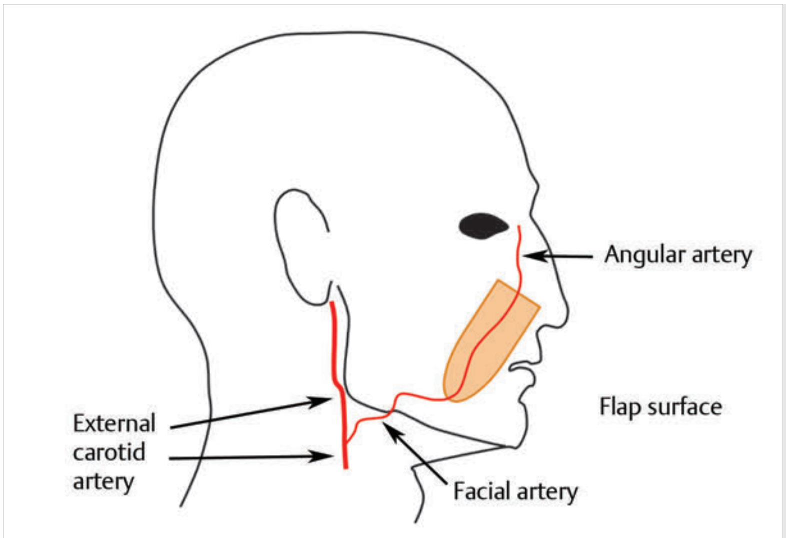

Fig. 4.4 As an axial pattern flap (except the tip), the nasolabial flap receives its blood supply from the facial and angular artery.

4.3.3 Indications

- Medically compromised patients with localized oral carcinomas. They benefit from reduced operation time (nasolabial flap reconstruction) more than from time-consuming microvascular reconstructions.
- Elderly patients with increased skin laxity in the nasolabial region.
- More appropriate for women because of their hairless nasolabial skin.
- Reconstructions of the anterior region of the oral cavity.

4.3.4 Variations

- Superiorly based for maxillary reconstructions
- Inferiorly based for mandibular and tongue/floor of the mouth reconstructions

4.3.5 Technique

Fig. 4.5 Squamous cell carcinoma of the alveolar ridge of the maxilla.

Fig. 4.6 Marking the resection margins.

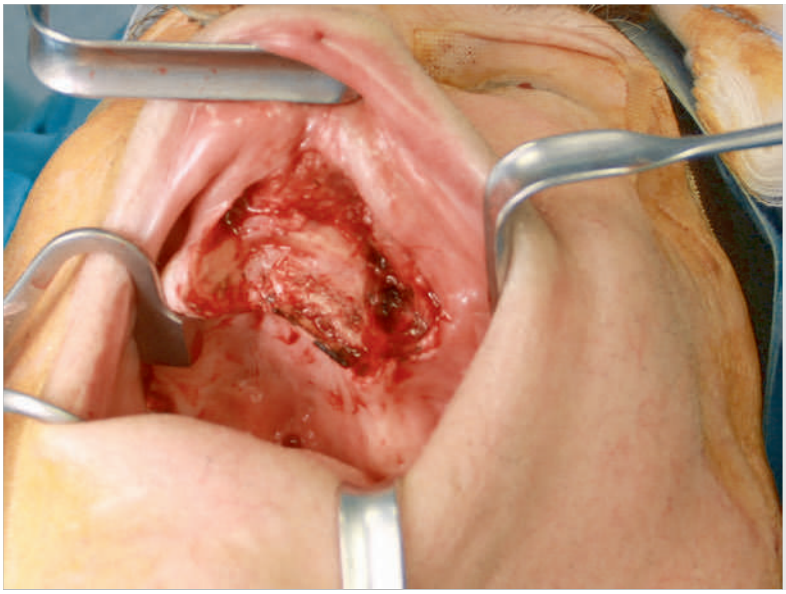

Fig. 4.7 Status after resection of the alveolar ridge carcinoma.

Fig. 4.8 Skin incision outline of the superiorly based nasolabial flap.

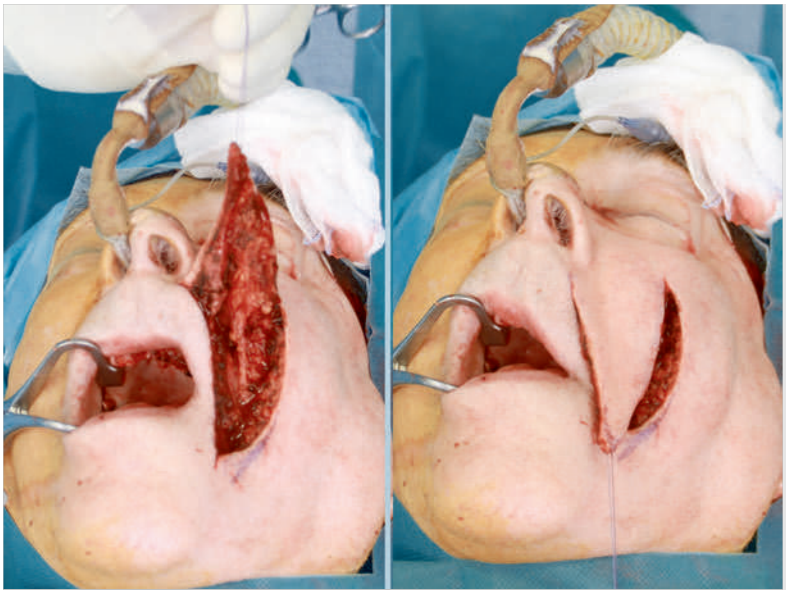

Fig. 4.9 Nasolabial flap harvested.

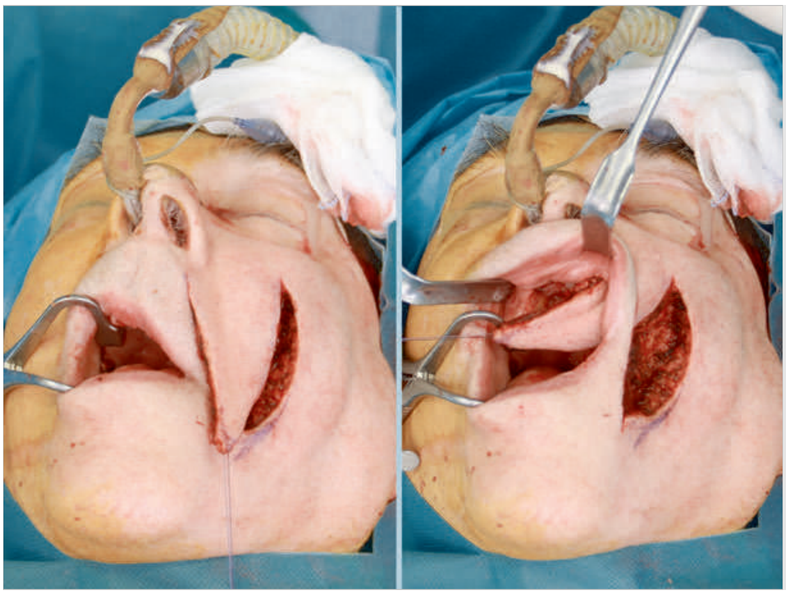

Fig. 4.10 Tunneling through the cheek: "pull through" of the flap and inset into the recipient site.

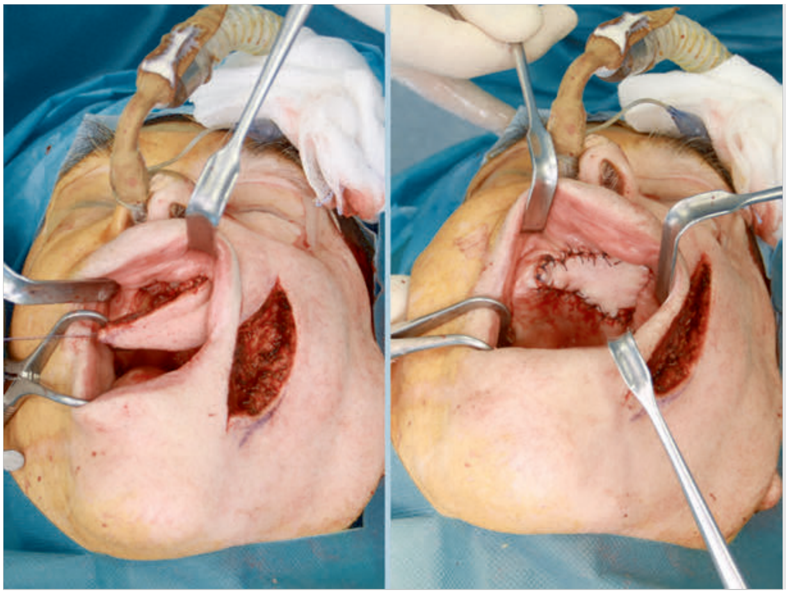

Fig. 4.11 Coverage of the defect by the nasolabial flap and de-epithelization of the tunneled portion of the flap.

Fig. 4.12 Primary closure of the donor site.

Fig. 4.13 Extraoral and intraoral views of donor and recipient sites 6 months postoperatively. Disadvantage: intraoral reconstruction with hirsute tissue.

4.4 Deltopectoral Flap

4.4.1 History

1917

On November 12, 1917, J.L. Aymard from the Queen Mary's Hospital in Sidcup, United Kingdom, performed a deltopectoral flap operation to reconstruct the nose. The flap did not gain wide acceptance at the time.

1965

Vahram Bakamjian, born 1918 as member of the Armenian minority in Aleppo (Syria), attended the American University of Beirut. After going to the United States in 1951, he did an ear-nose-throat and, later, a plastic surgery residency. From 1956, he worked as a head and neck surgeon in Buffalo where he reintroduced and popularized the “Bakamjian flap” for reconstructive surgery of the head and neck region. He died in 2010 at the age of 92.

4.4.2 Flap Design and Anatomy

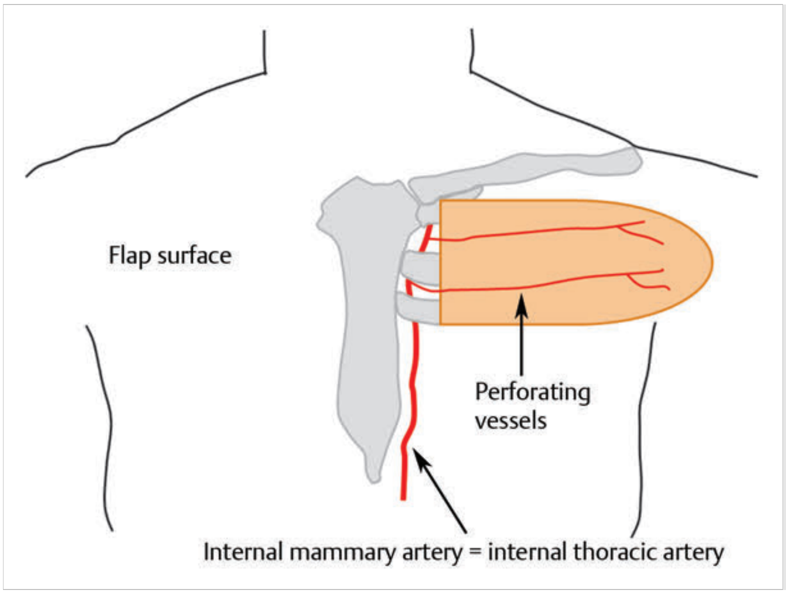

Fig. 4.14 As an axial pattern flap, the deltopectoral flap receives its blood supply from the perforating vessels of the internal mammary artery. If the flap is extended beyond the deltopectoral groove, the tip is a random pattern flap.

4.4.3 Indication

"Backup flap" for wound dehiscences after free flap reconstructions, mainly for wound healing disturbances of the irradiated neck.

4.4.4 Technique

First Stage Procedure

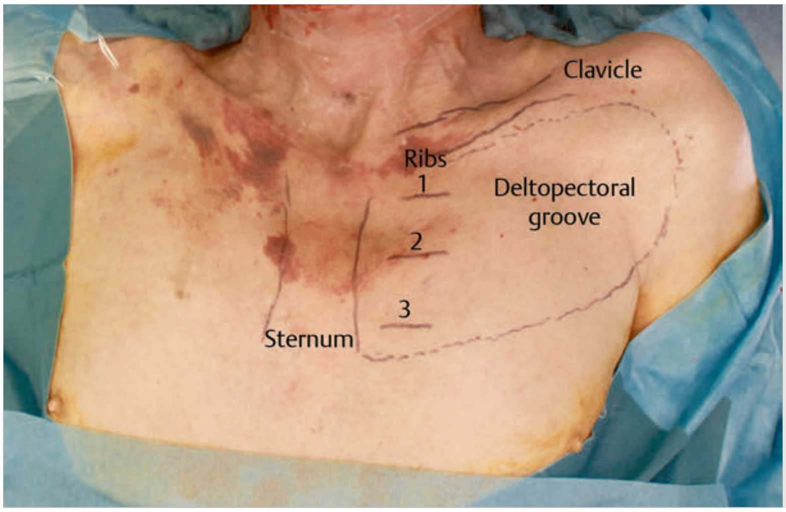

Fig. 4.15 Palpation and marking the landmarks: clavicle, sternum, and ribs 1 to 3. Marking the superior, the inferior, and the lateral extent of the flap. Lateral extension may include a region 3 cm beyond the deltopectoral groove, if necessary. Note: region beyond the deltopectoral groove lies not in the angiosome of the internal mammary perforators, but is a random pattern flap and remains robust in this region.

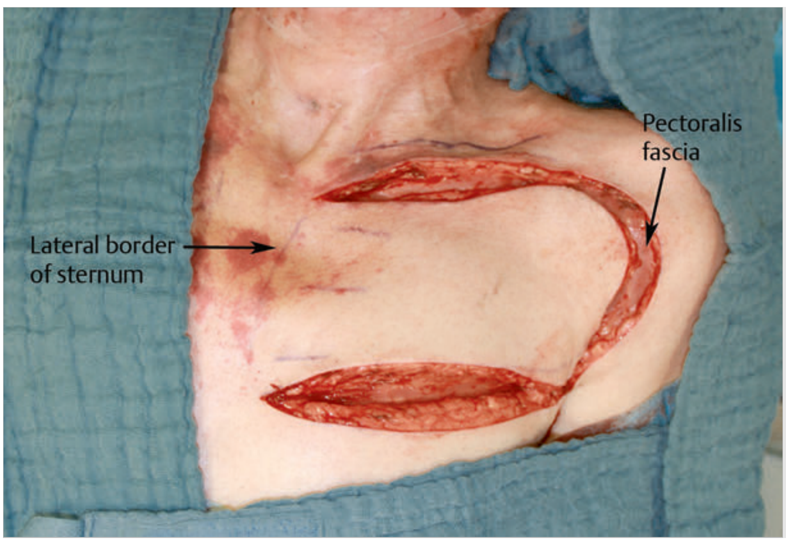

Fig. 4.16 Incision through dermis and subcutaneous fatty tissue onto the pectoralis fascia. Medial incisions should have a distance of 2 cm from the lateral border of the sternum to avoid damaging the perforators.

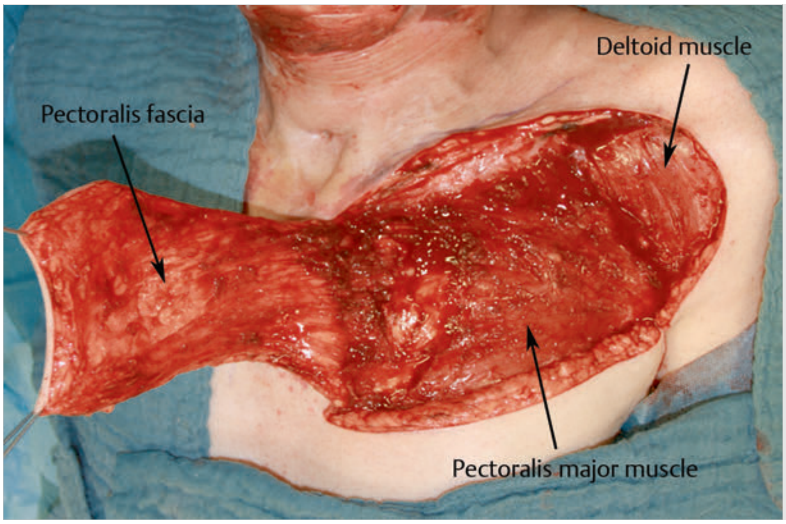

Fig. 4.17 Incision of the pectoralis fascia and integration of the fascia into the flap.

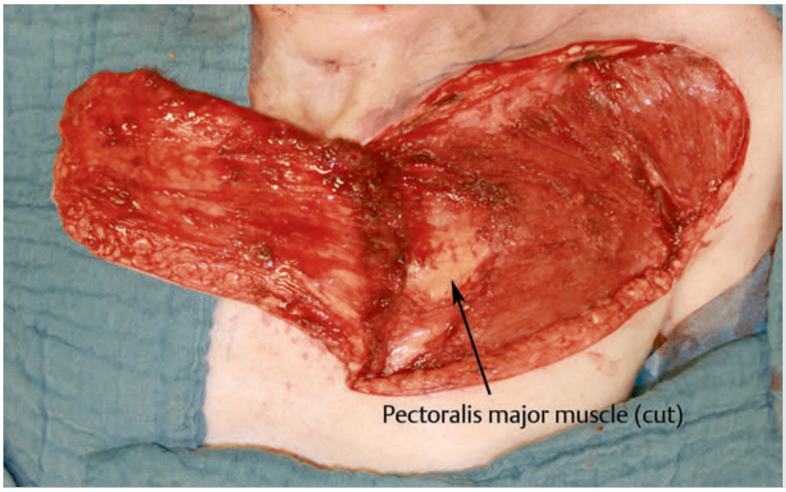

Fig. 4.18 Mobilization of the flap by incising some fibers of the pectoralis major muscle (if necessary), but preserve the region 2 cm lateral of the sternum.

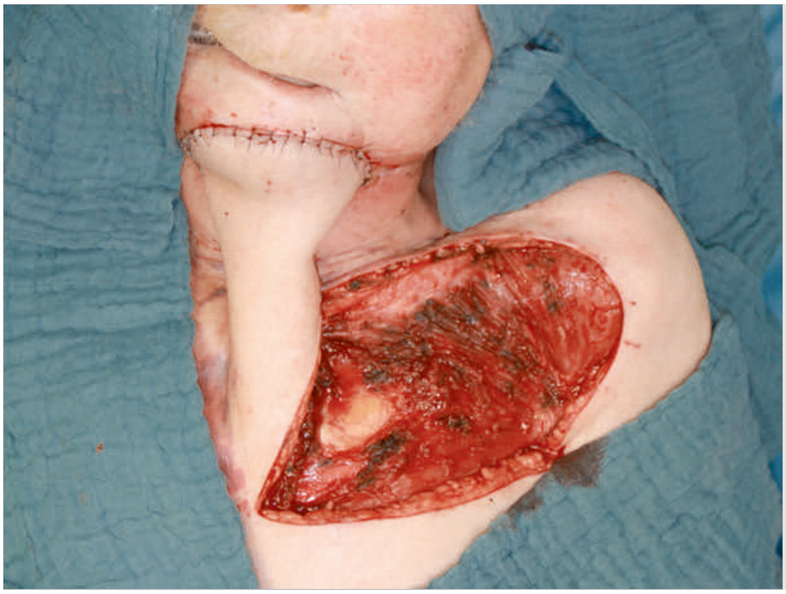

Fig. 4.19 Coverage of the recipient site. Form a tubed pedicle by careful coverage of the tube's inner surface site with artificial dermis. Avoid circumferential closure of the tube pedicle to prevent occlusion of the vessels.

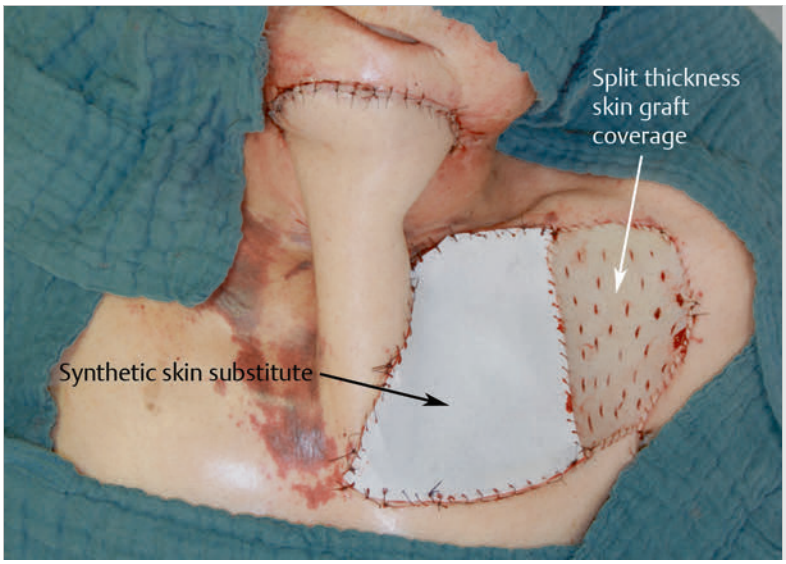

Fig. 4.20 Coverage of the deltopectoral donor site with split thickness skin graft. Temporary coverage of the medially located donor site with a synthetic skin graft.

Second Stage Procedure

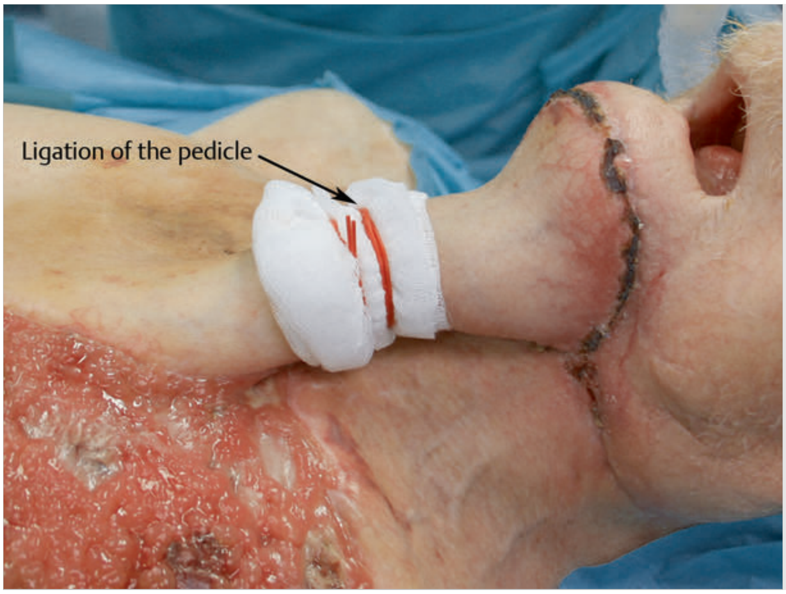

Fig. 4.21 Three weeks after flap harvest: ligation of the flap's pedicle. Controlling flap's autonomization at the recipient site.

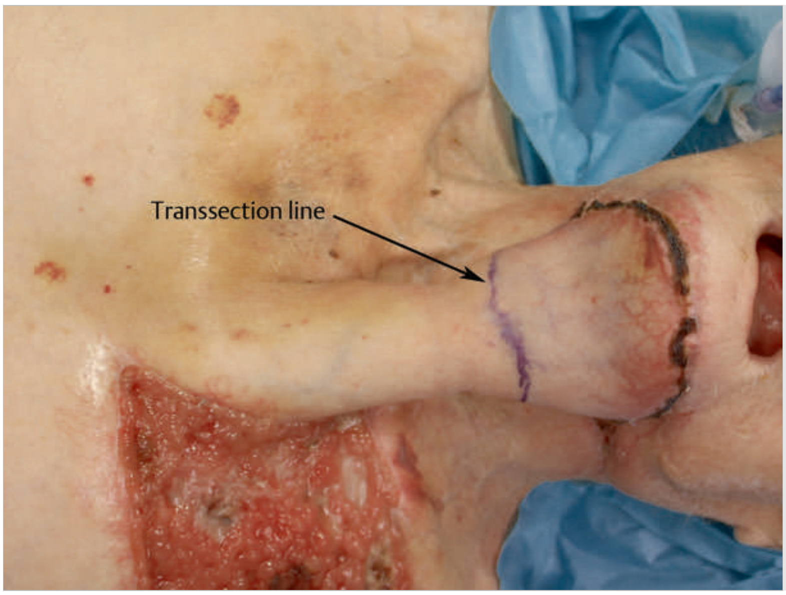

Fig. 4.22 Marking the transsection line.

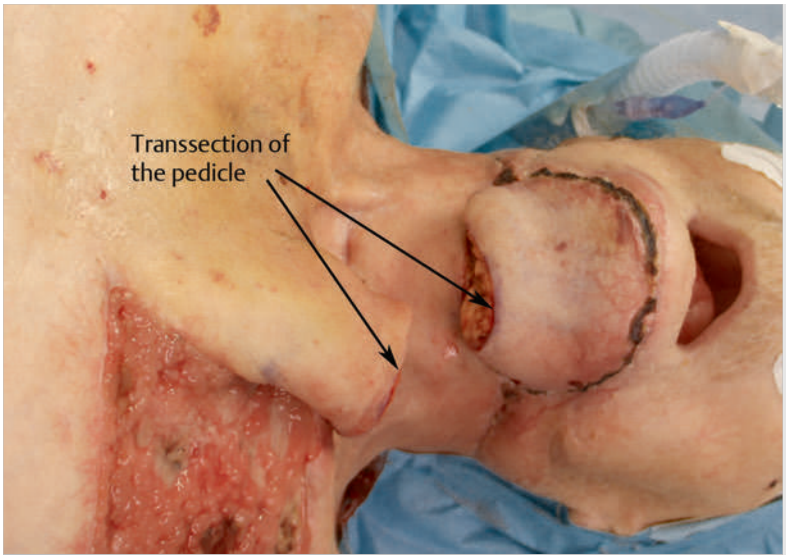

Fig. 4.23 Transsection of the tubed pedicle.

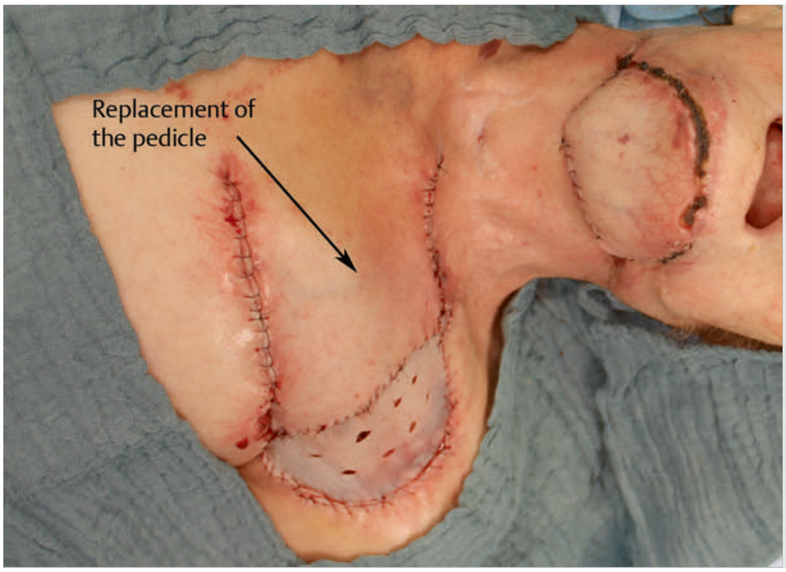

Fig. 4.24 Primary thinning of the transplant at the recipient site and suture. Replacement of the remaining pedicle to the original donor site. Coverage of the remaining distal donor site with split thickness skin graft.

4.5 Microvascular Anastomosis

4.5.1 History

1864

The doctoral thesis of Alexander Jassinowsky was published in German in 1889. His studies were performed in 1864 at the University of Dorpat (today Tartu in Estonia). Jassinowsky had provoked lacerations on the carotid artery of 22 animals and reported successful suturing of the vessels with silk.

1912

Alexis Carrel from Lyon (1873–1944) was awarded the Nobel Prize for pioneering vascular suturing techniques, which formed the basis for transplantation procedures. The medical faculty of Lyon University was named after Carrel until 1994. After coming to terms with its role in implementing eugenics policies during Vichy France, the university deleted his name.

The 1950s

Julius Jacobsen and Ernesto Suarez from Burlington, Vermont, carried out basic work for microvascular anastomosis techniques with a binocular microscope. The research was published in 1960.

1957

On July 30, 1957, Bernard Seidenberg from New York reconstructed the proximal part of the esophagus of a cancer patient with a microvascular pedicled jejunum transplant. This was the first reconstructive procedure using a microvascular anastomosed flap in humans.

1969

Donald McLean and Harry Buncke from Oakland, California, were the first to perform a scalp reconstruction by transferring a microvascular pedicled omentum flap. They published the procedure in 1972.

4.5.2 Technique

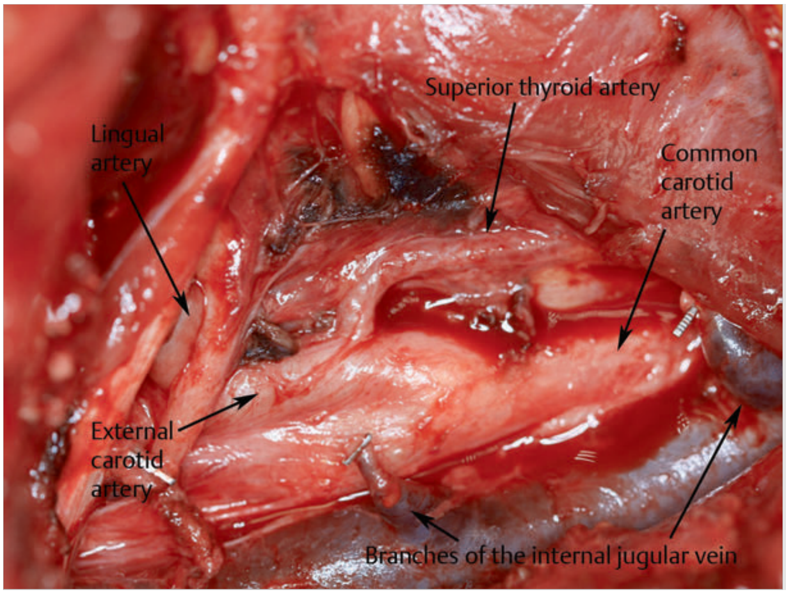

Fig. 4.25 Preparation of suitable recipient vessels as superior thyroid artery or lingual artery on the one hand and direct branches of the internal jugular vein on the other hand.

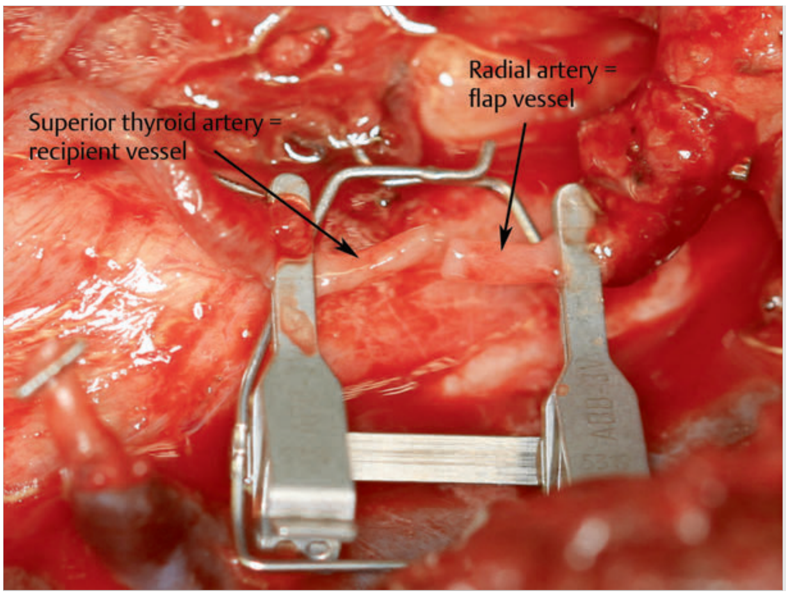

Fig. 4.26 Initial trimming of the adventitia of recipient and donor artery. Approximation of recipient and donor vessel by applying the double clamp.

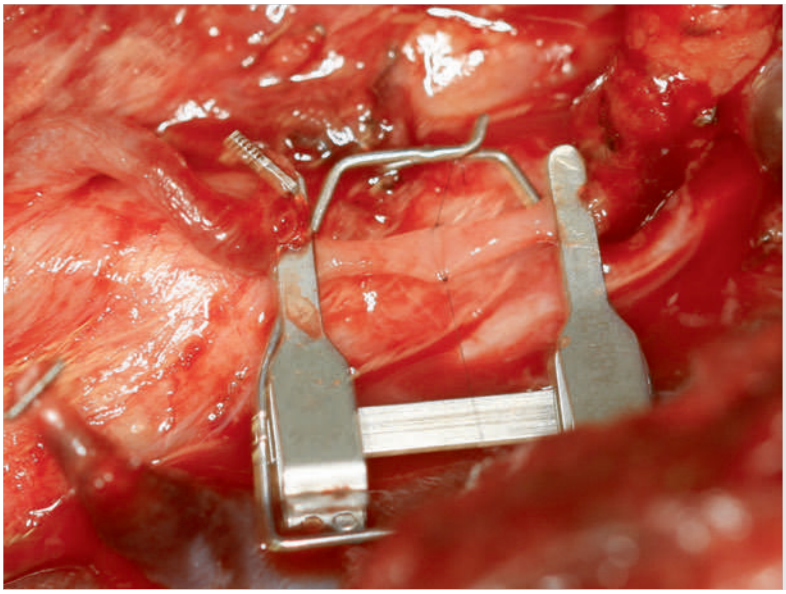

Fig. 4.27 End-to-end triangulation technique: second suture is placed 120° from the first. Sutures are fixed on the opponent edges of the approximator clamp to keep vessel walls under tension and to avoid adhesion of front and back walls (especially in venous anastomosis).

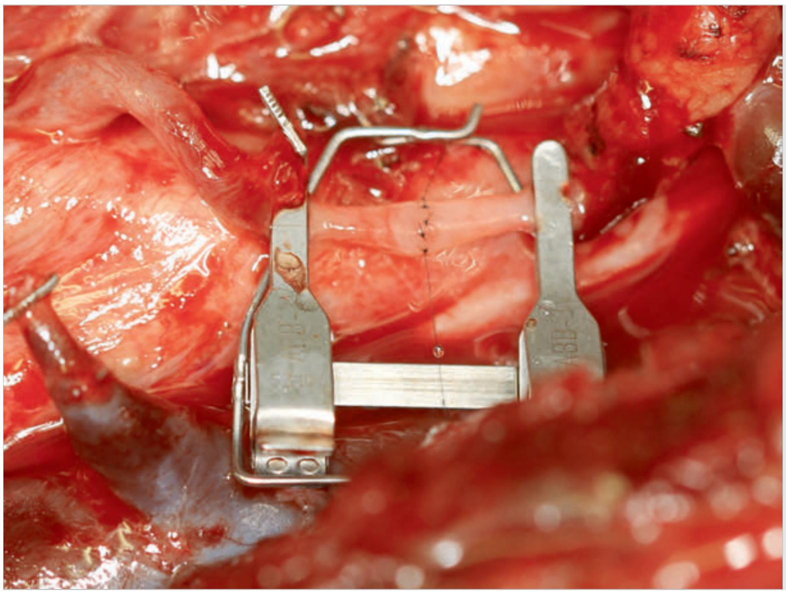

Fig. 4.28 Suturing of front wall is completed; take care of consistent gaps between the sutures.

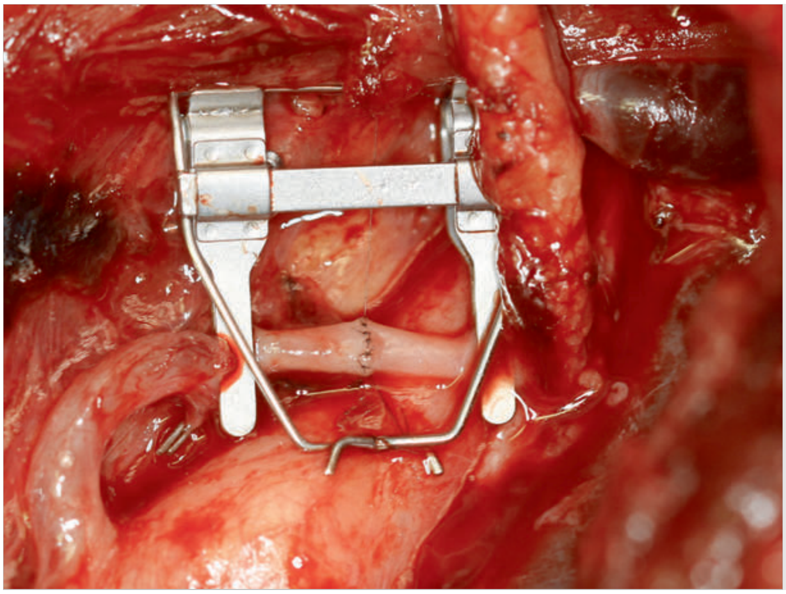

Fig. 4.29 Arterial anastomosis is completed.

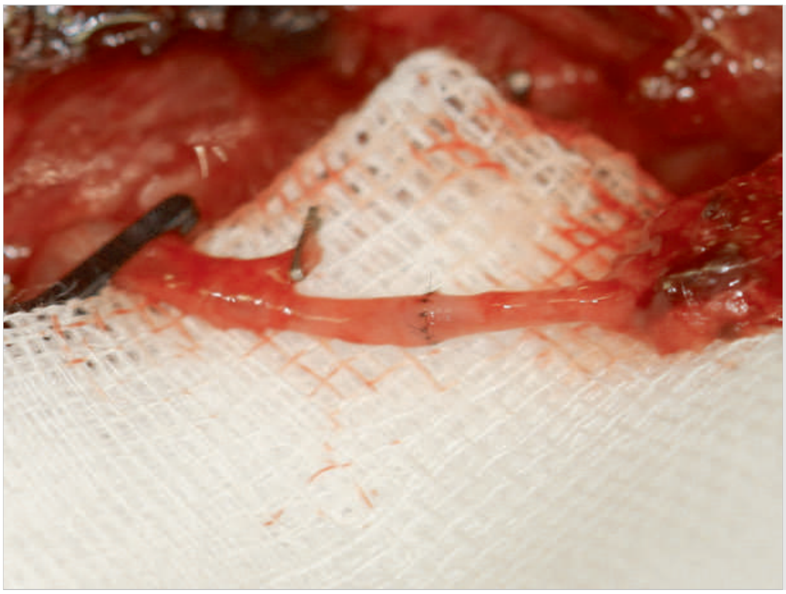

Fig. 4.30 Approximator clamp is removed, but a clamp proximal from the anastomosis is applied. Proximal clamp is not removed until first vein is anastomosed. Confirm no leakage at the anastomosis following release of the clamps.

4.6 Radial Forearm Flap

4.6.1 History

1978

Studies on cadavers investigating the angiosome of the radial forearm flap were first performed by Yang Guo-fan and Gao Yuzhi at the military hospital of Shenyang, China.

In 1981, they published (in Chinese) an initial description of a case study of 56 patients.

1981

In 1980, Wolfgang Mühlbauer from Munich, Klinikum rechts der Isar, traveled together with a German delegation to China and introduced the flap technique to the Western world. The Mühlbauer, Biemer, and Stock working group included the radius to the flap and used the osseocutaneous transplant for thumb reconstruction.

1983

David Soutar and his team from Glasgow described the use of the radial forearm flap for reconstructions of the oral cavity.

4.6.2 Indication

The “workhorse” flap: the universal flap for intraoral reconstruction.

4.6.3 Preliminary Examinations and Considerations

Allen Test

The procedure is named after Edgar Van Nuys Allen (1900–1961), a cardiovascular specialist from the Mayo Clinic in Rochester, Minnesota. The test examines the vascular function of the hand’s arteries and perfusion of the vascular palmar arch. In order to detect disturbances in blood circulation and, in consequence, possible postoperative perfusion insufficiencies, both arteries are first occluded by manual compression. The patient is then asked to repeatedly open and close the hand, so the blood is pumped out. Compression of the artery that is to be sacrificed as a future flap pedicle (in this case, the radial artery) is continued, while pressure on the other artery (ulnar artery) is released. It is possible to raise a radial forearm flap without further considerations, if the hand is equally reperfused with blood within 5 seconds.

Handedness

The radial forearm flap should always be raised from the nondominant hand.

4.6.4 Technique

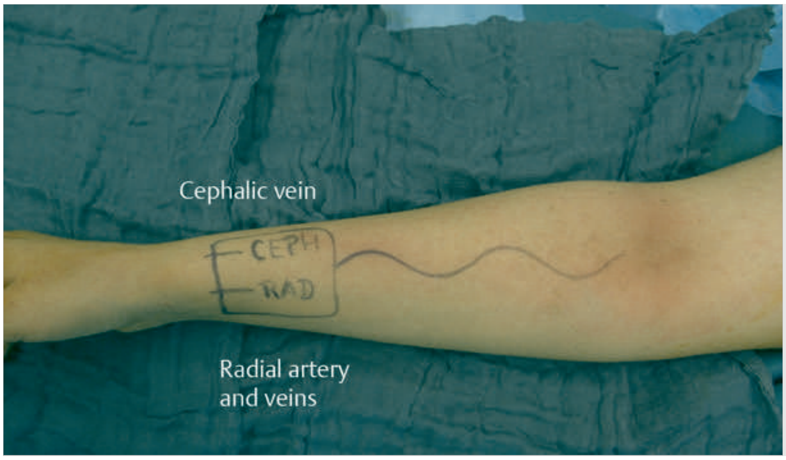

Fig. 4.31 Marking and preparation. Radial orientation: if the cephalic vein is to be included for venous drainage, the marking should be located beyond the brachioradialis muscle. Location of the distal border 1 cm proximal of the most proximal skin crease, when the hand is bent in the volar direction. Define the ulnar border, which can be extended beyond the flexor carpi ulnaris muscle according to the size needed. Define the proximal border by size of the flap, considering the above-mentioned specifications. Mark the radial vessels between the flexor carpi radialis and brachioradialis muscle.

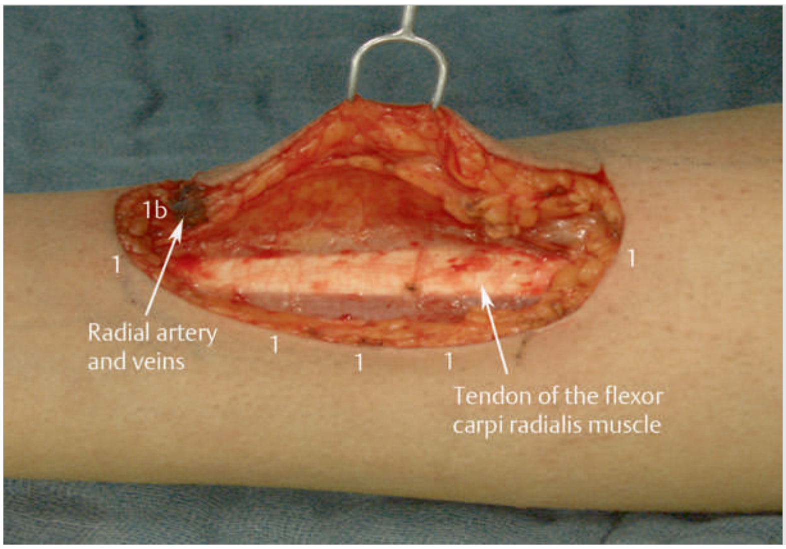

Fig. 4.32 Start the incision from the ulnar part of the flap distally through the skin and the subcutaneous tissue (1). Define the depth by the forearm fascia, which is integrated in the flap. If a large flap is required, expose the tendon of the flexor carpi ulnaris muscle, keeping the paratenon intact. Continue the ulnar-sided flap preparation beyond the tendons of the flexor digitorum and the palmaris longus muscles until reaching the flexor carpi radialis muscle. Localize the radial vessels (pedicle) at the distal end of the flap. The pedicle is running between the flexor carpi radialis and brachioradialis muscle. Ligate the pedicle containing the radial artery and its two comitant veins (1b).

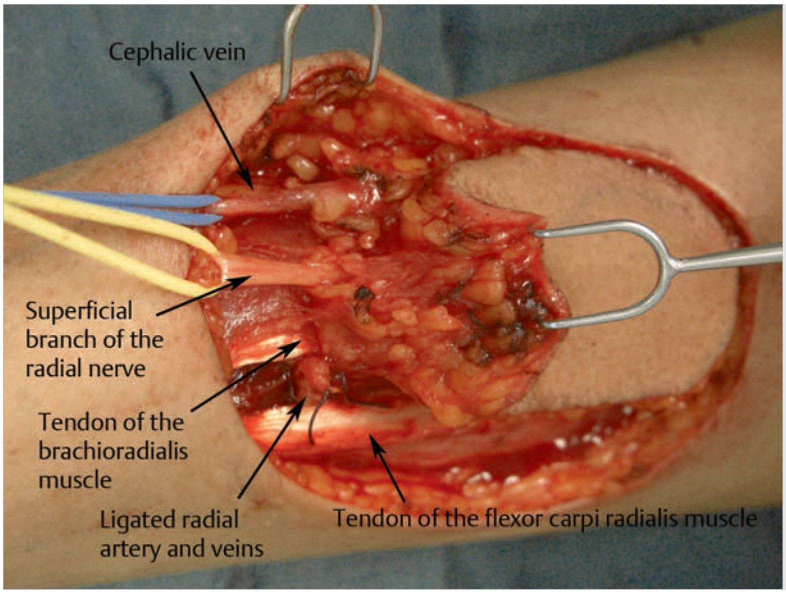

Fig. 4.33 Dissect in radial direction, in order to locate and preserve the superficial branch of the radial nerve, which runs above the tendon of the brachioradialis muscle. Divide the superficial radial nerve in ulnar and radial sections, where the ulnar branch is thinner than the radial branch. Locate and ligate the cephalic vein in the subcutaneous tissue at the radial border of the flap.

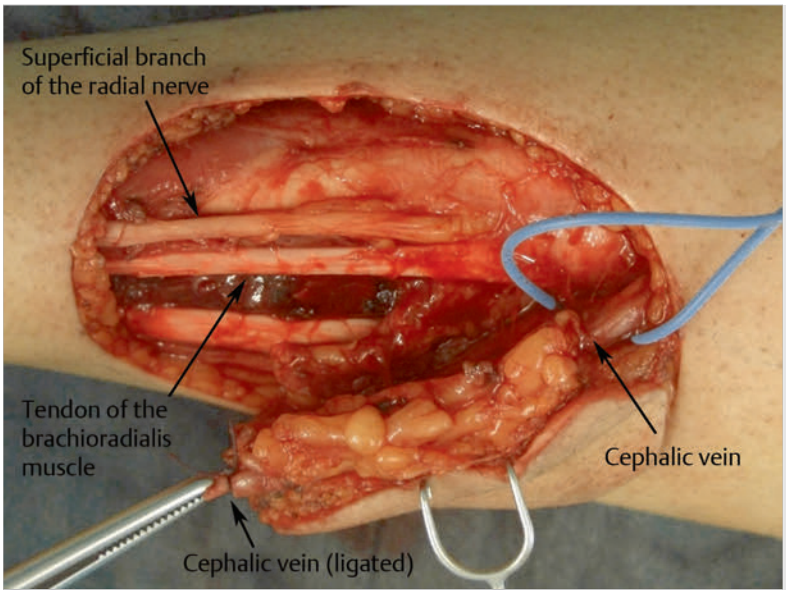

Fig. 4.34 Preparation of the radial border of the flap. Note the course of the cephalic vein: ligation of an anatomic constant radial branch of the cephalic vein, located approximately 3 cm proximal of the distal border. Separate the superficial branch of the radial nerve from the flap tissue. Continue the flap preparation from the distal to the proximal border of the skin island. Locate the vascular pedicle between the flexor carpi radialis and brachioradialis muscles. Carefully dissect the cephalic vein from the brachioradialis tendon, finishing the preparation at the proximal border of the skin island by dissecting cutis and subcutaneous tissue.

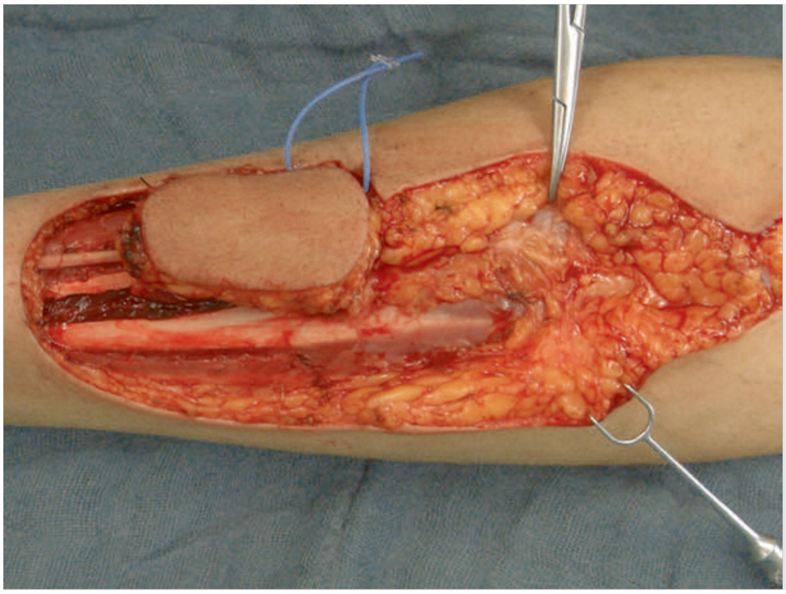

Fig. 4.35 Wave-like incision of the skin and subcutaneous tissue from the middle part of the proximal flap border to the antecubital fossa, until the fascia of the flexor carpi radialis muscle is reached. Identify the cephalic vein at the proximal flap border (blue vessel loop). Dissect the flap while protecting the cephalic vein and the radial pedicle.

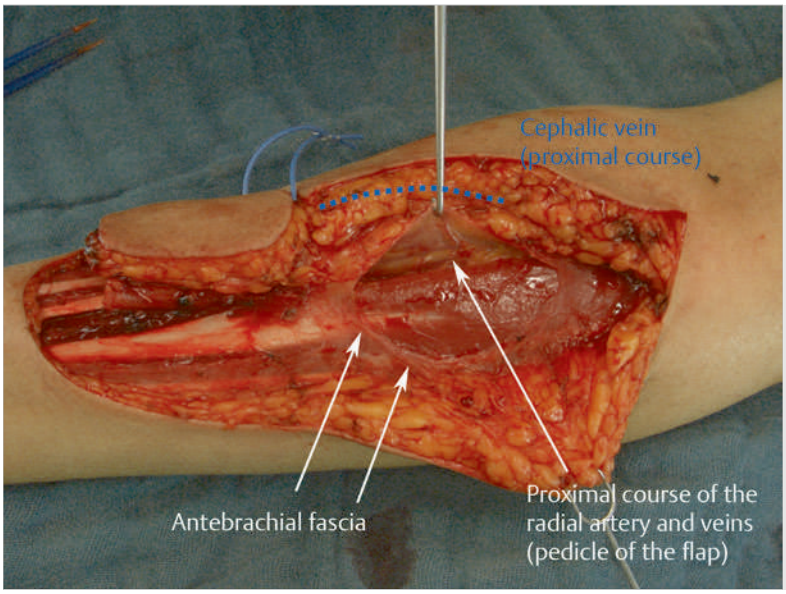

Fig. 4.36 Prepare the cephalic vein from the subcutaneous tissue located radial from the wave-like incision and open the antebrachial fascia at the bottom. Dissect the radial pedicle above the flexor pollicis longus muscle, while small branches to the deep muscles and radial bone are cauterized or clipped. Cut the comitant veins and the cephalic vein at the proximal end of the incision. Evaluate the venous drainage of each single vein. Dissect the radial artery in proximal direction.

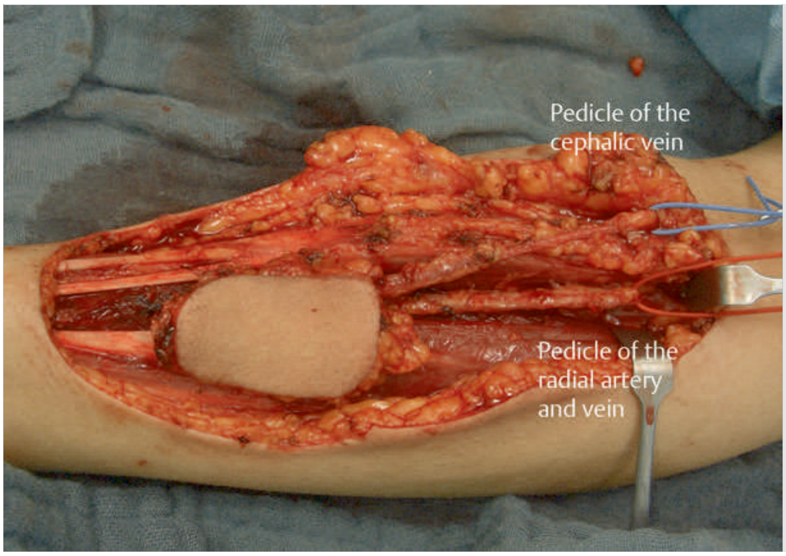

Fig. 4.37 Flap harvest is completed.

4.7 Anterolateral Thigh Flap/ Myocutaneous Vastus Lateralis Flap

4.7.1 History

1984

Song and coworkers described the anterolateral thigh as an additional free flap donor site.

1992

Wolff and coworkers reconstructed the oral cavity by flaps from the anterolateral thigh donor site. They used pure muscle flaps or myofascial flaps from the vastus lateralis muscle; these flaps were pedicled on the descending branch of the lateral circumflex femoral artery.

1996

Kimura and Satoh described primary thinning and defatting of the anterolateral thigh flap and hereby found an effective alternative to the radial forearm flap.

2002

Wei and coworkers raised the question, "Have we found an ideal soft tissue flap?" after harvesting 672 flaps from the anterolateral thigh donor site.

4.7.2 Indication

Huge reconstructions, as thinned anterolateral thigh flap alternative for the radial forearm flap.

4.7.3 Preoperative Procedures

Handheld Doppler ultrasound is used to identify the cutaneous perforator. To determine location of the perforator: draw a line between the anatomic landmarks of the anterior superior iliac spine (ASIS) and lateral patella—the perforator can be found halfway between these landmarks in most cases.

4.7.4 Technique

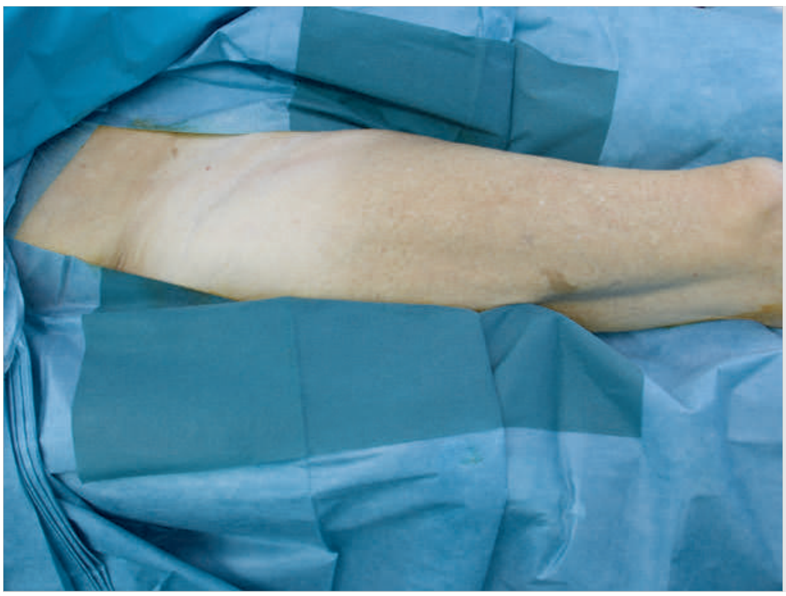

Fig. 4.38 Positioning of the thigh and circumferential skin preparation of lower limb extremity. Anatomic landmarks, ASIS and lateral patella, must be clearly visible and palpable.

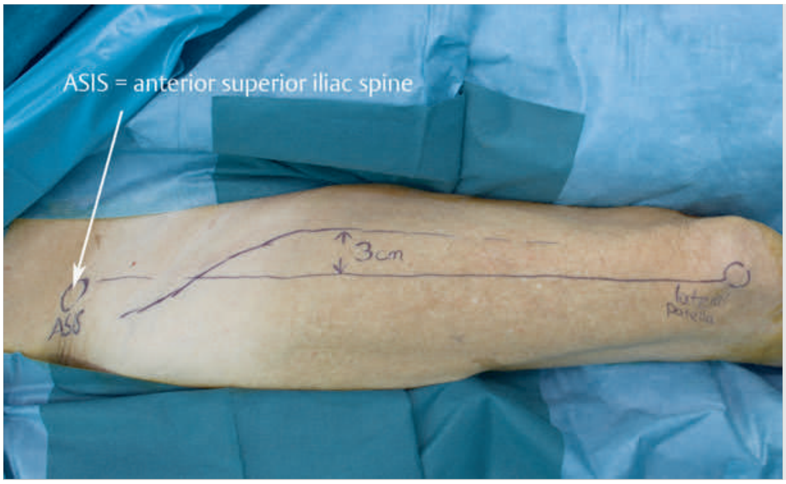

Fig. 4.39 Mark and connect the landmarks of the ASIS and lateral patella by a line. Draw a second line indicating the incision. Incision starts proximally and begins laterally to the interconnecting line. Incision crosses the line and turns to the medial side of the line while keeping a distance of 3 cm. Keeping this distance, the incision runs parallel to the first line in a distal direction.

Fig. 4.40 Location of the skin perforator around the midpoint of the connecting line. To avoid accidental laceration of the perforator vessel, the incision must strictly maintain the 3 cm distance from the ASIS/lateral patella line. Incision of skin and subcutaneous tissue down to the fascia of the thigh.

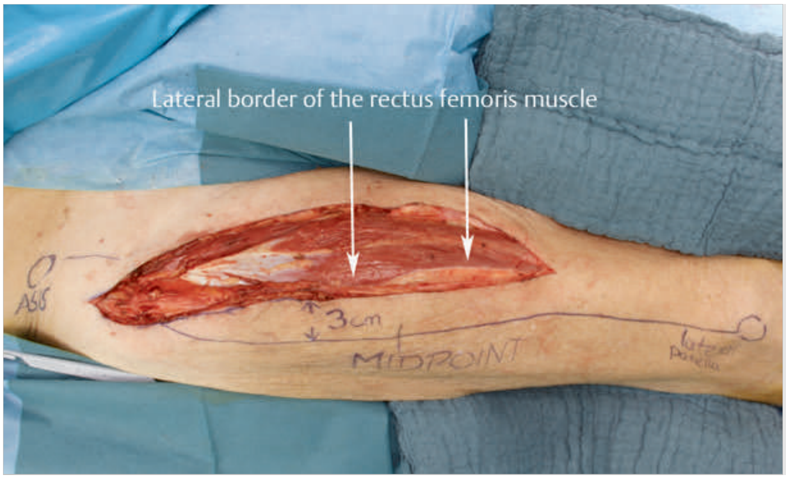

Fig. 4.41 Incision of the rectus femoris muscle fascia. Exposure of the lateral border of the rectus femoris muscle and the intermuscular groove. Demonstration of a septocutaneous perforator running from the intermuscular septum at the undersurface of the rectus femoris muscle in a lateral direction.

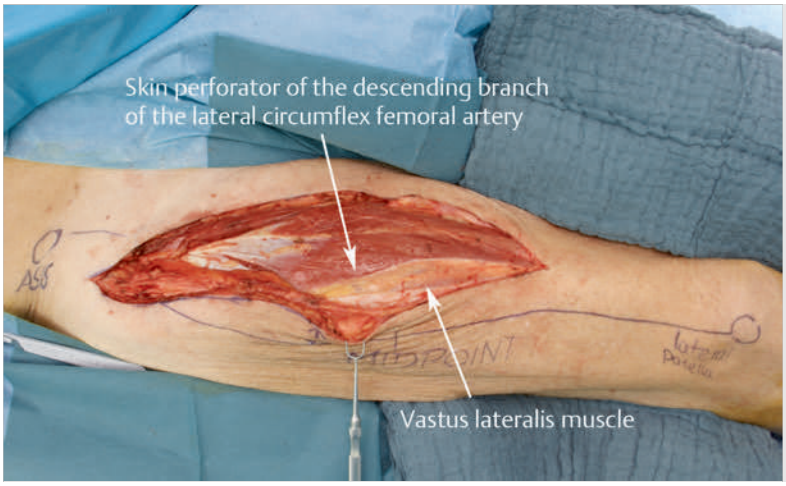

Fig. 4.42 Septocutaneous skin perforator of the descending branch of the lateral circumflex femoral artery seen running on the surface of the vastus lateralis muscle.

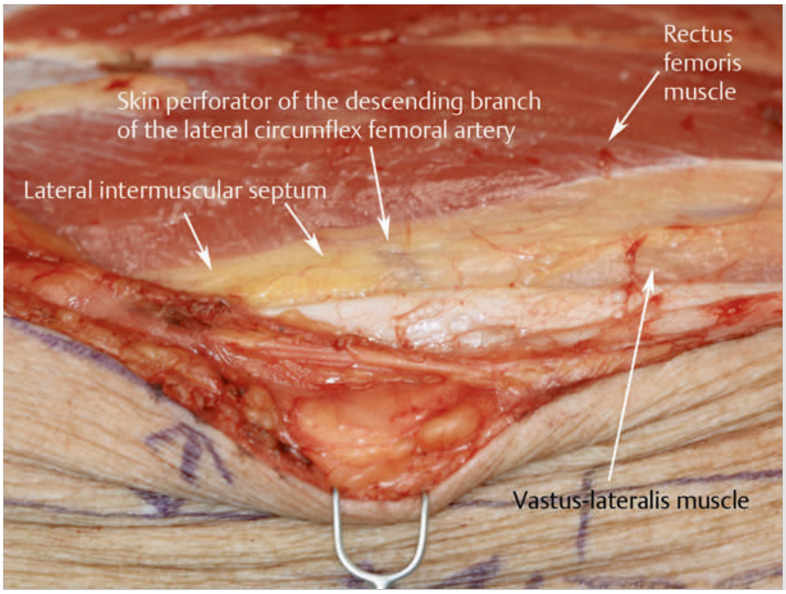

Fig. 4.43 Rectus femoris muscle is retracted slightly medially.

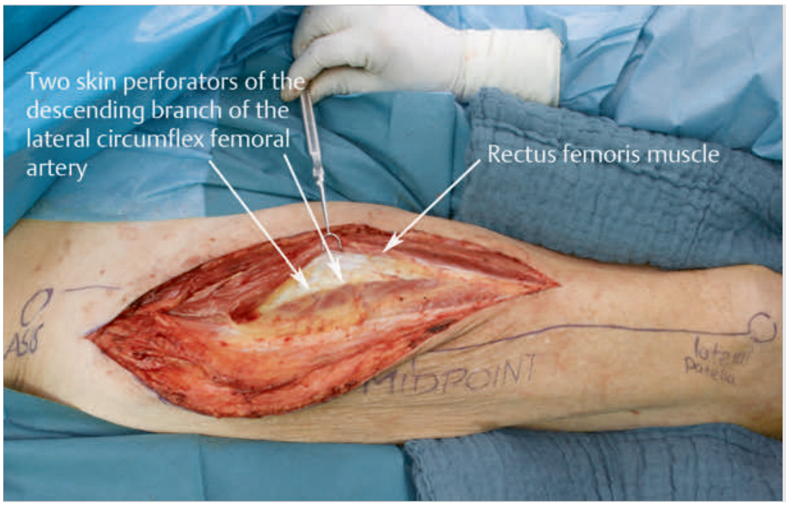

Fig. 4.44 Further retraction of the rectus femoris muscle in a medial direction and identification of a second perforator. Proximally: dissection continues along the muscular groove between the tensor fasciae latae muscle and the rectus femoris muscle. (Tip: blunt dissection with the fingers aids in safe demonstration of the proximal course of the vessels.)

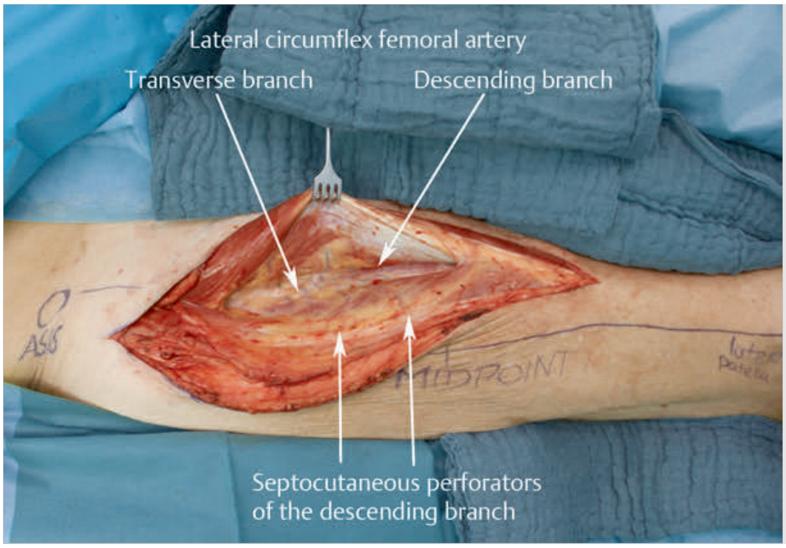

Fig. 4.45 Further retraction of the rectus femoris muscle. The lateral circumflex femoral artery with all its branches becomes visible. The descending branch, with its skin perforators, supplies perfusion for the myocutaneous vastus lateralis/anterolateral thigh flap; the transverse branch or the ascending branch provide perfusion for the myocutaneous tensor fasciae latae flap.

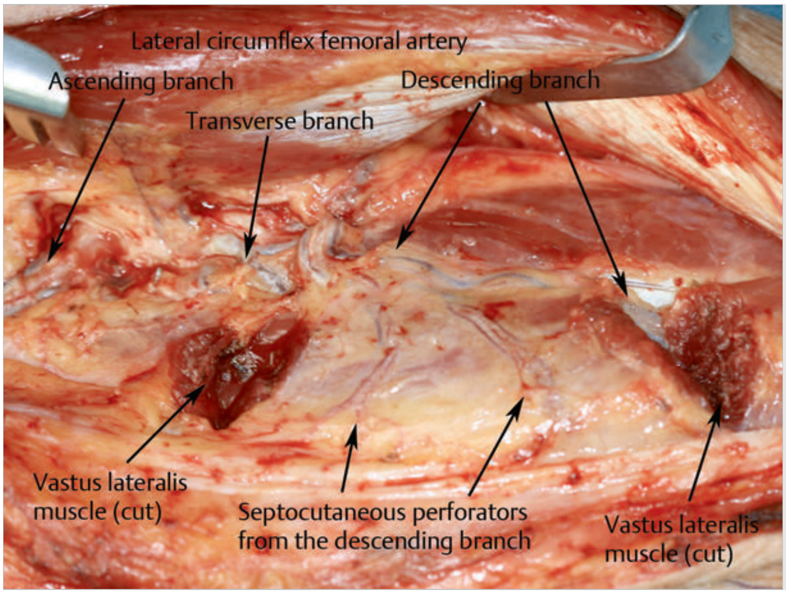

Fig. 4.46 Inclusion of a cuff of vastus lateralis muscle surrounding the perforators into the flap. Therefore, the vastus lateralis muscle is cut in medial-to-lateral direction 2 cm proximal and 2 cm distal from the perforators. This maneuver helps eliminate vascular spasm by avoiding any tension on the perforators.

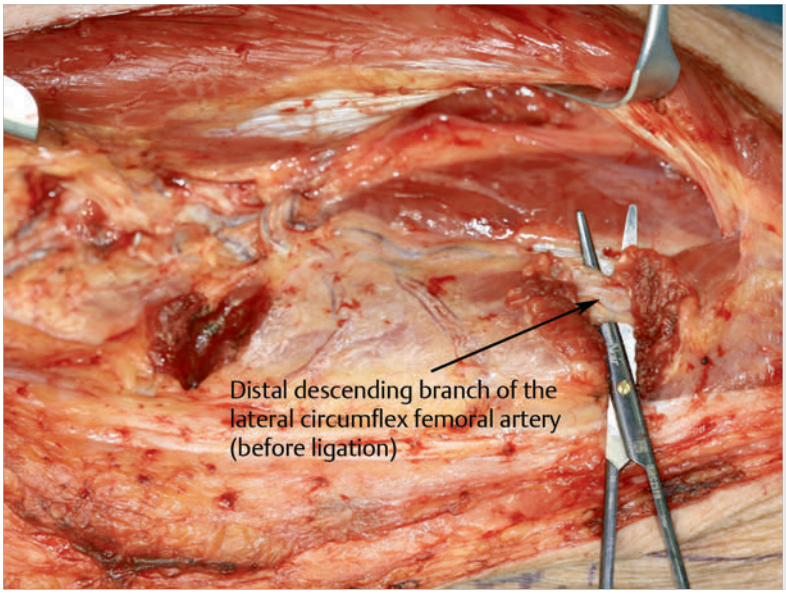

Fig. 4.47 Ligation of the descending branch 3 cm distal from perforators branching off.

Fig. 4.48 Incision of the skin paddle. Septocutaneous perforators are located in the center of the skin island. Incision of the skin and subcutaneous tissue down to the fascia.

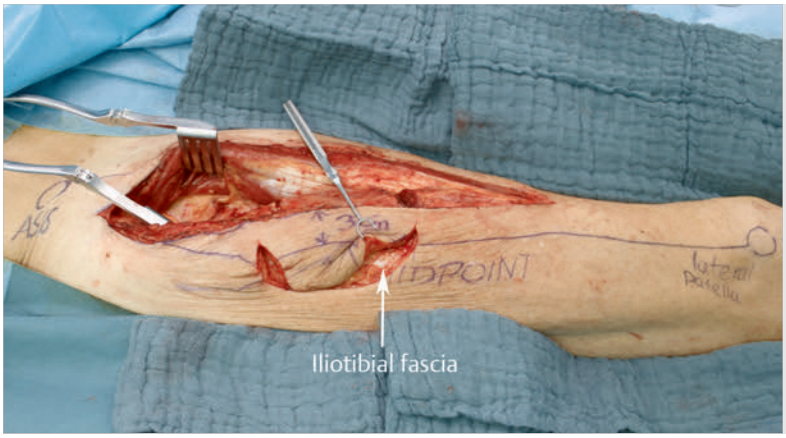

Fig. 4.49 Incision of iliotibial fascia. Perforators must be located in the center of the flap; avoid cutting the fascia too medially.

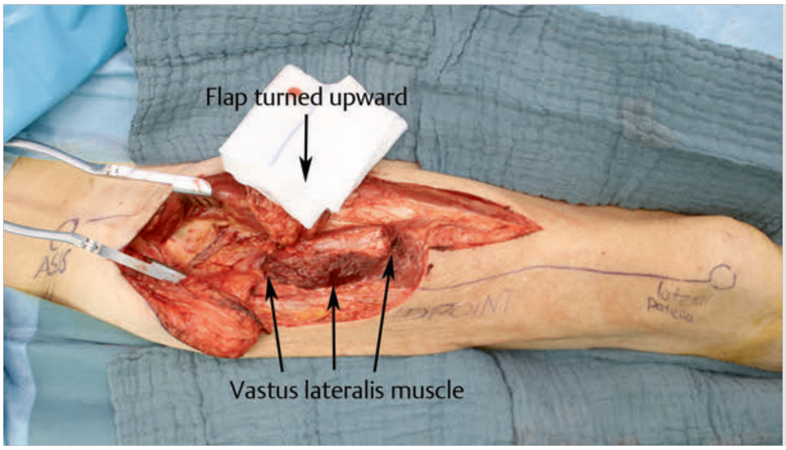

Fig. 4.50 Undermining of the included vastus lateralis muscle part, starting from medial to lateral direction. Separation of the vastus lateralis muscle and inclusion into the flap. Vastus intermedius muscle becomes visible on the base. Flap is turned slightly in a medial direction, the perforators become visible from the undersurface. Cut the iliotibial fascia while keeping a safe distance from the perforators. Fix the fascia to the skin island with resorbable sutures to prevent shearing.

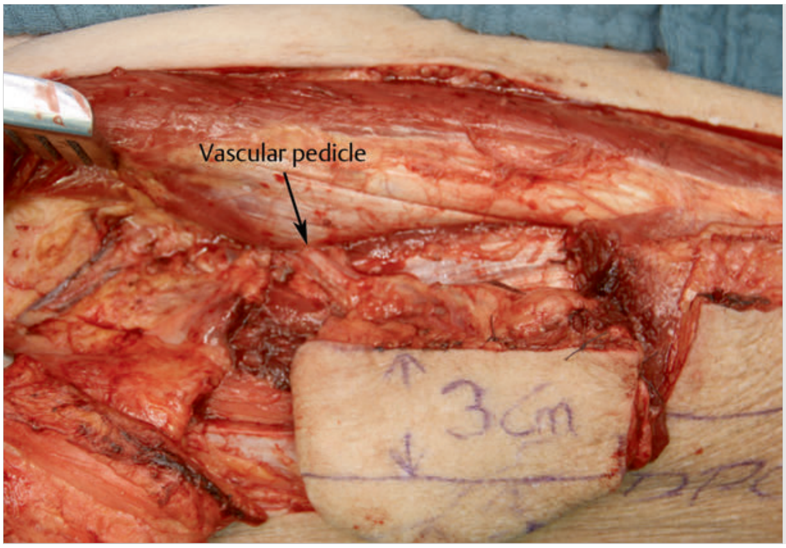

Fig. 4.51 Dissect the vascular pedicle (the descending branch) from distal to proximal direction until reaching its origin from the lateral circumflex femoral vessels.

Fig. 4.52 Myocutaneous flap harvest is completed.

4.7.5 Modification of the Procedure by Harvesting an Additional Myocutaneous Tensor Fasciae Latae Flap

History

Foad Nahai, born 1943 in Teheran, and his workgroup from the Emory University Hospital in Atlanta were the first to describe the clinical use of the fascia lata musculocutaneous free flap in 1978.

Indication

When there is a need for two extended skin islands, such as large combined extra- and intraoral defects.

Technique

Initial surgical stages as described until Fig. 4.45.

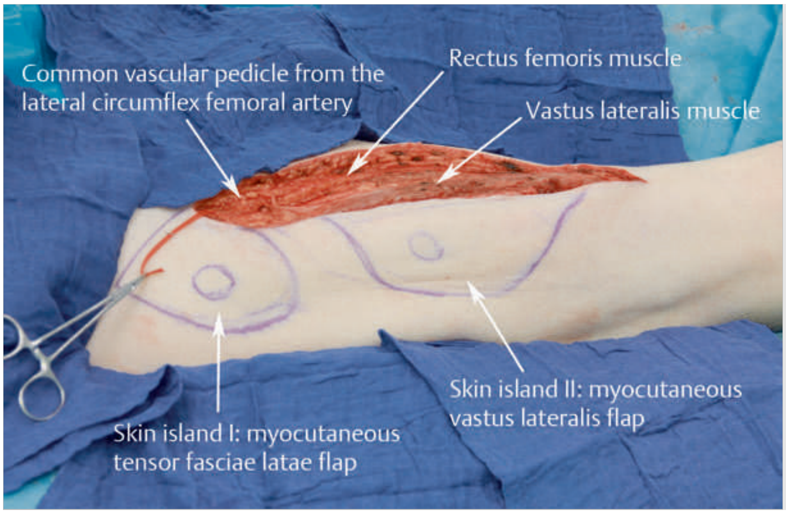

Fig. 4.53 Complete exposure of lateral circumflex femoral artery and its branches between the rectus femoris muscle and vastus lateralis (VL)/tensor fasciae latae (TFL) muscle.

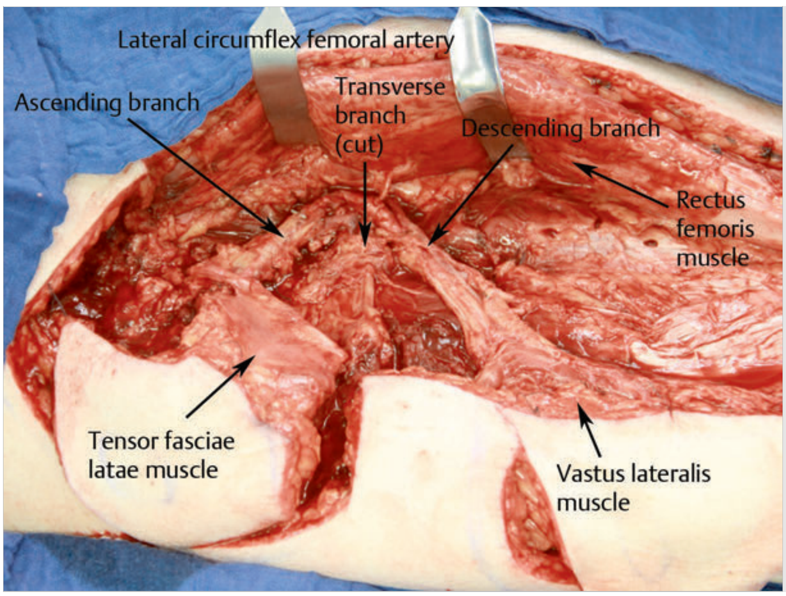

Fig. 4.54 Transverse branch is cut; descending and ascending branches are dissected in distal direction. Skin islands are marked.

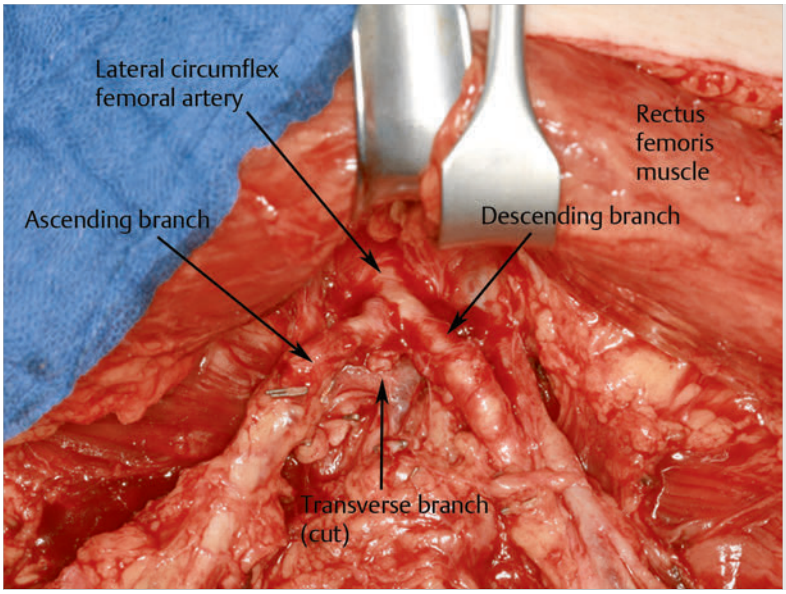

Fig. 4.55 Detailed vascular pedicles of myocutaneous TFL and VL flaps.

4.8 Osseocutaneous Fibula Flap

4.8.1 History

1974

On April 7, 1974, Ian Taylor (born 1938 in Melbourne) performed the first vascularized fibula flap transfer to reconstruct parts of the tibia.

1986

Wei et al. popularized the use of the fibula osteoseptocutaneous flap and presented the first 15 clinical cases.

1989

In New York, the first reconstruction of a mandibular defect with a free fibula flap was done by David Hidalgo (born 1952).

1992

Zlotolow and the colleagues of David Hidalgo incorporated secondary osseointegrated dental implants for functional rehabilitation into the neo-mandible constructed from a free fibula flap.

4.8.2 Indication

Composite tissue reconstructions of the lower and upper jaw.

4.8.3 Preoperative Procedures

Clinical Examinations

- Assessment of walking ability (claudication) in patients with peripheral artery occlusive disease
- Palpation of pedal pulses: dorsalis pedis artery and posterior tibial artery
- Use of handheld Doppler probe to mark out the cutaneous perforators (most commonly found at the junction of middle and lower third of the fibula)

Computed Tomography Angiography

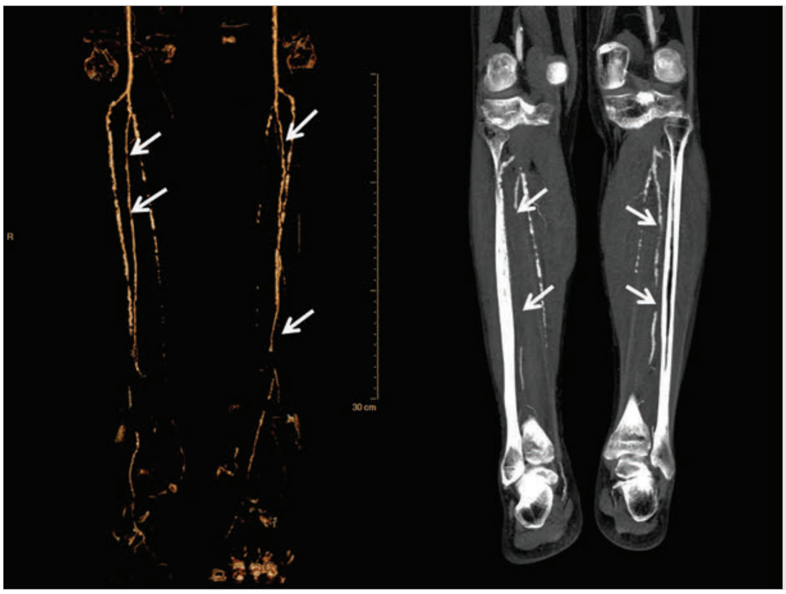

Fig. 4.56 Contraindication for a free fibula flap transfer. Left: anterior view on a three-dimensional (3D) reconstruction showing occlusive disease with insufficient peroneal vessels (*arrows*). Right: posterior view on the interrupted peroneal artery (*arrows*).

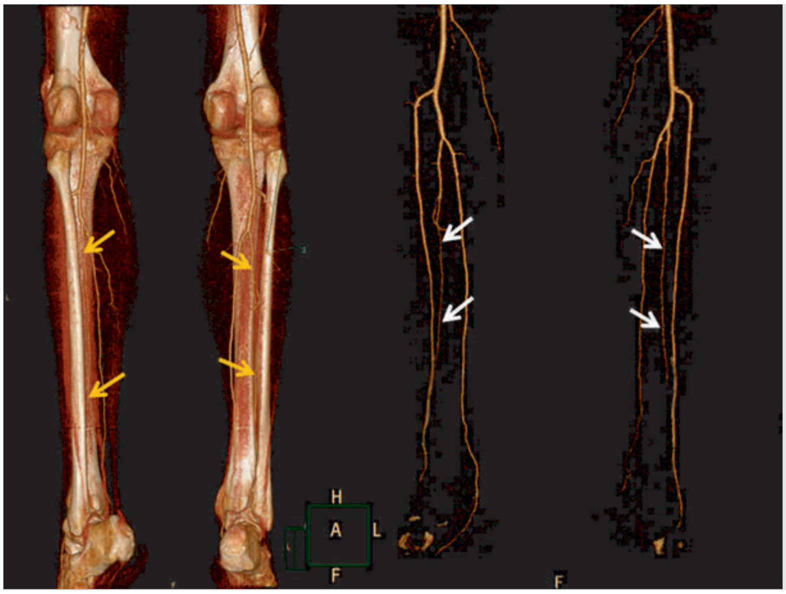

Fig. 4.57 Indication for fibula flap transfer. Left: well-perfused, sufficient peroneal artery, posterior view. Right: sufficient peroneal artery, anterior view on a 3D reconstruction.

4.8.4 Cross-sectional Anatomy

To illustrate fibula flap harvest further, schematic cross-sections to the corresponding clinical stages are included.

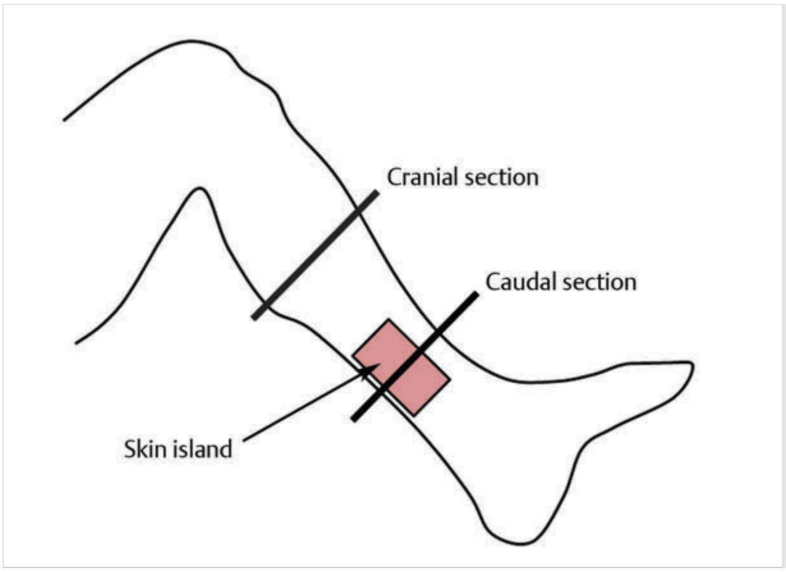

Fig. 4.58 Location of the cranial (see Fig. 4.66a)" and caudal cross-sections of the lower leg.

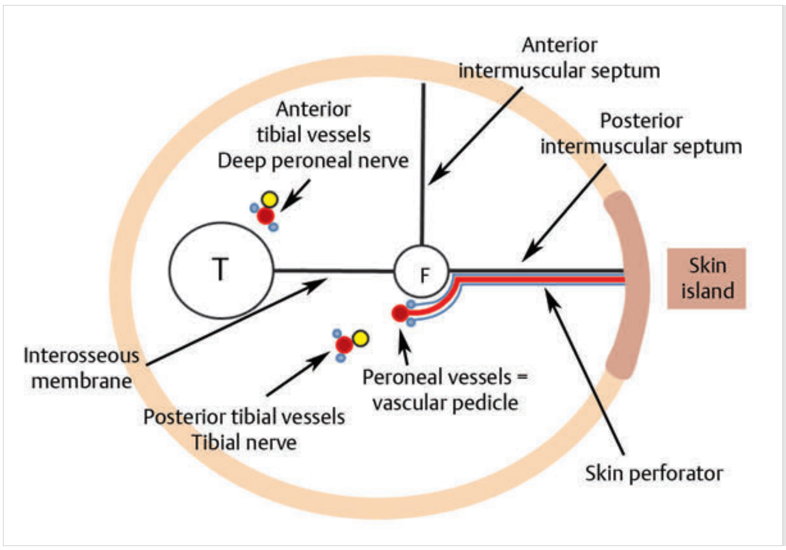

Fig. 4.59 Caudal cross-section of the lower leg: anatomic structures at the level of the skin island. T, tibia; F, fibula.

4.8.5 Technique

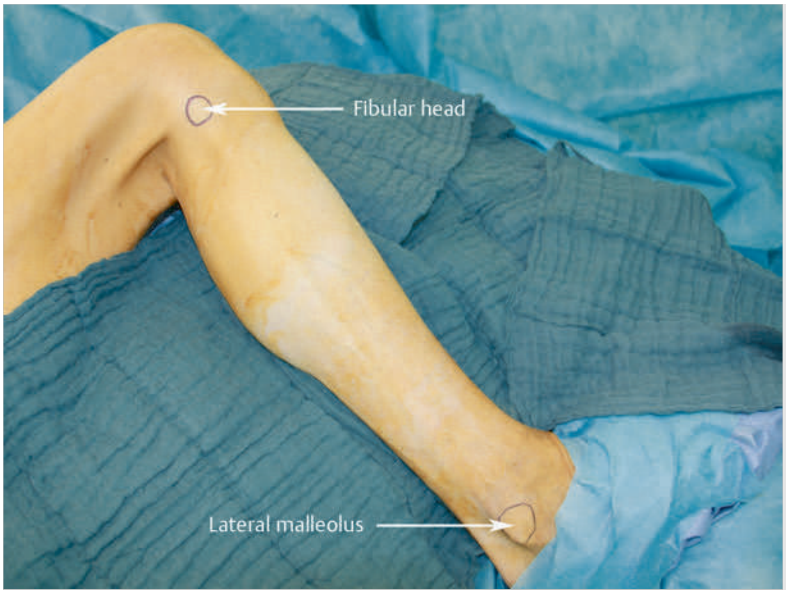

Fig. 4.60 Circumferential preparation of the leg. Fixation of the foot with the knee flexed and moved away from the surgeon. Marking the anatomic landmarks: fibular head and lateral malleolus.

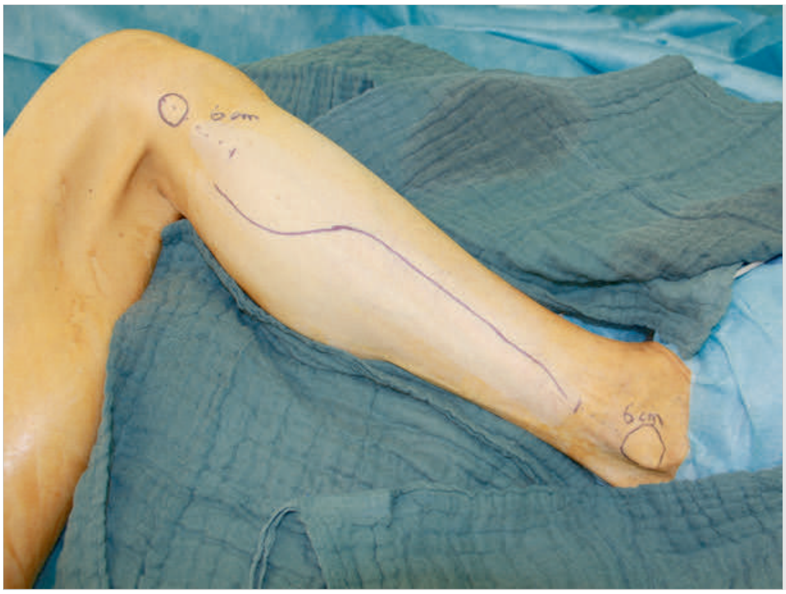

Fig. 4.61 Draw the incision line, starting 6 cm distal of the fibular head so as to preserve the common peroneal nerve, which crosses the fibular neck proximal to this mark. Incision line drawn extending from the lateral to the medial aspect of the underlying posterior intermuscular septum (separating the soleus muscle from the peroneus longus muscle). Incision line stops 6 cm proximal to the lateral malleolus to avoid instability of the ankle.

Fig. 4.62 Incision of skin and subcutaneous tissue down to the fascia covering the flexor group of muscles and the peroneus longus muscle.

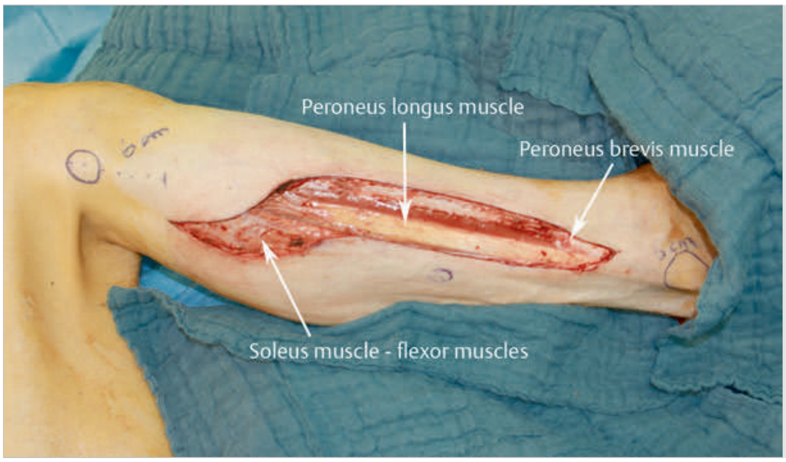

Fig. 4.63 Incision of peroneus longus muscle fascia. Separate the peroneus longus muscle, peroneus brevis muscle, and soleus muscle. Blunt and gentle retraction of the skin at the lateral aspect of the peroneus longus muscle; perforator becomes visible next to the Doppler marking.

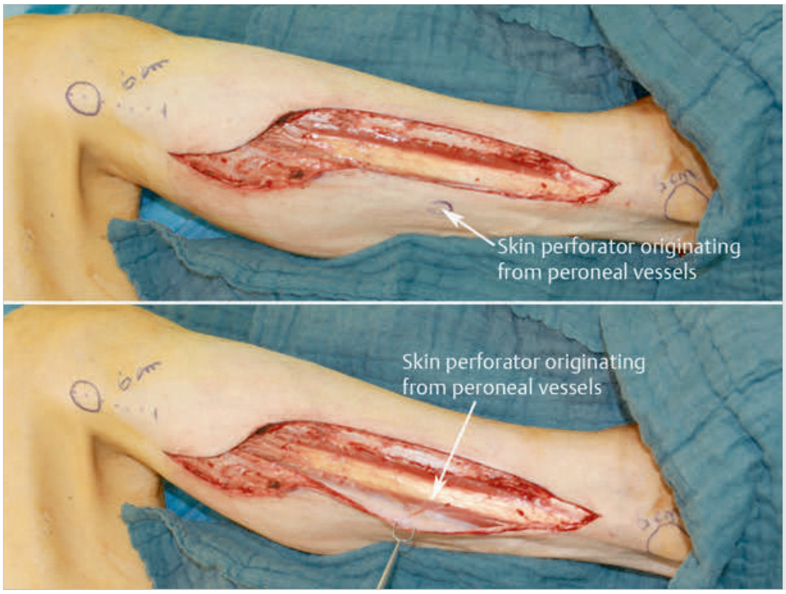

Fig. 4.64 Visualization of the skin perforator in the lateral intermuscular septum.

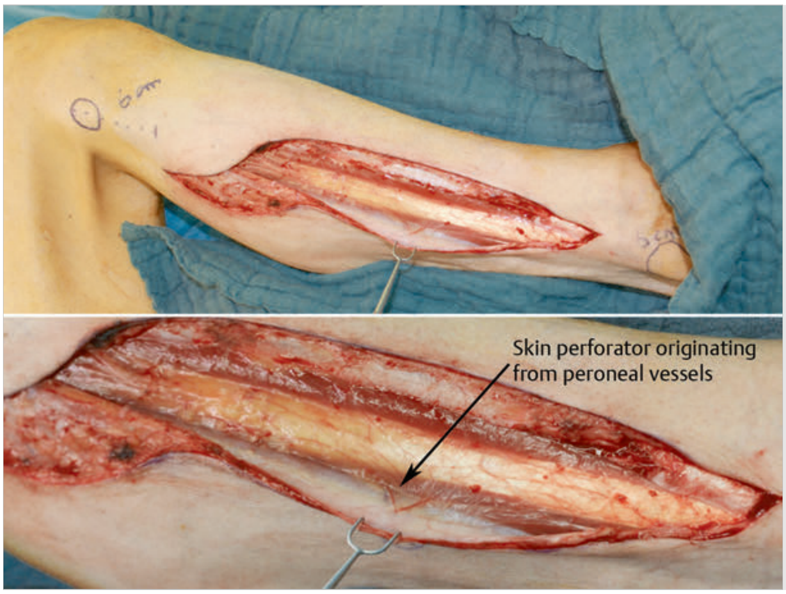

Fig. 4.65 Visualization of the skin perforator in detail.

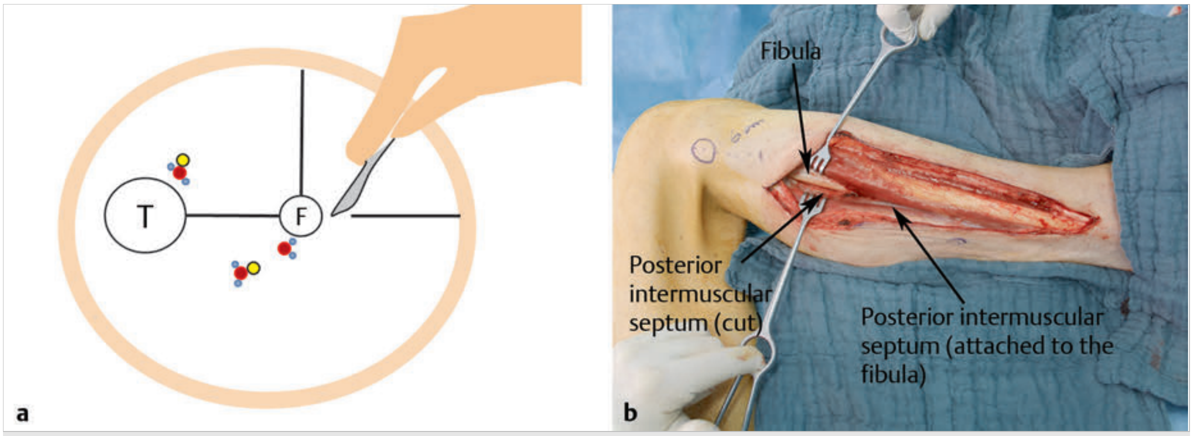

Fig. 4.66 a, b Cranial incision of the lateral intermuscular septum keeping a safe distance to the skin perforator vessels. Cranial detachment of the lateral margin of the fibular bone.

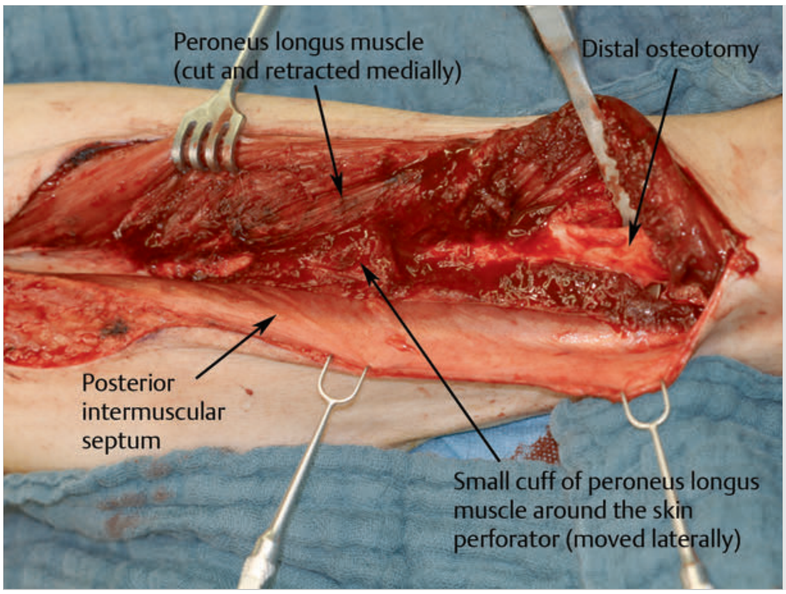

Fig. 4.67 Incision down to the fibula bone from cranial to caudal. Next to the skin perforators, the incision curves medially; in this region, the peroneus longus muscle is incised and a muscle cuff is left laterally to protect the perforator vessel. Carefully and circumferentially dissect the fibular bone with a curved raspatory at the levels of the proximal and distal osteotomy.

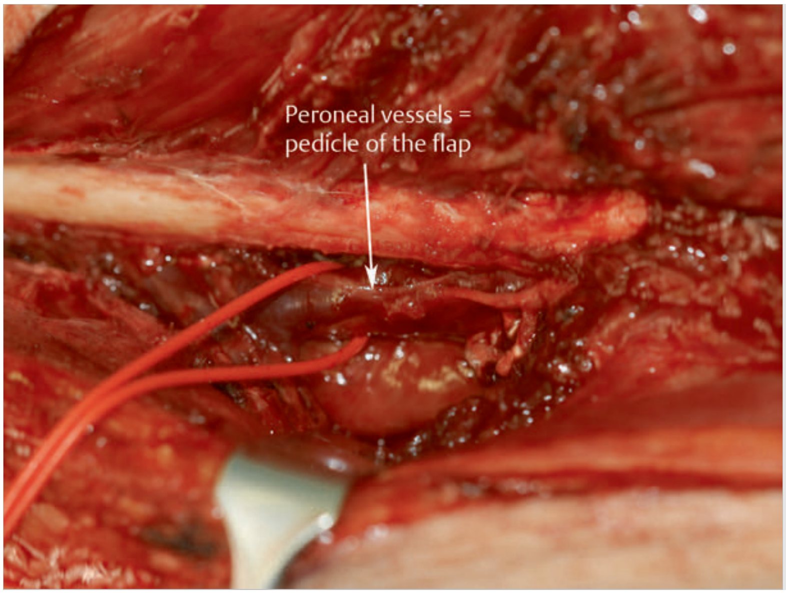

Fig. 4.68 Adjacent to the proximal osteotomy, dissect the tissue located medial to the incised posterior intermuscular septum. Palpate the peroneal vessels. Dissect the peroneal vessels and retract the pedicle in the lateral direction with a vessel loop.

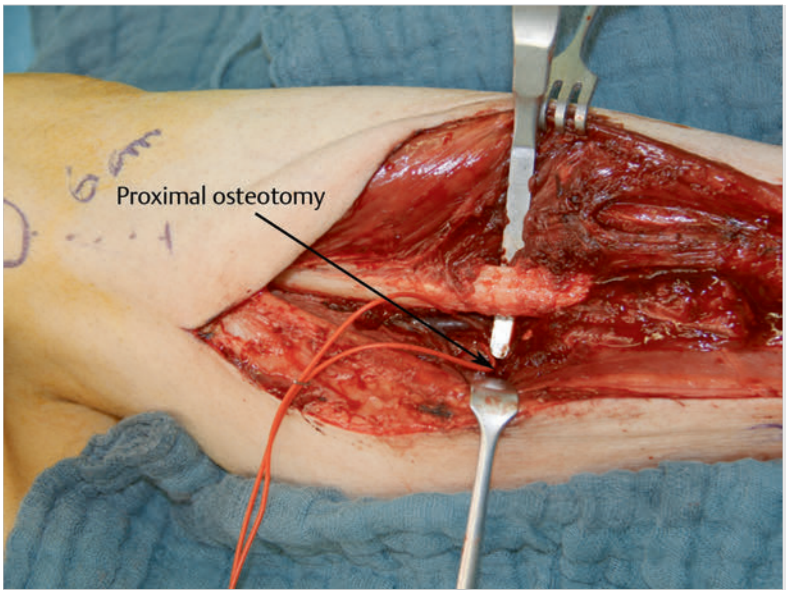

Fig. 4.69 Proximal osteotomy with protection of the pedicle with a raspatory.

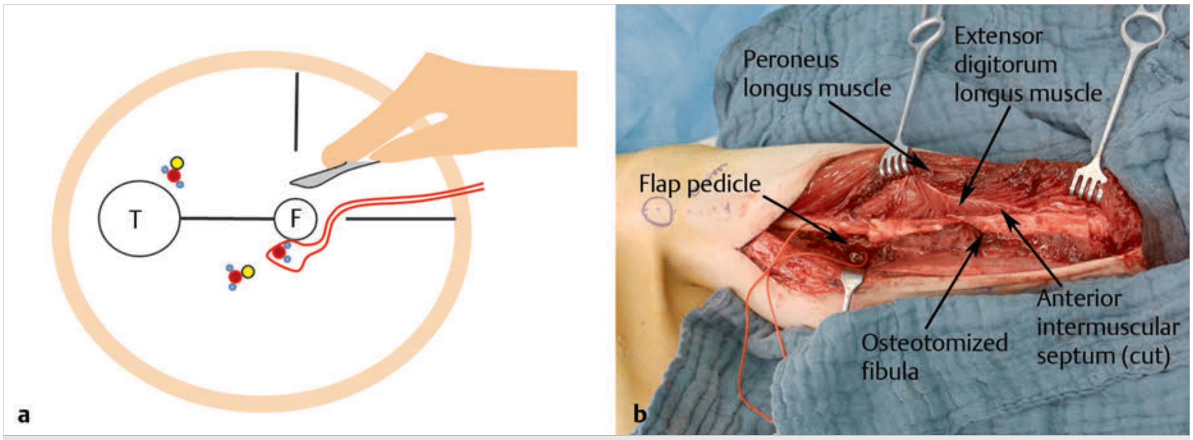

Fig. 4.70 a, b Distal osteotomy with protection of the pedicle with a raspatory. Incision of the anterior intermuscular septum adjacent to the fibula bone; extensor digitorum longus muscle becomes visible.

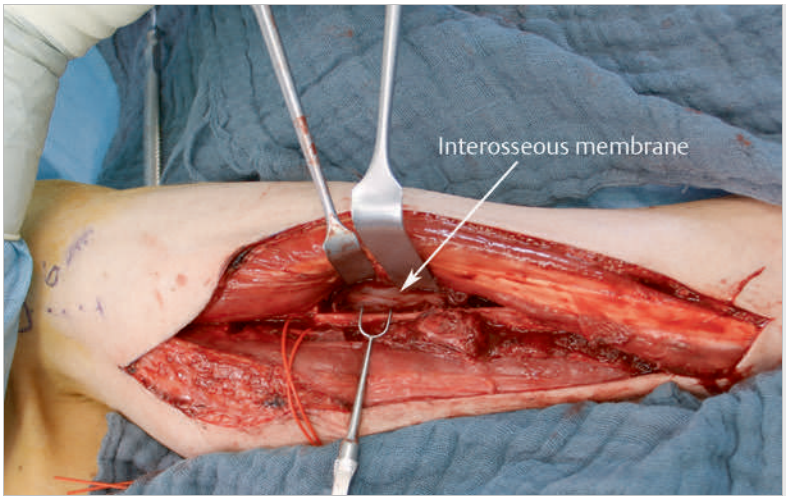

Fig. 4.71 Following retraction of the extensor digitorum longus muscle with hooks, the interosseous membrane becomes visible.

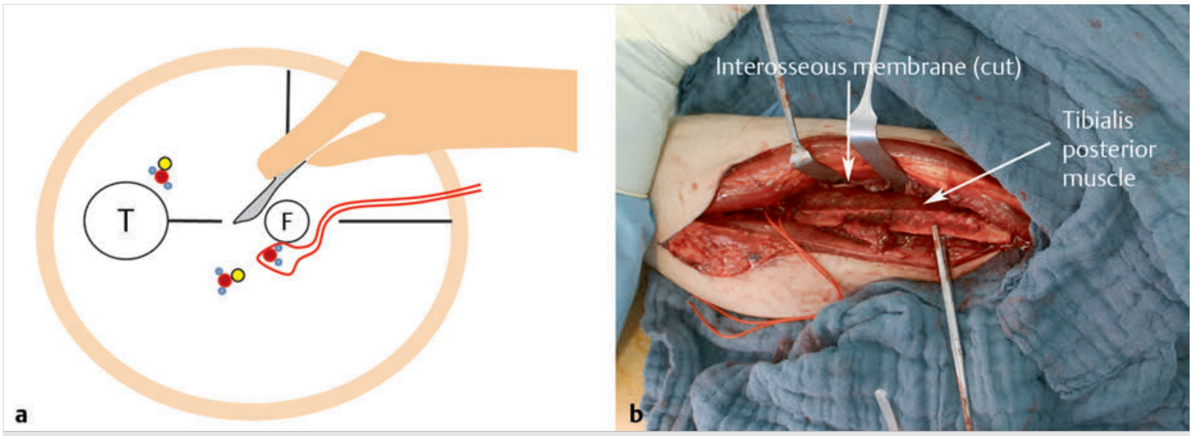

Fig. 4.72a, b Following incision of the interosseous membrane close to the fibula, the tibialis posterior muscle becomes visible. It is now possible to mobilize the fibula in the lateral direction with a hook.

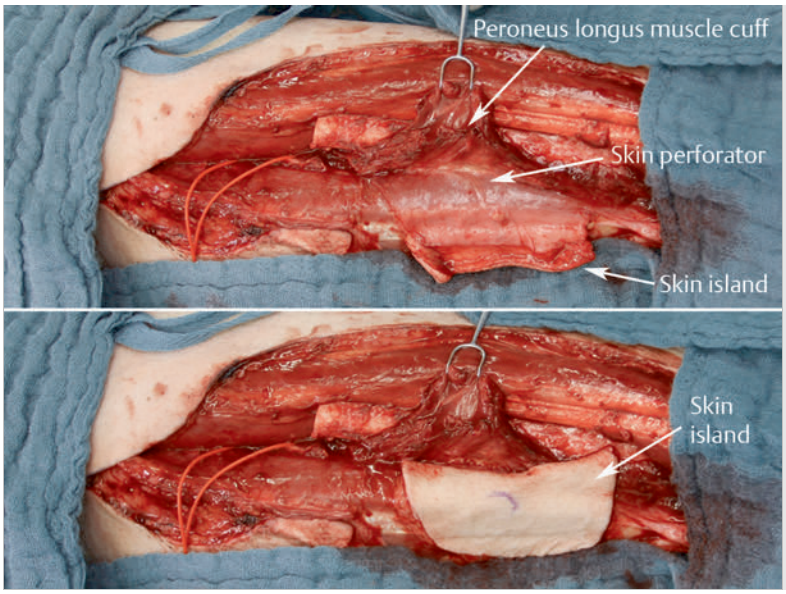

Fig. 4.73 Lateral incision of the skin island while keeping the skin perforator in the center. Try to avoid shearing of the skin island. Careful incision of the posterior intermuscular septum on the underlying soleus muscle. Keep a strict distance of 3 cm to the skin perforators.

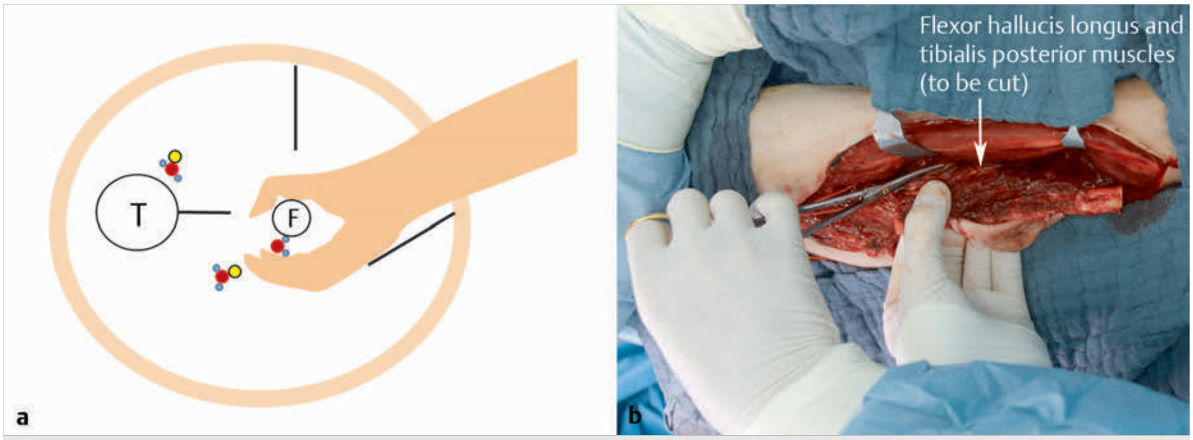

Fig. 4.74 a, b Fix the skin island to the periosteum with sutures to avoid shearing. While holding the flap and feeling the pulse of the pedicle between the fingers, the tibialis posterior muscle and the flexor hallucis longus muscle are incised above the fingers.

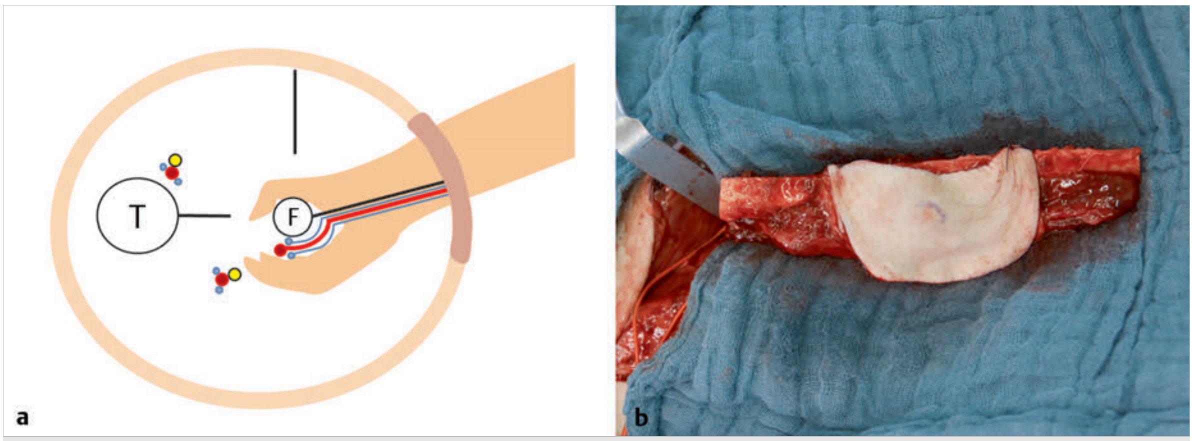

Fig. 4.75 a, b Osseocutaneous fibula flap harvested.

4.9 Considerable Alternatives in Reconstruction

4.9.1 Pedicled Flaps

- Temporalis muscle flap
  - Soft tissue reconstruction in the maxillary region
- Platysma flap
  - Soft tissue reconstruction of the floor of the mouth/ tongue region
- Pectoralis major flap
  - Extended soft tissue reconstruction for the floor of the mouth/tongue region
  - "Backup flap" for wound dehiscences after free flap reconstructions, mainly for wound healing disturbances of the irradiated neck
- Latissimus dorsi flap
  - Extended soft tissue reconstruction
  - "Backup flap" for wound dehiscences after free flap reconstructions, mainly for wound healing disturbances of the irradiated neck

4.9.2 Free Flaps

- Microvascular reanastomosed latissimus dorsi flap
  - Extended soft tissue reconstruction
- Deep circumflex iliac artery flap (anterior iliac crest bone flap)
  - Bony reconstruction of mandibula or maxilla
- Scapular flap
  - Composite tissue reconstruction

4.10 Principles of Complex Reconstruction Planning

The mandibula is affected by neoplasms and osteoradionecrosis to a much greater extent than the maxilla. Substantial principles of lower jaw reconstructions with fibula flaps are representatively demonstrated in the following text. Special attention is paid to individually built and commercially available planning and osteotomy devices.

4.10.1 Classification of Mandibular Defects

Various classification schemes for mandibular defects have been suggested. Although the system after Jewer et al. (1989) is widespread, the classification after Urken et al. (1991) seems to have more impact on reconstruction planning. The lower jaw is divided as follows: C for condyle, R for ramus, B for body, and S for symphysis.

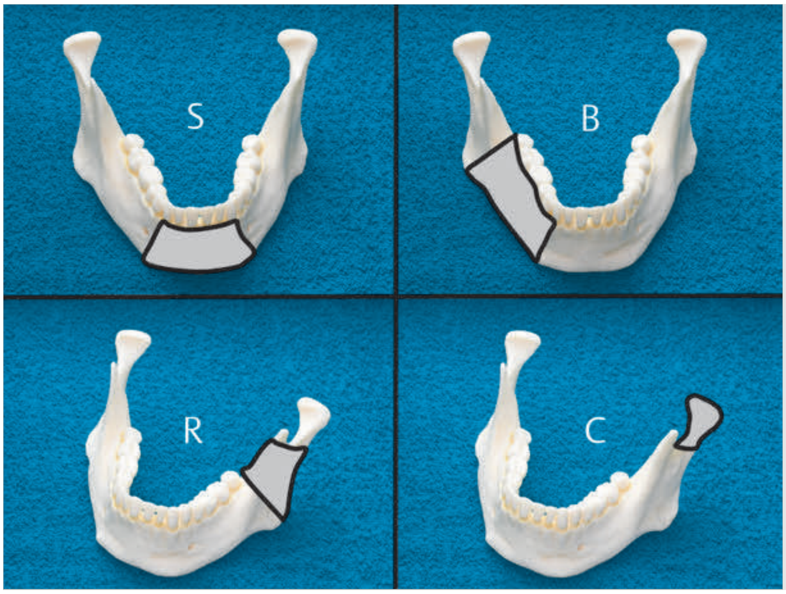

Fig. 4.76 Classification of mandibular defects after Urken et al. (1991). S, symphysis, from canine to canine; B, body, from canine to angle; R, ramus, from angle to incisura; C, condylar, from incisura to condyle.

4.10.2 Mandibular Reconstruction with Osseocutaneous Fibula Flaps

Reconstruction of the Basal Part or the Alveolar Process

Basal part reconstruction is recommended when mouth opening is reduced to less than 25 mm and consecutive insertion of dental implants is not possible.

Alveolar part reconstruction is recommended in patients with unrestricted mouth opening and possibility of consecutive dental implant insertion.

Choice of Donor Site for Osseocutaneous Fibula Flaps

The laterality of the fibula donor site depends on

- Whether the skin island is used for intraoral or extraoral reconstruction
- Whether the anastomoses are performed on the ipsi- or contralateral neck with respect to the fibula donor site

Anastomoses	Positioning of skin island	Laterality of fibula donor site
Left neck	Intraoral	Right fibula
Right neck	Intraoral	Left fibula
Left neck	Extraoral	Left fibula
Right neck	Extraoral	Right fibula

Fig. 4.77 Algorithm for osseocutaneous fibula harvest with respect to the location of anastomoses and soft tissue reconstruction.

Reconstruction of Class B Defects

Preoperative planning and operative management of an osteoradionecrosis case is demonstrated in Figs. 4.78 and 4.79. The patient underwent surgery and postoperative radiotherapy because of tongue cancer. Because of the intraoral dehiscence and the irradiated and insufficient cervical skin, a reconstructive procedure with two flaps was planned. An osseocutaneous fibula flap was suggested for mandibular and intraoral reconstruction with an additional radial forearm flap for extraoral coverage. Anastomoses for both flaps were to be performed on the contralateral, unoperated neck side. Due to the reduced mouth opening of the patient (15 mm preoperatively), the fibula transplant was placed at the mandibular base.

Fig. 4.78 Preoperative presentation of the patient.

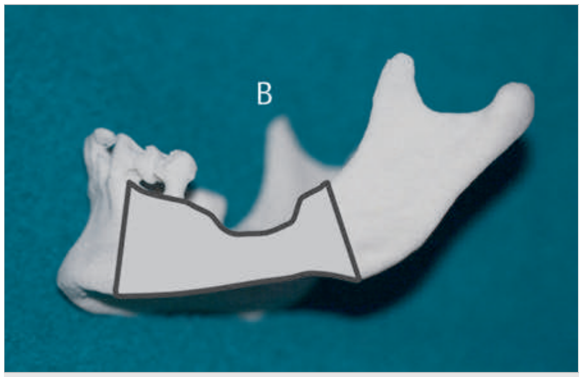

Fig. 4.79 Fabrication of a stereolithography (SLA) model from mandibula and fibula (not shown).

Preoperative Manufacturing of Individualized Cutting Devices and Operation

Fig. 4.80 Impression of the basal part of the mandible, which needs to be reconstructed, and construction of a plaster model.

Fig. 4.81 Defining the resection.

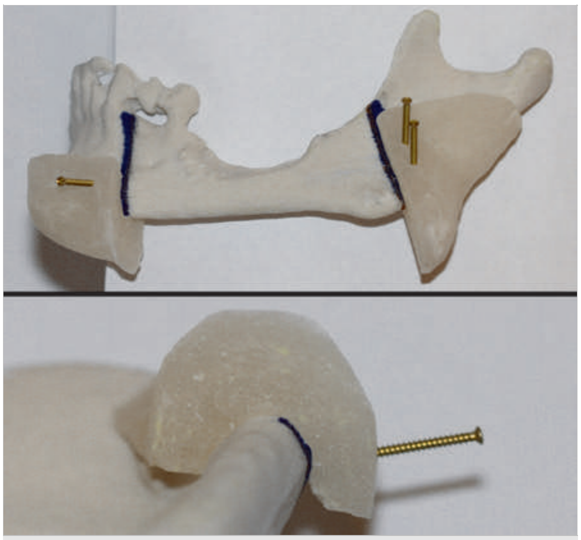

Fig. 4.82 Isolation of the plaster model. Individualized polymethyl methacrylate (PMMA) cutting guides with drilling holes are built.

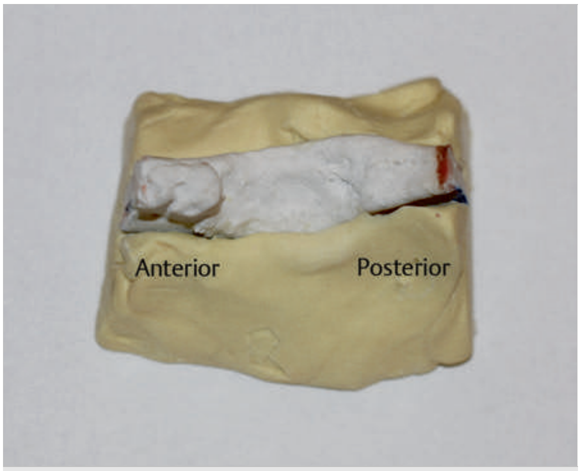

Fig. 4.83 Impression of the basal part of the mandible together with mandibular cutting guides. Defined resection of the diseased part of the mandible (on SLA model).

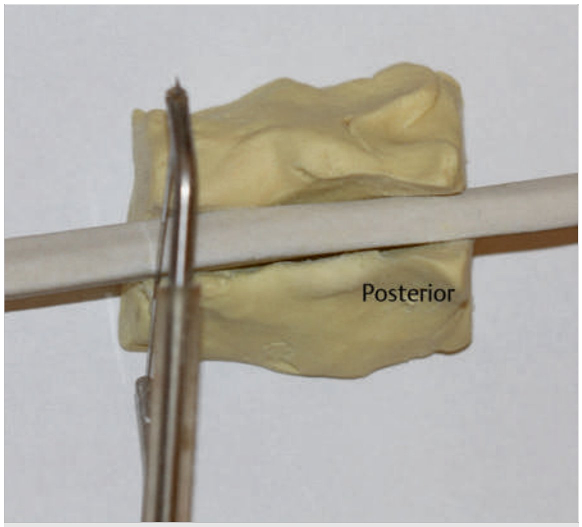

Fig. 4.84 According to the location of the perforator vessels, the SLA fibula is placed in the impression. Saw the fibula segment in accordance to the resection line.

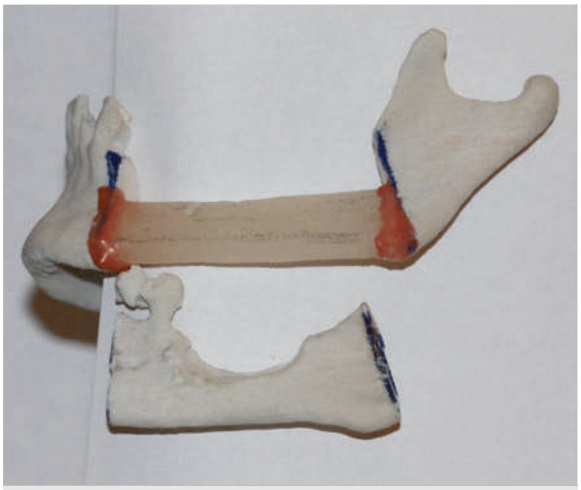

Fig. 4.85 The fibula segment is fixed with wax. If preoperative mouth opening is poor, as it is (15 mm), and dental implants will not be inserted, the fibula substitutes for the basal part of the mandibular body.

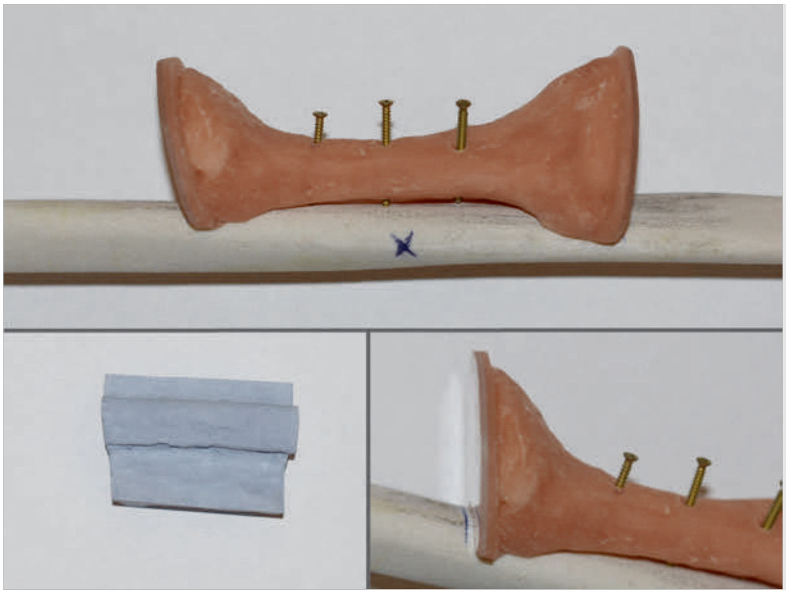

Fig. 4.86 Doubling the lateral rim of the fibular segment and fabrication of a plaster model. Fibular cutting guide is built from PMMA or an addition cross-linking silicone with respect to the location of the perforator. Drilling holes for fixation screws are prepared.

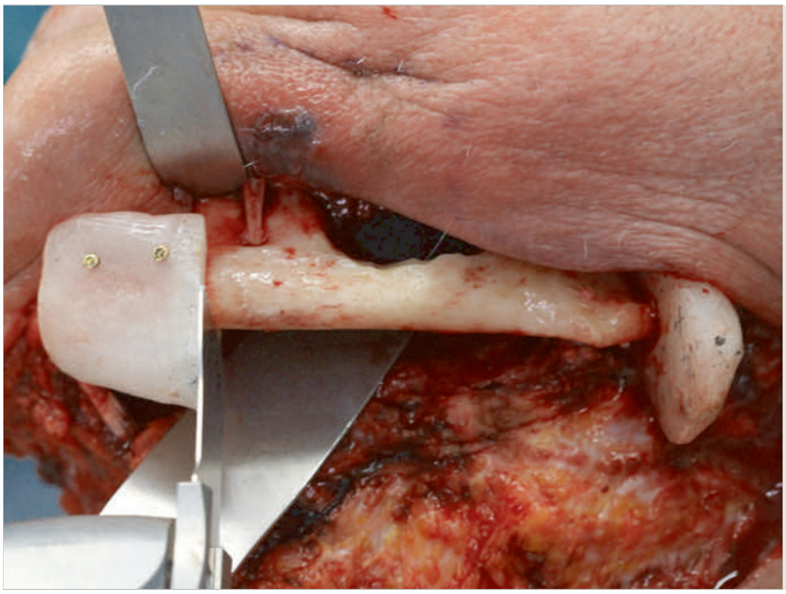

Fig. 4.87 PMMA cutting guides are fixed on the mandible.

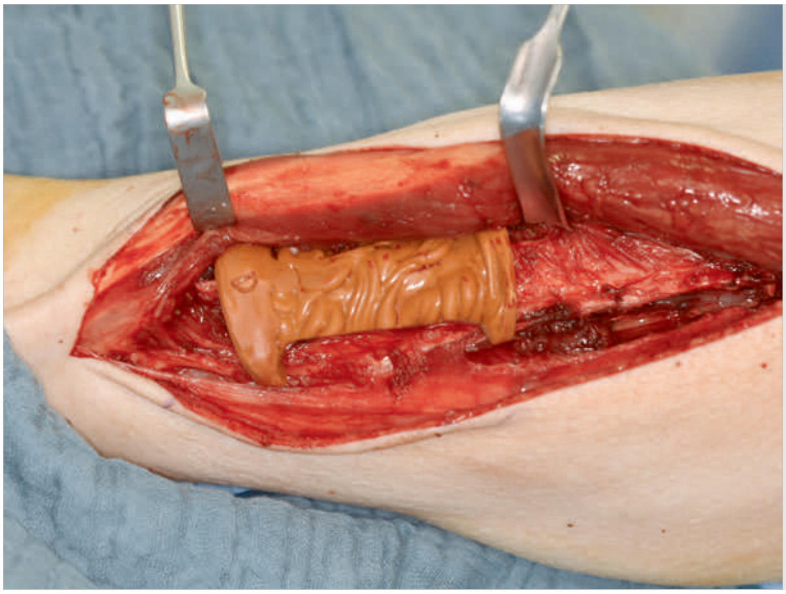

Fig. 4.88 Fixation of the silicone cutting guide on the fibula.

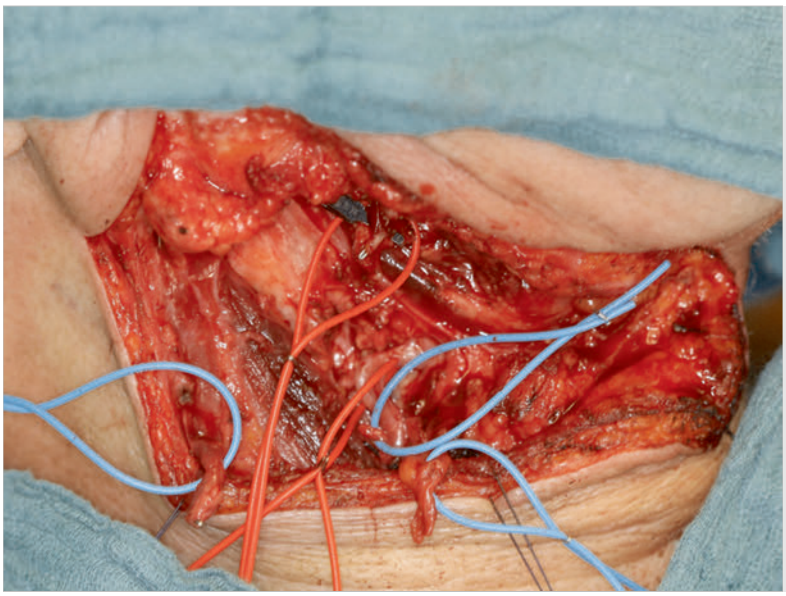

Fig. 4.89 Preparation of recipient vessels for radial forearm flap and fibula flap (arteries and veins) at the contralateral neck side.

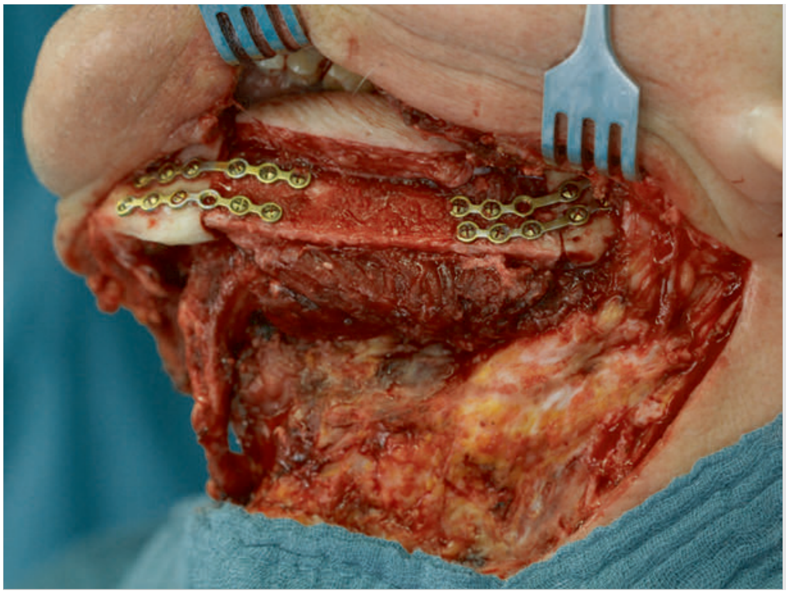

Fig. 4.90 Intraoperative status after anastomosis, insertion, and osteosynthesis of the fibula.

Fig. 4.91 Radial forearm flap and fibula flap at the end of the operation.

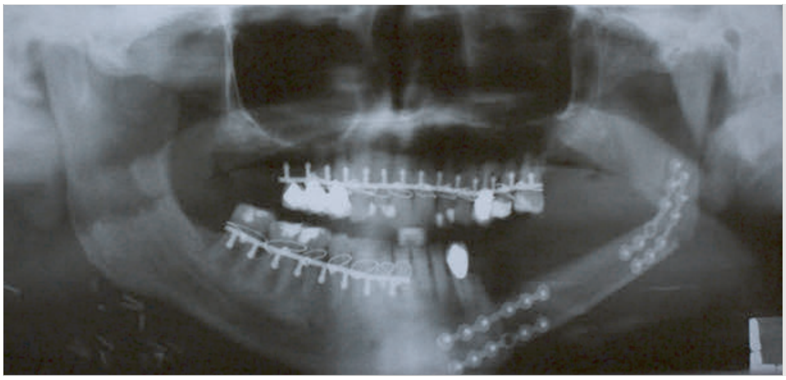

Fig. 4.92 Postoperative panoramic X-ray.

Fig. 4.93 Clinical view 12 days postoperatively.

Reconstruction of Class BR Defects

BR defects are characterized by a missing vertical reference. Thus, planning is performed with the commercially available virtual ProPlan CMF system (SYNTHES, Freiburg, Germany, and Materialise, Leuven, Belgium). After computed tomography (CT) of the head and neck region and the lower limb region resection of the mandibula, osteotomies of the fibula and reconstruction are simulated virtually. Corresponding cutting guides are fabricated. A case of a 49-year-old woman with a preoperative mouth opening of 41 mm is presented in Figs. 4.95 to 4.98.

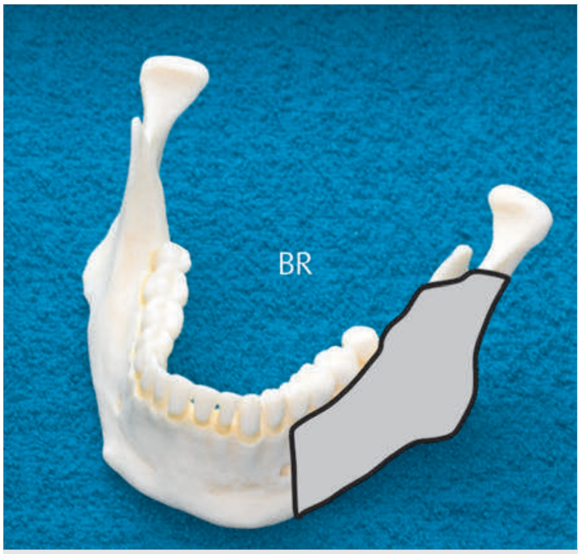

Fig. 4.94 Mandibular BR defect schematically.

Virtual Planning of Mandibular and Fibular Osteotomy (SYNTHES, Freiburg, Germany, and Materialise, Leuven, Belgium)

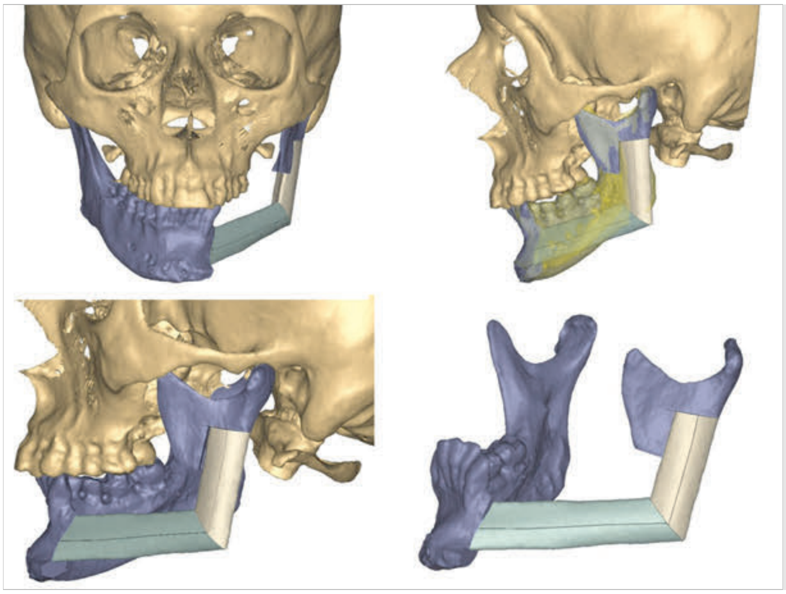

Fig. 4.95 After CT of mandible: virtual 3D visualization of the mandibular defect and determination of resection margins and fibula placement.

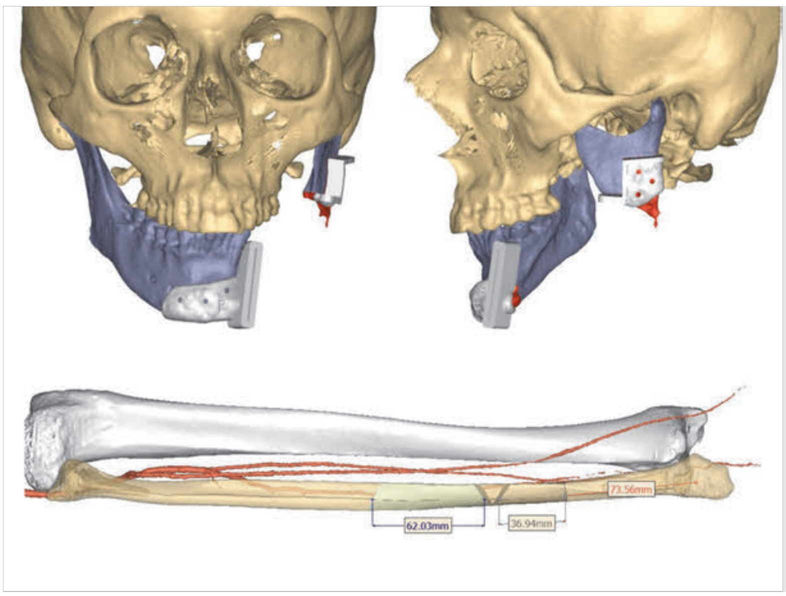

Fig. 4.96 Virtual placement of the mandibular cutting guides. Determination of the fibular osteotomies.

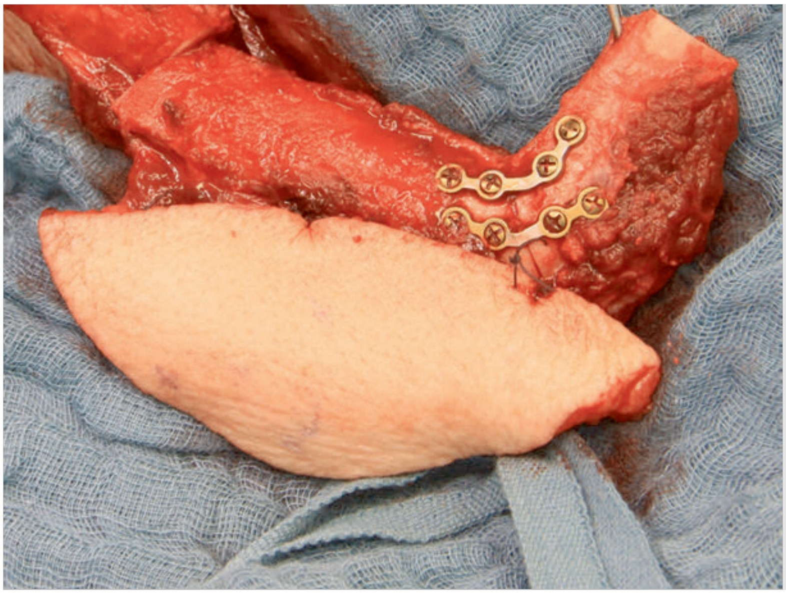

Fig. 4.97 Osteotomized and osteosynthesized fibular transplant.

Fig. 4.98 Postoperative panoramic X-ray of the mandibular reconstruction. Fibula transplant is placed cranially.

Reconstruction of Class BSB Defects

Planning of BSB defects is performed virtually.

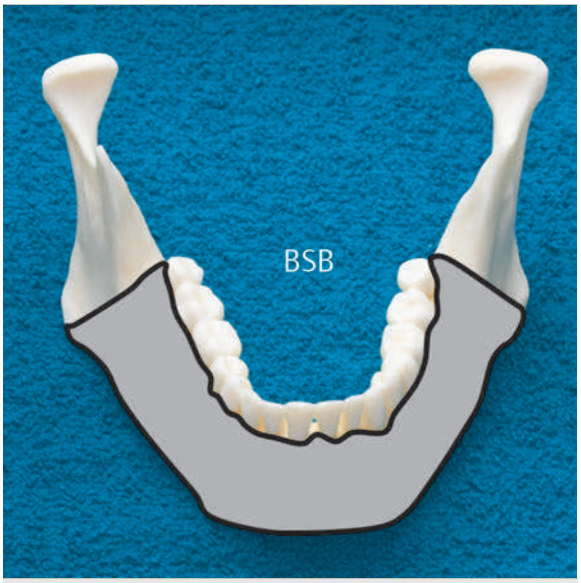

Fig. 4.99 Mandibular BSB defect schematically.

Cutting Devices Manufactured After Virtual Planning

Fig. 4.100 CT-guided 3D reconstruction of the neo-mandible and fabrication of an SLA model.

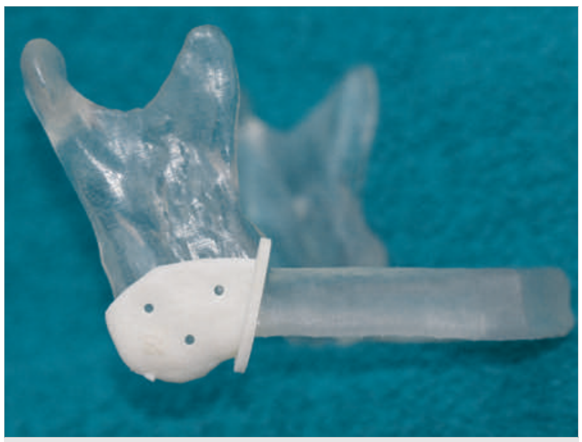

Fig. 4.101 Prefabricated cutting device for mandibular resection.

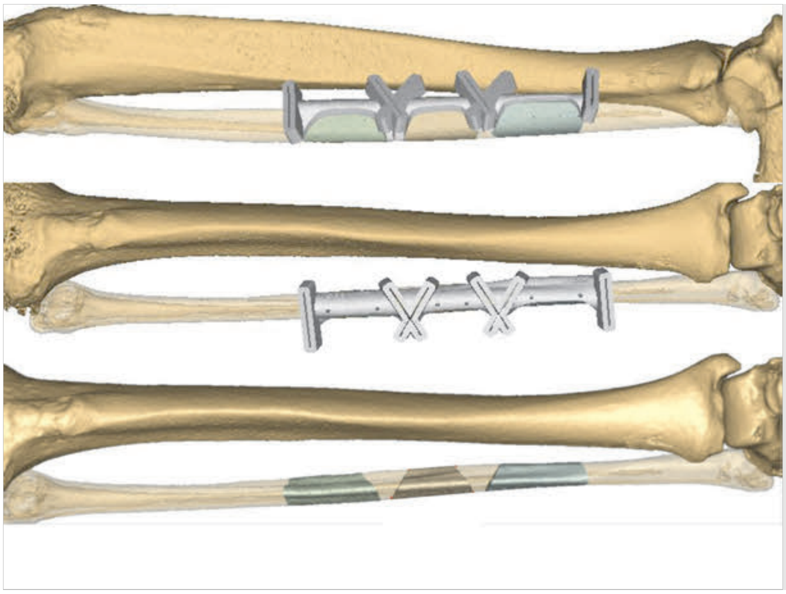

Fig. 4.102 Example of virtual adaptation and fabrication of fibular cutting guides (not case related).

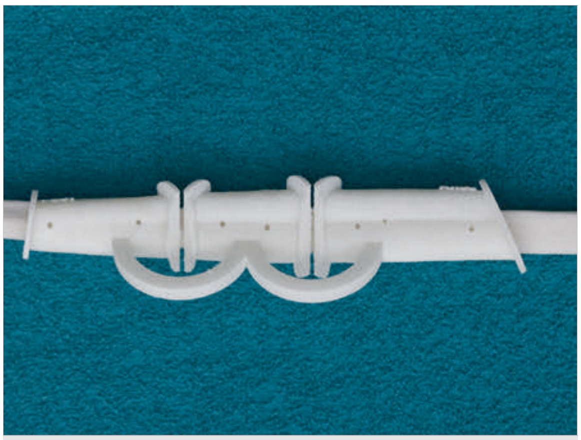

Fig. 4.103 Cutting guide placed on stereolithography model of the fibula.

Intraoperative Application

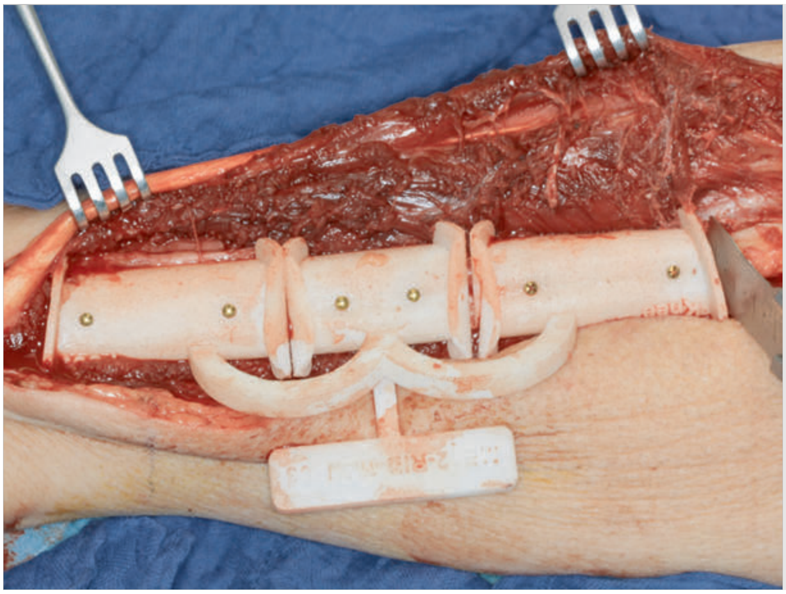

Fig. 4.104 Prefabricated cutting device for fibular osteotomies.

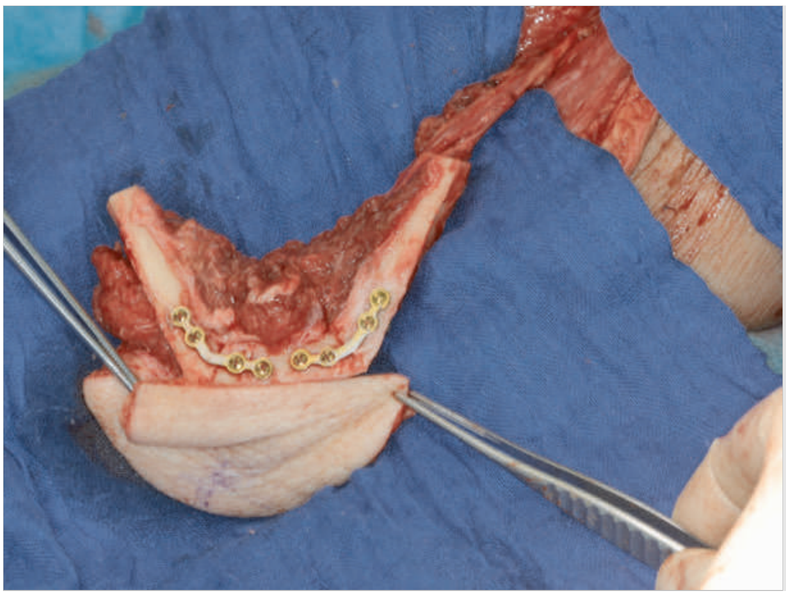

Fig. 4.105 From fibula to neo-mandible with skin island.

Modification: Osseous Fibula Transplant with Primary Implantation

Fig. 4.106 Four dental implants are primarily inserted when flap is still pedicled.

Fig. 4.107 Neo-mandible with implants.

Modification: Fibula Transplant with Two Skin Islands

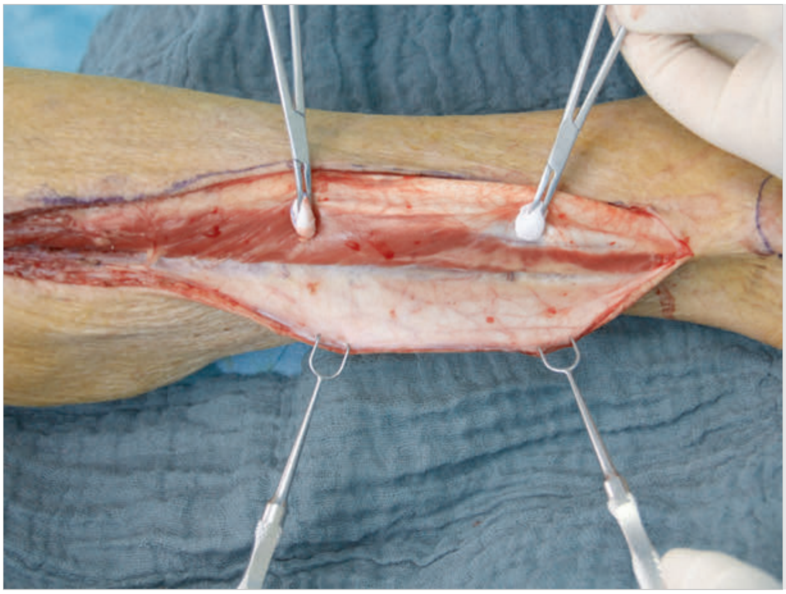

Fig. 4.108 Visualization of several skin perforators.

Fig. 4.109 Marking the perforators in the lateral skin region of the lower limb.

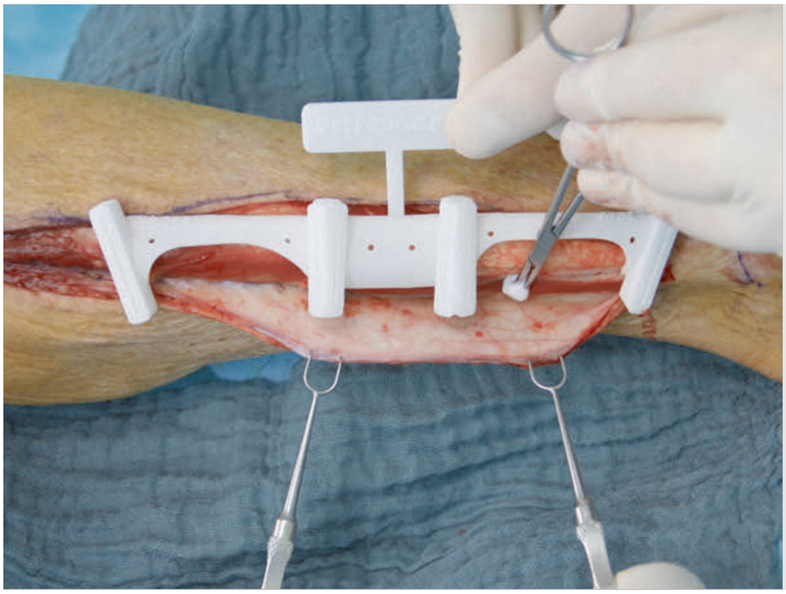

Fig. 4.110 Application of the cutting guide with respect to the perforators.

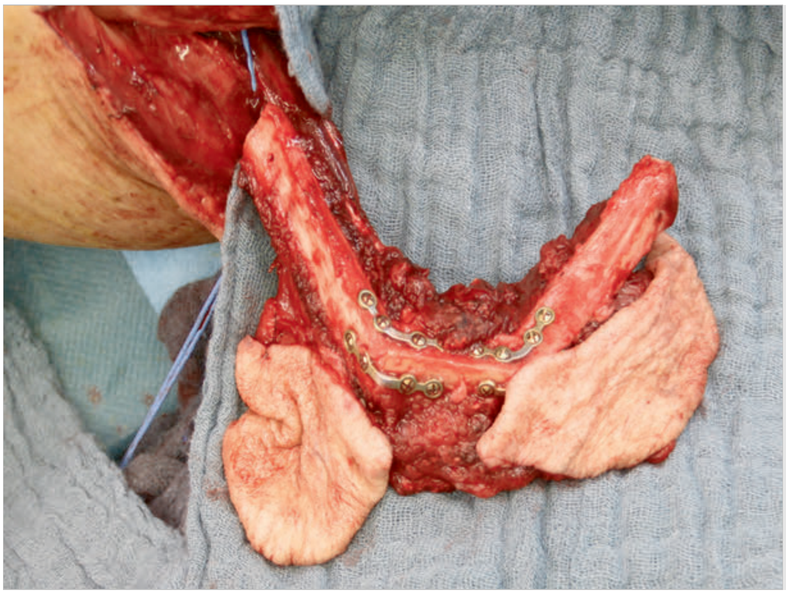

Fig. 4.111 Osteosynthesized neo-mandible with two skin paddles.

4.10.3 Combined Mandibula and Tongue Reconstruction

The operative management of an extended oral cancer case is presented in Figs. 4.112 to 4.118. The tumor mass infiltrated the tongue, the mandible, and the skin in the submental region. After tumor removal and neck dissection, the former tumor region was reconstructed by anterolateral thigh flap and an osseocutaneous fibula flap. Anastomoses for the anterolateral thigh flap were performed on the right neck, for the fibula flap on the left neck.

Fig. 4.112 Resected tumor mass.

Fig. 4.113 Anterolateral thigh flap for tongue reconstruction is harvested.

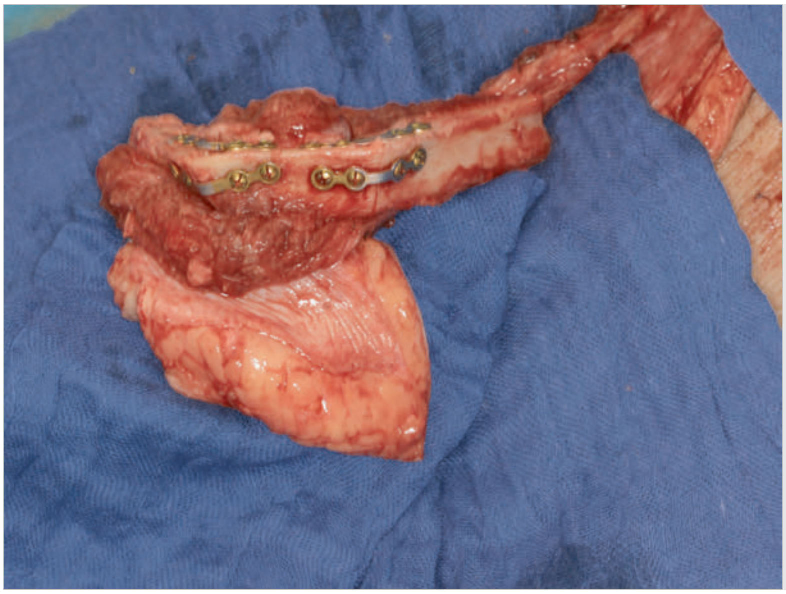

Fig. 4.114 Osseocutaneous fibula flap for mandibular and extraoral skin reconstruction is still pedicled at the lower limb. Fibula segments are osteotomized and osteosynthesized according to the cutting guides.

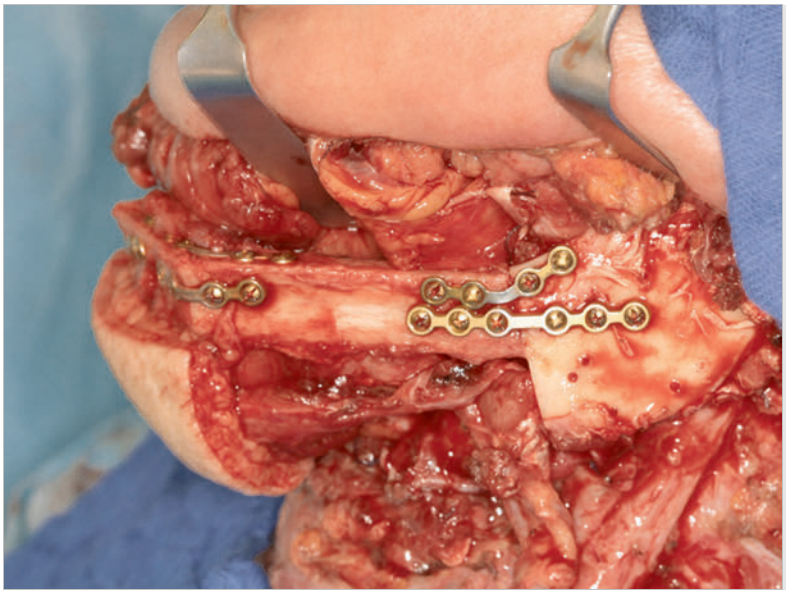

Fig. 4.115 Neo-mandible is anastomosed, inserted, and osteosynthesized. Skin paddle of the fibula flap in the submental region.

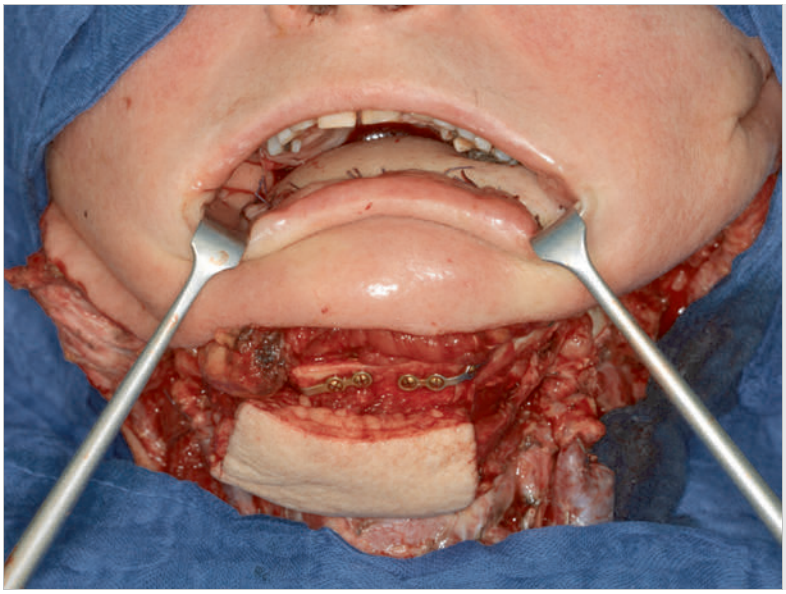

Fig. 4.116 Anterior view: anterolateral thigh flap is also anastomosed and covers the intraoral defect region.

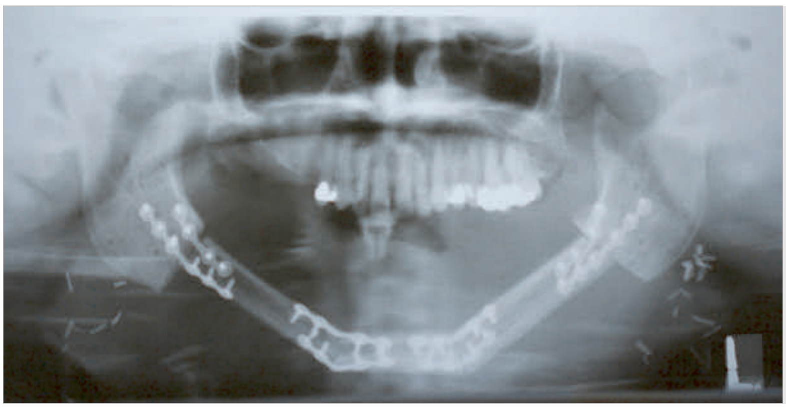

Fig. 4.117 Panoramic X-ray 10 days postoperatively. Bony reconstruction follows the cranial rim of the mandible.

Fig. 4.118 Patient 10 weeks after operation while receiving postoperative radiotherapy.

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