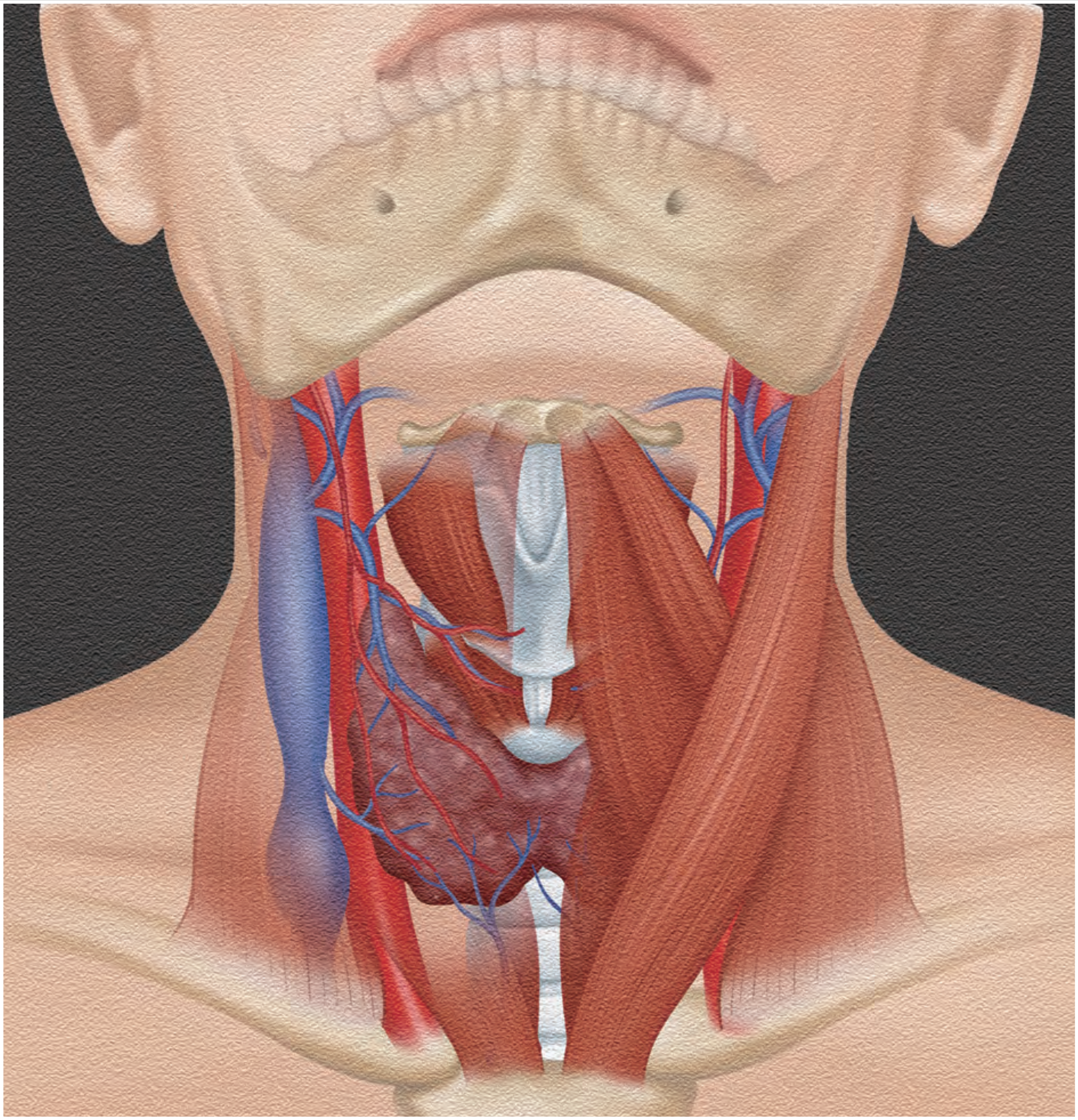
THE CHINESE UNIVERSITY OF HONG KONG

HEAD & NECK

DISSECTION AND RECONSTRUCTION MANUAL



ANDREW VAN HASSELT • EDDY WY WONG

HEAD & NECK

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DISSECTION AND RECONSTRUCTION MANUAL

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FOREWORD

A major challenge when learning head and neck surgery is to master the detailed 3-dimensional anatomy of the head and neck and cranial base. This is very difficult to learn from textbooks and videos, and some trainee surgeons do not have adequate opportunity to master the surgical anatomy in the operating room during their training. Hence the importance of head and neck cadaver dissection courses.

I had the privilege of serving as faculty member on two head and neck dissection courses held at the Chinese University of Hong Kong. The Chinese University of Hong Kong head and neck dissection course is truly international, with delegates traveling from all over the world to attend. What impressed me was the excellent organisation of the course, the attention to detail, the incredible enthusiasm of the local faculty and their high level of surgical expertise.

The Head & Neck Dissection and Reconstruction Manual, compiled by the Chinese University of Hong Kong faculty contains the key information that dissectors require to be able to proceed through the surgical steps of common head and neck and reconstructive surgery operations, and will be an important companion in the dissection room. I am particularly pleased that it will be made available as an open access resource for others around the world to use when running or participating in such cadaver dissection courses.

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FOREWORD

The successful publication of the "CUHK Head & Neck Dissection and Reconstruction Manual" represents a major achievement towards education and clinical training in the field of Head and Neck surgery, both regionally and internationally. The material reflects many hours of combined teamwork with our colleagues in the Department of Otorhinolaryngology, Head and Neck Surgery facilitated by the contribution from our "Silent Teachers", who have generously donated their bodies to the Faculty of Medicine, for education, training and research purposes.

Our Faculty launched the "Silent Teacher Body Donation Programme" in 2011. With intensive coordinated efforts of Faculty members together with organizations involved in life and death education and services, the body donation program has been well received by the Hong Kong community. Not only has the number of bodies received increased by more than 20 fold over the past 5 years, but the registration of donors has also grown exponentially. With the community engagement, it is clear the public is prepared and through this program, is actively participating in educating our future doctors. Our laboratory is thus enabled to engage with colleagues in clinical departments to offer advanced training and surgical skills development in diverse surgical specialties.

This superb publication pays tribute to our donors and their family members. We constantly appreciate and recognize their generosity. Our team members are clear on their caretaking role and are committed to work diligently with all colleagues in our faculty to provide the best education for tomorrow's doctors, so that they may be knowledgeable, skilled and compassionate.

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PREFACE

The head and neck is characterized by its complex anatomy that performs vital functions and is affected by diverse pathology. Head and Neck surgical and reconstructive techniques continue to evolve and mature. An in depth knowledge of the anatomy and safe dissection skills are essential talents for professionals practicing in this area to achieve optimal patient outcomes and to avoid unnecessary complications and suffering. The Chinese University of Hong Kong, Head & Neck Dissection and Reconstruction Course aims to educate trainees and head and neck surgeons to advance their knowledge and refine their skills in performing head and neck operations in a safe environment. We have included comprehensive coverage of the various reconstructive flaps and microvascular techniques as these are an integral component of the repertoire of head and neck patient care.

This manual not only acts as a reference for those who participate in our courses, but also provides a template to organize and run similar courses elsewhere. It also provides a valuable reference for any surgeon doing or planning these operations in clinical practice. Our team has spent considerable time detailing the procedures in this manual, emphasizing important steps for each operation. We aimed for a step by step guidance with simple and clear instructions. Every effort has been made to complement the text with oriented atlas like photographs that include labelling of key structures.

First and foremost we acknowledge the persons who bequeathed their bodies to our institution for educational purposes. Mr. James Ting and his able staff in the dissecting laboratory are credited for their care and preparation of cadavers. Dr. Jacky Lo and Dr. Kelvin Chow assisted with dissection when preparing the manual. Dr. Zenon Yeung captured excellent photographs during dissections and Miss Janet Fong crafted the professional diagrams from our amateur illustrations. Our department has provided generous support for this project. Lastly we recognize that without our families' selfless support, our daily work would not be possible.

We have created this manual to guide, complement and enhance value to be gained from the priceless opportunity of dissecting specimens of excellent quality. It is indeed a privilege to learn and advance our operative skills through hands on experience in the totally safe setting of the laboratory.

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Head and Neck: Dissection and Reconstruction Manual
Edited by Andrew Van Hasselt and Eddy WY Wong

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01

PAROTIDECTOMY

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PAROTIDECTOMY

STEP 1 INCISION AND ELEVATION OF SKIN FLAP

Create a modified Blair **Figure 1** or facelift incision. **Figure 2**

Raise a superficial cervico-fascial flap between the Superficial Musculo Aponeurotic System (SMAS) layer and the parotid fascia until the anterior border of the parotid gland is reached. **Figure 3**

STEP 2 IDENTIFICATON OF GREAT AURICULAR NERVE

Identify the great auricular nerve (GAN) and the external jugular vein (EJV) at the anterior border of sternocleidomastoid muscle (SCM) .

The posterior branch of the GAN is dissected toward the ear lobe and preserved. The anterior branch of the GAN is divided. **Figure 4**

STEP 3 SEPARATE PAROTID GLAND FROM SCM

The anterior border of SCM is skeletonized and separated from the parotid gland.

The posterior belly of the digastric muscle is identified by retracting the parotid gland superiorly.

STEP 4 IDENTIFICATION OF LANDMARKS FOR FACIAL NERVE

The tragal pointer is identified by following the cartilaginous external auditory canal medially.

Identify all the following ***landmarks for the facial nerve.***

- Tragal pointer. The facial nerve is 1 cm deep and inferior.
- Tympanic ring.
- Tympanomastoid suture line. This line leads directly to stylomastoid foramen medially.
- Posterior belly of digastric muscle. The facial nerve is at the same depth, just above the muscle.
- Palpate the styloid process The facial nerve is located in the angle between the styloid process and the posterior belly of the digastric muscle. The nerve crosses the styloid process more anteriorly.

Identify the main trunk of the facial nerve by blunt dissection with a fine haemostat. **Figure 5**

STEP 5 DISSECT FACIAL NERVE FROM PAROTID GLAND

Identify the Pes Anserinus then trace the upper and lower divisions of the facial nerve anteriorly.

Use fine curved blunt tipped scissors for the remainder of the nerve dissection. Tunnel and spread the tissues overlying the facial nerve and its branches and divide the parotid tissue overlying the nerve. It is important to dissect directly on the nerve so as not to lose sight of it. ***Never*** divide parotid tissue beyond exposed facial nerve. Wearing loupes (e.g. with 2.5x magnification) assists with the dissection and enables the surgeon to

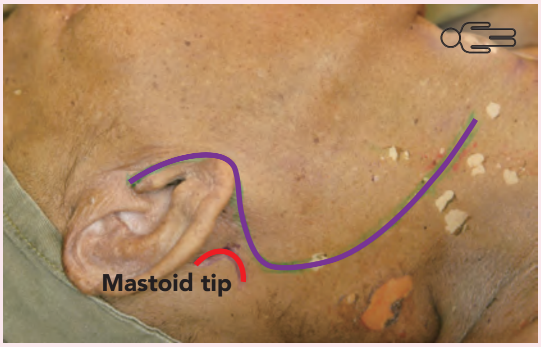

Figure 1

Modified Blair incision

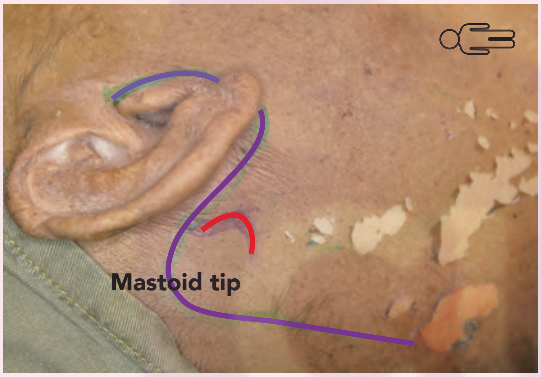

Figure 2

Facelift incision

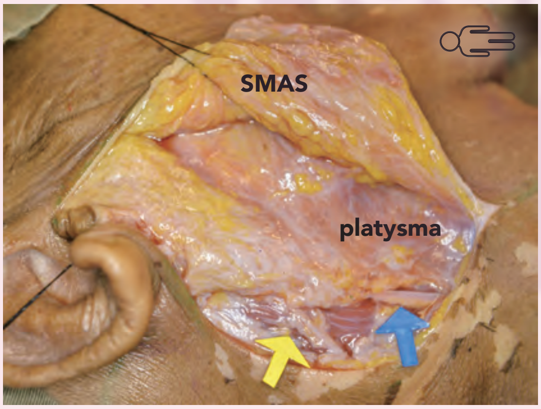

Figure 3

SMAS is continuous with platysma muscle, GAN (yellow arrow) and External jugular vein (blue arrow)

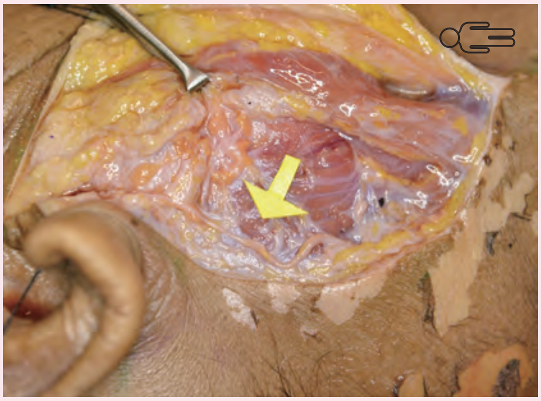

Figure 4

Posterior branch of GAN dissected toward the ear lobe (yellow arrow)

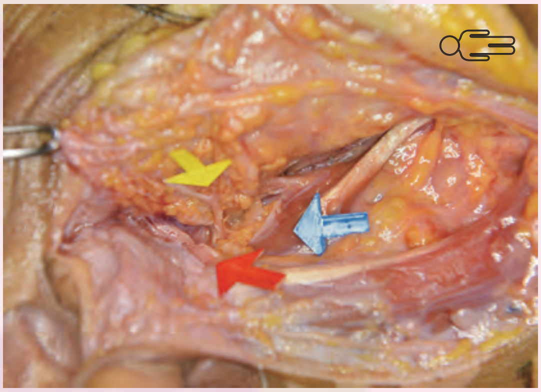

Figure 5

Main trunk of facial nerve (yellow arrow) with reference to posterior belly of digastric (blue arrow) and tragal pointer (red arrow)

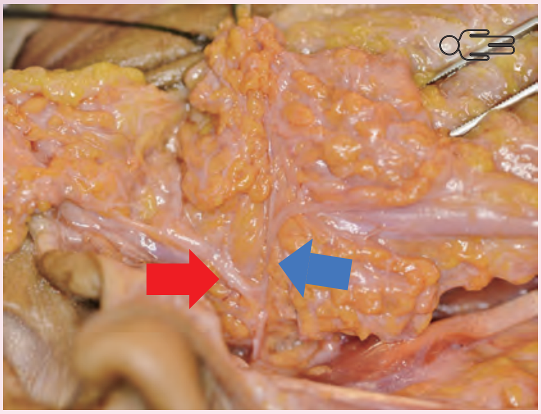

Figure 6

Upper (red arrow) and lower (blue arrow) divisions of facial nerve better distinguish between blood vessels and nerves. Use bipolar diathermy and fine silk ties for haemostasis. **Figure 6**

Divide the parotid fascia and parotid tissue superiorly and inferiorly to release the parotid posteriorly and to permit anterior mobilisation of the gland/tumour.

Dissect carefully along each branch and strip the superficial lobe off the branches of the facial nerve.

Identify the retromandibular vein as it crosses medial to the facial nerve. **Figure 7**

Remove the tumour with a cuff of the superficial parotid lobe.

TOTAL PAROTIDECTOMY OR DEEP LOBE TUMOUR

STEP 6

FREE UP THE FACIAL NERVE

Taking care to avoid unnecessary traction on the nerve, identify, dissect and circumferentially free up the facial nerve from the underlying deep lobe or tumour to provide access to the deep lobe.

The tumour can delivered either between the branches or below the facial nerve.

The deep lobe of the parotid/tumour is bordered medially by fat of the parapharyngeal space and can be delivered from the parapharyngeal space by blunt dissection.

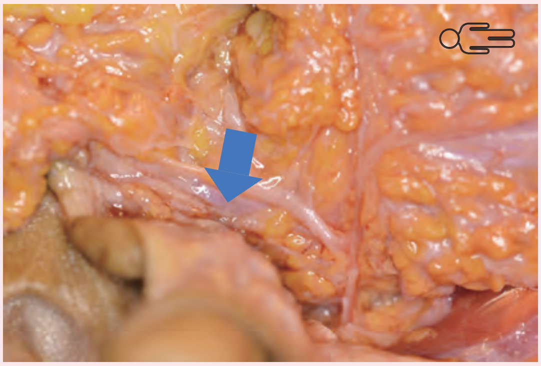

Figure 7

Retromandibular vein (blue arrow) deep to the facial nerve

KEY POINTS

1. Raise a flap deep to the SMAS.
2. Preserve the posterior branch of the GAN.
3. Locate all landmarks for identifying the facial nerve.
4. Use a fine haemostat superficial to the nerve and identify the Pes Anserinus and subsequent divisions.
5. Only divide tissue overlying the nerve with the nerve in view at all times.
6. For total parotidectomy, minimal traction on the facial nerve is the key to avoid prolonged facial nerve paresis.

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02

SUBMANDIBULAR GLAND EXCISION

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SUBMANDIBULAR GLAND EXCISION

STEP 1 INCISION

The skin incision is made at the hyoid level or 3 cm below the inferior border of mandible. **Figure 1**

Elevate subplatysmal flaps up to the inferior border of mandible.

STEP 2 HOW TO PROTECT THE MARGINAL MANDIBULAR NERVE

Identify the facial vein at the notch of the mandible and at the superior border of the submandibular gland.

The marginal mandibular nerve may then be exposed above the facial vein through dissection of the superficial cervico-fascial layers. **Figure 2**

Alternatively, the facial vein is divided and slung superiorly to protect the marginal mandibular nerve (Hayes Martin maneuver).

STEP 3 IDENTIFY LINGUAL NERVE AND HYPOGLOSSAL NERVE

Free the submandibular gland (SMG) from the anterior belly of digastric and the lateral surface of mylohyoid mucle. Divide the mylohyoid vessels. **Figure 3**

The free edge of the mylohyoid muscle is identified and retracted superior and laterally to expose the lingual nerve, hypoglossal nerve and Wharton's duct. **Figure 4**

After ligating the facial artery and vein superiorly, the SMG is retracted inferiorly to identify the submandibular ganglion that is then divided to free the lingual nerve, taking care not to place the tie across the main nerve. **Figure 5**

SUBMANDIBULAR GLAND EXCISION

STEP 4 IDENTIFY AND DIVIDE THE FACIAL ARTERY

The Wharton's duct is divided after identification of hypoglossal nerve. During surgery for sialolithiasis, the surgeon should follow and divide the duct anteriorly close to the floor of the mouth, so as not to leave behind a calculus.

The SMG can then be reflected inferiorly and the facial artery identified, ligated and divided where it exits from behind the posterior belly of the digastric muscle. **Figure 6**

The SMG is then completely excised following completion of the dissection off the tendon and posterior belly of the digastric muscle.

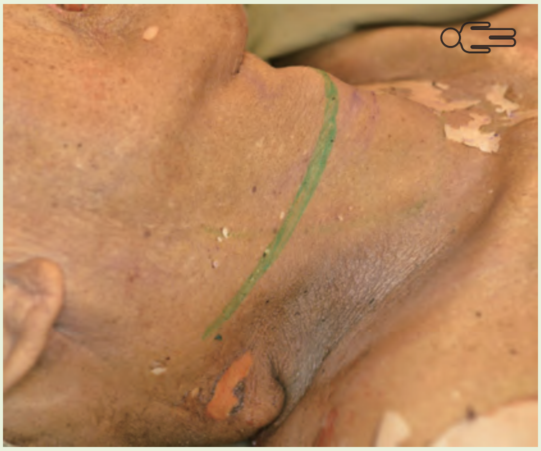

Figure 1

Upper neck incision at hyoid level

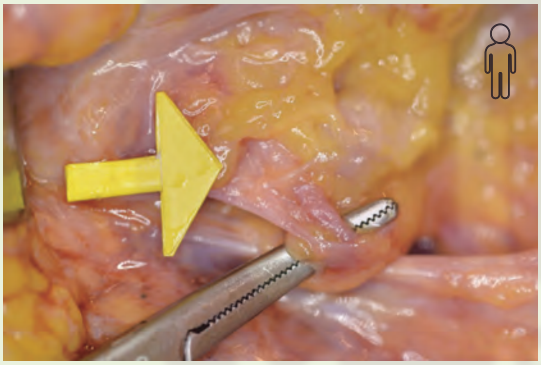

Figure 2

Marginal mandibular nerve (yellow arrow) crosses the facial vessels

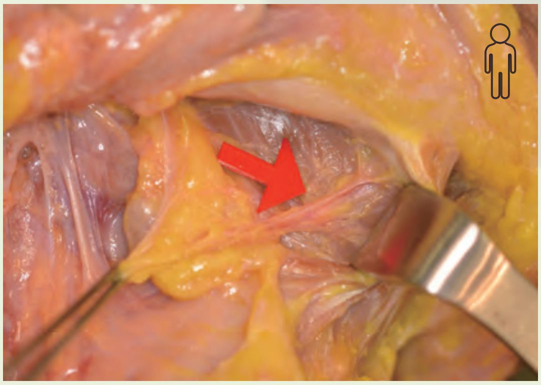

Figure 3

Mylohyoid vessel (red arrow) exposed after anterior belly of digastric is retracted

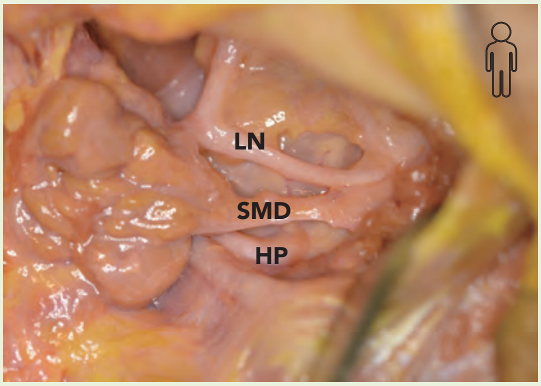

Figure 4

Mylohyoid muscle retracted to expose the lingual nerve (LN), submandibular duct (SMD) and hypoglossal nerve (HP)

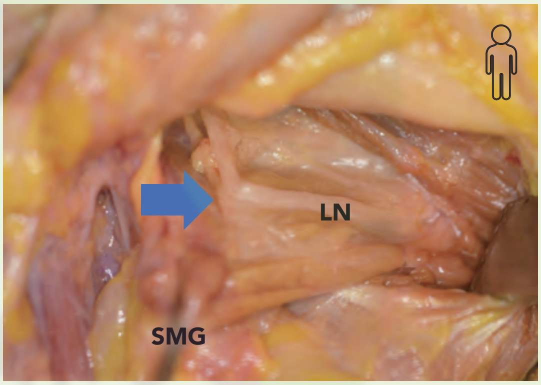

Figure 5

Submandibular gland (SMG) retracted downward to show the lingual nerve (LN) and the submandibular ganglion (blue arrow)

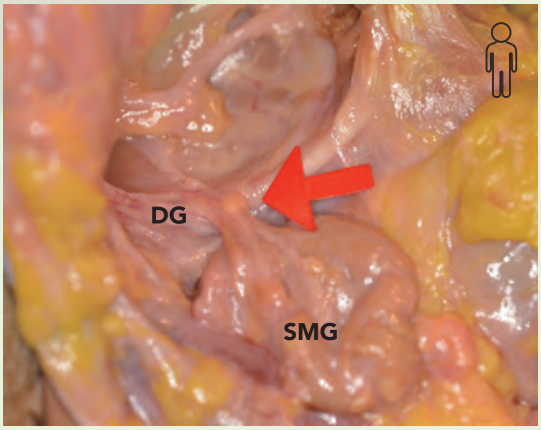

Figure 6

Facial artery (red arrow) passes behind the posterior belly of digastric (DG)

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KEY POINTS

1. Skin incision 3 cm below the border of the mandible.
2. Preserve the marginal mandibular nerve through direct identification or subcapsular dissection.
3. Identify and free the lateral surface of the mylohyoid muscle to permit its retraction.
4. Identify the lingual nerve, hypoglossal nerve and Wharton's duct.
5. Divide the Wharton's duct as anterior as possible in sialolithiasis.
6. Divide the submandibular ganglion.
7. Preserve the lingual nerve and hypoglossal nerve.
8. Ligate the facial artery twice: Once superiorly and again inferiorly as it crosses the digastric muscle.

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03

TRANSCERVICAL APPROACH TO THE PARAPHARYNGEAL SPACE

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Transcervical Approach to the Parapharyngeal Space

STEP 1 INCISION

Access to the parapharyngeal space is gained via an upper neck incision at the level of the hyoid bone.

Subplatysmal flaps may be raised or a subcapsular dissection is performed to raise the capsule of the submandibular gland (SMG) together with the skin flap to protect the marginal mandibular nerve.

Anterior border of SCM, the SMG and digastric muscle are identified.

STEP 2 MOBILIZE THE SUBMANDIBULAR GLAND

The facial artery is identified postero-inferior to the gland where it emerges medial to the posterior belly of digastric. The facial artery is then ligated and divided superior to the posterior belly of digastric.

The SMG is mobilised with gentle finger dissection in a posterior-to-anterior direction taking care to leave the thin fascial layer over the ranine veins and the hypoglossal nerve intact. **Figure 1**

STEP 3 ENTER THE PARAPHARYNGEAL SPACE (PPS)

By retracting the posterior belly of digastric posteriorly, the mandible superiorly and the submandibular gland anteriorly, the surgeon can pass a finger/instrument directly into the prestyloid PPS. The access can further be improved by dividing the stylo-mandibular ligament. **Figures 2, 3** The positive identification of hypoglossal nerve, vagus nerve, carotid artery and internal jugular vein before dissecting the tumour will ensure protection of these structures.

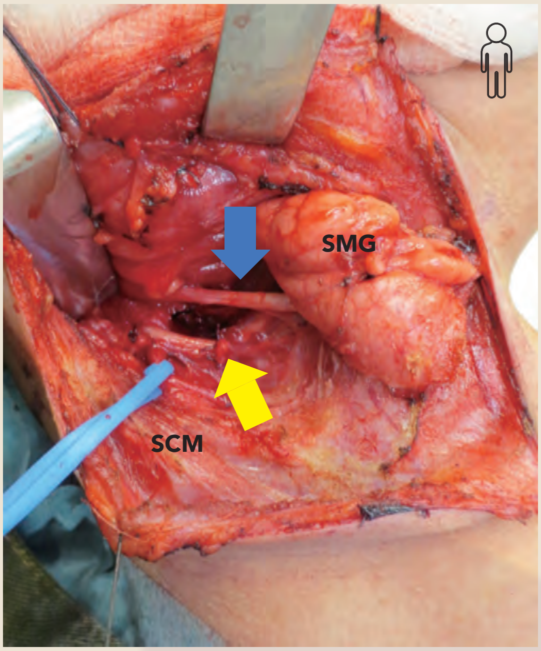

Figure 1

Submandibular gland (SMG) mobilized anteriorly to expose the digastric tendon (blue arrow) and hypoglossal nerve (yellow arrow)

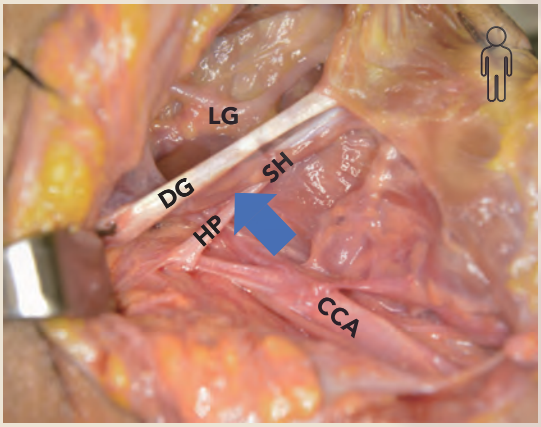

Figure 2

Entrance to the PPS (blue arrow) **LG**–lingual nerve **DG**–Digastric muscle **SH**–Stylohyoid muscle **HP**–Hypoglossal nerve **CCA**–common carotid artery

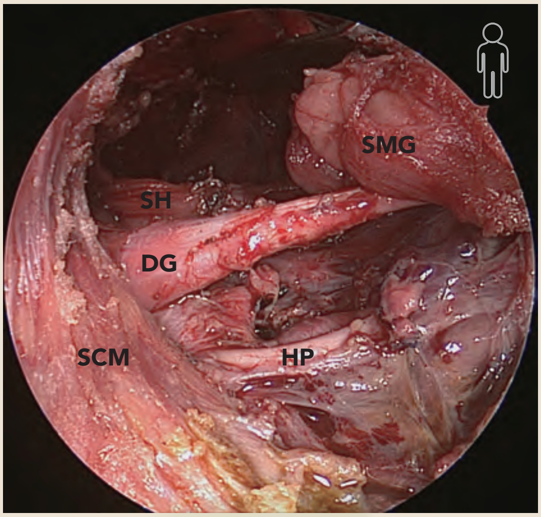

Figure 3

Endoscopic view of PPS after removal of tumour **DG**–Digastric muscle **SH**–Stylohyoid muscle **HP**–Hypoglossal nerve **SCM**–sternocleidomastoid muscle **SMG**–Submandibular gland

KEY POINTS

1. Neck incision adequately below the border of the mandible.
2. Subcapsular dissection over the submandibular gland to protect the marginal mandibular nerve.
3. Full length of the posterior belly of digastric and the anterior border of SCM skeletonized.
4. Facial artery ligated as it emerges deep to the posterior belly of the digastric muscle.
5. Submandibular gland reflected anteriorly.
6. The stylo-mandibular ligament divided.
7. Retract mandible, posterior belly of digastric and submandibular gland to facilitate access to PPS.
8. Identify hypoglossal nerve, vagus nerve, carotid artery and internal jugular vein before tumour dissection.
9. Access the prestyloid parapharyngeal space.

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04

SELECTIVE NECK DISSECTION

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Selective Neck Dissection

STEP 1 INCISION

It is important to know the anatomy and boundaries of the anatomical triangles of the neck.

A horizontal upper neck skin incision is made from the anterior border of the SCM to the midline of the neck just below the level of the hyoid bone. The incision should provide access from the lower border of the mandible to tissue at the level of the cricoid cartilage. **Figure 1**

Subplatysmal flaps are elevated up to the lower border of mandible and inferiorly to the level of the cricoid until the omohyoid muscle is seen. The external jugular vein and great auricular nerve should be identified lying on the SCM. **Figure 2**

The skin flaps can be anchored superiorly and inferiorly with 2–O silk sutures.

STEP 2 LEVEL I DISSECTION

Start the dissection at Level Ia with clearance of fibrofatty tissue in the submental triangles until both anterior bellies of the digastric (the lateral borders of the triangles) and the mylohyoid muscle (the floor of the triangles) are exposed, and inferiorly to the position of the upper border of the hyoid bone (the inferior border of the triangle). **Figure 3**

The surgeon next addresses Level Ib of the neck.

Subcapsular dissection: The fascia (capsule) overlying the submandibular gland is incised horizontally over the midpoint of the gland and is dissected from the gland in a superior direction in a subcapsular plane so as to avoid injuring the marginal mandibular nerve. With this technique the marginal mandibular

Level I Dissection

nerve is not routinely identified. The assistant however watches for twitching of the lower lip as this indicates proximity to the nerve during live surgery when no muscle relaxant has been administered.

Positive identification of marginal mandibular nerve: The mandibular nerve crosses the facial artery and vein which are both identified by blunt dissection with a fine haemostat at the mandibular notch where the facial vessels cross the mandible. Once they have been identified, find the marginal nerve crossing superficial to the vein. After identification of the nerve the facial vein is divided inferior to the nerve and slung upwards to protect the marginal mandibular nerve during the dissection. This method is recommended when clearance of perifacial lymph nodes in oral cavity cancer is indicated. **Figures 4, 5**

Next attention is directed to the fibrofatty tissue anterior to the gland between the anterior belly of digastric and mylohyoid muscle. Nodes here are especially important to remove in malignancies of the anterior floor of mouth. To resect these nodes the anterior belly of digastric is retracted forward and the tissue is delivered using electrocautery dissection with the plane of deep dissection being the mylohyoid muscle. Vessels and nerves to the mylohyoid muscle are encountered and need to be divided. **Figure 6**

To identify the lingual and hypoglossal nerves, the posterior free edge of the mylohyoid muscle is retracted with a right angle retractor. Inferior traction on the gland brings the lingual nerve and the submandibular duct into view. Parasympathetic secretomotor fibres that travel from the lingual nerve to the submandibular ganglion are divided under direct vision taking care not to injure the lingual nerve. The duct is divided after clear identification of both the lingual (superficial to its plane) and hypoglossal

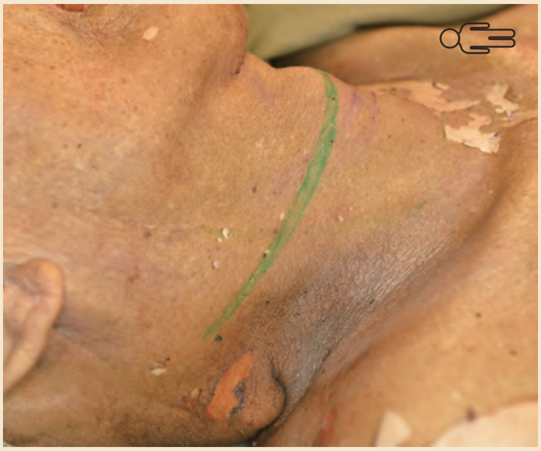

Figure 1

Upper neck incision

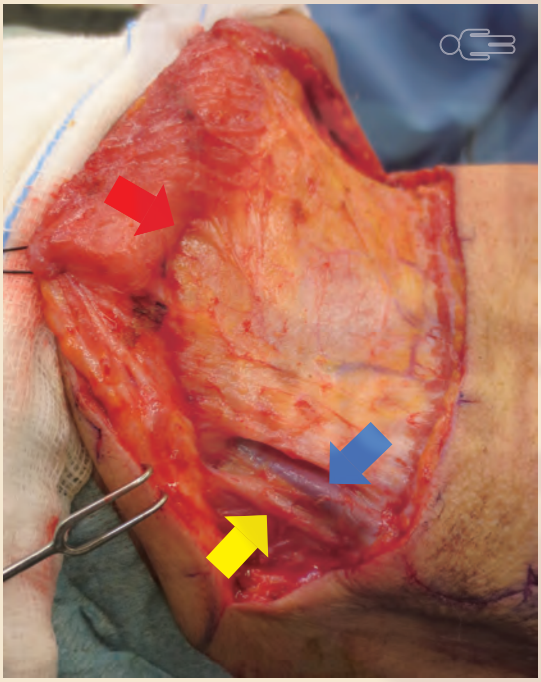

Figure 2

Subplatysmal flap (red arrow) raised to identify great auricular nerve (yellow arrow) and external jugular vein (blue arrow)

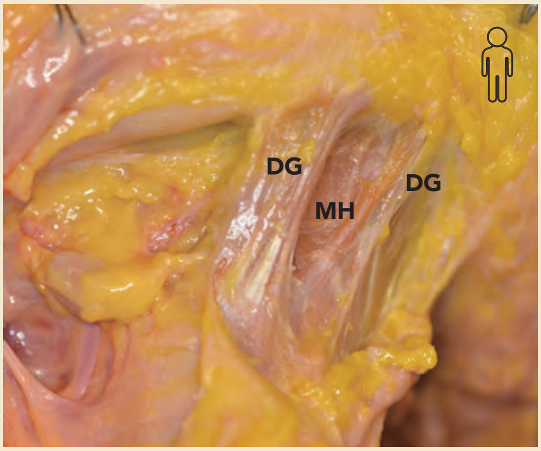

Figure 3

Level Ia to expose the digastric muscles **(DG)** and mylohyoid muscle **(MH)**

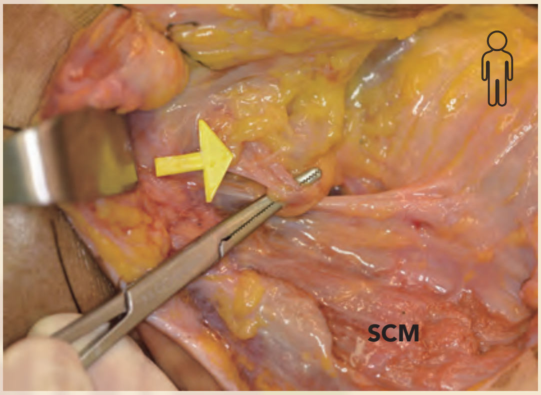

Figure 4

Marginal mandibular nerve (yellow arrow) cross the facial vessel at the mandibular notch

SCM – sternocleidomastoid muscle

LEVEL II DISSECTION

(deep to its plane) nerves. By exposing the posterior belly of digastric the proximal portion of the facial artery that loops from its superior border into the gland can be identified and divided. **Figures 7-9**

STEP 3 LEVEL II DISSECTION

Dissect fatty tissue containing lymphatics in the anterior parts of Levels II and III from the underlying infrahyoid strap muscles in a posterior direction towards the carotid sheath. The dissection also follows the medial or deep surface of the SCM and exposes deeper structures including the IJV and omohyoid muscle. A number of small segmental vessels entering the SCM are encountered and cauterized. The dissection is carried posteriorly along the deep or medial surface of the muscle in a subepimysial plane to the posterior edge of the SCM. **Figure 10**

LEVEL IIB CLEARANCE

Use retractors to pull the upper part of the SCM and the tail of parotid laterally. This will expose the accessory nerve and Level IIb lymphatic tissue. With a haemostat, create a tunnel immediately posterior to the IJV down to the prevertebral muscles. This manoeuver speeds up the subsequent dissection of Level IIb by clearly delineating the posterior wall of the IJV. The transverse process of the C1 vertebra can be palpated immediately posterior to the accessory nerve and IJV and serves as an additional landmark for the position of these structures in difficult surgical cases. The accessory nerve should be freed from the surrounding fibrofatty tissue atraumatically using a haemostat. Fibrofatty tissue is mobilized from the postero-superior corner (medial to the retracted SCM) with anterior traction on the fibrofatty tissue. The occipital artery passes across to the top of Level IIb and its

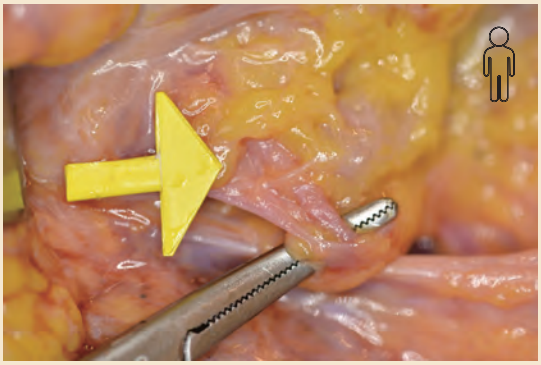

Figure 5

Close up view for the marginal mandibular nerve (yellow arrow)

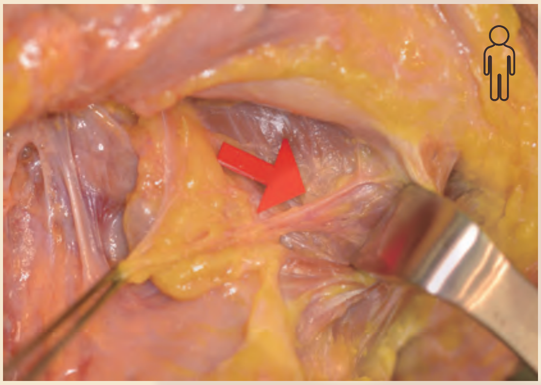

Figure 6

Mylohyoid artery (red arrow) exposed with anterior belly of digastric retracted

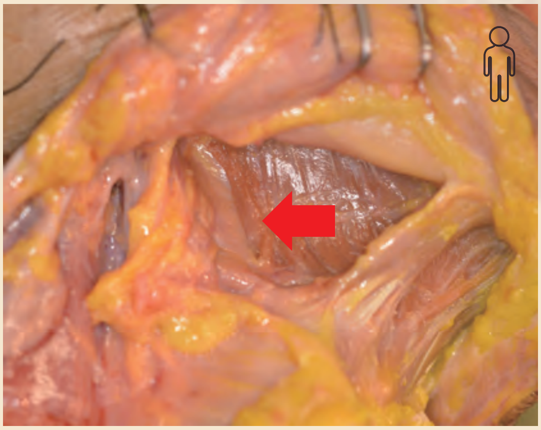

Figure 7

Posterior border of mylohyoid muscle (red arrow)

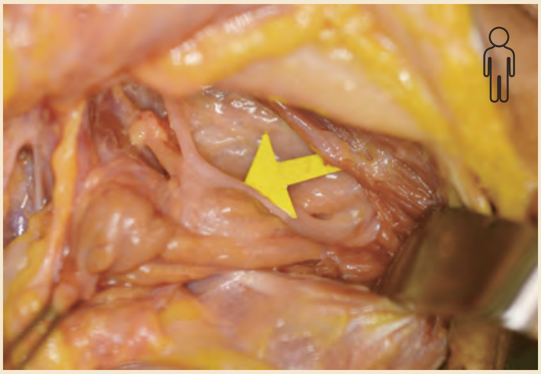

Figure 8

Lingual nerve (yellow arrow) identified after mylohyoid muscle retracted

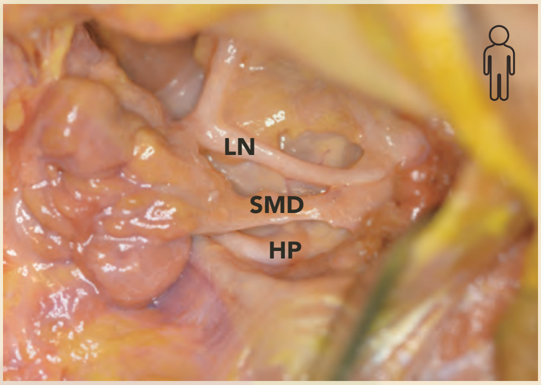

Figure 9

Identification of lingual nerve **(LN)**, submandibular duct **(SMD)** and hypoglossal nerve **(HP)**

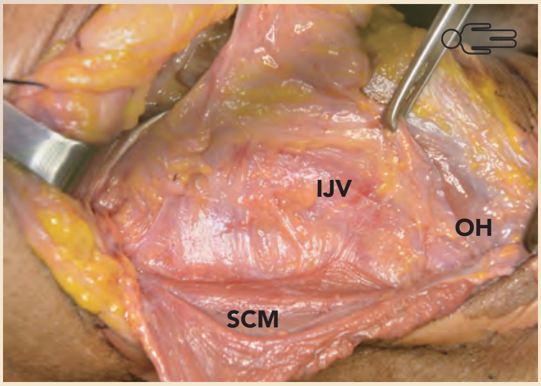

Figure 10

Dissection along the medial surface of SCM to expose the IJV and **OH**-omohyoid muscle

Level III Dissection

branches may need to be tied should they be severed while dissecting the superior part of Level IIb. Dissect through the fibrofatty tissue and onto the deep muscles of the neck which are seen to course in a postero-inferior direction. Once the fibrofatty tissue of Level IIb has been fully mobilized from the underlying muscles, pass the tissue antero-inferiorly under the mobilized accessory nerve. **Figures 11-15**

STEP 4 LEVEL IIA & III DISSECTION

While retracting the SCM posteriorly and the fibrofatty tissue of Levels II and III anteriorly with sharp-toothed rake retractors, dissect the fatty tissue of Levels II and III in an anterograde direction from the medial or deep posterior border of SCM. The deep dissection plane is the muscular floor of the neck, encountered by dissecting between the branches of the cervical plexus which need to be identified and preserved. **Figure 16**

The phrenic nerve and brachial plexus are not seen in this dissection, but are relevant if Level IV is dissected. Continue the anterograde dissection with a scalpel or scissors until the ansa cervicalis, the carotid sheath containing the common and internal carotid arteries, vagus nerve and IJV are sequentially exposed. The carotid sheath is incised along the full course of the vagus nerve and the neck dissection specimen is dissected off the IJV by dissecting inside the carotid sheath.

Continue dissecting the fat and lymphatics from the anterior aspect of the IJV until the common carotid artery is again reached. Divide and ligate tributaries of the IJV with ligatures.

Inferiorly, the fibrofatty tissue at the junction of Levels III and IV is divided at the level

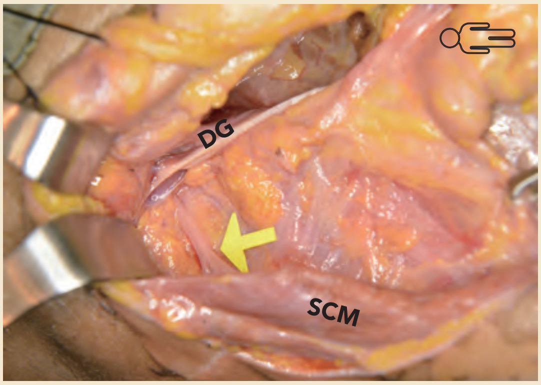

Figure 11

Accessory nerve (yellow arrow) identified at Level II, **DG**–posterior belly of digastric and **SCM**–sternocleidomastoid muscle

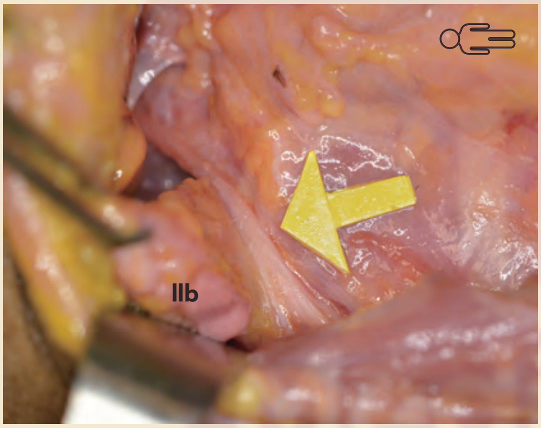

Figure 12

Accessory nerve (yellow arrow) and Level IIb

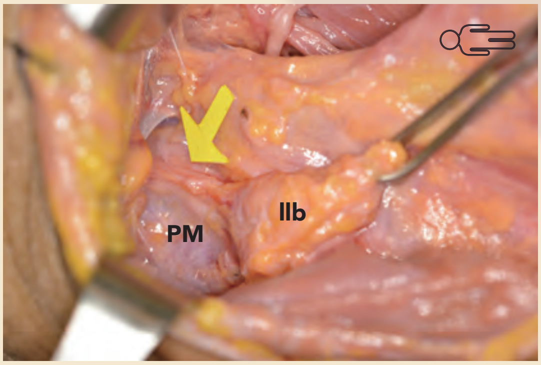

Figure 13

Level IIb dissected free from the underlying prevertebral muscle **(PM)** and accessory nerve (yellow arrow)

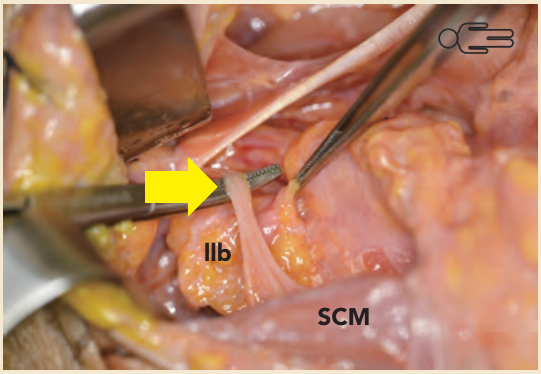

Figure 14

Level IIb tunnel under the accessory nerve (yellow arrow)

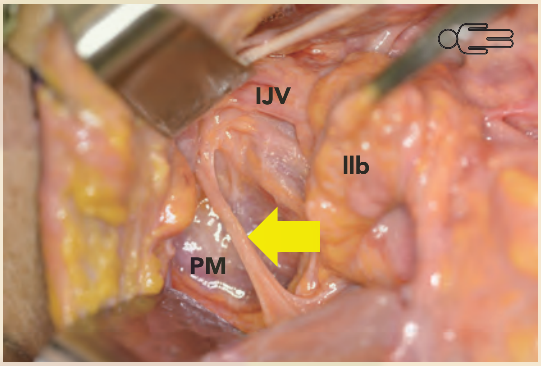

Figure 15

Completed Level IIb dissection, accessory nerve (yellow arrow), Internal jugular vein-**IJV** and Prevertebral muscle-**PM**

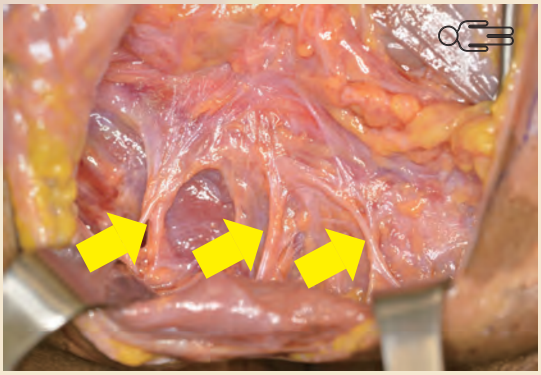

Figure 16

Cervical plexus (yellow arrows)

Level IV Dissection

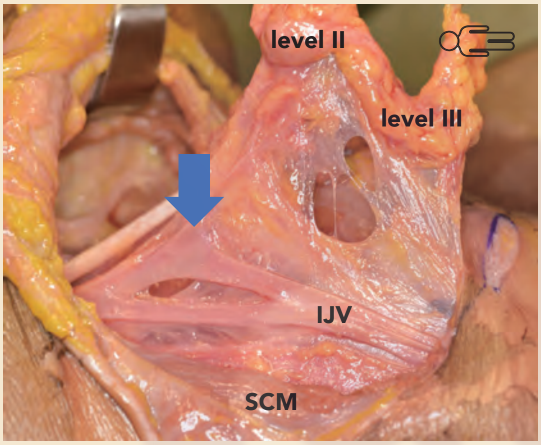

Figure 17

A bifurcated internal jugular vein **(IJV)** and its tributary (blue arrow)

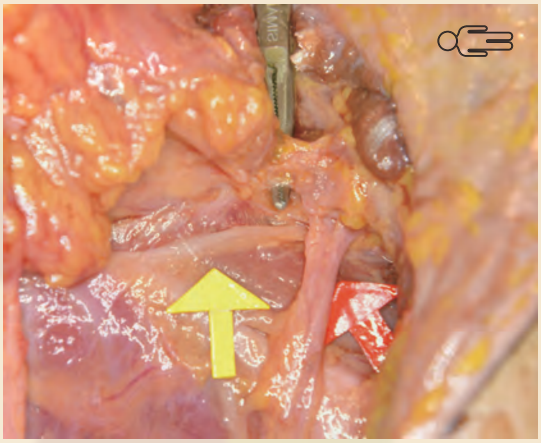

Figure 18

Level IV lymphatics (on top of the curved artery) and the relationship with the transverse cervical artery (red arrow) and phrenic nerve (yellow arrow)

of the omohyoid (in a supraomohyoid neck dissection). Identify and preserve the superior thyroid artery where it originates from the external carotid artery. **Figure 17**

STEP 5 LEVEL IV DISSECTION

With a lateral neck dissection, Level IV is dissected by applying traction to the fibrofatty tissue deep to the omohyoid muscle in a cephalad direction and to the omohyoid muscle in a caudal direction, while dissecting the fibrofatty tissue from Level IV. The transverse cervical vessels may be encountered and its ascending branches need to be ligated. A finger may also be used to establish a dissection plane between the fat of Level IV and the brachial plexus and phrenic nerve. Be vigilant for the thoracic duct (left neck) or right lymphatic duct (right neck) or their tributaries which may unknowingly be transected resulting in a chylous leak. **Figure 18**

The final step is to strip the neck dissection specimen off the infra-hyoid strap muscles. Remember to take care not to injure the hypoglossal nerve and pharyngeal veins superiorly.

KEY POINTS

1. A horizontal incision from the anterior border of the SCM to the midline of the neck just below the level of the hyoid bone is made.
2. Level Ia dissection clears tissue between the anterior bellies of both digastrics and off the mylohyoid muscle.
3. Incising the submandibular capsule horizontally over its midpoint and dissecting the gland in a subcapsular plane avoids injuring the marginal mandibular nerve which is not routinely identified.
4. If the facial artery and vein are identified with a fine haemostat at the mandibular notch, the marginal nerve will be found crossing superficial to the vein.
5. Fibres that travel from the lingual nerve to the submandibular ganglion are divided under direct vision so that the lingual nerve is not injured.
6. The submandibular duct is divided after identifying both the lingual (superficial to its plane) and hypoglossal (deep to its plane) nerves.
7. Identify the accessory nerve from its position adjacent to the IJV superiorly deep to the posterior belly of digastric to its entry into the SCM.
8. Dissect all fibrofatty tissue from the posterior border of the SCM in an anterior direction preserving the branches of the cervical plexus, vagus nerve, carotid artery and off the IJV.
9. Identify and preserve the superior thyroid artery where it originates from the external carotid artery, this is the medial limit of dissection.
10. Establish a dissection plane between the fat of Level IV, the brachial plexus and phrenic nerve, and be vigilant for the thoracic duct.

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Modified Radical Neck Dissection Type II

Alexander C Vlantis

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INCISION

Various incisions can be used for a neck dissection. The incision depends on whether the neck dissection is an isolated procedure or is to be combined with a procedure to resect a primary tumour. For incisions with a three point junction, avoid placing the junction directly over the carotid artery. **Figures 1, 2**

STEP 1 INCISION AND FLAP RAISING

The skin incision is made to expose the platysma which is then also incised. The skin and platysma flap is raised in the subplatysmal plane by following the deep surface of the platysma. Expose the inferior border of the mandible superiorly, the clavicle inferiorly, the anterior border of the trapezius posteriorly and the midline of the neck anteriorly. Give attention to elevating the flap over the posterior triangle as the platysma is usually absent here, by keeping sufficient subcutaneous tissue on the skin. This is done by placing a finger under the flap to gauge the thickness of the flap while it is being raised and to provide adequate counter traction. This will also prevent button-holing the skin. Identifying the spinal accessory nerve is the best way to prevent it from being injured. In thin patients, the accessory nerve can be very superficial and can be injured during flap elevation. **Figure 3**

STEP 2 LEVEL I DISSECTION

Start the dissection at Level Ia with clearance of fibrofatty tissue in the submental triangle to expose both anterior bellies of the digastric (DG) muscles and the mylohyoid (MH) muscle between them. **Figure 4**

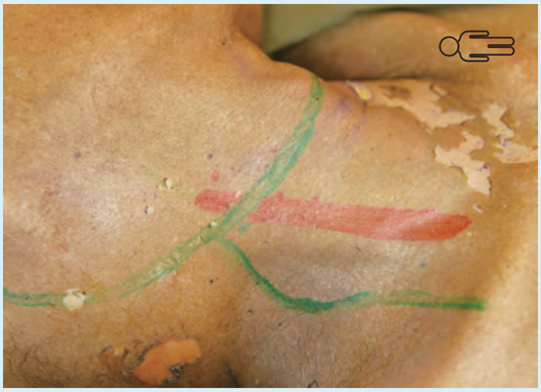

Figure 1

T incision, avoid placing the 3 point junction over the carotid artery

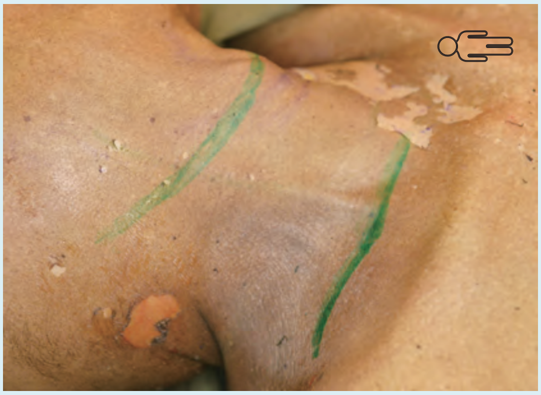

Figure 2

Horizontal incision to avoid a 3 point junction

The surgeon next addresses Level Ib

SUBCAPSULAR DISSECTION

The fascia (capsule) overlying the submandibular gland is incised midway over the gland and is dissected from the gland in a superior direction in a subcapsular plane so as to avoid injury to the marginal mandibular nerve. Using this technique the marginal mandibular nerve does not need to be routinely identified. The assistant however watches for twitching of the lower lip as this indicates proximity to the nerve.

POSITIVE IDENTIFICATION OF MARGINAL MANDIBULAR NERVE

The marginal mandibular nerve crosses the facial artery and vein. The facial artery and vein are identified by blunt dissection with a fine haemostat at the mandibular notch where the facial vessels cross the mandible. After identification of the nerve, the facial vein is divided and slung upwards to protect the marginal mandibular nerve during the dissection. This method is recommended for clearance of perifacial lymph nodes in oral cavity cancer. **Figures 5, 6**

Next, attention is directed to the fibrofatty tissue anterior to the gland between the anterior belly of digastric and mylohyoid muscle. These nodes are especially important to resect with malignancies of the anterior floor of mouth. To resect these nodes, retract the anterior belly of digastric anteriorly and deliver the tissue using electrocautery dissection with the deep dissection plane being on the mylohyoid muscle. **Figure 7**

To identify the lingual and hypoglossal nerves, the posterior free edge of the mylohyoid muscle is retracted with a right

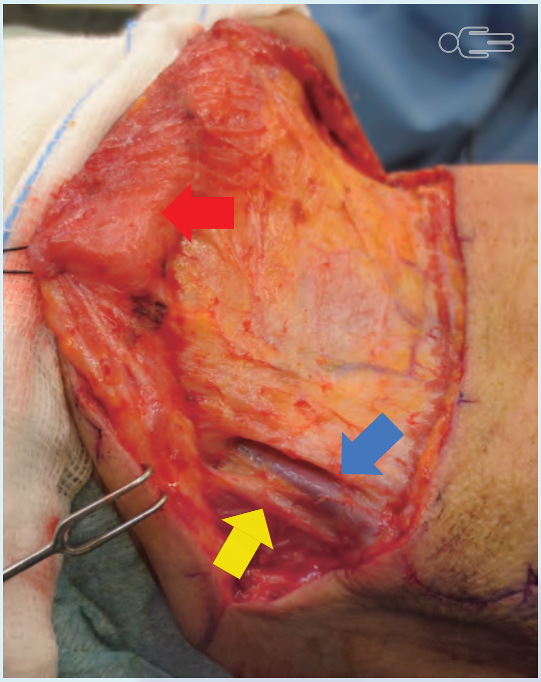

Figure 3

Platysma muscle (red arrow), External jugular vein (blue arrow) and Great auricular nerve (yellow arrow)

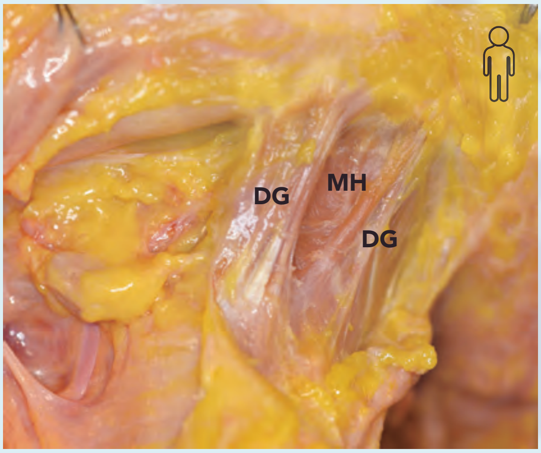

Figure 4

Level Ia dissection, **DG**-anterior belly of digastric, **MH** – Mylohyoid muscle

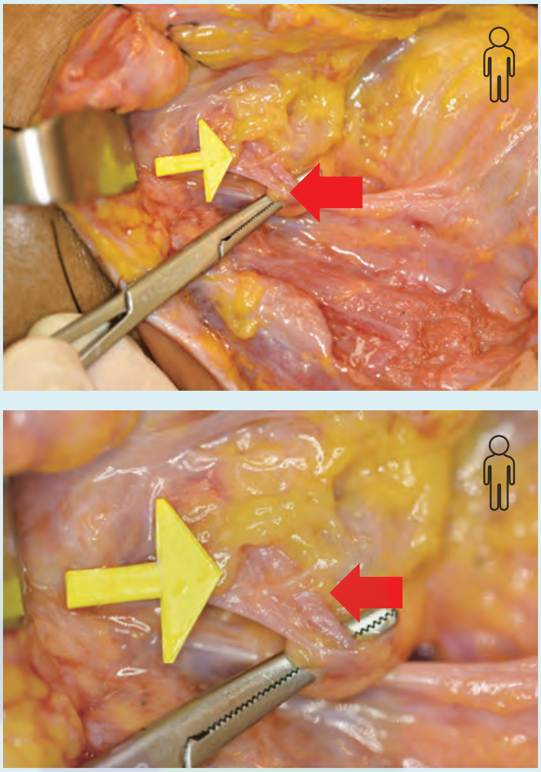

Figure 5-6

Marginal mandibular nerve (yellow arrow)
Facial vessel (red arrow)

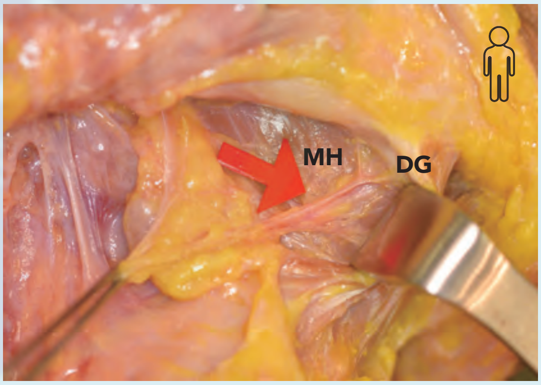

Figure 7

Lymphatic tissue removed with the digastric muscle (**DG**) retracted and the artery to mylohyoid exposed (red arrow)

Modified Radical Neck Dissection Type II

angle retractor. **Figure 8** Inferior traction on the submandibular gland (SMG) brings the lingual nerve and the submandibular duct into view. The submandibular ganglion can be divided under direct vision with special care taken not to injure the lingual nerve. The duct can also be divided after clear identification of both the lingual and hypoglossal nerves. **Figure 9** By following the posterior belly of digastric, the proximal portion of the facial artery and vein can be identified and divided. **Figure 10**

STEP 3 IDENTIFY ACCESSORY NERVE (CN XI)

The accessory nerve is identified 1-2 cm posterior to the exit site of the GAN at the posterior border of SCM. **Figure 11** The nerve is traced distally until it goes under or deep to the trapezius muscle as well as proximally towards the IJV by dividing the SCM. The branches to SCM need to be divided and occasionally there will be a contribution to the accessory nerve from the cervical plexus at the posterior border of SCM. **Figure 12**

STEP 4 LEVEL IIB DISSECTION

The parotid tail and the superior attachment of the SCM can be divided with a knife or cautery until the fatty tissue of Level IIb is exposed. **Figure 13** Level IIb lymphatics are further dissected down to the deep muscle that runs in a postero-inferior direction. The occipital artery is usually encountered and needs to be divided during the dissection. **Figures 14,15** The contents of Level IIa and IIb are dissected off from the IJV and the deep muscles of the neck until the cervical plexus comes into view. The dissected accessory nerve is translocated posteriorly and the dissection of Levels IV and V continues.

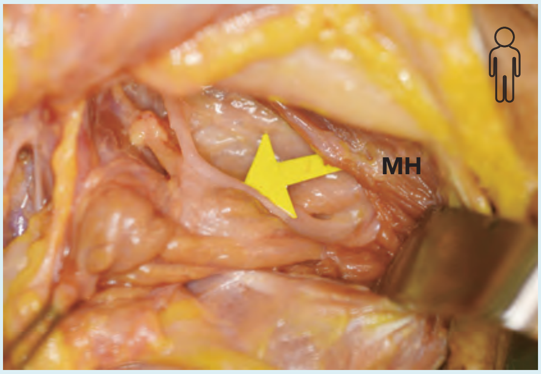

Figure 8

Lingual nerve (yellow arrow)

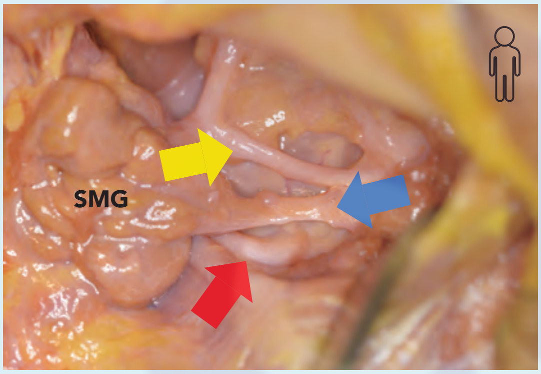

Figure 9

Lingual nerve (yellow arrow), Submandibular duct (blue arrow) and Hypoglossal nerve (red arrow)

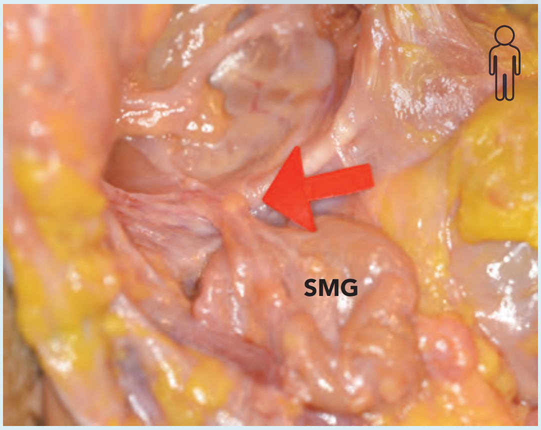

Figure 10

Facial vessel (red arrow)

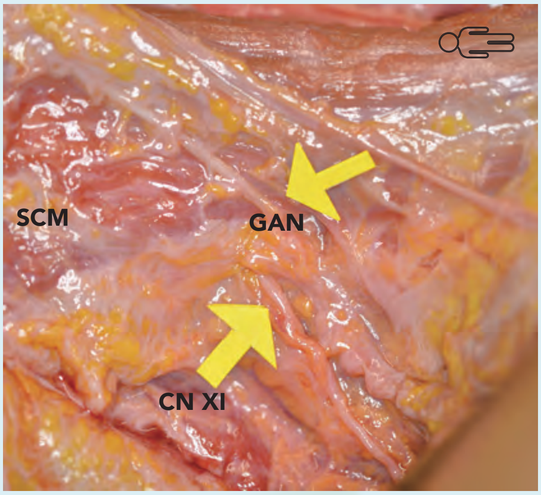

Figure 11

Accessory nerve (**CNXI**) identified 1 cm posterior to **GAN** at the posterior border of SCM

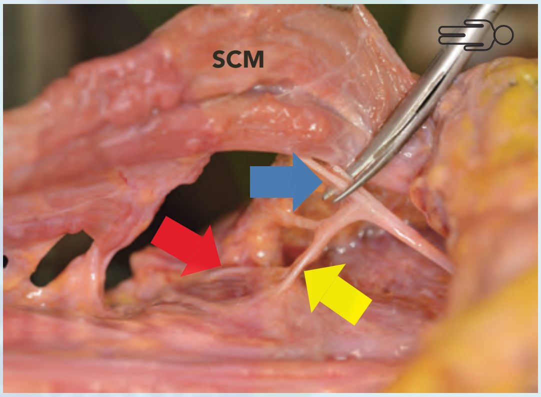

Figure 12

Accessory nerve branches, SCM branch (blue arrow), Trapezius branch (red arrow) and cervical plexus contribution (yellow arrow)

MODIFIED RADICAL NECK DISSECTION TYPE II

STEP 5 LEVEL IV & V DISSECTION

Divide the SCM approximately 1 cm above the clavicle while applying continuous traction. The IJV within the carotid fascia can be identified after division of the muscle fibers. The dissection continues in the supraclavicular fossa but leave the lymphatic tissue posterior to IJV intact to prevent injury to the thoracic duct located in Level IV. Identify the omohyoid muscle and the external jugular vein in the supraclavicular fossa and divide the muscle and ligate the external jugular vein. **Figure 16** The dissection goes deep until the transverse cervical vessels and the prevertebral fascia come into view. The brachial plexus can be identified below the fascia and should be kept intact. **Figure 17** The dissection is then completed with a blunt finger or with a dental swab in an antero-superior direction. The phrenic nerve will be identified descending on the scalenus anterior muscle running in a medial direction. Finger dissection can also be done postero-superiorly with care taken not to rupture the transverse cervical vessels. The dissected accessory nerve should now be identified again because the supraclavicular nerve running in the fibrofatty tissue can be divided with diathermy or a knife but not the spinal accessory nerve. The transverse cervical artery can be dissected free from the lymphatic tissue by dividing the ascending branch alone, preserving it for future use. **Figure 18**

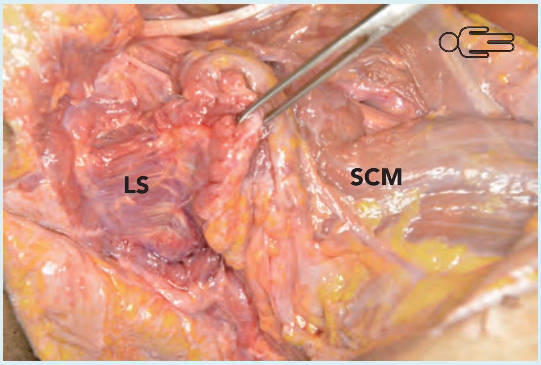

Figure 13
Superior attachment of SCM divided to expose the underlying levator scapulae (**LS**) muscle

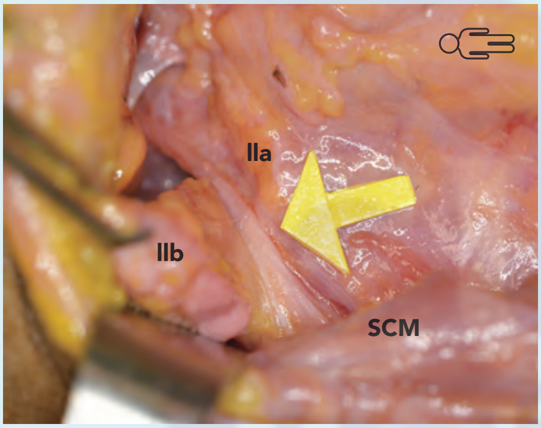

Figure 14
Accessory nerve (yellow arrow)

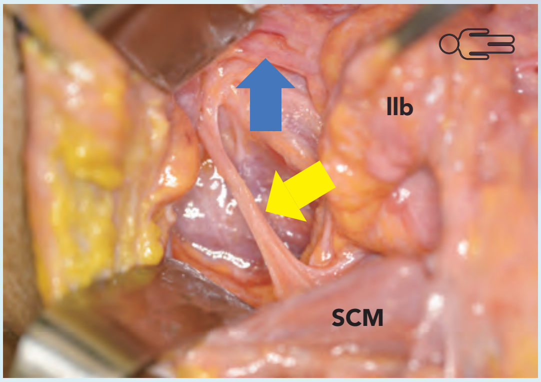

Figure 15
Level IIb lymphatic dissected free from accessory nerve (yellow arrow), IJV (blue arrow)

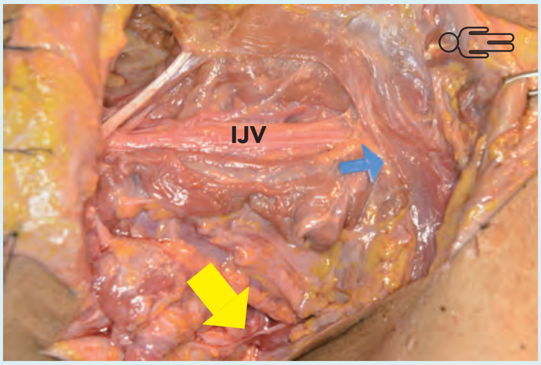

Figure 16
Omohyoid muscle (blue arrow) and translocated accessory nerve (yellow arrow)

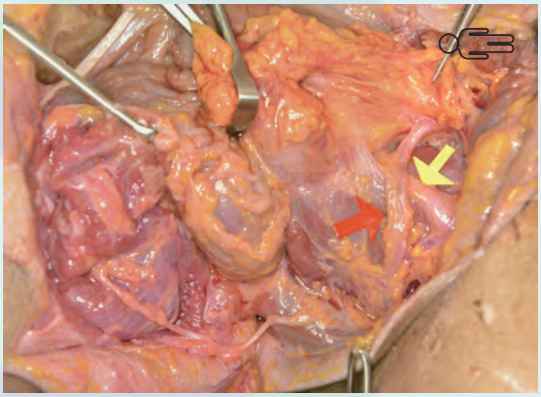

Figure 17
Brachial plexus (yellow arrow) and transverse cervical vessel (red arrow)

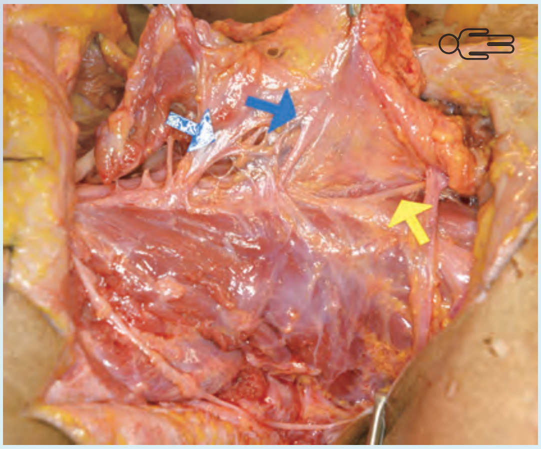

Figure 18
Phrenic nerve (yellow arrow) and cervical plexus (blue arrows)

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Modified Radical Neck Dissection Type II

STEP 6 AVOID INJURY TO THE THORACIC DUCT

The Level IV lymphatics adjacent to the IJV should be carefully divided between clamps and ligated with silk ligatures to avoid a troublesome chyle leak especially on the left side. Attention also needs to be given to the phrenic and vagus nerves so that they are not clamped as they run close to the area you are now dissecting. **Figure 19**

STEP 7 ANTEROGRADE DISSECTION OF LEVELS II-V LYMPHATICS

Anterograde dissection of Levels II-V lymphatics begins with anterior traction applied to the fibrofatty tissue. The surgeon establishes a subepimysial dissection plane on the deep muscles of the neck, except over the brachial plexus where the overlying fascia is retained to protect the nerves. Dissection proceeds over a broad front until the entire cervical plexus has been exposed. The phrenic nerve is identified and preserved as it descends obliquely across the scalenius anterior muscle. **Figure 20** The cervical plexus is divided from the phrenic nerve and the dissection continued anteriorly onto the carotid fascia. **Figure 21**

The carotid fascia is incised with a scalpel and the IJV, common carotid artery and vagus nerves will come into view. Tributaries from the IJV will be seen when the dissection reaches the anterior border of the IJV. These tributaries need to be divided and ligated with silk ligatures. The ansa hypoglossi, which courses either deep or superficial to the IJV, may be preserved.

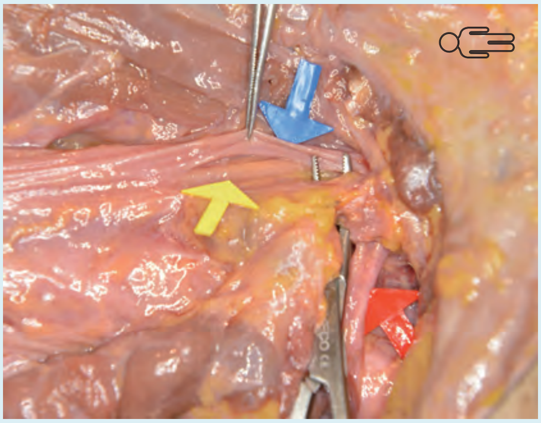

Figure 19

Internal jugular vein (blue arrow), Transverse cervical vessel (red arrow) and Vagus nerve (yellow arrow)

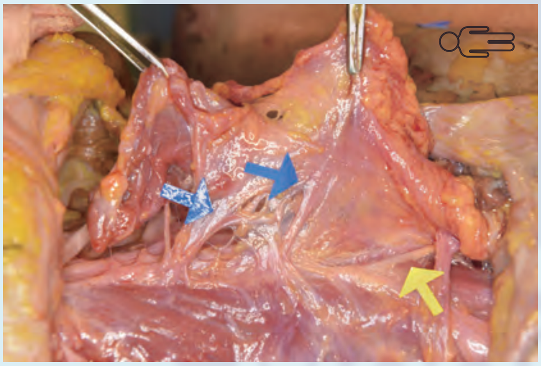

Figure 20

Phrenic nerve (yellow arrow) and cervical plexus (blue arrows)

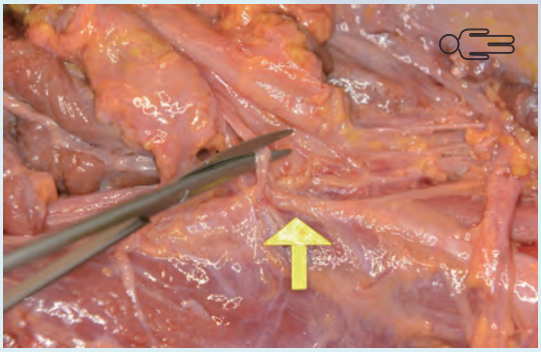

Figure 21

Divide the cervical plexus away from phrenic nerve (yellow arrow)

MODIFIED RADICAL NECK DISSECTION TYPE II

The final step is to free the neck dissection specimen off the infrahyoid strap muscles to identify and preserve the superior thyroid vascular pedicle, and to deliver the neck dissection specimen. **Figure 22**

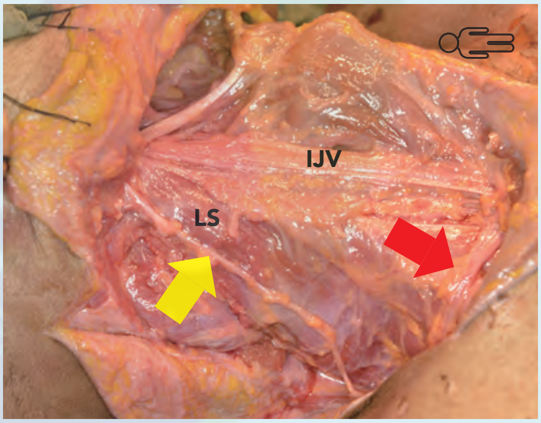

Figure 22

Completed MRND type II, transverse cervical vessel (red arrow) and accessory nerve (yellow arrow) on levator scapulae (**LS**)

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KEY POINTS

1. Choose your incision according to the primary tumour and avoid 3 point junctions in the post irradiated patient.
2. Identify and protect the marginal mandibular, lingual and hypoglossal nerves in Level I.
3. Identify IJV and accessory nerve at Level II and make Level IIb clearance safe and efficient.
4. Accessory nerve can be identified 1 cm posterior to the GAN at posterior triangle.
5. Keeping the prevertebral fascia intact is the key to avoid phrenic nerve and brachial plexus injury.
6. Level IV lymphatics should be dissected with caution to avoid a chyle leak.
7. Identify the vagus nerve within the carotid sheath.
8. Cervical plexus should be divided away from the roots to avoid injury to phrenic nerve.
9. Tributaries of IJV should be divided and ligated to avoid troublesome bleeding.
10. Superior thyroid artery should be identified and preserved during neck dissection.

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06

THYROIDECTOMY

Siu Kwan Ng

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THYROIDECTOMY

STEP 1. EXPOSING THE THYROID GLAND

The collar incision **Figure 1** (curvilinear skin crease incision) is made at 1.5-2 finger breadths above the clavicular heads (when the neck is extended)

A subplatysmal flap is elevated up to the thyroid notch superiorly, to the sternal notch inferiorly and SCM laterally. **Figure 2** Note that the platysma is absent in the midline of the neck and is more readily identified at the lateral part of the incision. Alternatively, defining the subplatysmal plane can be aided by finding the anterior jugular veins which are located immediately beneath that plane.

Identify the midline raphe between the sternohyoid muscles. **Figure 3** This raphe is divided from the thyroid notch superiorly to sternal notch inferiorly. The sternohyoid muscle is retracted laterally to expose the sternothyroid muscle.

Identify the medial edge of the sternothyroid (ST) muscle which lies deeper and lateral to the medial edge of sternohyoid (SH) muscle. **Figure 4**

Dissect the sternothyroid muscle off the thyroid gland surface from upper pole to lower pole, keeping the dissection plane close to the muscle. **Figure 5** The middle thyroid vein (of which there can be several or be absent), if encountered is ligated and divided

STEP 2. DISSECTION AND RELEASE OF THYROID UPPER POLE

The medial 1 cm of the sternothyroid muscle insertion is coagulated and divided to facilitate the upper pole exposure. **Figure 6**

Using Babcock forceps (Kocher forceps are quite traumatic and may tear the thyroid parenchyma causing bothersome bleeding),

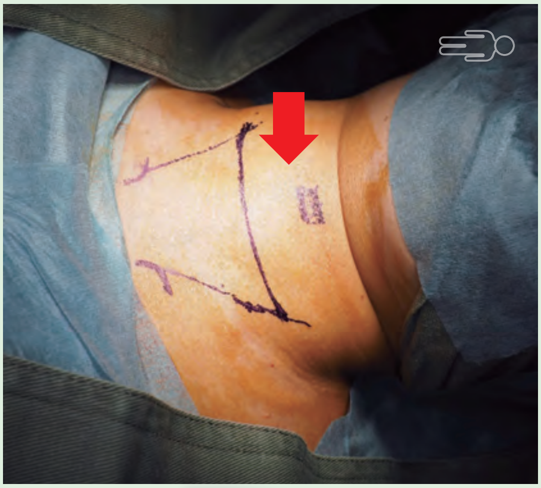

Figure 1

Curvilinear skin crease incision with reference to cricoid cartilage

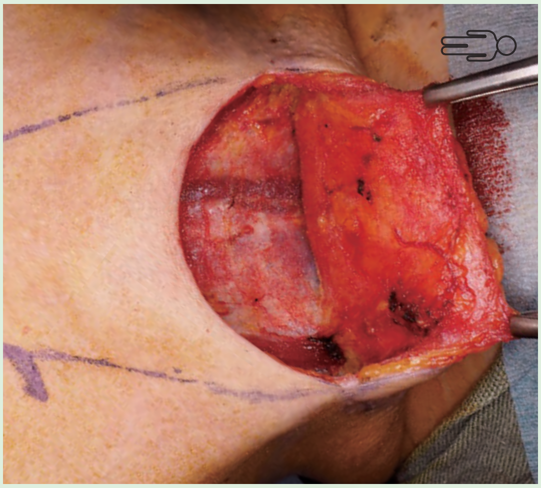

Figure 2

Subplatysmal flap evevated up to the thyroid notch superiorly and sternal notch inferiorly

the upper pole of the thyroid is firmly held and pulled inferiorly and laterally. This maneuver exposes the avascular space between the upper pole of the thyroid and the cricothyroid muscle (the space of Reeve). **Figure 7**

Gentle dissection into this space using the blunt tip of closed Metzenbaum scissors can facilicate exposure of the external laryngeal nerve in the majority of patients. **Figures 8, 9**

The superior pedicle is ligated below the external laryngeal nerve. **Figures 10, 11**

STEP 3. DISSECTION OF TRACHEO-OESOPHAGEAL REGION

After releasing the upper pole, the whole thyroid lobe is rotated medially by seperating the remaining alveolar tissue between the gland and the sternothyroid muscle. This step exposes the tracheo-oesophageal region. **Figure 12**

Capsular dissection (i.e. dissection close to the true thyroid capsule) releases the lower thyroid pole. Attention is drawn to the presence of the inferior parathyroid gland which if seen, should be preserved and dissected off the thyroid gland. The inferior parathyroid glands are normally located between the lower pole of the thyroid and the isthmus, most commonly on the anterior or the posterolateral surface of the lower pole of the thyroid, or located in the lower neck in proximity to the thymus. Sometimes it is not easy to identify the inferior parathyroid gland. **Figures 13, 14**

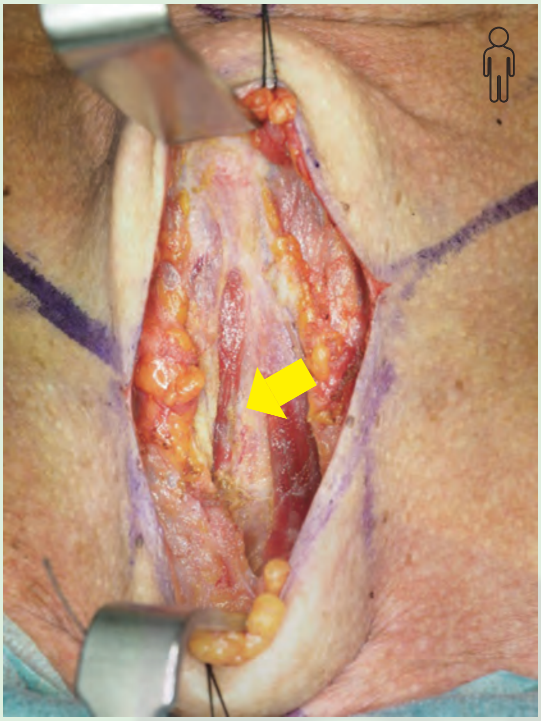

Figure 3
Identify midline raphe

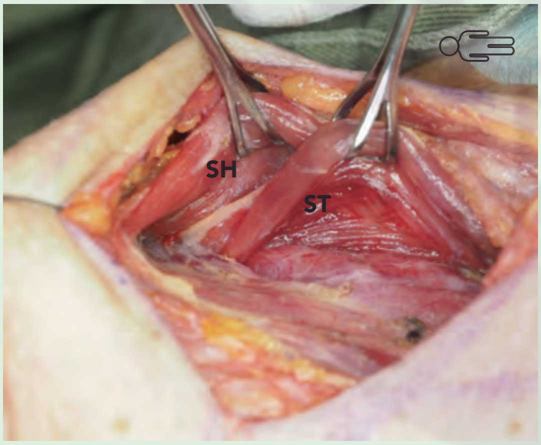

Figure 4
Identify the medial edge of the sternothyroid (**ST**) and sternohyoid (**SH**) muscles

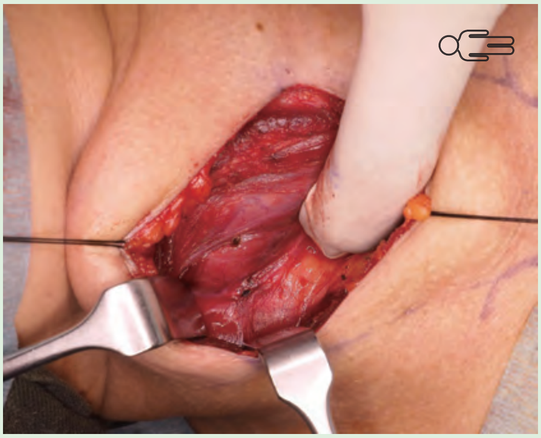

Figure 5
Dissect the thyroid gland off the sternothyroid muscle

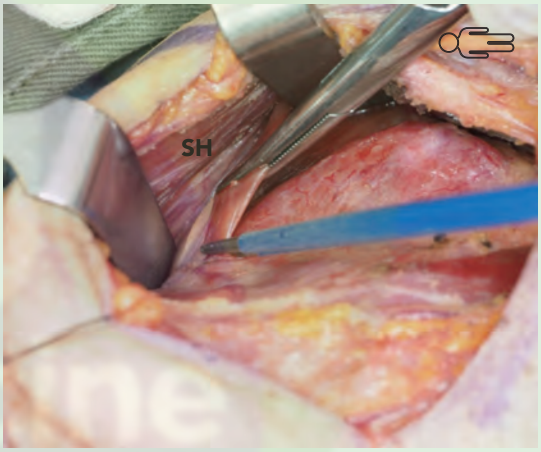

Figure 6
Divide the medial 1 cm of sternothyroid muscle insertion. **SH** – sternohyoid muscle

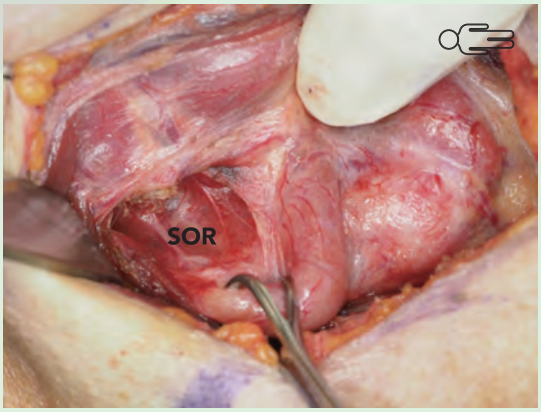

Figure 7
Space of Reeve (**SOR**) exposed with the upper pole of thyroid pulled inferiorly and laterally

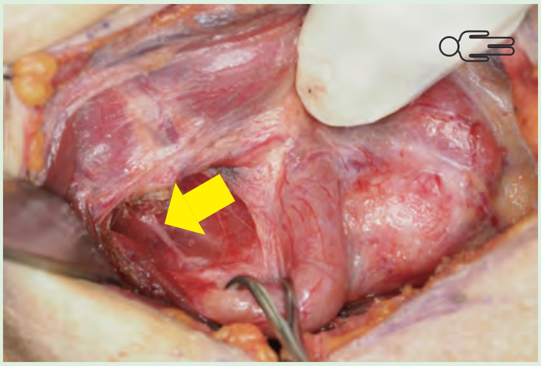

Figure 8

External laryngeal nerve

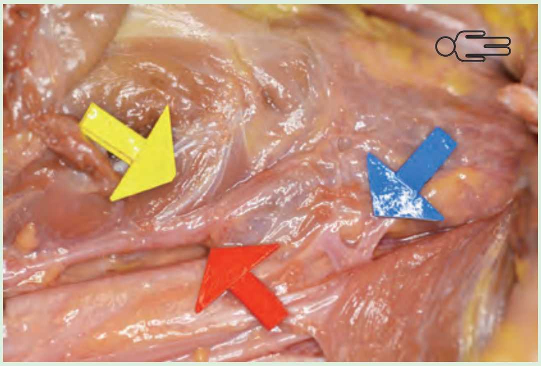

Figure 9

Middle thyroid vein (blue arrow)
Superior thyroid artery (red arrow)
External laryngeal nerve (yellow arrow)

After the lower pole is released, an attempt is made to identify the recurrent laryngeal nerve (RLN) lying within the tracheo-oesophageal groove (right side would be more lateral). The RLN is located by carefully dissecting/teasing apart the tissues in *Simon's triangle* which is formed by the common carotid artery laterally, the oesophagus medially, and the inferior thyroid artery superiorly. **Figures 15, 16**

After identification of the recurrent laryngeal nerve, capsular dissection is continued cranially keeping sight of the recurrent laryngeal nerve at all times. The branches of the inferior thyroid artery are divided close to the capsule so that the blood supply to the parathyroid glands is preserved. The superior parathyroid gland is commonly surrounded by a fat pad. This gland is normally located at the level of the upper two-thirds of the thyroid, in a posterior position and is closely related to the *Tubercle of Zuckerkandl*, about 1 cm above the crossing point of the recurrent laryngeal nerve and inferior thyroid artery. The parathyroid gland has a characteristic orange or rich yellow colour. The gland should be preserved with its blood supply from the inferior thyroid artery by peeling the gland off the thyroid capsule. **Figures 17, 18**

The recurrent laryngeal nerve is traced cranially until it enters into the larynx around 0.5 cm caudal to the inferior cornu of the thyroid cartilage. Berry's ligament attaches the thyroid gland to the cricoids and first 2 tracheal rings. The ligament can be carefully divided while paying attention to the RLN at its entry point into the larynx. **Figures 19, 20**

After the division of Berry's ligament, the thyroid lobe is dissected off the trachea. The isthmus is then ligasure coagulated and divided (or clamped, divided and oversewn with 3-0 vicryl stitches).

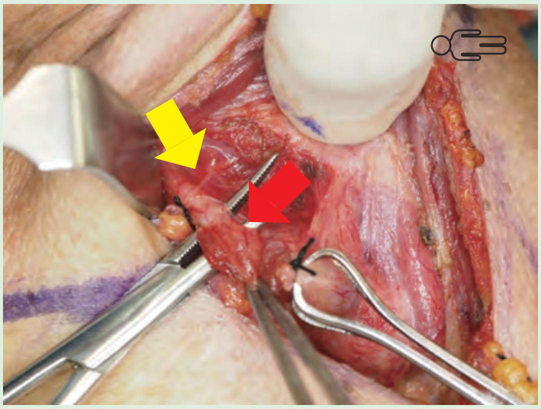

Figure 10
The superior pedicle (red arrow) is ligated below the external laryngeal nerve (yellow arrow)

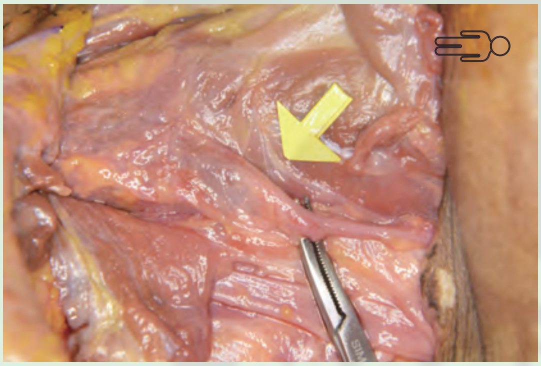

Figure 11
External laryngeal nerve (yellow arrow)

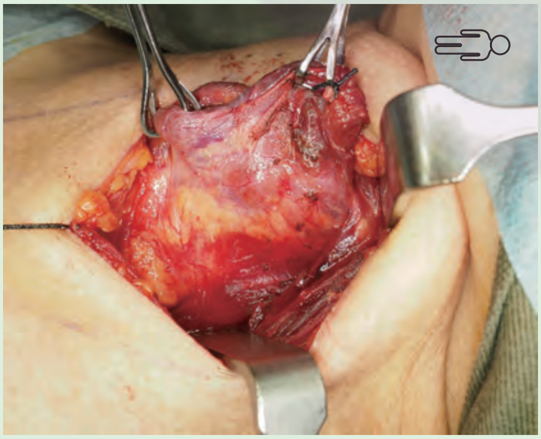

Figure 12
Exposure of the tracheo-oesophageal region

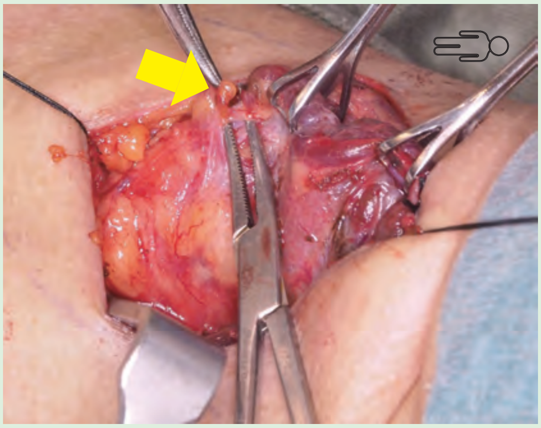

Figure 13
Dissection of inferior parathyroid gland (yellow arrow)

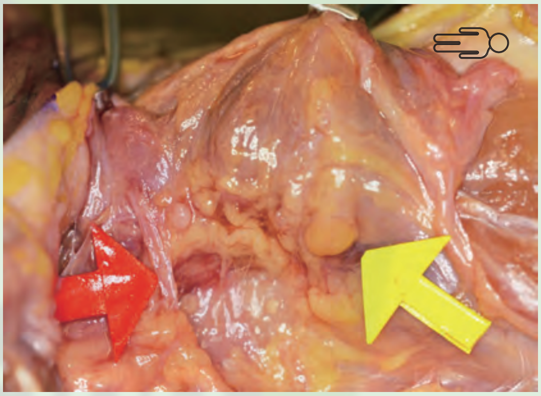

Figure 14
Superior parathyroid gland (yellow arrow)
Inferior thyroid artery (red arrow)

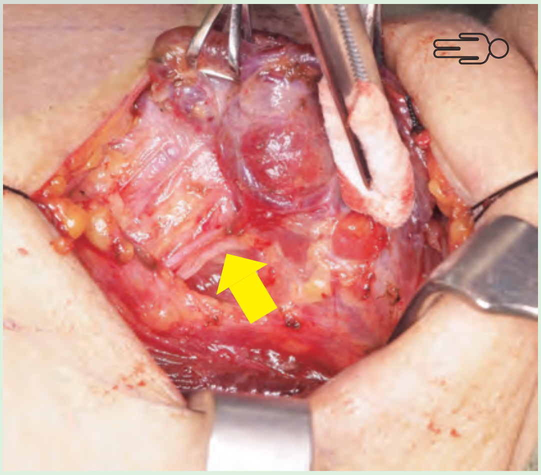

Figure 15
Recurrent laryngeal nerve

TOTAL THYROIDECTOMY

Repeat the same procedure on the other side without dividing the isthmus. The prelaryngeal area should be dissected and examined for the presence of a pyramidal lobe to ensure complete excision of thyroid tissue.

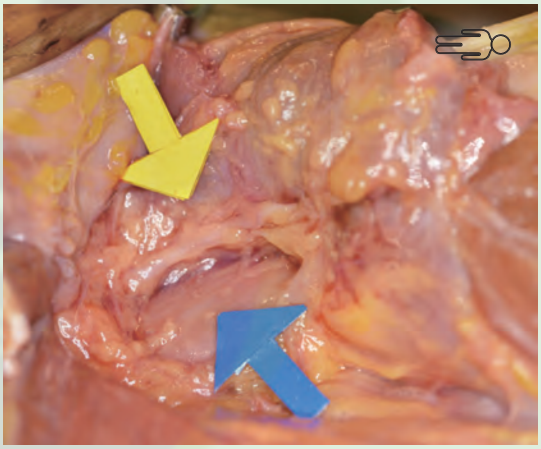

Figure 16

Recurrent laryngeal nerve (yellow arrow)
Oesophagus (blue arrow)

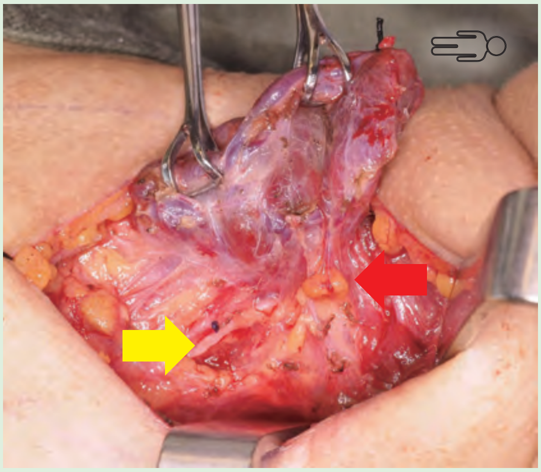

Figure 17

Recurrent laryngeal nerve (yellow arrow) and Superior parathyroid gland (red arrow)

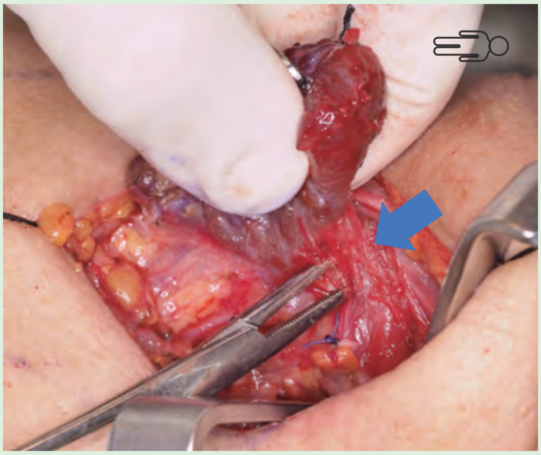

Figure 19

Berry's Ligament (blue arrow)

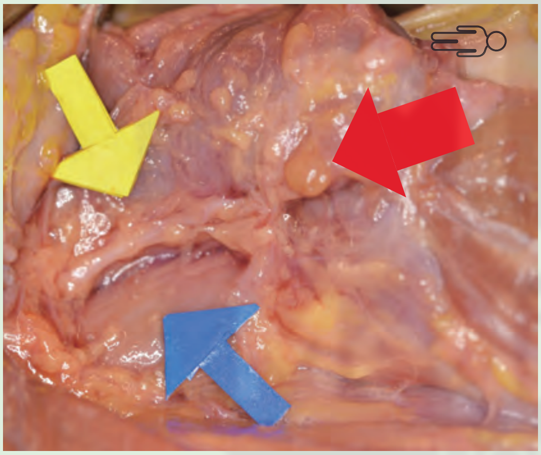

Figure 18

Recurrent laryngeal nerve (yellow arrow) and Superior parathyroid gland (red arrow) Oesophagus (blue arrow)

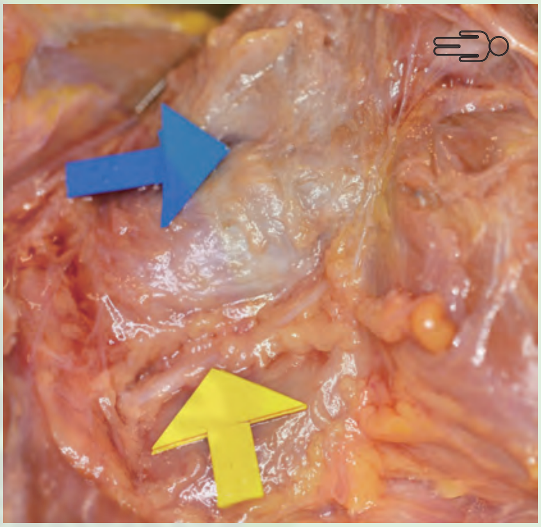

Figure 20

Berry's ligament (blue arrow), Recurrent laryngeal nerve (yellow arrow)

KEY POINTS

1. The skin flap is raised in the subplatysmal plane. The platysma is more readily identified at the lateral part of the incision.
2. Inadequate seperation of the strap muscles at the median raphe limits lateral retraction and exposure.
3. Limited separation of the sternothyroid muscle from its medial insertion on the thyroid cartilage improves the exposure of the upper pole of the thyroid gland, aiding identification of the external laryngeal branch of the superior laryngeal nerve.
4. When approaching a very big goiter, the overlying strap muscles can be transected horizontally to improve the surgical exposure.
5. Freeing the upper pole of the thyroid gland early in the surgery improves the mobility of the thyroid lobe. By medially rotating the lobe out of the thyroid bed, the tracheo-oesophageal region is opened facilitating dissection and identification of the recurrent laryngeal nerve.
6. Dissection is kept close to the thyroid capsule. This minimizes the chance of injury to both the recurrent laryngeal nerve (before its identification) and the parathyroid glands.
7. Routine identification of the recurrent laryngeal nerve has been shown to reduce the chance of injury.
8. Atraumatic forceps should be used to hold the thyroid tissue during dissection.
9. The Zuckerkandl lobe can be quite big in some patients giving the erroneous impression that the recurrent laryngeal nerve penetrates the thyroid gland.
10. For total thyroidectomy, it is prudent to check for the presence of a pyramidal lobe which, if present, should also be excised.

07

TOTAL LARYNGECTOMY

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CU Medicine
HONG KONG

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TOTAL LARYNGECTOMY

STEP 1 INCISION AND POSITION OF STOMA

A superiorly based apron flap incision is marked with the horizontal limb placed about 2 cm above the clavicles with the vertical limbs parallel to and 1cm posterior to the anterior borders of the sternocleidomastoid muscles (SCM).

The stoma is marked immediately below the horizontal limb so that its future upper border will be the apron flap. The size of the stoma should approximate the size of the patient's thumb to facilitate the use of a voice prosthesis, or be about 1.5 times the diameter of the trachea. The lower border of the stoma should be 2 cm above the upper border of the manubrium. It is important not to place the stoma too low in the neck, especially when the neck is already extended for surgery. **Figures 1, 2**

Musculocutaneous flaps are elevated in the subplatysmal plane to 2 cm superior to the hyoid bone above, and to the sternal notch below.

STEP 2 RETRACTION OF THE SCM AND DIVISION OF OMOHYOID MUSCLE

Incise the investing layer of deep cervical fascia along the anterior border of SCM and divide the external jugular vein/great auricular nerve if necessary.

Retract the SCM laterally and then dissect on the medial surface of the SCM from medial to lateral and anterior to posterior to expose the omohyoid muscle and internal jugular vein (IJV). The segmental blood supply to the SCM is cauterized with bipolar diathermy and then the belly of the omohyoid muscle is divided. With gentle retraction on the IJV, the middle thyroid vein is divided between clamps

MOBILIZATION OF LARYNX

and ligated. The internal jugular vein and the lateral border of sternohyoid muscle are clearly defined at this stage. **Figure 3**

STEP 3 DIVISION OF THE INFRAHYOID MUSCLES

Divide and ligate the anterior jugular vein. The sternohyoid strap muscle is exposed in and just above the sternal notch. The sternohyoid muscle and then deep to it the sternothyroid muscle are divided with diathermy to expose the thyroid lobe medially and the IJV laterally beneath them.

STEP 4 REPEAT STEPS 2 & 3 ON THE CONTRALATERAL SIDE

Repeat steps 2 and 3 on the contralateral side so that both thyroid lobes are exposed. The contralateral (the side without larynx cancer) thyroid lobe can usually be preserved to avoid hypocalcaemia and hypothyroidism if there is no gross tumour invasion into the thyroid gland on imaging.

STEP 5 PRESERVATION OF ONE THYROID LOBE

The thyroid isthmus is divided and oversewn with a suture.

The contralateral thyroid lobe is mobilized from the trachea and rotated laterally to free it from the larynx. The recurrent laryngeal nerve can be identified in the tracheo-oesophageal groove, but the nerve is obviously cut in a total laryngectomy. The oesophagus should be identified and preserved. The superior laryngeal artery is divided from the superior thyroid artery which is preserved to maintain blood supply to the thyroid lobe.

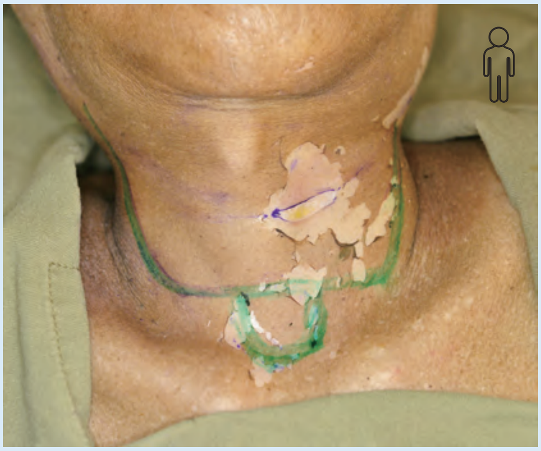

Figure 1

Apron incision and the stoma

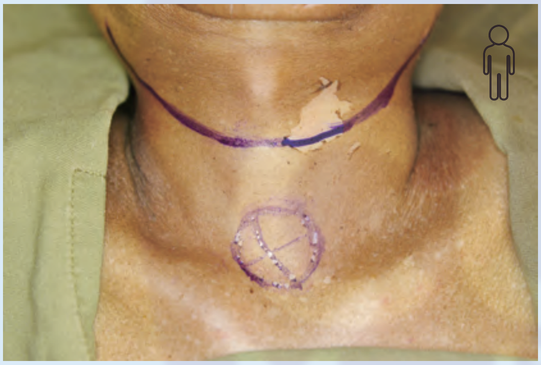

Figure 2

Alternative incision with stoma away from the main incision

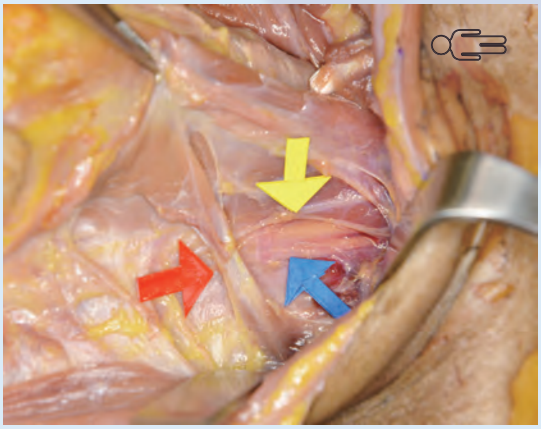

Figure 3

SCM retracted to expose the omohyoid muscle (red arrow), IJV (blue arrow) and free edge of sternohyoid muscle (yellow arrow)

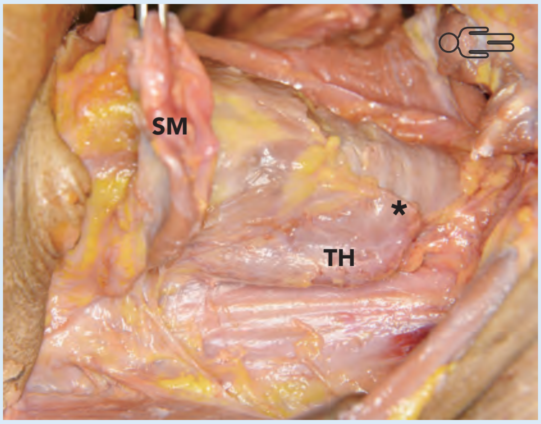

Figure 4

Strap muscle (**SM**) dissected free from the right thyroid lobe (**TH**) and isthmus (*) divided

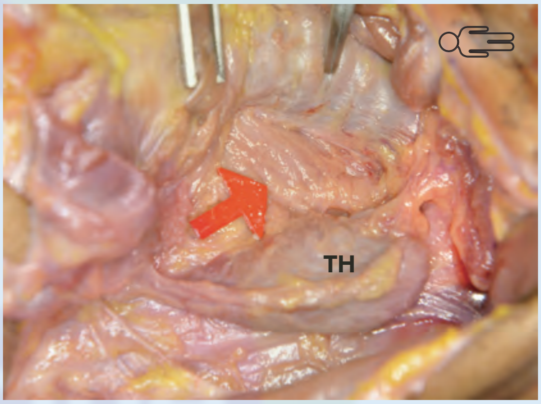

Figure 5

Thyroid (**TH**) mobilized from the laryngeal frame work and the oesophagus (red arrow) is exposed

MOBILIZATION OF LARYNX

The ipsilateral (the side with larynx cancer) thyroid lobe is left attached to the larynx as an additional margin and the recurrent laryngeal nerve, superior thyroid artery and inferior thyroid arteries are divided to free up the larynx. Care must be taken once again to identify and preserve the oesophagus.

The superior laryngeal nerve is identified before it penetrates the thyrohyoid membrane and is divided on both sides. **Figures 4-6**

STEP 6 SEPARATING THE CONSTRICTOR FROM THE THYROID CARTILAGE

The larynx is rotated to the contralateral side and the posterior border of thyroid ala is palpated. The attachment of the inferior constrictor muscle at the oblique line on the thyroid cartilage is incised and the constrictor muscle together with the perichondrium is stripped off from the thyroid cartilage. The mucoperiosteum continues to be stripped off from the lateral wall of the pyriform fossa (strip it off from the medial aspect of the thyroid ala in a subperichondrial plane with a swab or sponge held over a fingertip, or with a Freer's elevator). If the tumour extends into the hypopharynx, this step is omitted to ensure adequate resection margins. The same procedure is repeated on the other side. **Figures 7, 8**

STEP 7 RELEASING THE HYOID BONE SUPERIORLY

The hypoglossal nerve which is deep to the greater cornu of the hyoid bone must be identified and preserved on both sides. The muscles attaching to the

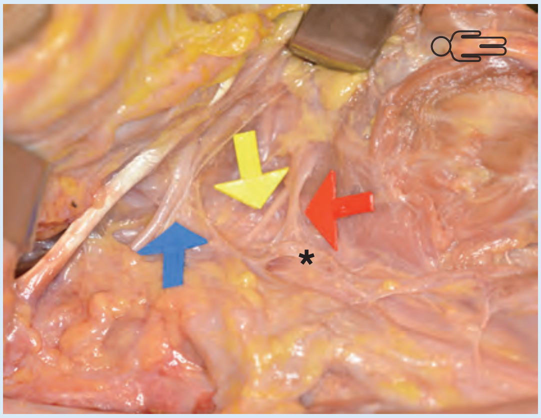

Figure 6

Hypoglossal nerve (blue arrow), superior laryngeal nerve (yellow arrow) and the superior laryngeal artery (red arrow) arising from superior thyroid artery (*)

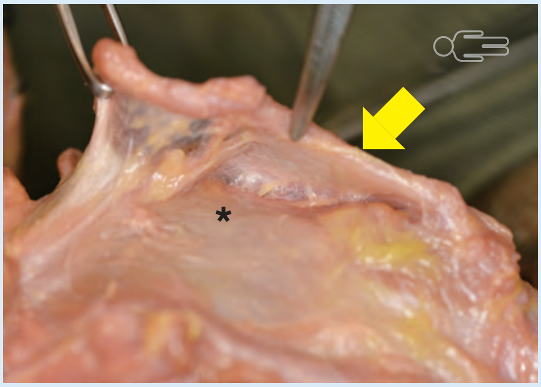

Figure 8

Piriform fossa mucosa (*) dissected free from the thyroid cartilage (yellow arrow)

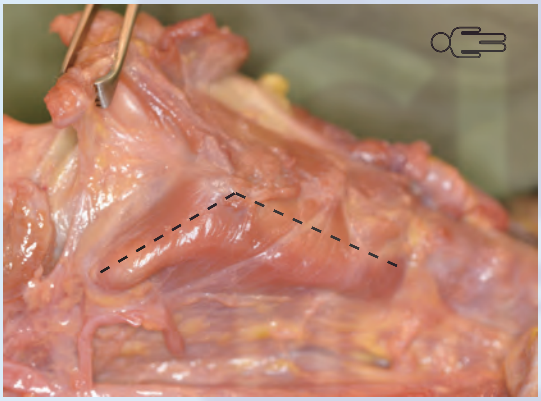

Figure 7

Incise at the oblique line (indicated above) to divide the inferior constrictor muscle

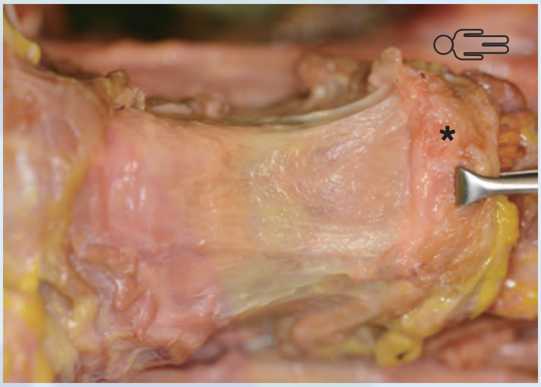

Figure 9

Suprahyoid myotomy with Allis tissue forceps holding the hyoid bone (*)

HONG KONG

Mobilization of Larynx

superior surface of the body of the hyoid are divided using cautery with the tip of the cautery in contact with the superior border of hyoid bone to avoid injury to the hypoglossal nerve. The stylohyoid ligament is divided from the lesser cornu of the hyoid bone to further mobilize the bone. Rotate the hyoid bone to the contralateral side to identify the greater cornu. Using scissors divide the soft tissue on the medial and posterior aspect of the greater cornu of the hyoid to isolate the greater cornus on both sides. Keeping the tip of the scissors on the hyoid bone will prevent the hypoglossal nerve from being inadvertently cut. Further dissect transversely with diathermy along the superior margin of the hyoid bone and then into the superior aspect of the pre-epiglottic space. Identify the hyo-epiglottic ligament in the midline. Dissect superiorly along the hyo-epiglottic ligament to the epiglottis and then strip the vallecula mucosa from the anterior surface of the epiglottis. The tip of the epiglottis is identified through the mucosa and is readily grasped with an Allis tissue forceps. The pharynx is entered by incising into the mucosa along the superior free edge of the tip of the epiglottis if the pharynx is to be entered from above. **Figure 9**

STEP 8 DIVISION OF THE TRACHEA

Just prior to entering the pharynx, the trachea should be transected between tracheal rings 2 and 3. Do not cut through tracheal cartilage but divide cleanly between 2 tracheal rings. **Figure 10** The orotracheal or nasotracheal tube is withdrawn and the trachea re-intubated through the neck wound. Make sure to divide the posterior tracheal wall at least in the same plane as the tracheal rings by dividing the posterior wall higher than

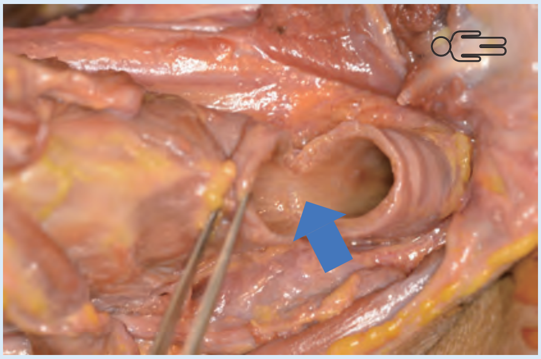

Figure 10
Trachea (blue arrow) transected between 2 tracheal rings

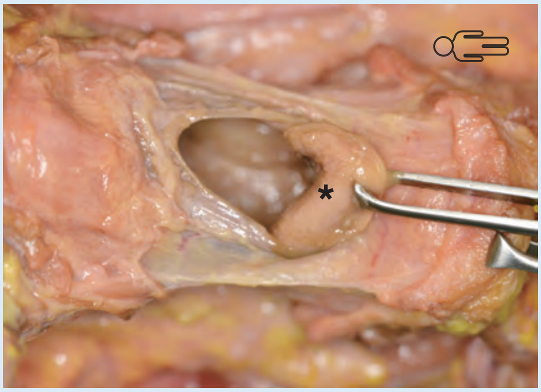

Figure 11
Epiglottis tip (*) grasp with Allis tissue forceps

you imagine you should. The posterior tracheal wall should be slightly longer than the anterior tracheal wall as this aids in fashioning the stoma.

STEP 9A ENTRY INTO THE PHARYNX FROM ABOVE

Grasp the tip of epiglottis with Allis tissue forceps through the thin mucosa. The pharynx is entered in the midline at the tip of the epiglottis and the pharyngeal incision is continued on the opposite side to the tumour by hugging the lateral margin of the epiglottis.

On the non-tumour side, the mucosa of the pharynx is divided from its attachment to the larynx by dividing the mucosa of the medial pyriform fossa under vision. The larynx can then be rotated to bring the tumour into view.

On the tumour side and under full view, the mucosa of the pyriform fossa is divided with adequate 1-2 cm margins to separate the larynx from the pharynx laterally.

The inferior aspect of the left and right pyriform fossa incisions are joined by tunneling between the cricopharyngeus and the trachea on each side and then dividing the postcricoid mucosa and cricopharyngeus transversely. The laryngeal specimen is delivered from the wound at this stage. **Figures 11, 12**

STEP 9B ENTRY INTO THE PHARYNX FROM BELOW

Develop the avascular plane between the trachea and oesophagus and separate the upper stump of the trachea from the oesophagus. Do not separate the lower trachea from the oesophagus. Bilateral crico-arytenoid muscles and the post

Closure of Pharynx

cricoid mucosa will gradually be exposed. The pharynx is entered by incising into the post cricoid mucosa from the midline and once the pharynx has been punctured, the pyriform fossa mucosa opposite to the tumour is divided with scissors to expose the hypopharynx and larynx. The larynx is mobilized by completing the mucosal incision across the vallecula and the ipslateral pyriform fossa with adequate margins. The laryngeal specimen is delivered from the wound at this stage. **Figures 13, 14**

STEP 10 CLOSURE OF PHARYNX

A watertight seal is essential and is achieved with a meticulous, multilayered closure. A feeding tube should be placed and hemostasis assured prior to inserting any closing sutures. The initial layer of closure is a running Connell stitch using 3-0 Vicryl. One suture with needle attached should be anchored at the inferior portion of the pharyngotomy, just above the oesophagus. Closure begins with the inferior suture proceeding superiorly. The pharynx can be closed in either a straight line or T- fashion. **Figures 15, 16**

The second layer is achieved with interrupted sutures. This closes the fascia over the incision line again using 3-0 Vicryl. In the third and final layer of closure, sutures are used to close either constrictor muscle or strap musculature over the incision line.

STEP 11 FASHION THE STOMA

The final portion of the laryngectomy is completion of the tracheostoma. The inferior border is addressed first and sutures of 2-0 nylon are used. The stitch is placed through the skin and then from outside to inside the tracheal lumen

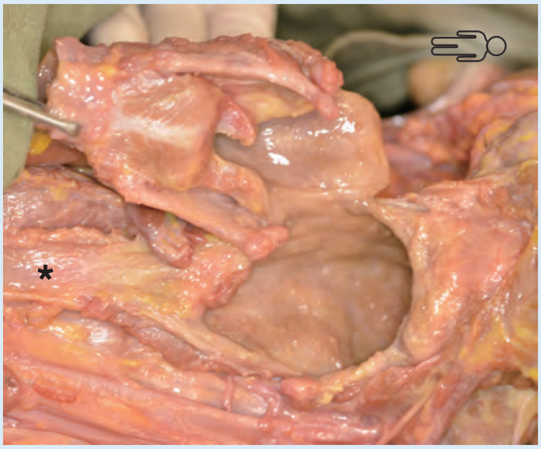

Figure 12
The larynx rotated to bring the tumour into view, Oesophagus (*)

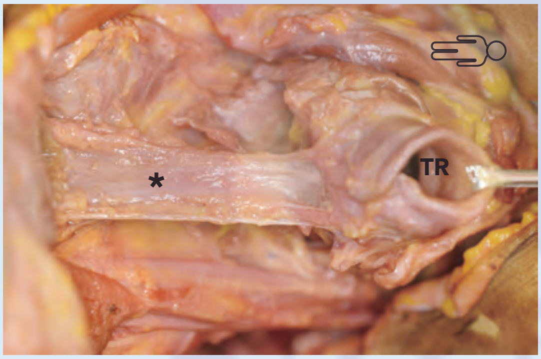

Figure 13
Develop the avascular plane between the trachea (**TR**) and oesophagus (*)

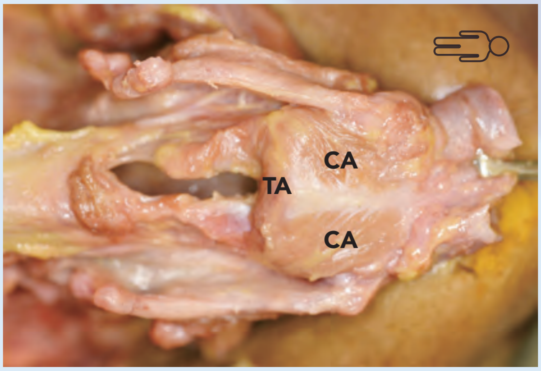

Figure 14
Post cricoid mucosa cut open providing entry to the larynx, crico-arytenoid muscle (**CA**) and Transverse arytenoid muscle (**TA**)

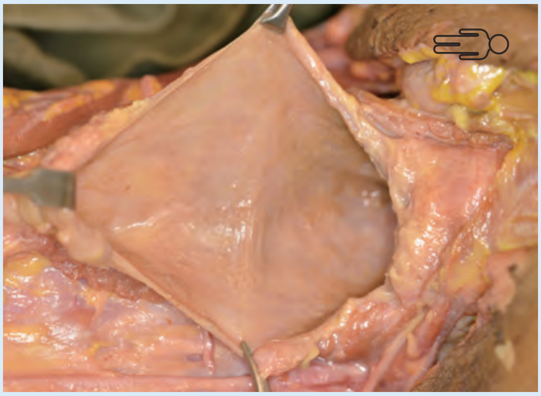

Figure 15
Preserved pharyngeal mucosa wide enough to avoid dysphagia after primary closure

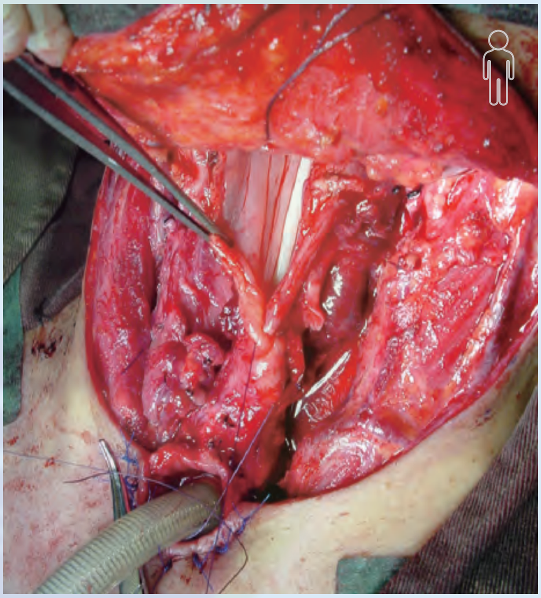

Figure 16
Closure of pharyngeal mucosa using running Connell suture

Wound Closure and Fashion the Stoma

just below a tracheal ring. The suture is then passed back through the skin from subcutaneous to external, just horizontal to the initial entry point. In this manner a half mattress is formed for the tracheal part of the stitch around the tracheal ring thus lending strength to the stoma. **Figure 17**

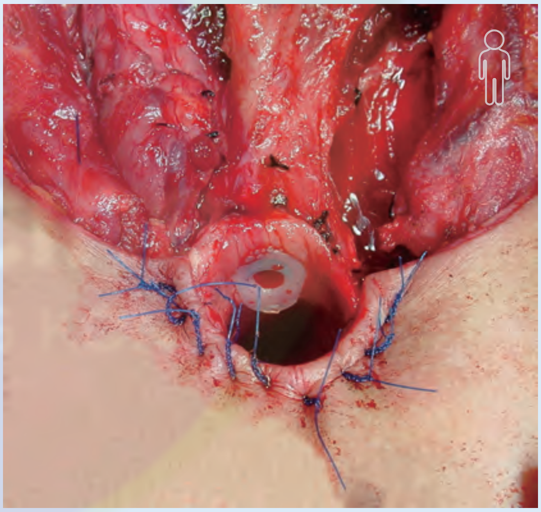

Figure 17.
Stoma fashioned with half mattress sutures
Note placement of tracheo-oesophageal valve

KEY POINTS

1. Mark a superiorly based apron flap with the horizontal limb placed 2 cm about the clavicles.
2. Do not to place the stoma too low in the neck by ensuring the lower border of the stoma is 2 cm above the upper border of the manubrium.
3. After raising the flaps, retract the SCM and divide the omohyoid muscle and middle thyroid vein.
4. Divide the infrahyoid muscles to expose the thyroid lobes.
5. Preserve the contralateral (the side without larynx cancer) thyroid lobe to avoid hypocalcaemia and hypothyroidism, if it is not invaded by tumour.
6. The inferior thyroid artery is preserved, as is the superior thyroid artery by dividing the superior laryngeal artery from it.
7. The hyoid bone is released superiorly from all attached tissues while preserving the hypoglossal nerves.
8. The trachea is divided cleanly between tracheal rings and the posterior tracheal wall is divided in the same plane.
9. The pharynx is entered either superiorly or inferiorly and the larynx separated from the pharynx under direct vision sparing as much normal pharyngeal mucosa as is oncologically feasible and safe.
10. Use a Connell suture to achieve water tight closure of the pharynx and half mattress sutures to fashion the stoma.

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Gortex Thyroplasty

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GORTEX THYROPLASTY

STEP 1 MARK THE INCISION

Palpate for the thyroid cartilage.

Identify the thyroid notch, midline and inferior border of thyroid cartilage. **Figure 1**

STEP 2 EXPOSE THE THYROID CARTILAGE

A transverse skin crease incision 5 cm long is made at the level of mid-thyroid cartilage from the midline towards the posterior border of thyroid cartilage.

Small superior and inferior skin flaps are raised in the subplatysmal plane.

The sternohyoid and thyrohyoid muscles are divided to expose the thyroid lamina from the midline to the oblique line (where the sternothyroid muscle inserts).

The bare cartilage of the thyroid lamina is exposed by incising and elevating a rectangular and inferiorly based peri-chondral flap down to the inferior border of thyroid cartilage using a Freer's dissector.

STEP 3 OPENING A WINDOW IN THE THYROID CARTILAGE

From the midpoint between the thyroid notch and lower border of the thyroid cartilage in the midline, draw a line, parallel to the inferior border of thyroid lamina, posteriorly towards the oblique line (this approximates the level of vocal cord)

Using a 4 mm cutting burr followed by a diamond burr, open a small window in the thyroid lamina, 1 cm from midline (parallel to the above line) and 4 mm above inferior border of thyroid lamina. Ensure the inner perichondrium remains intact. **Figure 2**

GORTEX THYROPLASTY

Then pass a duck-bill dissector (otological instrument) via the window, hugging the inner table of the thyroid cartilage, and dissect and create a subperichondrial pocket on the inner side of thyroid lamina.

STEP 4 AUGMENTATION WITH GORTEX STRIP

Fashion the Gortex into a 2 mm strip and insert it into the inner pocket until optimal voice or endoscopic confirmation of adequate medialization is achieved. **Figure 3**

Trim the excess Gortex, then reposition the perichondrial flap and repair the strap muscles. A small wound drain can be inserted.

Then close the wound in 2 layers.

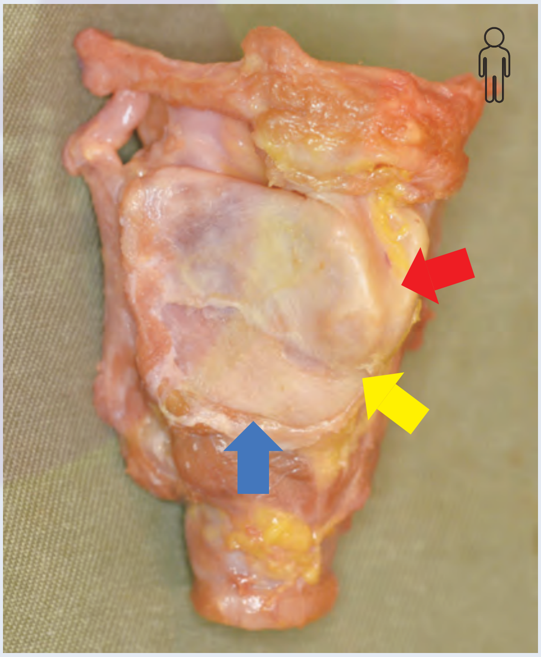

Figure 1

Thyroid notch (red arrow), midline (yellow arrow) and Inferior border (blue arrow)

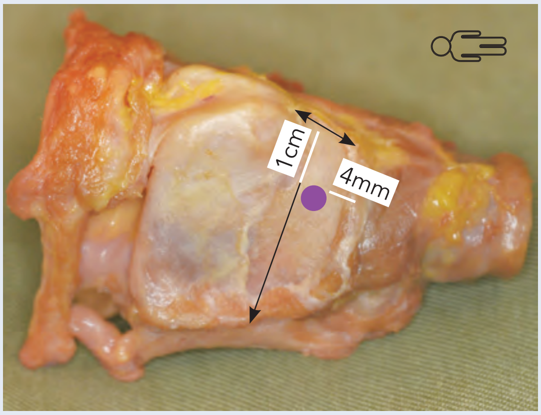

Figure 2

Landmarks for cartilaginous window

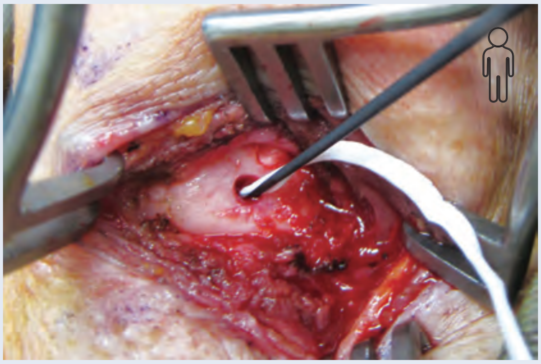

Figure 3

Augmentation with Gortex strip assisted with duck bill dissector

KEY POINTS

1. Identify the thyroid notch, midline and inferior border of thyroid cartilage.
2. Expose the inferior border and midline of thyroid cartilage.
3. Identify the landmarks to create the cartilaginous window.
4. Create a subperichondrial pocket on the inner side of thyroid lamina.
5. The adequacy of augmentation is guided by the voice quality and endoscopic observation of the position of the vocal cords.

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09

MIDLINE STEP MANDIBULOTOMY AND MANDIBULECTOMY

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Midline Step Mandibulotomy

STEP 1 INCISION

Incise the lower lip vertically in the midline until the periosteum covering the mandible is exposed and then incise the periosteum to expose the bone of the mandible. **Figure 1**

STEP 2 EXPOSE THE OSTEOTOMY SITE

Elevate the soft tissues off the mandible in a subperiosteal plane with a periosteal elevator so that enough bone is exposed to accommodate two 4- or 5- or 6-hole plates and prepare for the osteotomy. **Figure 2**

The mental foramen with its nerve is the lateral limit of elevation on both sides. **Figure 3**

Choose the optimal site for the step osteotomy (two vertical and one horizontal limbs) to minimize the risk of dental injury. It may be necessary to remove a tooth to provide adequate space for the blade in which case the osteotomy is done through the centre of the socket.

Choose the optimal site for the two plates so that the screw holes do not involve dental roots, while centering the plate on the planned osteotomy. The minimum requirement is two 4-hole plates to provide adequate stability.

A notched or stair-step osteotomy gives more stability than a straight osteotomy.

STEP 3 MARK THE OSTEOTOMY SITE AND CONTOUR THE PLATES

Use the oscillating saw to mark and partially start the planned osteotomies.

Contour the plate using plate bending forceps to snugly hug the bone. Then drill each hole, one at a time, and screw the

MIDLINE STEP MANDIBULOTOMY

screw into the bone engaging the plate if it has a locking screw head. Do not over-tighten the screw as it needs to be removed. Take care to avoid stripping the screw and bone thread. This preparation will greatly facilitate the realignment and stability of the mandible after surgery. **Figure 4**

Remove the screws and plates and remember to keep the plates orientated so that the correct plate is properly positioned for the final reduction and fixation. **Figure 5**

STEP 4 COMPLETE THE OSTEOTOMY

The osteotomy is completed with the oscillating saw and then a thin osteotome is gently used to complete the bony division and to separate the ends if necessary. **Figure 6**

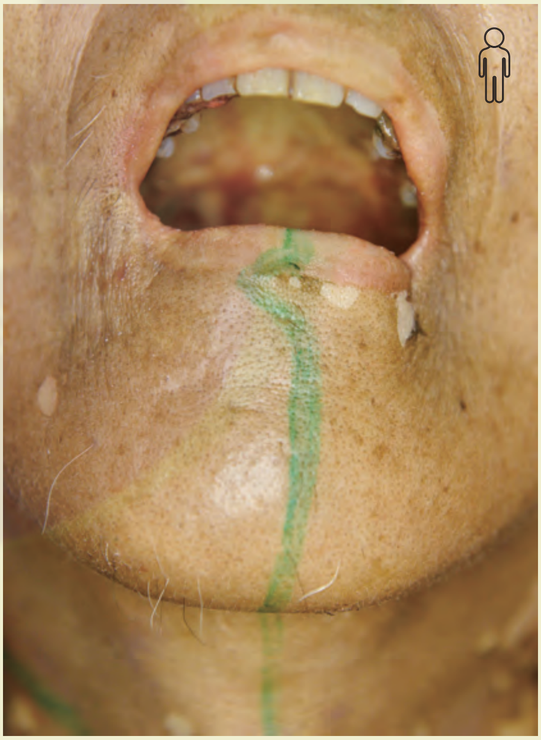

Figure 1

Lip split with a notch at the vermillion border to facilitate closure

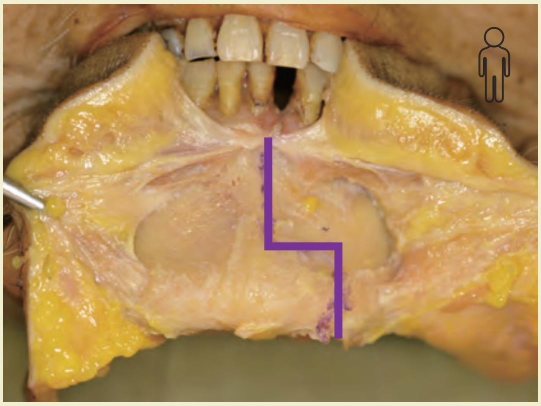

Figure 2
Expose the mandible for osteotomy and plating

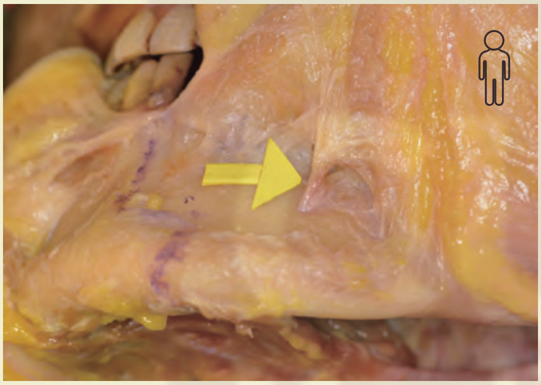

Figure 3
Mental nerve (yellow arrow) exiting from mental foramen

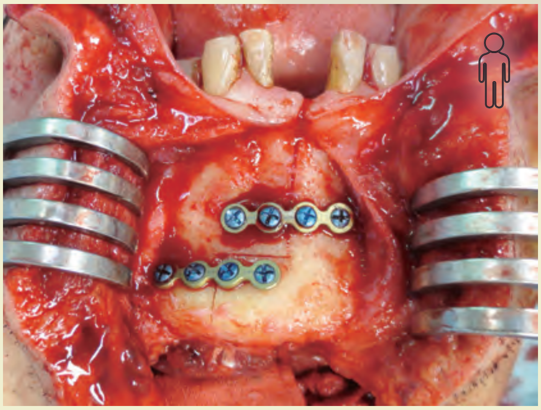

Figure 4
Preplate with 2 x 4 hole mini-plates

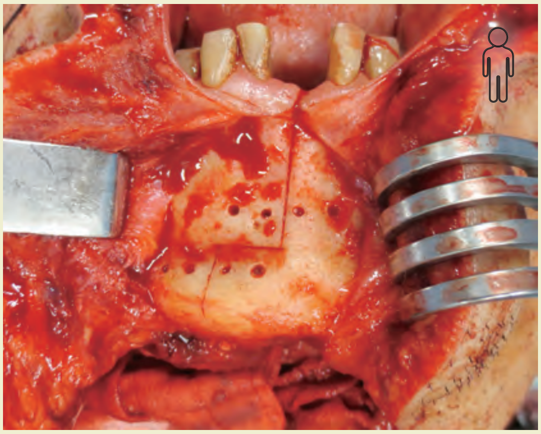

Figure 5
Remove the plate before osteotomy remembering not to damage the holes

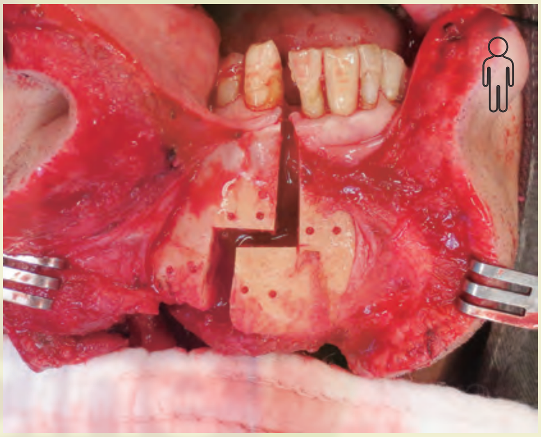

Figure 6
Osteotomy completed and mandible can swing open after dividing the soft tissue

SEGMENTAL MANDIBULECTOMY

A cheek flap is raised to expose a segment of the mandible to beyond the mental nerve which is sacrificed. Osteotomy is performed according to the clinical requirement to remove a segment of the mandible. In live surgery, the soft tissue in front of and behind the mandible should be stripped from the bone and the osteotomy site. A malleable retractor is inserted to protect the tissues. **Figure 7**

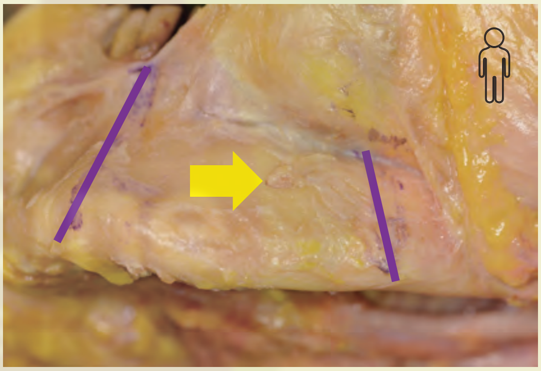

Figure 7

Mandible exposed for segmental mandibulectomy with mental nerve (yellow arrow) sacrificed

KEY POINTS

1. A notch at the vermillion border in the lip split improves cosmetic outcome.
2. The mental nerve is the lateral limit for soft tissue elevation.
3. Step osteotomy gives better stability.
4. Avoid injury to the dental roots by placing the plate below the root.
5. At least 2 x 4 hole plates are used to guarantee stability of the osteotomy.
6. Unicortical screws are sufficient for locking plate.
7. Preplating before osteotomy provides better alignment after mandibulotomy.

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10

MAXILLARY SWING APPROACH TO THE NASOPHARYNX

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INTRODUCTION

The nasopharynx may contain pathology that requires surgical intervention. This may be done endoscopically as a minimally invasive procedure or as an open procedure. The advantage of an open procedure is the better surgical access it offers. There are a variety of open routes to the nasopharynx including transnasal, transmaxillary, infratemporal fossa and transpalatal approaches. The maxillary swing is a variation of a transmaxillary approach and offers wide access to the nasopharynx as well as to the pterygopalatine fossa and pterygomaxillary fissure. At the same time the approach preserves soft palate function which is so vital for speaking and swallowing. Indications for performing a maxillary swing approach to the nasopharynx include the surgical excision of a locally residual or recurrent nasopharyngeal malignancy which is usually a carcinoma or resection of a recurrent juvenile nasopharyngeal angiofibroma. This approach is also used for covering an exposed internal carotid artery with a pedicled or free flap following radionecrosis of the nasopharynx after radiotherapy for a nasopharyngeal malignancy.

SURGICAL STEPS

Pre-operative consent includes but is not limited to the facial incisions, loss of sensation in the infraorbital nerve distribution, possible loss of the maxilla bone, wound dehiscence and breakdown, oronasal and oronasopharyngeal fistulae and ectropion.

The operation may be considered in three stages: First the soft tissue preparation - the incisions and limited soft tissue dissection to expose bone for the osteotomies, second the bone work involving - miniplate preparation, the osteotomies and the maxillary swing, and thirdly the closure.

It is important to complete the soft tissue dissection and bone exposure before doing any bone work to avoid excessive blood loss.

GENERAL PREPARATION

A routine tracheostomy is performed either under local anaesthesia or following the administration of a general anaesthetic. Peri-operative antibiotics are given on induction of general anaesthesia.

The patient is positioned supine and the head supported with a head ring. An ocular lubricant or ointment is placed into both eyes, such as chloramphenicol eye ointment if the patient is not allergic to it. The eyes are protected according to the institution's protocol. The contralateral eye may be covered with a transparent protective adhesive dressing. A tarsorrhaphy is performed on the ipsilateral eye taking care not to invert the eyelashes which avoids corneal abrasions.

The patient's face and neck are prepared with the institution's usual topical solution. An alcohol based solution, or other solution that may be irritant to the eyes or to which the patient is allergic should be avoided. The oral cavity is also prepared. The nasal cavity is packed with topical vasoconstrictor soaked ribbon gauze.

Marking the Skin and Mucosal Incisions

The scalp, lower neck and chest are draped, leaving the forehead, face, upper neck and both ears exposed.

Using a sterile skin marking pen, draw an incision 5 mm below and parallel to the lower eyelid lash line. This incision is placed close to the palpebral margin so that oedema of the lower lid above the scar is avoided after surgery.

At the vertical or parasagittal plane of the lateral orbital rim, the incision turns postero-inferiorly towards the 135 degree angle that the inferior border of the maxillary process of the zygoma makes with the zygomatic process of the maxilla. This inferior border can be palpated through the soft tissues of the lateral cheek. The incision is marked to the midpoint of this angled line between the lateral orbital rim and the inferior border of the zygoma. This incision is roughly parallel but posterior to the zygomaticomaxillary suture line.

The medial end of the lower eyelid incision is not carried onto the nasal bone as would be the case for a Weber Ferguson incision that is made to follow the concept of facial subunits. Instead this incision avoids the epicanthal fold and so turns inferior just before the vertical or parasagittal plane at the medial canthus to follow the junction of the cheek and the lateral nose to the ala. It then follows the alar groove into the nostril. After a 90 degree notch is made on the nasal sill of the vestibule floor, the incision then continues to the midline junction of the columella and the lip, at which point it turns inferiorly through 90 degrees and continues in the midline of the philtrum to the midline of the upper vermillion border of the lip. **Figure 1** A notch is made at the vermillion border and the incision continues in the midline of the lip and through the superior labial frenulum to the midline gingiva between the upper central incisors.

Use a tonsil or Ferguson Auckland mouth gag to open the mouth and retract the tongue to visualize the hard and soft palates.

On the hard palate mucosa a paramedian or parasagittal incision is marked 7 mm from the midline on the side of the swing. Make a mark from the junction of the hard and soft palate posteriorly to the premaxilla mucosa anteriorly where the incision turns towards the midline and to the gingiva between the two upper central incisors.

Identify the maxillary tuberosity and the bony spines of the pterygoid plates and pterygoid hamulus immediately posterior to the tuberosity.

The posterior end of the hard palate incision is continued laterally through the soft palate mucosa to the posterior surface of the ipsilateral maxillary tubercle. **Figure 2**

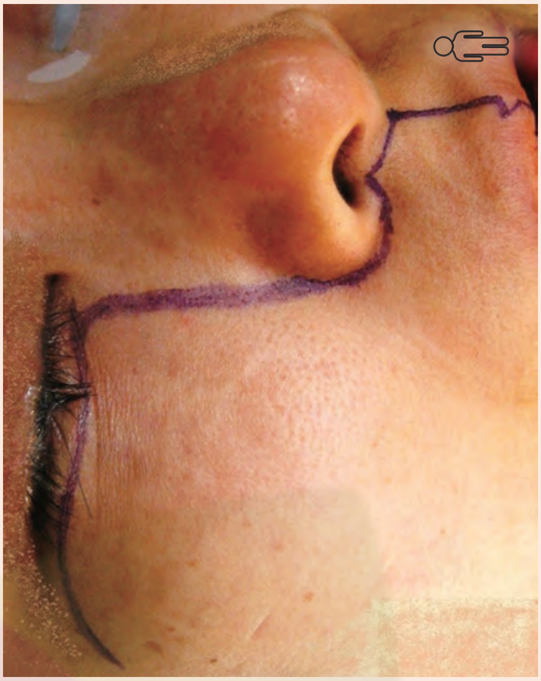

Figure 1

The skin incisions for the maxillary swing approach. The medial canthal structures are avoided. A notch is marked in the nasal vestibule and at the vermillion border

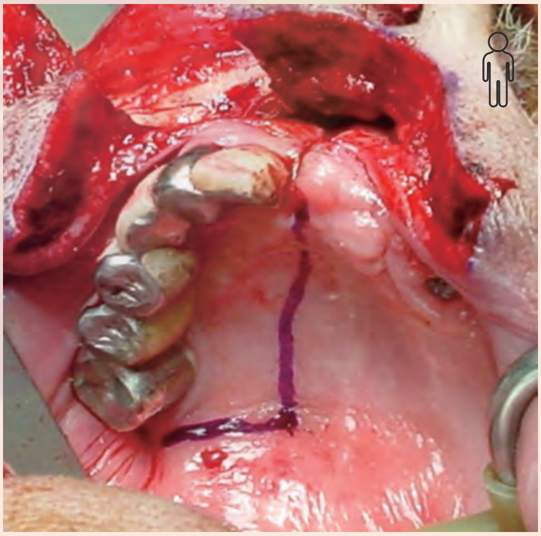

Figure 2

The hard palate paramedian and soft palate incision

Soft Tissue Dissection to Expose Bone for the Osteotomies

All incisions are infiltrated with a vasoconstrictor such as 1:80 000 adrenaline. All facial skin and palatal incisions are made with a scalpel and are carried through from the skin or mucosa to the periosteum and onto bone. The lower eyelid and soft palate incisions are exceptions.

With very gentle pressure on the eye, and with retraction of the cheek skin, the lower eyelid is put under tension and the skin incised with a number 15 scalpel blade. **Figure 3**

The skin is divided until the stretched orbicularis oculi muscle is visible. This muscle is gently stroked with the scalpel blade until all the fibres are divided taking care not to incise into the inferior orbital septum or anterior capsule of the inferior orbital fat pad. Using single skin hooks to retract the lower eyelid skin, the skin and orbicularis muscle are elevated with sharp dissection as a unit from the orbital fat pad in a preseptal plane. Using sharp dissection on the inferior orbital fat pad septum will preserve facial nerve branches which innervate the orbicularis muscle on its deep surface. **Figure 4**

As the medial end of the lower eyelid incision turns inferior, the angular vein and artery will be encountered. They should be ligated and divided otherwise they tend to retract and bleed. **Figures 5, 6**

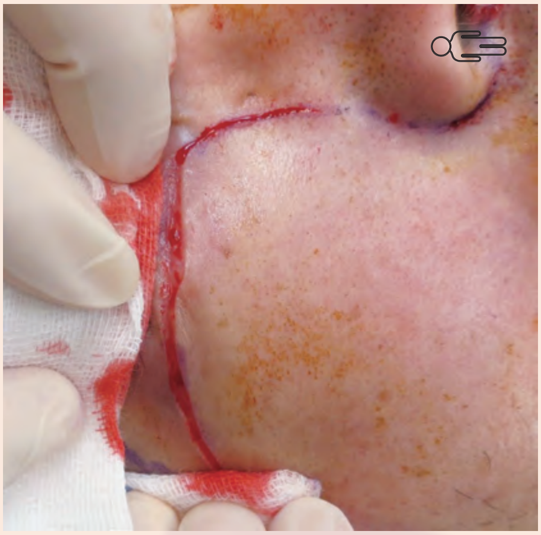

Figure 3

The lower eyelid is put under gentle tension and the incision made

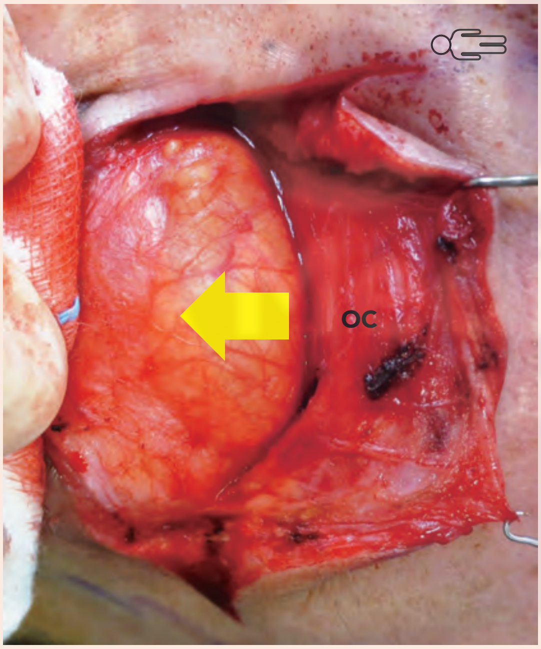

Figure 4

The lower eyelid musculocutaneous flap is elevated off the inferior orbital fat pad (yellow arrow) in the preseptal plane. **OC** – orbicularis oculi

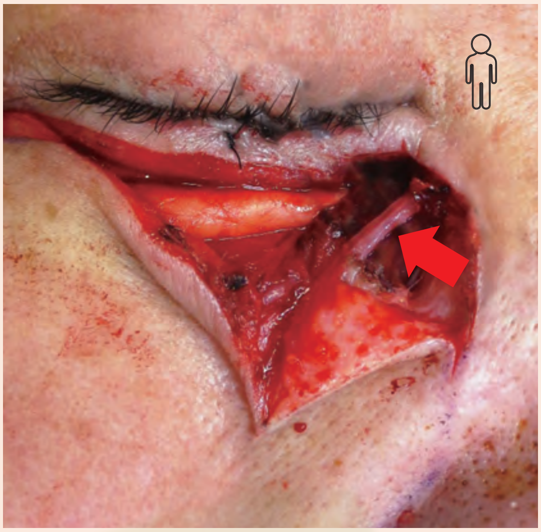

Figure 5

The angular vessel encountered in the facial incision (indicated above)

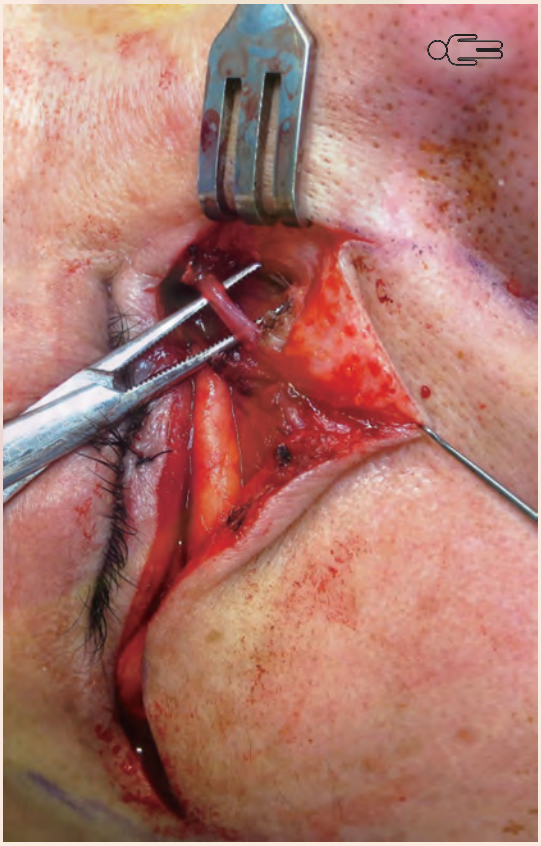

Figure 6

The angular vessels are ligated and divided

SOFT TISSUE DISSECTION TO EXPOSE BONE FOR THE OSTEOTOMIES

The inferior orbital septum fuses with the periosteum at the superior surface of the inferior orbital rim. The periosteum of the inferior orbital rim is incised anterior to this fusion on the anterior surface of the rim, so as to preserve the integrity of the inferior orbital fat pad. **Figure 7**

Using a periosteal elevator such as a Howarth's, the soft tissues of the cheek are elevated off the upper maxilla in a subperiosteal plane to the level of the infra-orbital foramen. **Figure 8** The infra-orbital nerve and vessels are identified, ligated and divided. **Figure 9**

Do not elevate the soft tissue off the anterior maxilla further inferior than the infraorbital foramen as the maxilla depends on the soft tissue of the cheek for its blood supply.

At the lateral end of the lower eyelid incision, stay in the subperiosteal plane and elevate tissue laterally off the zygoma until the inferior margin of the zygoma can be palpated with the angled end of the elevator. It is not necessary to incise the skin over the entire zygoma, but just enough to allow the osteotomy to be made. Usually the skin incision is made to the midpoint of the zygoma.

Muscles incised with the facial incision include the orbicularis oculi, nasalis and orbicularis oris. **Figure 10**

Once the rim of the ipsilateral pyriform aperture has been defined, free the nasal cavity soft tissues from the margin of the nasal aperture with diathermy.

Retract the nasal ala medially and incise the lateral wall of the nasal vestibule to expose the ipsilateral nasal cavity and inferior turbinate, taking care not to injure the inferior turbinate or septum so as to avoid troublesome bleeding.

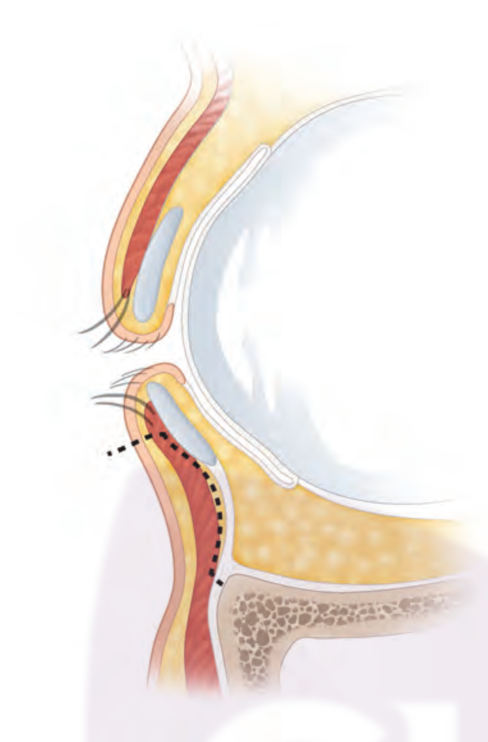

Figure 7

The lower eyelid incision is carried through the skin and orbicularis muscle. The lower eyelid musculocutaneous flap is elevated off the inferior orbital fat pad in the preseptal plane and the orbital periosteum incised on the anterior aspect of the inferior orbital rim

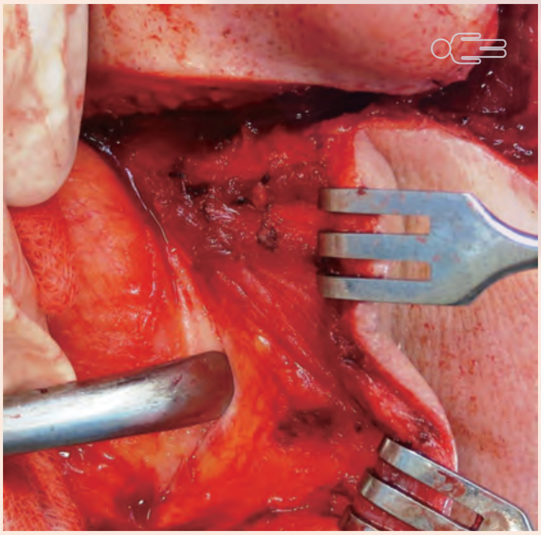

Figure 8

The soft tissues of the cheek are elevated off the upper maxilla in a subperiosteal plane to the level of the infra-orbital foramen

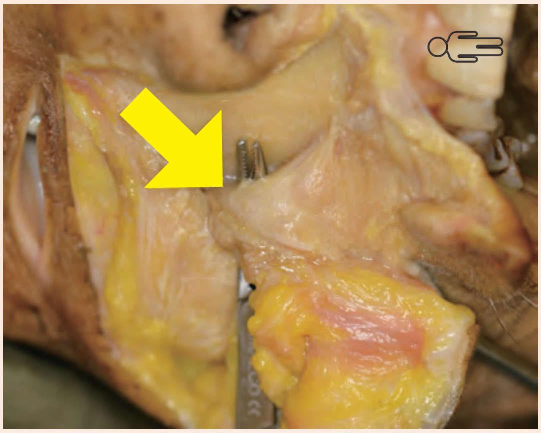

Figure 9.

The infra-orbital nerve and vessels (yellow arrow) are ligated and divided

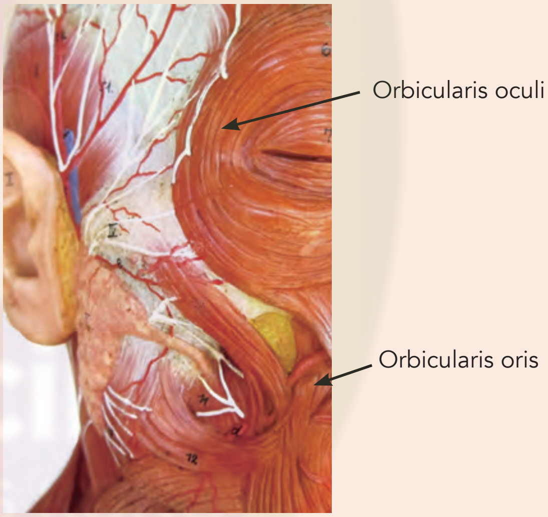

Figure 10

Facial muscles divided with the facial incision

Soft Tissue Dissection to Expose Bone for the Osteotomies

In this way the nasal cavity is entered through the facial wound. At the inferior margin of the aperture, use an elevator to elevate the mucoperiosteum of the floor of the nasal cavity. Elevate the entire nasal cavity floor mucoperiosteum from the septum medially to the lateral aspect of the inferior meatus laterally and from the pyriform aperture anteriorly to the posterior margin of the hard palate posteriorly, which is the horizontal plate of the palatine bone. Then incise the elevated mucosa from anterior to posterior as lateral as possible to create a medially based mucoperiosteal flap that will be used to cover the maxillary osteotomy at the end of the procedure. **Figures 11, 12**

A scalpel is used to incise the mucosa of the hard palate along the planned paramedian incision onto bone. The incision is extended laterally on the soft palate from the posterior edge of the hard palate incision to the groove between the maxillary tuberosity and the pterygoid plates. **Figure 2**

Use a periosteal elevator in the subperiosteal plane to elevate the hard palate mucoperiosteum off the hard palate bone on the non-swing side of the palatal incision to just beyond the midline. **Figure 12**

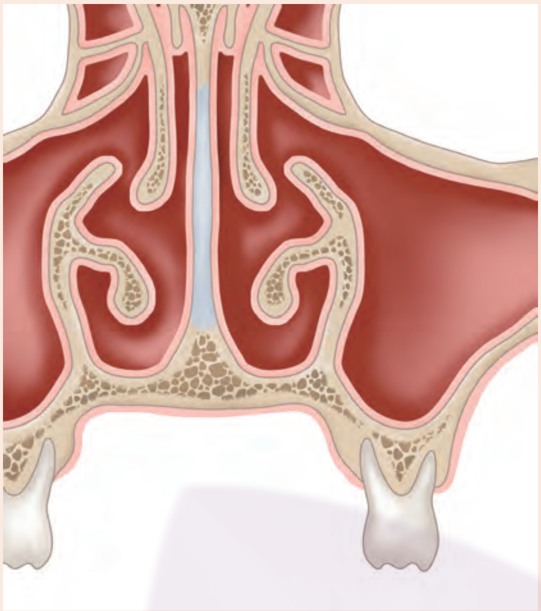

Figure 11

Coronal view of the hard palate and nasal floor showing mucosa in pink

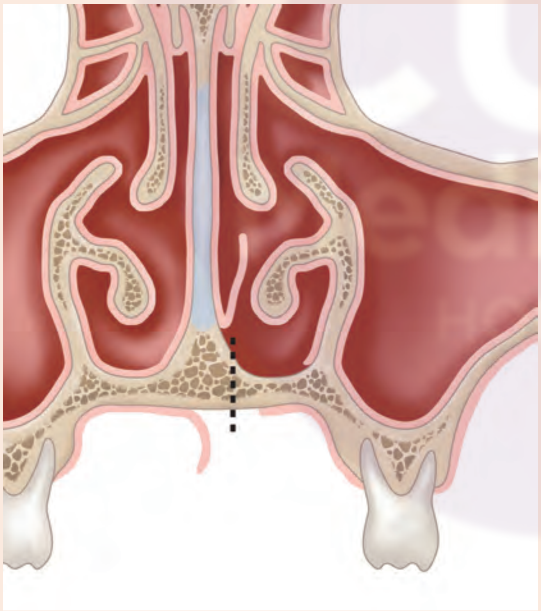

Figure 12

Coronal view of the hard palate and nasal floor showing the positions of the respective mucosal incisions and elevated mucoperiosteal flaps. The position of the osteotomy is indicated by the dotted line

Bone Work, Miniplate Preparation, Osteotomies and the Maxillary Swing

Refer to the patient's sagittal imaging to confirm that the orbital floor does not dip below the level of the infra-orbital foramen in the plane of the foramen nor at the mid point of the orbit. **Figures 13, 14**

If this is the case, the osteotomy must be placed below the level of the orbital floor. If the orbital floor does not bulge or hang into the antrum, then a straight horizontal osteotomy is marked at the level of the inferior margin of the infra-orbital foramen, from the rim of the pyriform aperture medially to the malar surface of the zygoma laterally. **Figures 15-18**

This osteotomy will separate the boney orbit superiorly from the remaining maxilla/zygoma inferiorly. At the lateral end of this osteotomy, a second osteotomy is marked at 90 degrees to the postero-inferior border of the zygoma. This osteotomy completes the division of the zygoma. **Figure 18**

A third vertical osteotomy is marked in the midline of the anterior surface of the maxilla and extends to between the upper medial incisors. **Figure 15** On the exposed hard palate bone (the palatine process of the maxilla and horizontal plates of the palatine bones), the plane of the vertical osteotomy is marked just off the midline on the ipsilateral side so that it divides the nasal cavity floor from the septum. This osteotomy divides the maxilla just off the midline away from the septum, so that the septum remains intact articulating with the contralateral maxilla. **Figures 12, 15, 24**

A 1 cm x 1 cm sagittal saw blade is used to mark the osteotomies where two 4-hole miniplates will be placed and their holes drilled.

Two 4-hole miniplates are contoured to the bone. One plate is placed in the midline of the anterior surface of the maxilla where

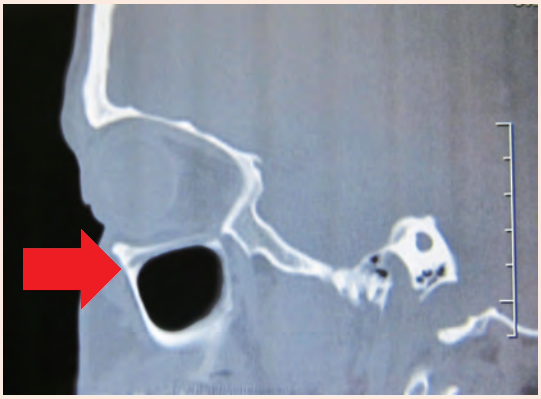

Figure 13

The sagittal plane of the orbital floor at the infra-orbital foramen (indicated above).

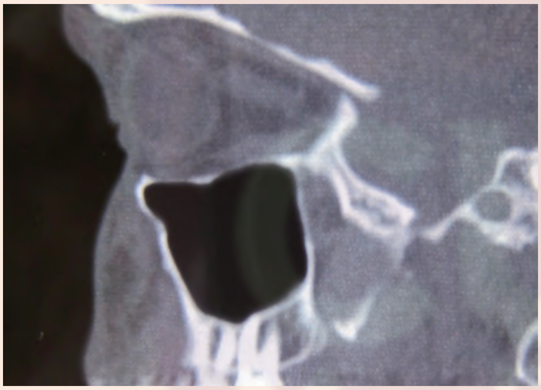

Figure 14

The sagittal plane of the orbital floor at the mid-orbit.

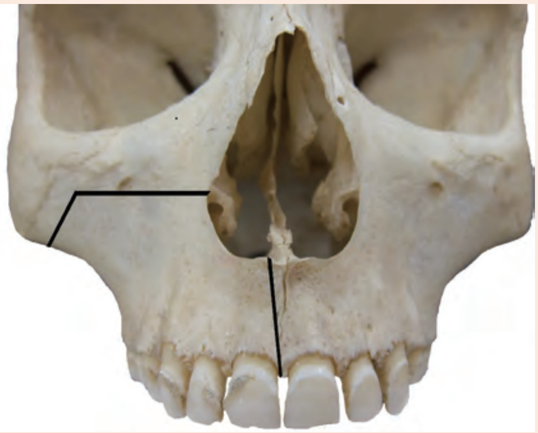

Figure 15

Anterior view of a dry skull showing the positions of the osteotomies.

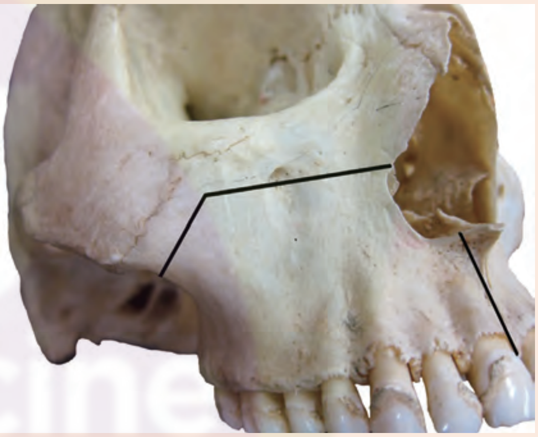

Figure 16

Oblique view of a dry skull showing the positions of the osteotomies.

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Bone Work, Miniplate Preparation, Osteotomies and the Maxillary Swing

a very prominent crest may need to be burred down to facilitate plating. It is important that the holes avoid the roots of the teeth by positioning the miniplates above or between the teeth roots if the height of the maxilla is inadequate. **Figure 19**

The second miniplate is positioned over the osteotomy that divides the lower lateral free border of the zygoma. The miniplates should be positioned at 90 degrees to the osteotomy **Figure 20**. As each hole is drilled a screw is inserted but not tightened fully. This is done before drilling the next hole. Drilling all the holes before inserting screws may lead to misalignment of the holes. Remove all screws and record or mark the orientation of the plates. A drawing using sterile adhesive strips to attach the orientated plates to the diagram is suggested.

A heavy curved osteotome is inserted into the oral cavity and its blade positioned into the mucosal incision behind the maxillary tubercle to divide the maxillary tuberosity from the pterygoid plates. **Figures 21, 22**

Using a finger to guide the osteotome and then it is tapped by an assistant and the osteotomy completed. This intentional separation ends superiorly in the pterygomaxillary fissure and the pterygopalatine fossa. There will be no movement of the maxilla at this stage as none of the other osteotomies have yet been completed. This is done first while the maxilla is still stable, otherwise unpredictable fracturing of the pterygoid process can occur.

The maxilla and zygoma osteotomies are deepened to the hilt of the more controllable 1 cm oscillating saw blade, keeping the blade perpendicular to the

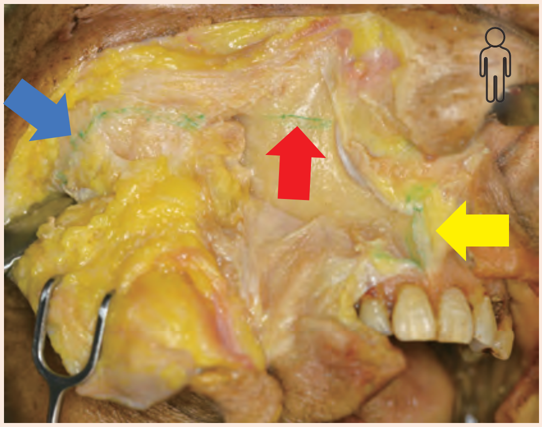

Figure 17
Zygomatic process (blue arrow), Frontal process (red arrow) and Alveolar process (yellow arrow)

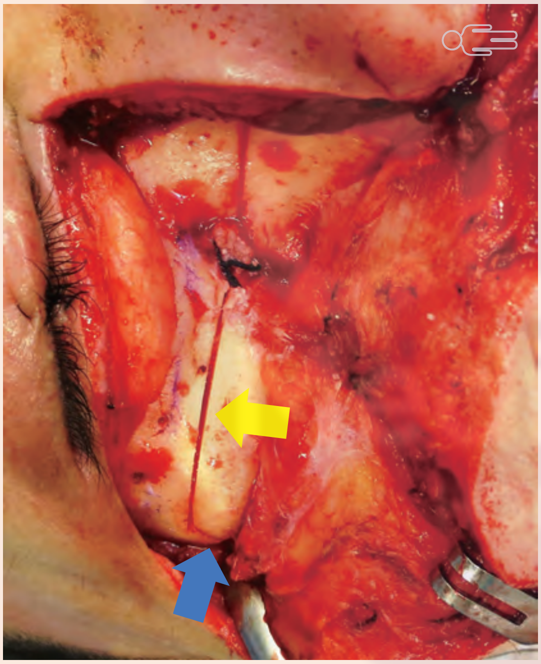

Figure 18
The infra-orbital (yellow arrow) and zygomatic (blue arrow) osteotomies. The ligated infra-orbital neurovascular bundle is visible.

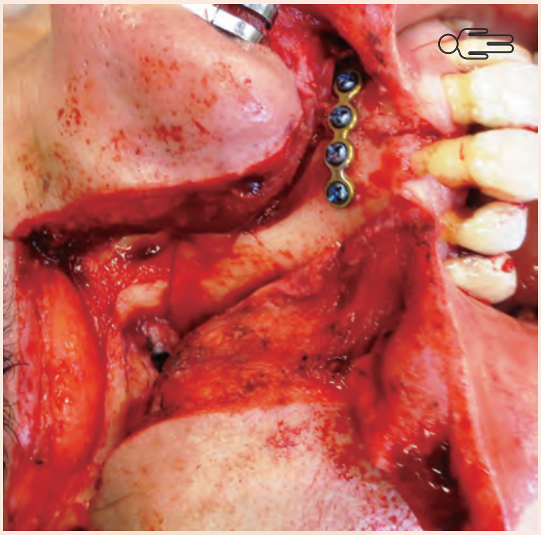

Figure 19
Plating the alveolar osteotomy.

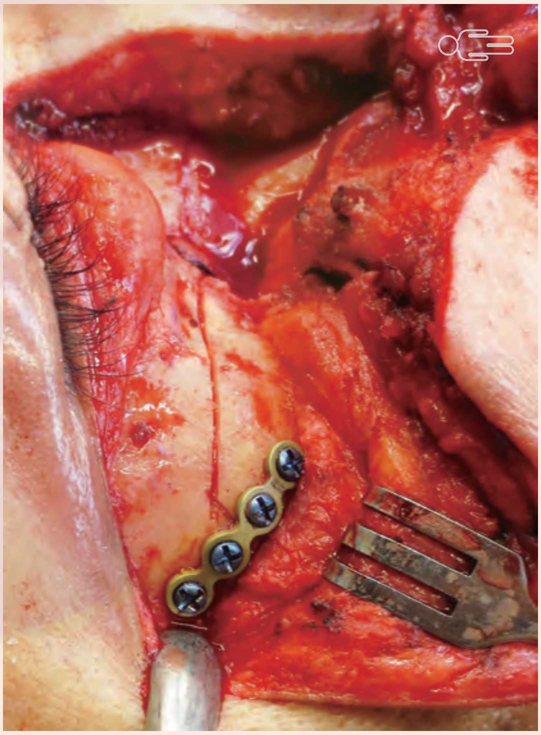

Figure 20
Plating the zygomatic osteotomy.

BONE WORK, MINIPLATE PREPARATION, OSTEOTOMIES AND THE MAXILLARY SWING

bone. The blade is then changed for a longer 4 cm blade. At some time prior to this, the axial image should be reviewed and the anterior-posterior dimension of the maxillary sinus measured to determine the distance from the anterior surface of the maxilla to the posterior wall of the maxillary sinus. Figure 23

The posterior wall of the maxillary sinus is thin and will easily fracture when the maxilla is mobilized. It does not need to be sawed, which should actually be avoided. Sawing the posterior wall of the antrum will lacerate the internal maxillary artery and lead to torrential bleeding before the osteotomies can be completed and the maxilla swung away to gain access to the bleeding artery.

When making the inferior orbital osteotomy it is important to keep the sagittal saw blade horizontal. It is especially important to know about the level of the orbital floor and whether it dips below level of the infra-orbital foramen, which can be determined from the preoperative imaging. This is to avoid injuring the contents of the orbit while making the osteotomy, the lateral nasal wall will offer increased resistance medially, and the lateral wall of the antrum will offer increased resistance laterally. The resistance decreases significantly once these walls have been divided.

When making the midline vertical paramedian or parasagittal maxillary osteotomy under direct vision, an assistant ensures that the hard palate mucoperiosteal flap and the nasal floor mucoperiosteal flap are both retracted away from the blade so as not to damage or lacerate them. Figure 12 The palatal osteotomy is extended posteriorly to the posterior margin of the hard palate. Figure 24

A sharp straight osteotome is then inserted into the anterior osteotomy and gently twisted to finalize fracturing the bone.

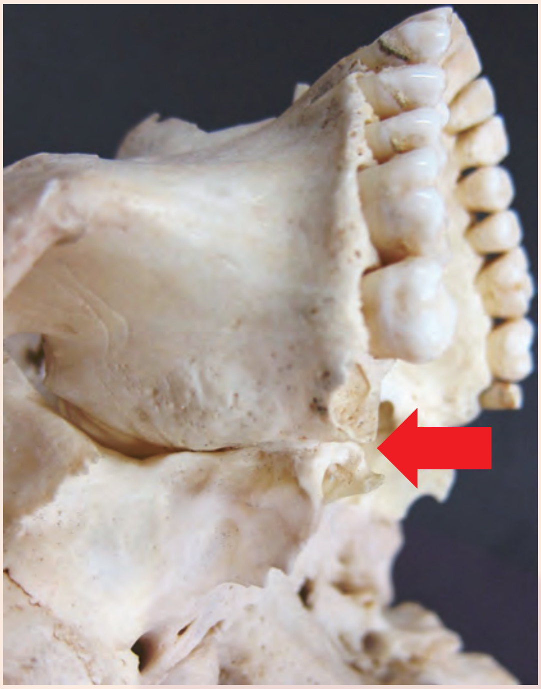

Figure 21

The (red arrow) indicates the position that the blade of the curved osteotome is placed by palpation to divide the maxilla from the pterygoid process

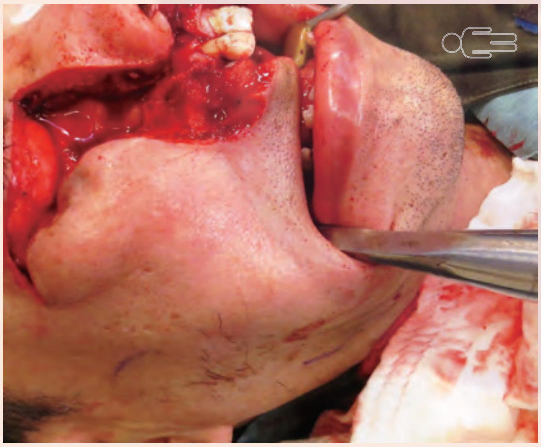

Figure 22

The blade of the curved osteotome is placed by palpation into the groove posterior to the maxillary tubercle in order to divide the maxilla from the pterygoid process

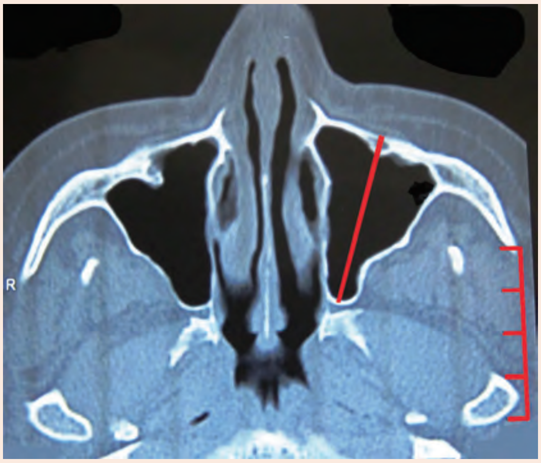

Figure 23

The horizontal distance between the infra-orbital foramen and the posterior wall of the antrum should be estimated prior to the horizontal infra-orbital osteotomy. This facilitates the appropriate selection of the saw blade length to avoid lacerating the maxillary artery.

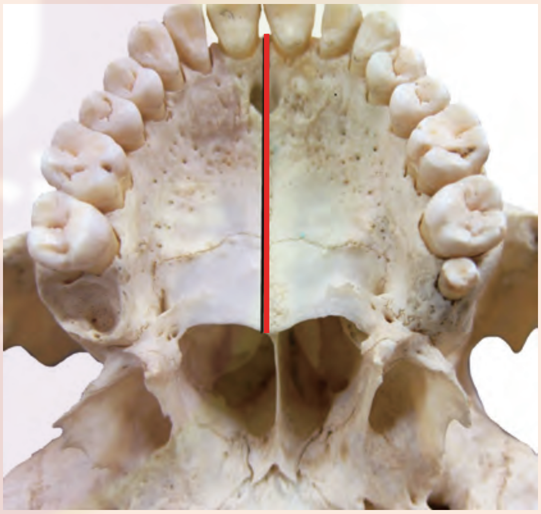

Figure 24

The position of the vertical maxillary osteotomy is just to the ipsilateral side of the midline to avoid the nasal septum

Bone Work, Miniplate Preparation, Osteotomies and the Maxillary Swing

This is usually the thin posterior wall of the maxillary antrum where it is best that the oscillating saw blade does not reach to avoid lacerating the internal maxillary artery. **Figures 25, 26** If the maxilla remains stable, twisting and tapping a sharp straight osteotome can be performed at multiple sites. Take care not to damage the screw holes.

When the maxilla is loose it is gently retracted or swung laterally and any soft tissue that is tethering the maxilla is divided with a pair of curved mayo scissors. **Figure 27** The maxilla is wrapped in a long saline soaked swab which is used to retract and keep the maxilla out of the surgical field with a Rochester pean forceps or equivalent.

If there is significant bleeding, it is usually due to laceration of the internal maxillary artery and this must be quickly stopped. Using suction and a long curved haemostat, the artery is clamped, divided and tied with a strong silk ligature.

The inferior turbinate is excised and the posterior nasal septum can be resected for better exposure of the nasopharynx.

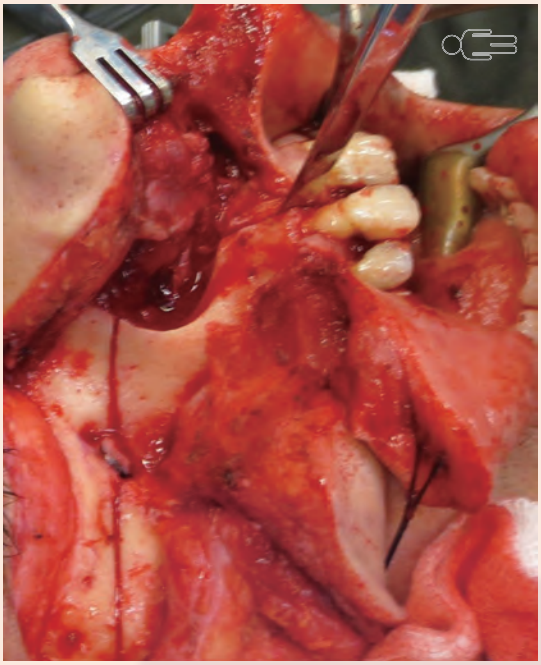

Figure 25

A thin sharp osteotome is placed into the osteotomy and gently twisted to complete the fracture of the posterior wall of the antrum

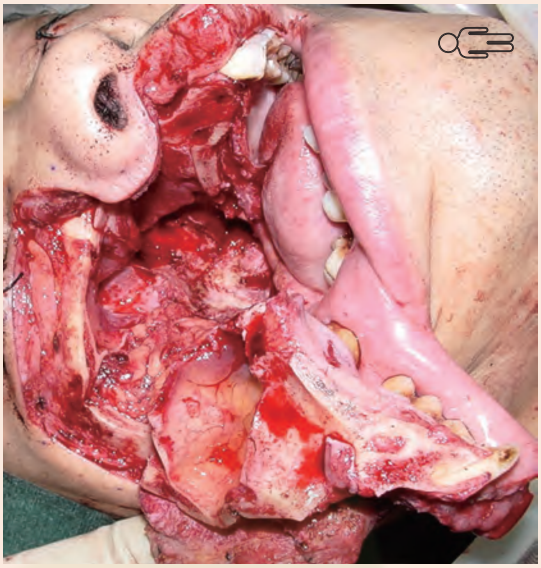

Figure 27.

The position of the maxilla once it has been fully swung laterally. It remains based on the soft tissues of the cheek

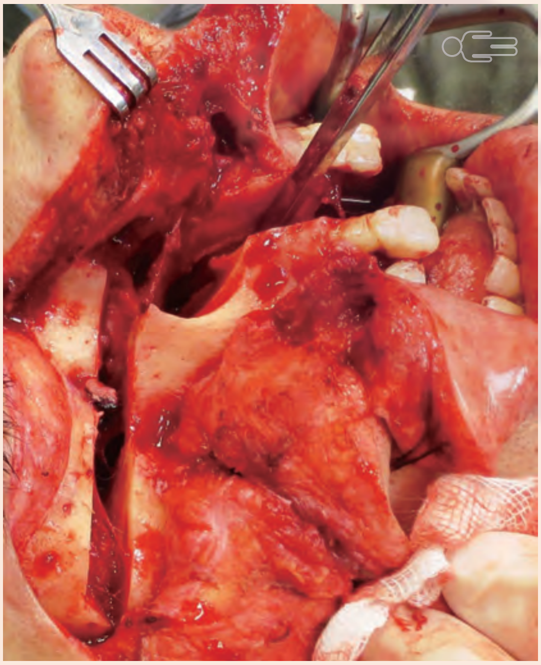

Figure 26

The twisting of the osteotome finalizes the bone work. Soft tissue remains to be divided before the maxilla is fully swung laterally

CLOSURE

Bleeding that occurs from the pterygoid venous plexus may initially be controlled with packing. Meticulous haemostasis is achieved with bipolar cautery, suture ligatures, clips, bone wax, oxidized cellulose polymer and topical haemostatics.

A fine bore nasogastric tube is placed via the contralateral nasal cavity for postoperative enteral feeding.

Depending on the operation, the nasopharyngeal wound may be left to mucosalize, dressed with a mucosal graft taken from the inferior turbinate or with a vascularized septal mucosal flap based on the posterior septal branches from the sphenopalatine artery.

The nasopharynx is packed with a dressing via the ipsilateral nasal cavity, such as a single length of paraffin gauze, to hold any graft in place and to aid mucosalization. A foley catheter is inserted into the nasopharynx via the contralateral nasal cavity and the balloon inflated with sufficient sterile water to prevent the pack from slipping into the oropharynx.

On the swung maxilla, an inferior meatal antrostomy is fashioned by carefully elevating the mucosa off the medial wall of the anrtum and using a bone nibbler to remove the bone. The mucosa is laid over the raw bone. In this way the crest between the nasal cavity floor and antral floor is removed which allows free drainage of antral mucus in the future.

The soft and hard palate mucosal incision is preloaded with 3.0 synthetic absorbable polyglycolic acid sutures. This will allow for the accurate placement of the sutures while maximum access is available. Posteriorly it is best to insert the suture through the mucosa of the soft palate and then through the posterior mucosa of the swung maxilla. Medially it is best to insert the suture through the mucoperiosteum of the swung maxilla and then through the

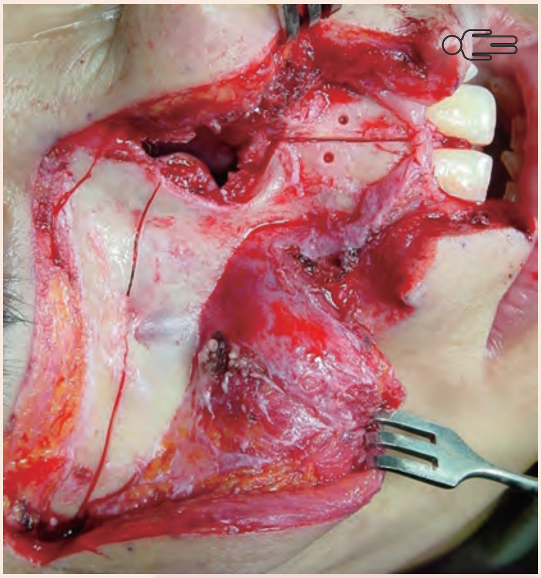

Figure 28

The reduced maxilla at the end of the procedure before fixation of the miniplates

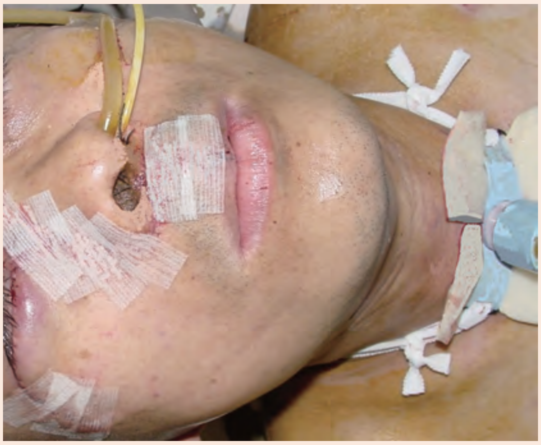

Figure 29

At the end of the procedure, the wounds are closed and dressed. The patient has a tracheostomy tube in place. From the contralateral nostril the fine bore feeding tube that will be used for enteral nutrition in the postoperative period is seen, as is the foley catheter whose cuff is inflated with sterile water which keeps the pack from falling into the oropharynx.

mucoperiosteum of the contralateral hard palate flap. The sutures are kept in order by clamping each with a haemostat and sliding its finger grip onto a closed larger forceps.

The maxilla is then reduced and held firmly in position. Figure 28 At this point make sure the mucosal flap of the nasal floor or any packing material is not trapped between the maxilla bones. While maintaining accurate reduction, the two 4-hole miniplates are securely screwed into place and each screw tightened but not to the point of stripping either the bone or screw thread. Figures 19, 20

The sutures of the palate mucosa are tied starting posteriorly. Care should be taken as it will not be possible to reinsert a suture should it tear out or break.

The facial and lip wounds are closed in two layers, a deeper subcutaneous layer and a skin layer. The subcutaneous layer and lip mucosa are closed using a 3-0 braided absorbable suture. The skin is closed using a 4-0 non-absorbable monofilament suture except for the lower eyelid where a 5-0 is used.

It is important to securely anchor the superomedial corner of the cheek flap to its counterpart. This is to ensure that the main stress of the cheek flap is taken at this point and is not transmitted to the lower eyelid wound. This is accomplished by preloading four braided absorbable sutures with sufficient tissue on both sides of the wound before tying the sutures and closing the rest of the cheek and eyelid wounds.

A prefabricated palatal dental splint is securely placed to maintain apposition of the hard palate mucoperiosteal flap against the underlying bone during the healing phase.

POSTOPERATIVE PERIOD

Day 0 - The following are ordered on the day of the operation or the following day. Peri-operative antibiotics are continued for 5 days. A chest X-ray is performed to confirm the position of the nasogastric tube prior to feeding. Chest physiotherapy, tracheostomy care and suctioning. Institution-based mouth care.

Day 1 - The nasopharyngeal foley is deflated after 24 hours

Day 5 - The lower eyelid sutures are removed.

Day 6 - The nasopharyngeal pack is shortened and loosened on day 6.

Day 7 - The nasopharyngeal pack is removed on day 7. Start rinsing the nasal cavities and nasopharynx three times a day with normal saline. The rest of the facial sutures are removed.

Day 8 - The tracheostomy tube is removed if there has been no significant bleeding.

Day 14 - The nasogastric tube is removed and an oral liquid diet begins on day 14.

Day 21 - A soft diet begins if the palatal wounds are well healed.

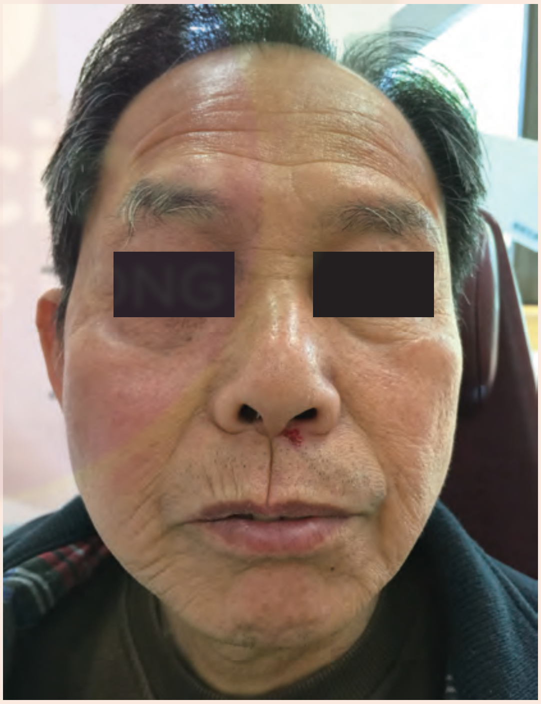

Figure 29

The facial scar of a patient who underwent a maxillary swing procedure.

KEY POINTS

1. Complete the soft tissue dissection and bone exposure to avoid excessive blood loss before doing any bone work.
2. Make the lower eyelid incision close to the palpebral margin, 5 mm below and parallel to the eyelid lash line, to avoid oedema of the lower lid above the scar.
3. The hard palate mucosal incision is made in a paramedian or parasagittal plane and 7 mm from the midline on the side of the swing.
4. The lower eyelid flap (skin and orbicularis muscle) is elevated off the orbital fat pad in a preseptal plane taking care not to incise into the capsule of the fat pad.
5. Via the pyriform aperture, elevate the mucoperiosteum of the entire nasal cavity floor and then incise the elevated mucosa from anterior to posterior as lateral as possible to create a medially based mucoperiosteal flap.
6. A heavy curved osteotome is placed behind the maxillary tubercle to divide the maxillary tuberosity from the pterygoid plates.
7. A straight horizontal osteotomy is made at the level of the inferior margin of the infraorbital foramen, from the pyriform aperture to the malar surface of the zygoma.
8. A straight vertical osteotomy is made just off the midline on the ipsilateral side to divide the nasal cavity floor keeping clear of the septum.
9. A thin sharp osteotome is placed into the osteotomies and gently twisted to complete the fracture of the posterior wall of the antrum which frees the maxilla.
10. The loosened maxilla is gently retracted laterally and any soft tissue that is tethering it is divided with a pair of curved mayo scissors.

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LATISSIMUS DORSI AND THORACODORSAL ARTERY PERFORATOR FLAP

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Latissimus Dorsi and Thoracodorsal Artery Perforator Flap

FLAP TERRITORY

The latissimus dorsi (LD) flap is a muscle or musculocutaneous flap from the back area that has a long and reliable pedicle. The skin island may be designed in a vertical, oblique or transverse fashion overlying the muscle. It can be used as a pedicled flap (eg. for breast reconstruction) or a free flap (eg. for lower limb reconstruction).

Partial LD flaps have been used for facial reanimation as have perforator flaps based on the thoracodorsal artery (TDA) creating a TDAP flap.

A reversed LD flap based on the secondary perforators is less commonly used but is an option in back reconstruction.

VASCULAR ANATOMY

The LD muscle flap is a type V flap supplied by a dominant pedicle (TDA) and secondary segmental pedicles (posterior intercostal perforators). The TDA arises from the subscapular artery (third part of axillary) and usually divides into transverse and vertical branches which are angulated at 45° allowing the LD to be split). The vertical pedicle enters the muscle 8-10 cm below the axilla approximately 2-2.5 cm medial to the anterior muscle edge. **Figure 1**

FLAP HARVEST

The LD flaps can be harvested with the patient either prone or in a lateral decubitus position with the arm abducted to 90 degrees and elbow flexed to 90 degrees. The TDAP flap can be harvested in a ‘partial’ or dorsal decubitus position by placing a vertical block at the spine area.

The tip of the scapula, anterior border of LD muscle, posterior iliac crest and the midline of the back are relevant

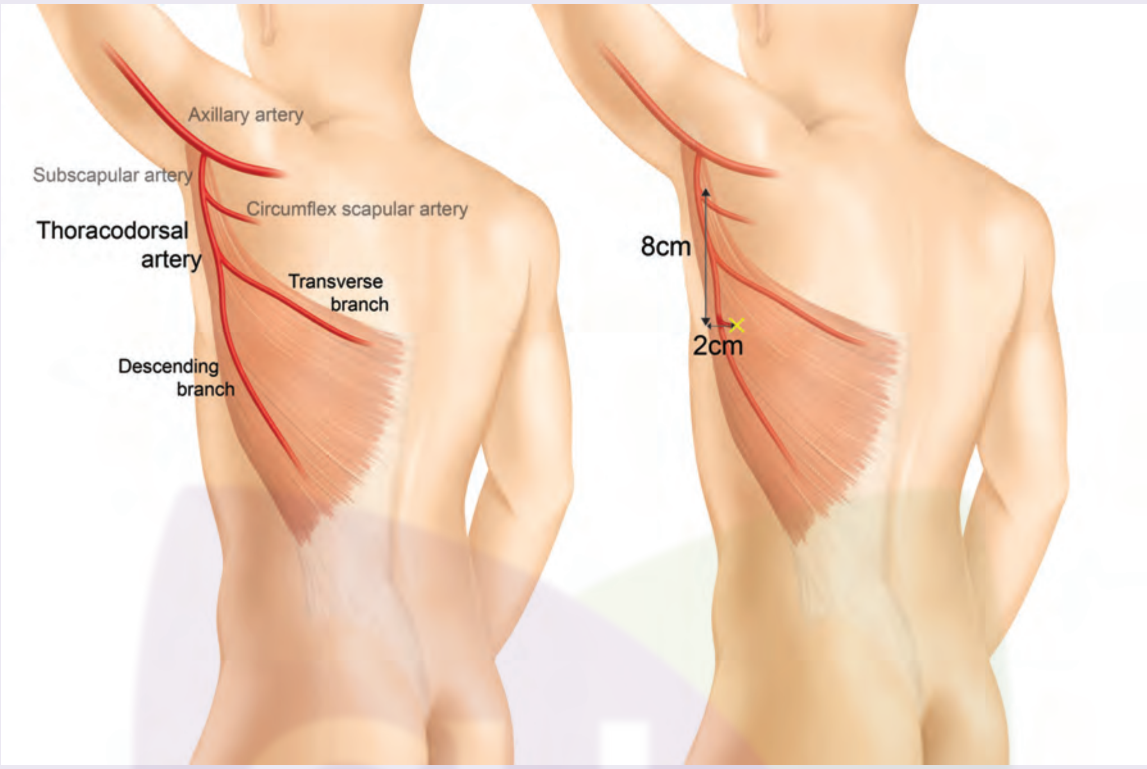

Figure 1
Vascular anatomy of the LD flap

anatomical landmarks. Design your skin island according to need and begin over the supero-anterior border. The anterior muscle edge is identified followed by the pedicle. **Figures 2, 3**

Bevelling away down to the muscle's surface allows for more soft tissue where needed.

Carefully separate the superior part of the muscle from the underlying serratus anterior (SA) and tip of scapula and divide its bony attachments inferiorly and posteriorly. **Figures 4-6** It is easy to get into the wrong muscle plane if you start from inferior to superior.

The pedicle is traced proximally dividing branches to SA and teres major muscles. The circumflex scapular artery and vein can be divided where additional pedicle length is needed, isolating it up to the subscapular artery. **Figures 7, 8**

A TDAP flap is based on cutaneous perforators from the vertical/descending branch of the TDA. The skin island is usually based over the anterior edge of the muscle. A preoperative handheld doppler probe is often used to locate the perforators. It is important to identify the leading edge of the LD carefully. It is common to make the posterior incision first to allow a posterior/medial to lateral

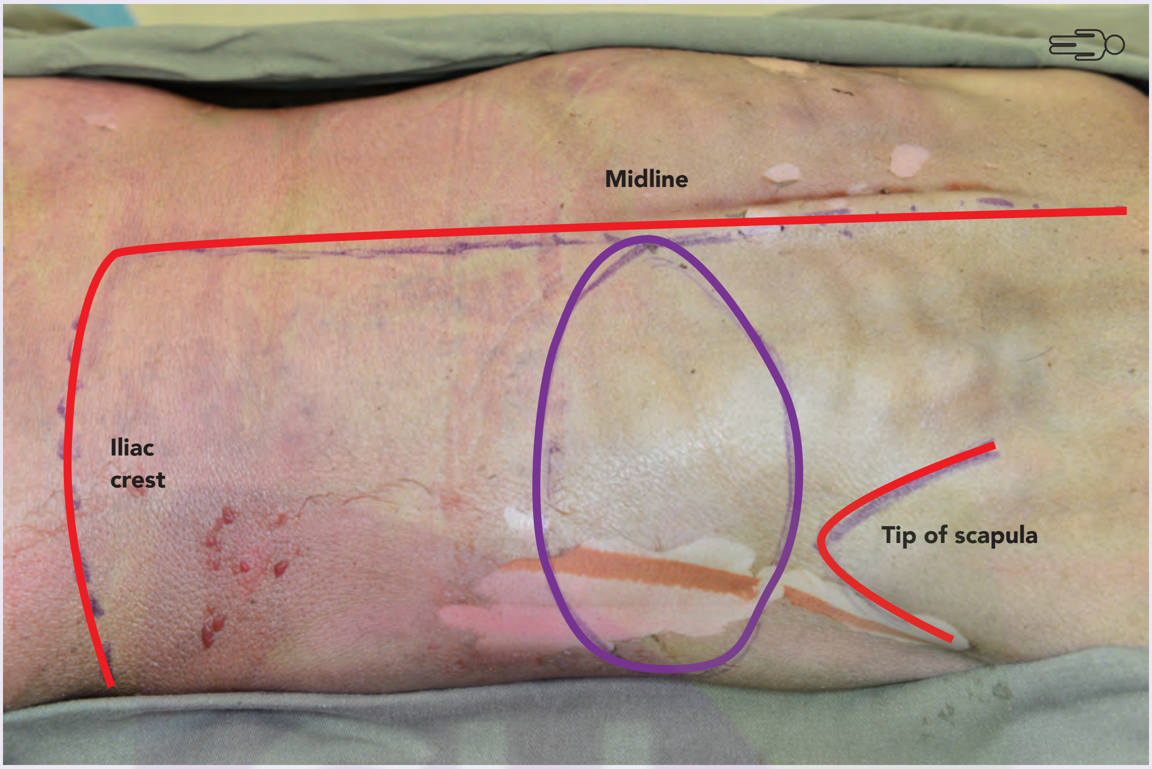
Midline
Iliac crest
Tip of scapula

Figure 2
Skin flap designed in horizontal pattern

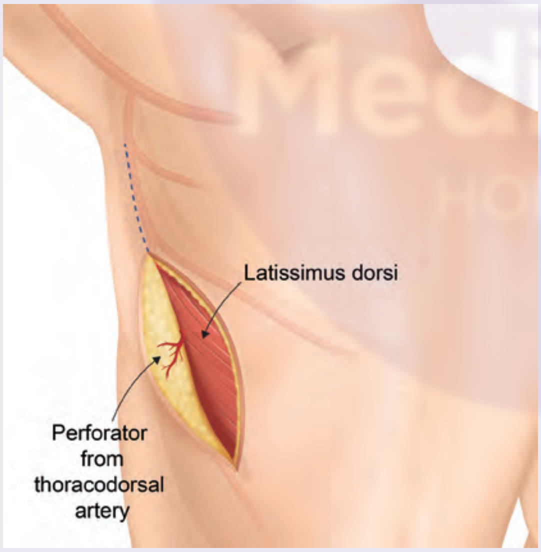
Latissimus dorsi
Perforator from thoracodorsal artery

Figure 3
Skin flap designed in vertical pattern

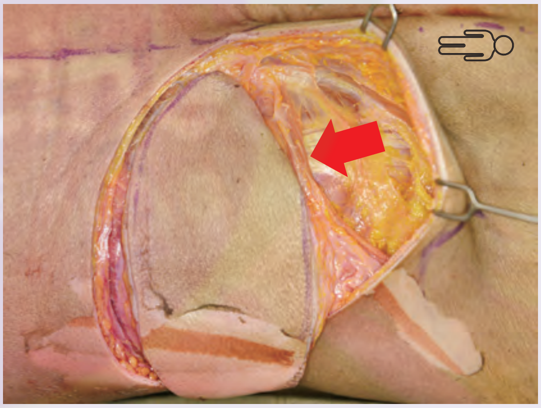

Figure 4
Superior border of **LD**

Latissimus Dorsi and Thoracodorsal Artery Perforator Flap

dissection to facilitate localization of the perforators. However, it is possible to go lateral to medial from the mid axillary area, particularly if no preoperative localization has been performed.

The perforator(s) are dissected to free the pedicle from the muscle and then traced proximally to the TDA deep to the muscle. There are an average of 1-3 perforators that are greater than 0.5 mm in calibre.

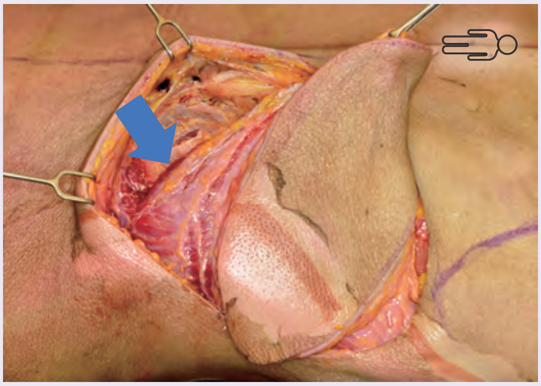

Figure 5

Dividing the inferior attachment of **LD**

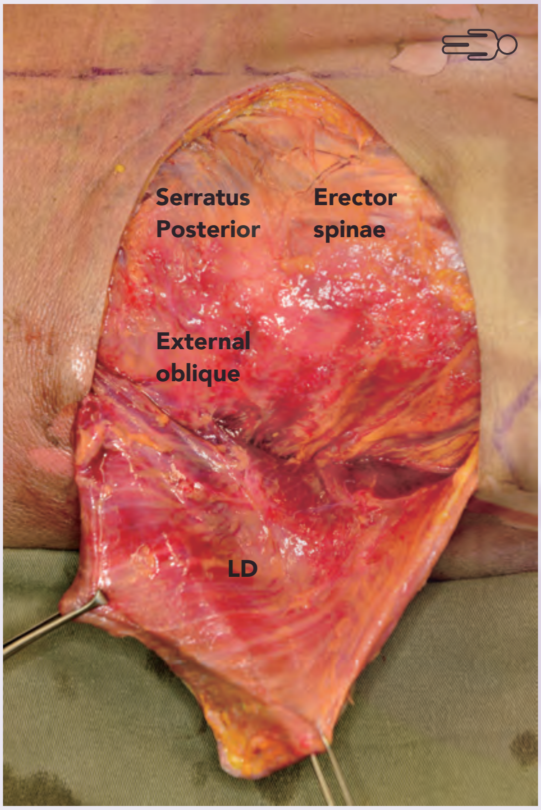
Serratus
Posterior
Erector
spinae
External
oblique
LD

Figure 6

LD raised from the underlying muscles

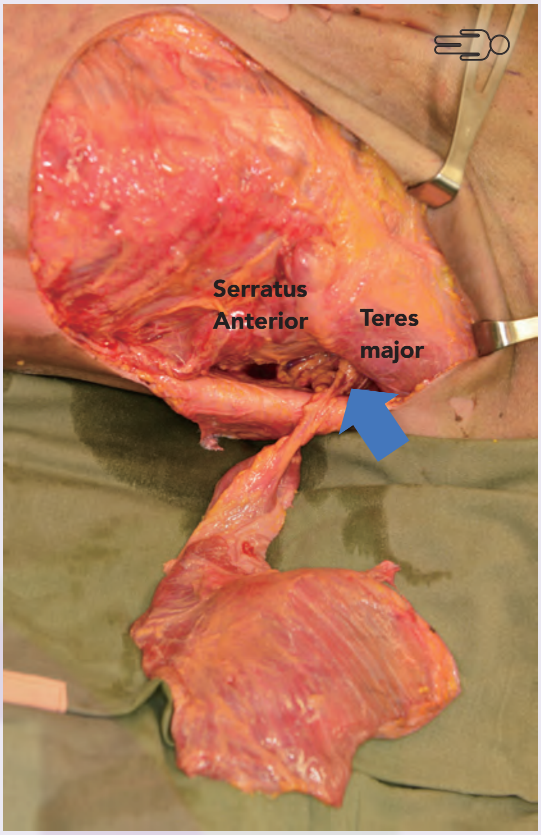
Serratus
Anterior
Teres
major

Figure 7

Pedicle (Blue arrow) traced proximally to identify the thoracodorsal artery (**TDA**)

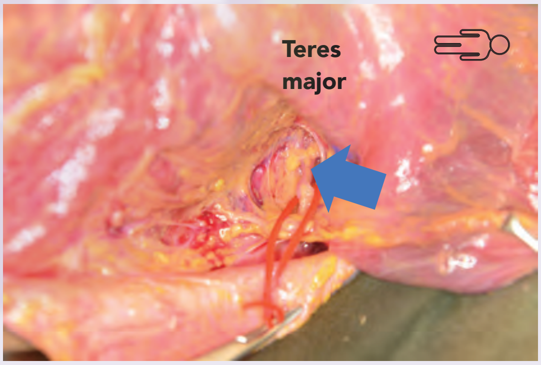
Teres
major

Figure 8

Close up view of the **TDA** (blue arrow)

KEY POINTS

1. The latissimus dorsi flap is supplied by the thoracodorsal artery (TDA).
2. The pedicle enters the muscle 8 cm below the axilla and approximately 2 cm medial to the anterior muscle edge.
3. Relevant landmarks include the anterior edge of LD muscle, iliac crest, tip of the scapula and midline of the back.
4. Dissection is begun by separating the superior part of the LD muscle from the underlying serratus anterior.
5. The pedicle can be lengthened by dividing the circumflex scapular artery and vein.
6. TDAP flap is a perforator flap based on the descending branch of the TDA.

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MEDIAL SURAL ARTERY PERFORATOR FLAP

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MEDIAL SURAL ARTERY PERFORATOR FLAP

FLAP TERRITORY

The medial sural artery perforator (MSAP) fasciocutaneous flap was first described by Cavadas (2001) as a refinement of the medial gastrocnemius flap. The territory approximates to the medial half of the upper third of the posterior calf, an area of about 8x12 cm. It can be extended anteriorly to 2/3rd of the distance from the midline to the anterior tibial margin. It is a useful alternative to the radial forearm flap providing thin hairless tissue with relatively little donor site morbidity particularly when compared to the posterior tibial artery flap.

Caution should be exercised in patients with peripheral vascular disease or diabetes mellitus. An analogous lateral sural artery perforator flap can be raised in most patients as an alternative.

VASCULAR ANATOMY

The MSA usually arises from the popliteal artery (from a common sural trunk in up to 30%). After a few centimeters, the vessel enters and runs through the medial belly of the gastrocnemius muscle and some branches ‘perforate’ through to the skin. The MSA usually divides into lateral and medial branches, this usually occurs in the substance of the muscle (85%). Some surgeons prefer to use the lateral (nearer the midline) row of perforators on the basis that it is usually dominant. Muscle devascularisation is not a major concern as there are other vascular supplies to the muscle apart from the MSA. **Figure 1**

There are usually 2-4 perforators of about 1 mm diameter that are concentrated at an area 4.5 cm from the midline and 8-12 cm from the popliteal fossa crease. The

Medial Sural Artery Perforator Flap

first perforator is usually 8 cm along a line drawn from the middle of the popliteal crease to the medial malleolus. Markings should be made with the patient lying on their back and the knee flexed to 90 degrees. Note that frog-legging (external rotation of the hip) distorts the skin and vessel positions. **Figures 2, 3**

The artery is about 2 mm in diameter at its origin. Depending on the perforator chosen and amount of retrograde dissection, the pedicle ranges from 9-16 cm.

The posterior cutaneous nerve of the thigh can be also harvested in instances where a sensate flap is required.

FLAP HARVEST

Preoperative examination with a handheld doppler ultrasound probe or duplex ultrasound helps to locate the perforators. Some surgeons approximate this to the intersection of the lines from the popliteal crease to the medial malleolus and medial femoral epicondyle to the lateral malleolus. The flap can be harvested with the patient either supine (frog-legged, for contralateral side) or prone. **Figures 3, 4**

In this dissection, the flap territory is taken to be the upper third of the posterior medial calf. A vertical line marks the midline of the posterior calf and the dissection begins here in either the subfascial or suprafascial (more difficult) plane from midline to lateral (in reality, the medial side of leg). Starting from the anterior border of the flap is easier with the patient in the supine position.

The largest perforator(s) is identified and then traced back towards the popliteal artery by splitting the muscle. The

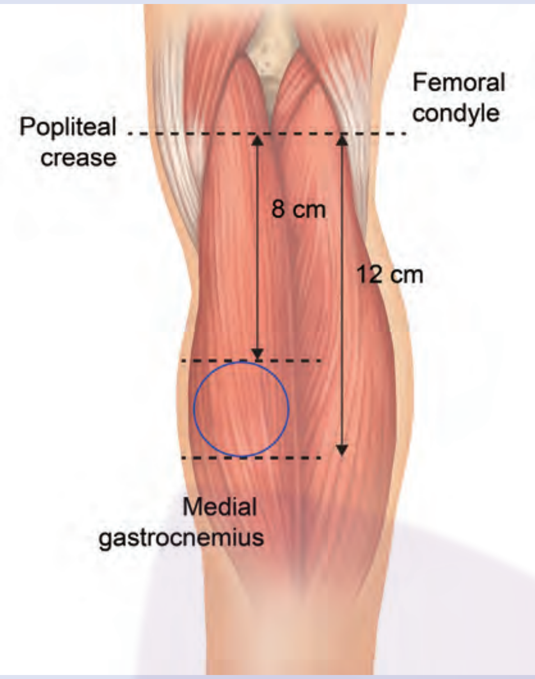
Popliteal crease
Femoral condyle
8 cm
12 cm
Medial gastrocnemius

Figure 1
Design of the flap

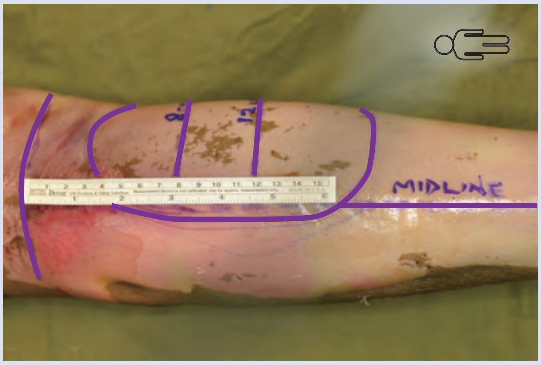
8
12
MIDLINE

Figure 3
Design of the flap and measurement to locate the perforators

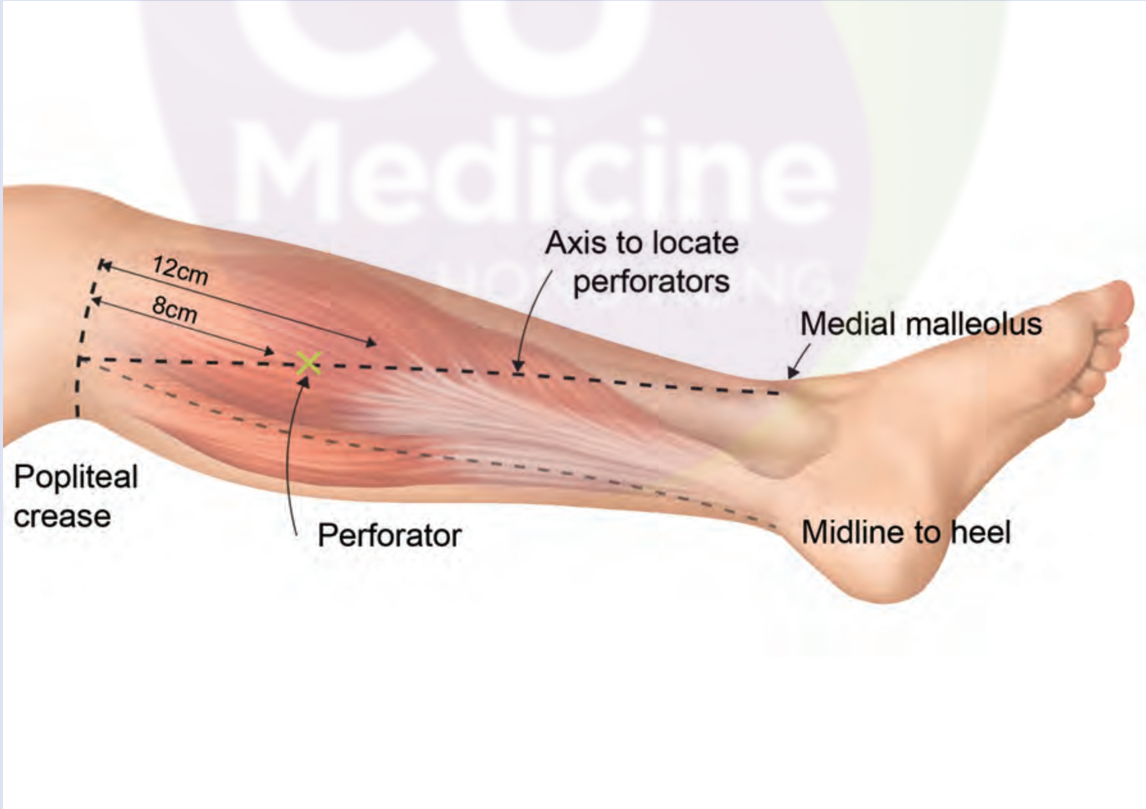
12cm
8cm
Axis to locate perforators
Medial malleolus
Popliteal crease
Perforator
Midline to heel

Figure 2
Landmarks to locate the perforator(s)

MEDIAL SURAL ARTERY PERFORATOR FLAP

remaining borders of the flap can be incised at this point. **Figures 5-8**

Take care to spare the motor nerve to the medial belly of the gastrocnemius.

Taking the superficial cutaneous veins (short saphenous) along with the skin paddle facilitates alternate/additional drainage.

The donor site can usually be closed directly if it is 5-6 cm or less in width. The muscle surface can be aponeurotic and if skin grafts are needed, it may be worthwhile trimming the thick fibrous layer to improve take.

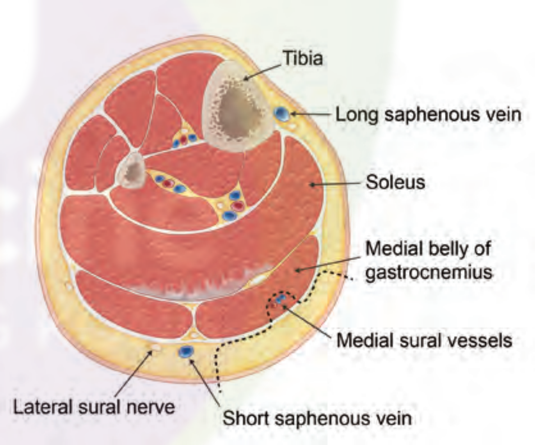
Tibia
Long saphenous vein
Soleus
Medial belly of gastrocnemius
Medial sural vessels
Lateral sural nerve
Short saphenous vein

Figure 4
Cross section of the calf

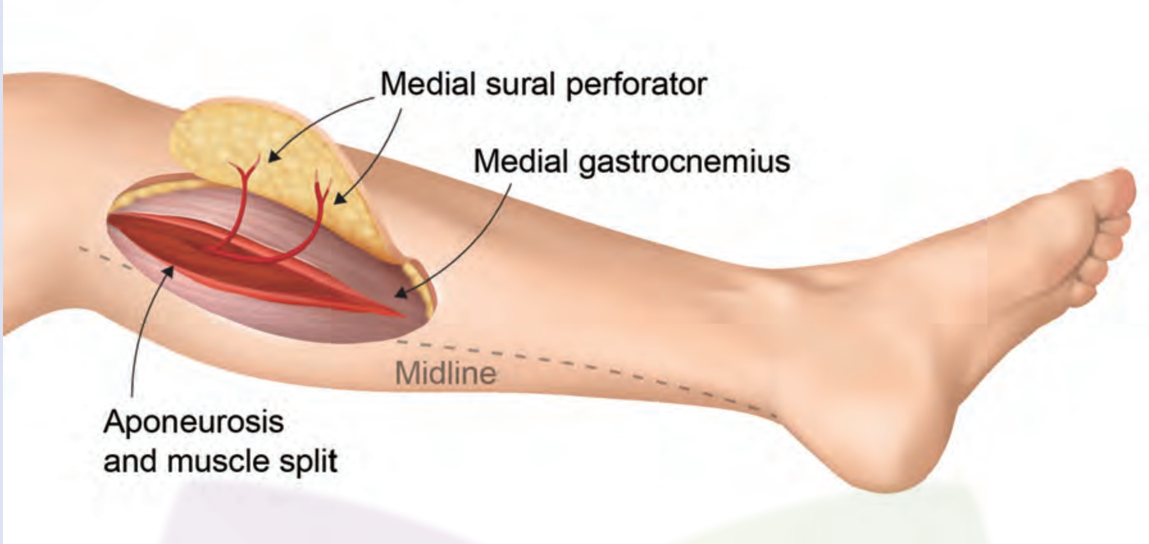
Medial sural perforator
Medial gastrocnemius
Midline
Aponeurosis and muscle split

Figure 5

Schematic diagram of a raised medial sural flap

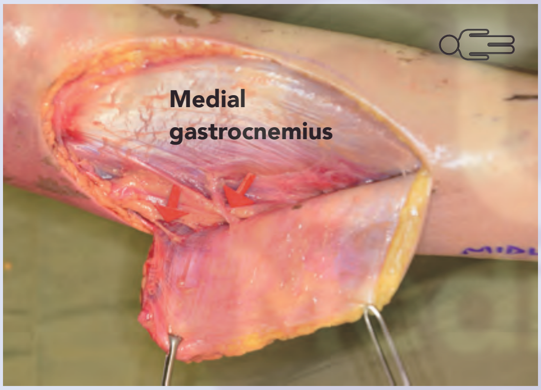
Medial gastrocnemius

Figure 6

Two perforators

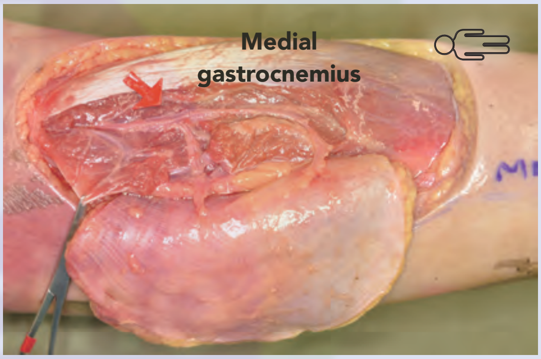
Medial gastrocnemius

Figure 8

Intramuscular course of the medial sural artery

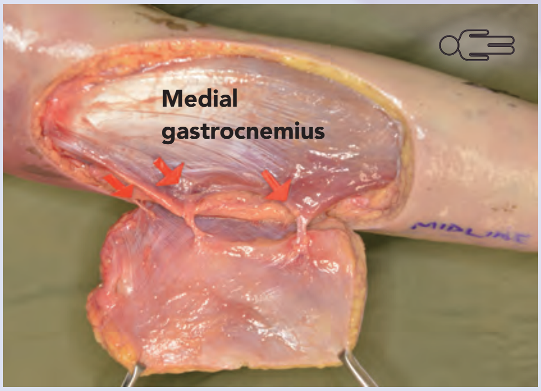
Medial gastrocnemius

Figure 7

Posterior border of the flap incised with perforators indicated

KEY POINTS

1. The MSAP flap is a useful alternative to the radial forearm flap.
2. The MSA usually arises from the popliteal artery and runs through the medial belly of the gastrocnemius.
3. The perforators are concentrated at a distance of 8-12 cm from the popliteal fossa crease.
4. The flap can be harvested with the patient in a frog-legged or prone position.
5. Take care to spare the motor nerve to the medial belly of the gastrocnemius.
6. The muscle surface can be aponeurotic and this is best trimmed if skin grafts are required.

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Lateral Arm Flap

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LATERAL ARM FLAP

FLAP TERRITORY

This flap consists of the fasciocutaneous tissue over the lateral aspect of the arm between the insertion of the deltoid muscle and the elbow. It is thin, pliable and hairless and is suitable for use in reconstruction of the face and hand (classically, for preparation for tendon transfer). The short 5-6 cm pedicle is its main drawback.

VASCULAR ANATOMY

The flap is supplied by the perforators from the posterior radial collateral artery (PRCA) that arises from the profunda brachii artery. The PRCA runs along the lateral intermuscular septum (LIS) which separates the triceps posteriorly and the brachioradialis anteriorly and classically forms a network just above the elbow. **Figure 1**

FLAP HARVEST

The patient is positioned supine with the arm on a table in a pronated position or by the side of the trunk.

The axis of the flap and the PRCA lie between the deltoid insertion (DI) and the lateral epicondyle (LE) that also marks the location of the LIS. **Figures 2, 3**

The proximal limit of the flap lies at the deltoid insertion whilst the distal limit of the flap is the LE (though extended variants have been described, reaching up to 8 cm beyond the LE).

Distal lateral arm flap (DLAF) includes the most distal perforator 4-5 cm above the LE with the flap centered on the LE/elbow. Distal skin tends to be thinner.

Dissection begins anteriorly in the subfascial plane towards the LIS until the perforators are seen. The elevation of the

LATERAL ARM FLAP

posterior flap is performed in a similar fashion to isolate the LIS which has an elongated attachment to the humerus. The tissues of the anterior flap tend to be more adherent and are difficult to dissect. **Figure 4**

The vessels distal to the flap are identified and ligated and the flap is then dissected free by dividing the attachment of the septum to the humerus, from distal to proximal, deep to the level of the pedicle. The pedicle is traced as proximally as possible paying attention to avoid damage to the radial nerve. Fibres of the lateral head of triceps may be divided as necessary. **Figures 5, 6**

The lower lateral cutaneous nerve (LLCN) of the arm can be included with the flap but needs to be divided in any case.

The LLCN of the forearm runs through the flap and may have to be sacrificed, causing numbness of the lateral forearm.

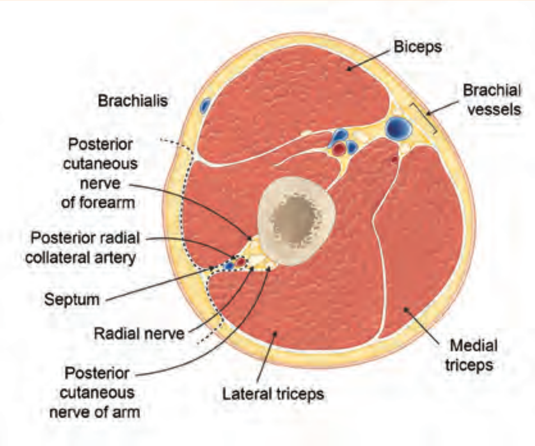
Biceps
Brachialis
Brachial vessels
Posterior cutaneous nerve of forearm
Posterior radial collateral artery
Septum
Radial nerve
Posterior cutaneous nerve of arm
Lateral triceps
Medial triceps

Figure 1

Cross section of the upper arm

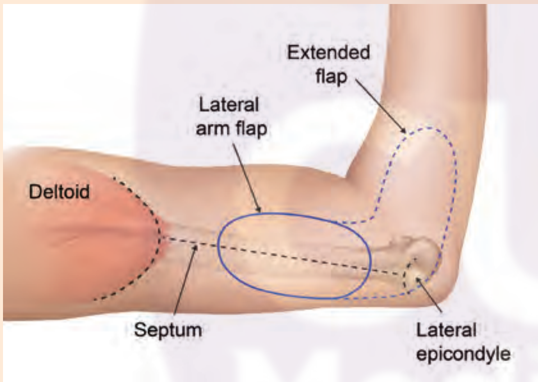
Extended flap
Lateral arm flap
Deltoid
Septum
Lateral epicondyle

Figure 2

Design of the lateral arm flap and extended lateral arm flap

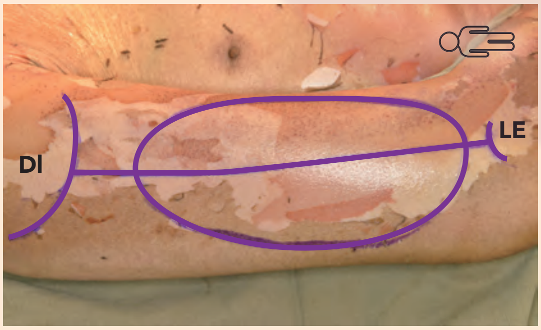

Figure 3

Design of the flap according to the axis of the humerus from the deltoid insertion (**DI**) to lateral epicondyle (**LE**)

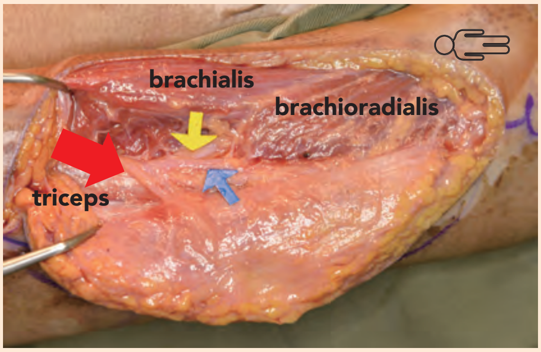
brachialis
brachioradialis
triceps

Figure 4

Identification of the pedicle (blue arrow), posterior cutaneous nerve of the arm (red arrow) and posterior cutaneous nerve of the forearm (yellow arrow)

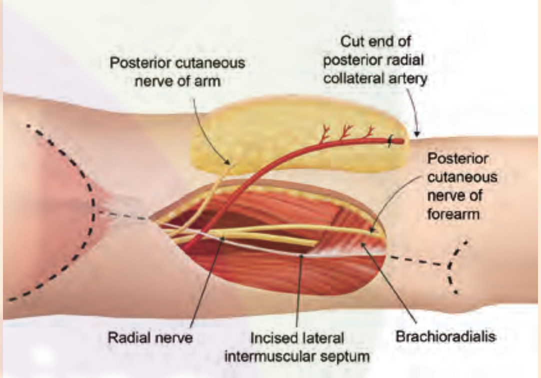
Posterior cutaneous nerve of arm
Cut end of posterior radial collateral artery
Posterior cutaneous nerve of forearm
Radial nerve
Incised lateral intermuscular septum
Brachioradialis

Figure 5

Schematic diagram of raised lateral arm flap

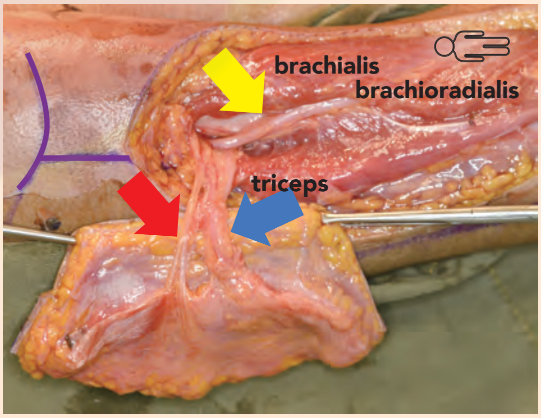
brachialis
brachioradialis
triceps

Figure 6

Isolated lateral arm flap with the cutaneous nerve to the arm (red arrow), pedicle (blue arrow) and cutaneous nerve of the forearm (yellow arrow)

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KEY POINTS

1. Lateral arm flap is a thin, pliable and hairless fasciocutaneous flap.
2. The flap is supplied by the perforators from the posterior radial collateral artery (PRCA) which runs along the lateral intermuscular septum (LIS).
3. The axis of the flap and the PRCA lie between the deltoid insertion and the lateral epicondyle.
4. Dissection begins anteriorly in the subfascial plane towards the LIS until the perforators are seen.
5. The pedicle is traced as proximally as possible paying attention to avoid damage to the radial nerve.

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ANTEROLATERAL THIGH FLAP

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ANTEROLATERAL THIGH FLAP

FLAP TERRITORY

This flap is composed of the skin and subcutaneous tissue of the lateral aspect of the anterior thigh centred on the septum between vastus lateralis (VL) and rectus femoris (RF).

VASCULAR ANATOMY

The flap is supplied in most cases by perforators from the descending branch of the lateral circumflex femoral artery (LCFA). These often pass through the VL muscle to reach the skin whereas in other cases they travel in the septum between the VL and RF.

The more proximal portion of the anterolateral thigh skin is often supplied by a vessel from the transverse branch of the LCFA. **Figure 1** This flap would necessarily have a shorter pedicle.

FLAP HARVEST

Mark a line from the anterior superior iliac spine (ASIS) to the lateral corner of the upper border of the patella bone (axis) and mark its halfway point. Most perforators reach the skin within 3 cm of this point, usually in the inferolateral quadrant. **Figures 2, 2.1**

Mark an ellipse of a generous size centred on this axis and point. **Figures 3, 3.1**

Incise the medial edge of the flap down through the deep fascia to the muscle, usually RF or vastus medialis.

Gradually elevate the flap subfascially from medial to lateral until skin perforator vessels are visualized. **Figure 4**

To increase exposure, retract the RF muscle medially to expose the descending branch of the LCFA running from medial to lateral over the aponeurosis of the vastus intermedius.

ANTEROLATERAL THIGH FLAP

In clinical practice, it is best to trace the perforator in a retrograde manner from distal (skin side) to proximal (main pedicle), dividing the overlying muscle fibres in the manner of a facial nerve dissection during a superficial parotidectomy. **Figure 5**

For the purposes of this course, if you running out of time, you can estimate and incorporate the course of the vessel by taking a cuff of muscle on either side.

If there are no suitable perforators in the anterolateral thigh (ALT) territory, the flap can be converted to a tensor fascia lata (TFL) flap that lies more superiorly or an anteromedial thigh (AMT) flap medially. Both have shorter pedicles.

The lateral edge of the flap can be incised down to the muscle and elevated subfascially from lateral to medial, taking care to preserve the previously identified perforators. **Figure 6**

A straight or lazy S incision is made from the apex of the flap to the area of the femoral artery which is at the mid-inguinal point between ASIS and the pubic symphysis. The skin and subcutaneous tissue is divided up to the lateral border of the sartorius muscle. The pedicle can be traced to its origin from the profunda femoris.

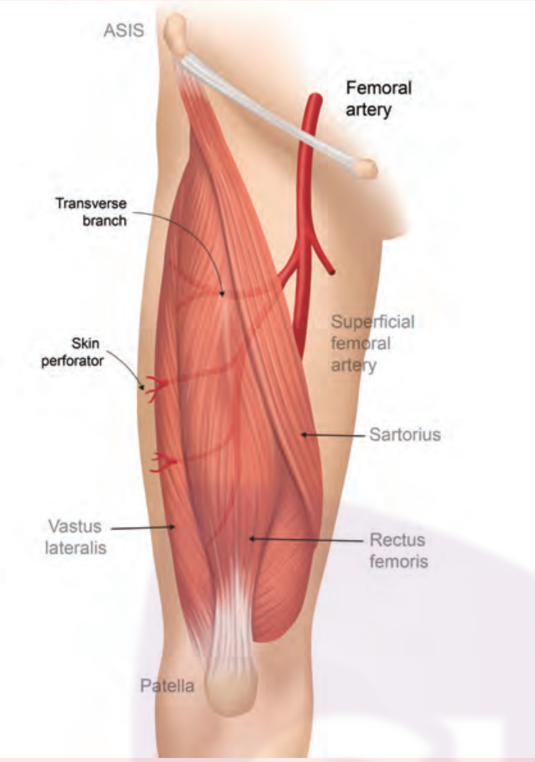
ASIS
Femoral artery
Transverse branch
Skin perforator
Superficial femoral artery
Sartorius
Vastus lateralis
Rectus femoris
Patella

Figure 1
Vascular anatomy of ALT flap

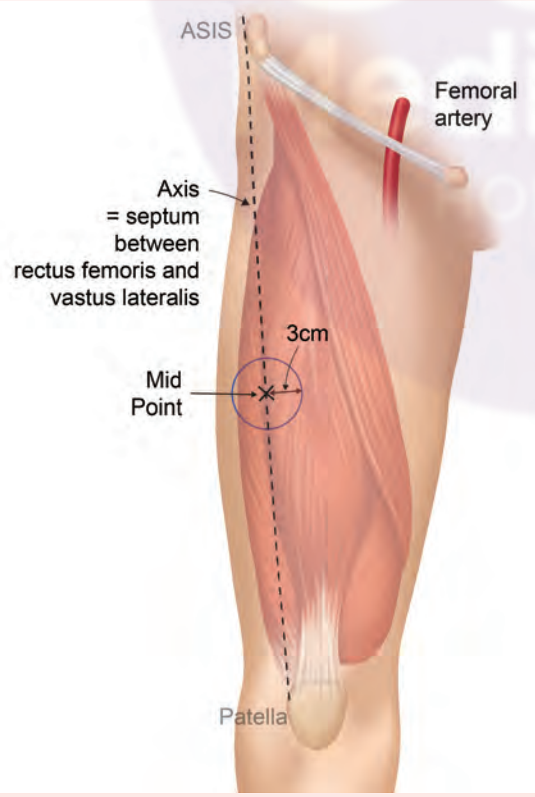
ASIS
Femoral artery
Axis
= septum
between
rectus femoris and
vastus lateralis
3cm
Mid
Point
Patella

Figure 2
Landmarks for locating perforators

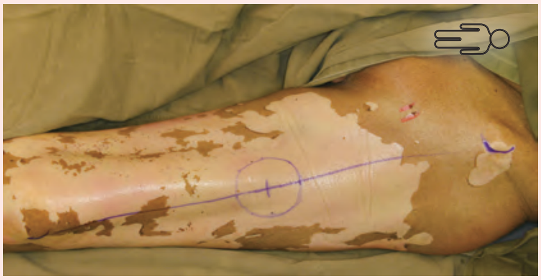

Figure 2.1
Landmarks for locating perforators

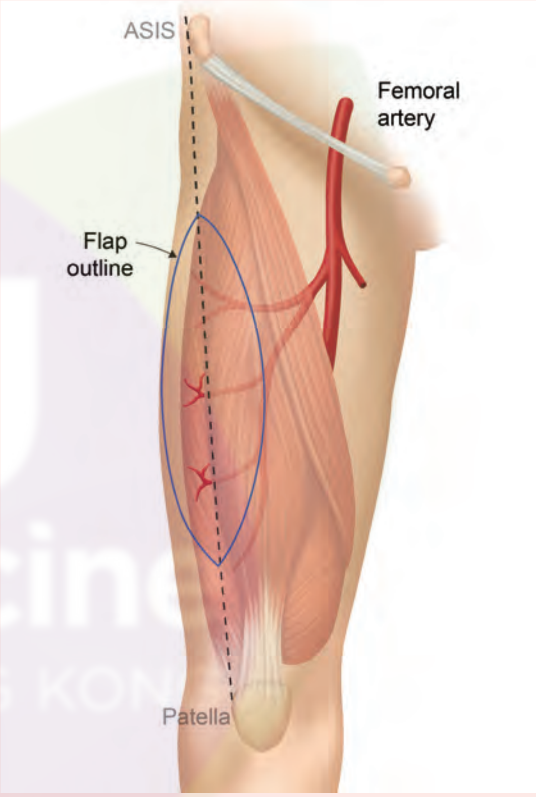
ASIS
Femoral artery
Flap
outline
Patella

Figure 3.
Design of the flap with respect to the perforators

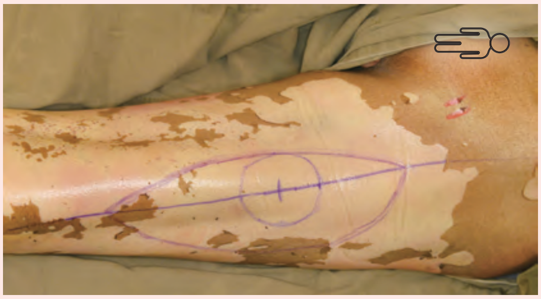

Figure 3.1
Design of the flap with respect to the perforators

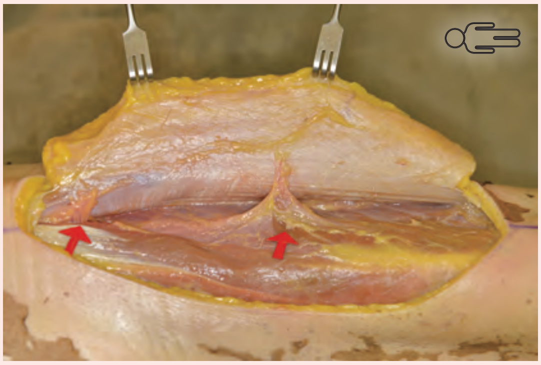

Figure 4

Perforators (red arrow)

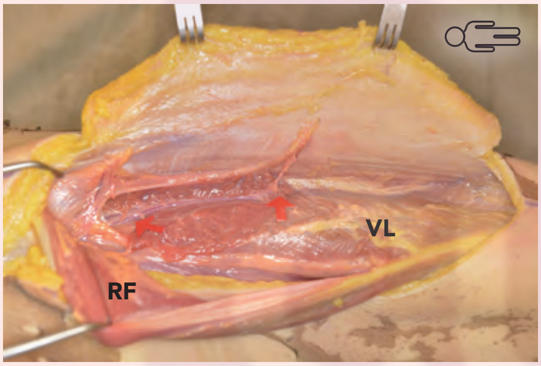

Figure 5

Descending branch of the LCFA (red arrow)

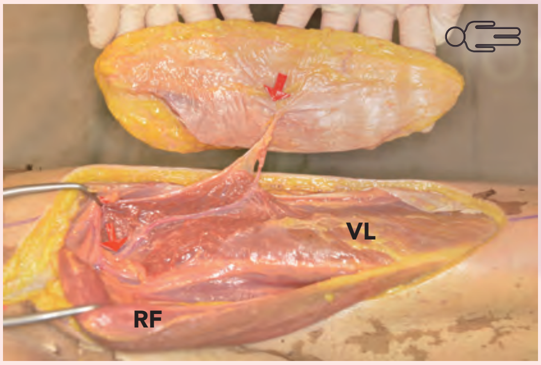

Figure 6

Descending branch of the LCFA and perforator (red arrow)

KEY POINTS

1. The flap is centered on the septum between vastus lateralis and rectus femoris.
2. The flap is supplied by perforators from the descending branch of the lateral circumflex femoral artery (LCFA).
3. Most perforators are located within 3 cm of the midpoint between a line from the ASIS and lateral upper corner of the patella bone.
4. Incise the medial edge of the flap first and perforators are then identified by elevating the flap subfascially from medial to lateral.
5. Retracting the rectus femoris medially facilitates the identification of the descending branch of LCFA.
6. The flap can be converted to a TFL flap or AMT flap if there are no suitable perforators in the ALT territory.

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Radial Forearm Flap

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Radial Forearm Flap

FLAP TERRITORY

This flap consists of fasciocutaneous tissue from the volar surface of the distal forearm supplied by branches of the radial artery. It is most often designed as a free flap but may be pedicled e.g. distally for hand defects. The flap can be made 'sensate' by inclusion of either the medial or lateral cutaneous nerves of the forearm.

The flap is based on the axis of the radial artery. For larger flaps, care should be taken to ensure that the ulnar pedicle is not exposed. Instead the flap should extend over the radial border to the dorsum if necessary, although this will increase the sensory deficit.

VASCULAR ANATOMY

Septocutaneous perforators from the radial artery approach the skin between the flexor carpi radialis (FCR) and brachioradialis (BR), with drainage through venae comitantes (VC) and/or cephalic vein. Over its length there are an average of 9-17 skin perforators that tend to be found in proximal and distal clusters. The diameter of the artery is around 2.5 mm. **Figure 1**

FLAP HARVEST

The patient should be placed in a supine position with the arm on a board positioned almost perpendicular to the body. The operation is often performed under tourniquet control and a preoperative Allen's test should be performed.

The axis of the flap lies just medial to the course of the radial artery at the wrist, approximately along a line connecting the centre of the antecubital fossa to the radial border of the wrist where the radial pulse

RADIAL FOREARM FLAP

is palpable, approximating to the course of the artery. **Figure 2**

The superficial veins are marked with the tourniquet tightened.

The skin incision should begin distally, usually from the ulnar aspect, and dissection proceeds subfascially taking care to preserve paratenon. Some surgeons dissect suprafascially first, changing to a deeper level in the proximity of the vessel (over the bellies of branchioradialis and FCR). **Figure 3**

The perforators lie in the 'septum' or connective tissue between the skin flap and artery, between the radial border of the flexor carpi radialis and the ulnar border of brachioradialis. The septum is approached from the radial side in a similar manner, preserving the cephalic vein for anastomosis when the VC are narrow in calibre.

Dividing and ligating the distal artery early makes the flap harvest easier. **Figure 4**

The pedicle is then traced proximally dissecting it free from the overlying brachioradialis. A lazy 'S' incision over the line of the artery may be used. In this dissection, use an incision over the radial border of the forearm. **Figure 5**

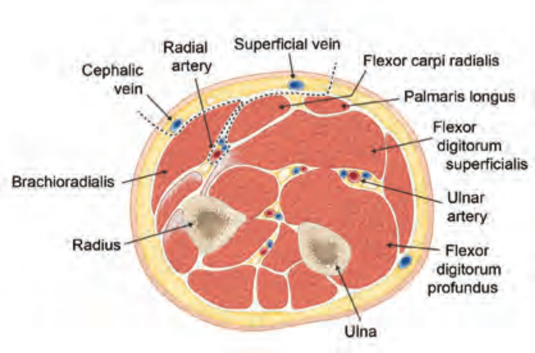
Radial artery
Superficial vein
Cephalic vein
Flexor carpi radialis
Palmaris longus
Flexor digitorum superficialis
Brachioradialis
Ulnar artery
Radius
Flexor digitorum profundus
Ulna

Figure 1
Cross section anatomy of the forearm

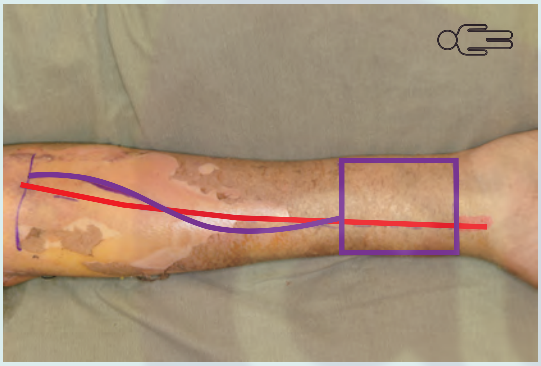

Figure 2
Course of radial artery (red) and flap design (purple)

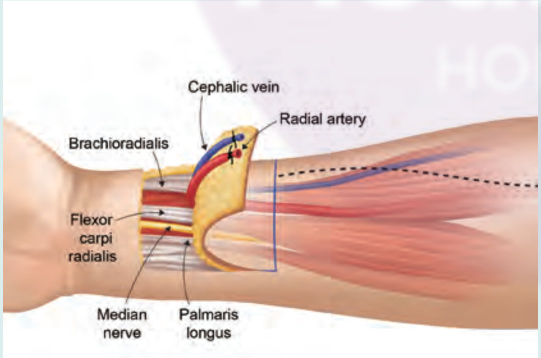
Cephalic vein
Radial artery
Brachioradialis
Flexor carpi radialis
Median nerve
Palmaris longus

Figure 3
Distal radial artery and cephalic vein divided and the flap raised with preservation of paratenon

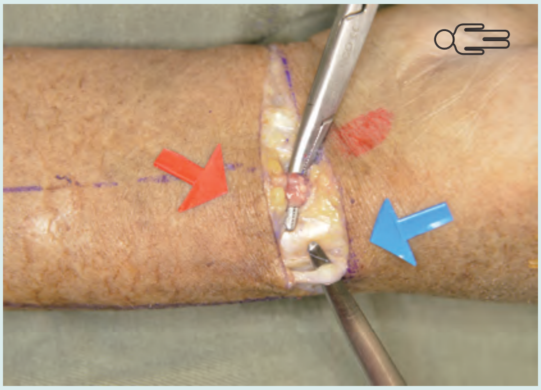

Figure 4
Radial artery (red)
Cephalic vein (blue)

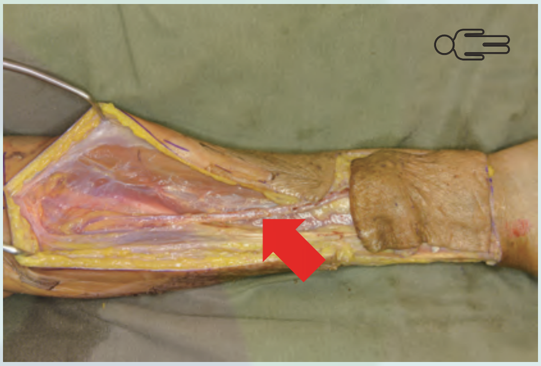

Figure 5
Radial artery

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KEY POINTS

1. This flap consists of fasciocutaneous tissue supplied by branches of the radial artery.
2. Septocutaneous perforators from the radial artery approach the skin between the FCR and BR, and drain through venae comitantes or the cephalic vein.
3. A preoperative Allen's test should be performed.
4. The skin incision should begin distally and proceed subfascially taking care to preserve paratenon.
5. Dividing and ligating the distal artery early makes the flap easier to harvest.

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Pectoralis Major Flap

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Pectoralis Major Flap

FLAP TERRITORY

The pectoralis major myocutaneous flap (PMMF) is useful in head and neck reconstruction. The extent of coverage and the reach of the flap are dependent on the anatomy of the patient but the upper limits are generally considered the zygomatic arch externally and the tonsillar bed internally.

VASCULAR ANATOMY

The PMMF is mainly supplied by perforators of the pectoral branch of the thoraco-acromial artery which runs on the underside of the PM.

The lateral thoracic artery provides a secondary blood supply but is usually sacrificed to maximize the reach of the flap.

The superior thoracic artery contributes supply to the lateral superior portion of the muscle and is usually divided when the flap is raised.

The course of the pectoral branch of the thoraco-acromial artery can be identified by drawing a line from the xiphoid to the acromion. A second line is made vertically from the midpoint of the clavicle to intersect the first line. The course of the artery corresponds to the line drawn from the midpoint of the clavicle continuing to the medial portion of the acromion to xiphoid line. **Figure 1**

FLAP HARVEST

Identify the clavicle, ipsilateral sternal border, xiphoid, and humeral insertion of the PM.

Design the size and location of the skin paddle over the PM.

Skin overlying any portion of the muscle may be utilized. The size and and location

PECTORALIS MAJOR FLAP

of skin paddle depends on reconstructive requirements. In most cases, the skin paddle is located at the infero-medial border of the PM between the nipple and the edge of the sternum. In women, the skin paddle can be designed below the breast in the inframammary fold.

The larger the skin paddle harvested, the higher the likelihood the skin will survive the transfer due to the increased number of myocutaneous perforators.

For additional length, the skin paddle may be extended as a random-pattern flap beyond the inferior edge of the muscle. Excessive thickness of the fatty tissue is associated with a higher risk of skin necrosis. **Figure 2**

The first incision is made from the lateral edge of the skin paddle toward the anterior axillary line (defensive incision - which preserve the deltopectoral flap). This incision is carried down to the muscle and allows identification of the medial and inferior extents of the muscle. At this point, the skin paddle can be moved inferiorly or superiorly so that most of it lies over muscle.

The other incisions are made down to the muscle. The skin paddle can be temporarily sutured to the fascia.

The superior skin flap is elevated to clavicle whilst preserving perforators to the deltopectoral flap. A tunnel can be created to the neck where needed. **Figure 3**

The inferior skin flap is elevated to reveal the lower edge of the PM and the muscle is then elevated off the chest wall. There are normally numerous chest wall perforators at the muscular attachments. In live patients, take care to control bleeding as vessels can retract into the chest.

The pedicle can be identified on the deep surface of the superior part of the muscle. **Figure 4** Cut the muscle close to the sternal

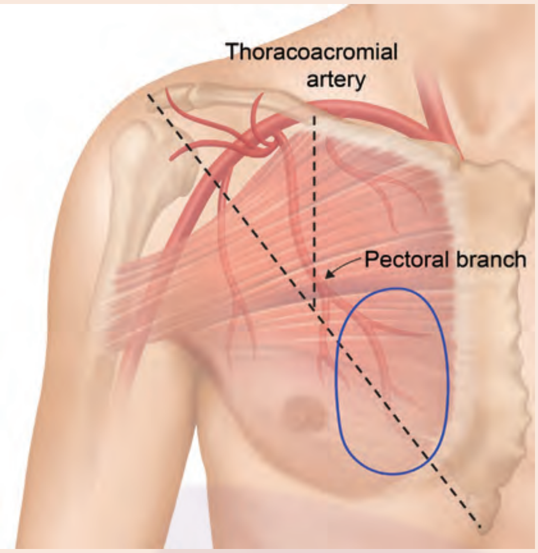

Figure 1

Schematic diagram to locate the pedicle of **PM** flap

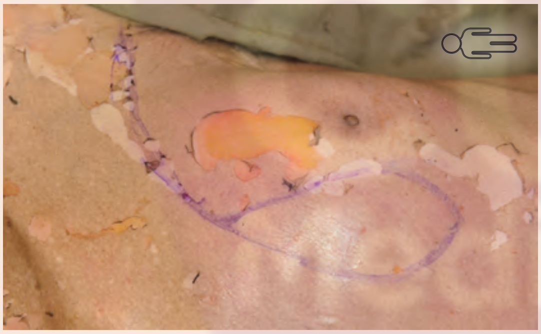

Figure 2

Design of the skin island in **PM** flap with "defensive incision"

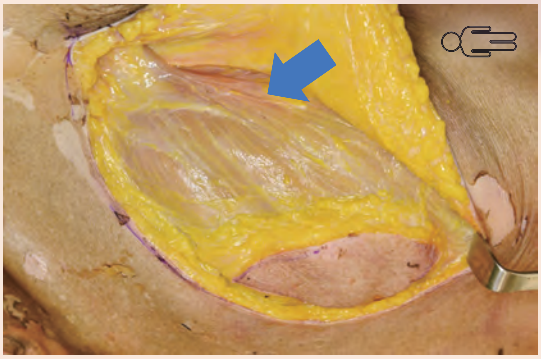

Figure 3

Identify the free edge (blue arrow) of **PM** muscle and ensure the skin island is "within" the boundary of **PM** muscle

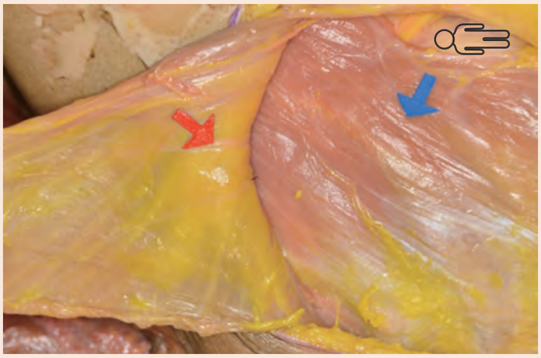

Figure 4

PM muscle raised to show the pectoralis minor (blue arrow) and pedicle (red arrow) running on the under surface

PECTORALIS MAJOR FLAP

attachments, taking care with the internal mammary perforators. Laterally, cut the muscle taking care to preserve the pedicle. The lateral thoracic artery is usually sacrificed to increase length and rotation. **Figure 5**

When insetting the flap, take care not to overly rotate, kink, or compress the proximal flap.

Flap reach can be increased by dividing the clavicular portion of the muscle above the pedicle and by splitting and removing the middle one-third of the clavicle.

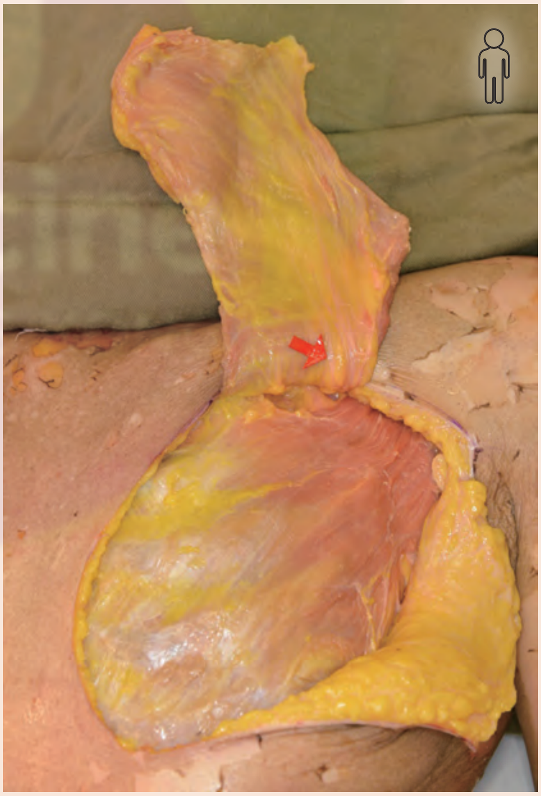

Figure 5

Raised **PM** flap to show the pedicle (red arrow) from thoraco-acromial artery

KEY POINTS

1. The PMMF is mainly supplied by the pectoral branch of the thoraco-acromial artery and a secondary blood supply from the lateral thoracic artery.
2. The course of the pedicle can be identified by locating the landmarks including the xiphoid, acromion and midpoint of the clavicle.
3. Place the skin paddle over the infero-medial border of the PM.
4. Defensive incision preserves the deltopectoral flap for future use.
5. Flap reach can be increased by dividing the lateral thoracic artery and the clavicular portion of the muscle above the pedicle.

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Fibula Flap

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FIBULA FLAP

FLAP TERRITORY

This flap includes a segment of the fibular bone with or without the overlying skin island on the peroneal/ lateral aspect of the calf.

VASCULAR ANATOMY

The peroneal artery and vein lie on the medial surface of the fibula, posterior to the interosseus membrane, making dissection relatively difficult. At the bifurcation (anterior tibial and peroneal arteries), the vessels start posterior to and at some distance away from the bone before moving diagonally downwards to a position closer to the bone.

There are some important points related to the vascularity of the leg and its variants.

Peronea arteria magna – a dominant peroneal artery has reciprocally small tibial vessels. This condition may be ipsilateral as other leg may be satisfactory. This is rather rare.

Low bifurcation – the pedicle would be short (and vein grafts may be necessary).

The skin island may be supplied by perforators from the posterior tibial system traversing the soleus and thus separate from the peroneal artery system. It is a misconception from the pre-perforator flap era that including a cuff of soleus/ flexor hallucis longus (FHL) will improve the reliability of the skin island. Although it requires more dissection, tracing the perforators to the pedicle will optimize reliability. Including unnecessary muscle has adverse implications, in particular reducing the maximum tolerable ischaemic time.

FIBULA FLAP

FLAP HARVEST

Preoperatively, if the pedal pulses (dorsalis pedis and posterior tibial) are palpable and strong then this is usually sufficient as a screening test. In selected patients such as the elderly, arteriopaths and post traumatic cases, an angiogram may be useful.

Bend the knee to a 40-60 degree angle and mark the top and bottom of the fibula bone. It is conventional to leave some bone at both ends to preserve the common peroneal nerve (~4cm above) and the ankle joint (6cm below) respectively. Mark the posterior edge of the fibula which is the axis of the skin island.

Mark an elliptical skin island centred on the axis along the posterior edge of the fibula **Figures 1, 2** and at the junction of the middle and lower thirds of the fibula.

Incise the anterior skin edge down through the fascia to the muscle (usually the peroneals) and elevate the flap subfascially from anterior to posterior until you reach the posterior lateral intermuscular septum situated posterior to the peroneal muscles. You should then be able to see the skin perforators. **Figure 3**

Incising to the fascia and elevating for a distance supra-fascially **Figure 4** helps protect the sural nerve and short saphenous vein posteriorly as well as the peroneal tendons anteriorly by not exposing them.

Adjust your posterior incision if necessary and incise down to muscle (gastrocnemius/ soleus). Now elevate this posterior flap (sub)fascially in an anterior direction to meet the same septum and the perforators seen before. Perforators that run through the posterior muscles are more likely to arise from a system separate from the peroneal system and will not reliably supply the skin island. The muscles can

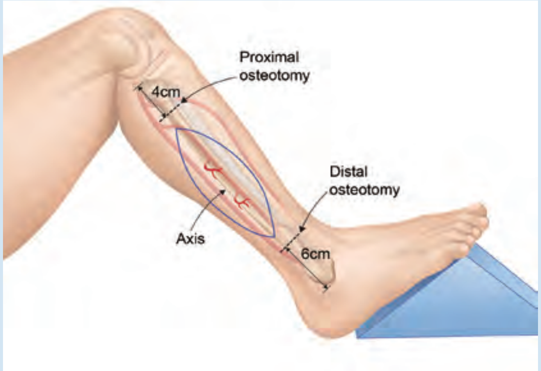
Proximal osteotomy
4cm
Distal osteotomy
Axis
6cm

Figure 1

Design of the fibula flap

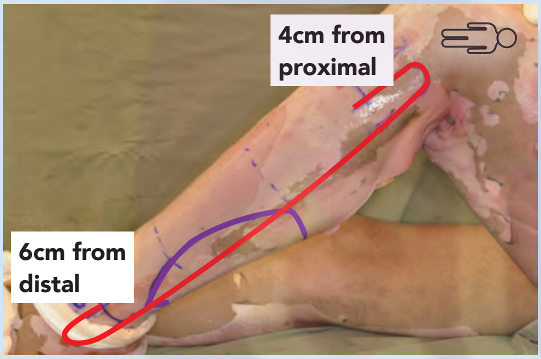
4cm from proximal
6cm from distal

Figure 2

Design of the fibula flap, posterior border of fibula (red colour)

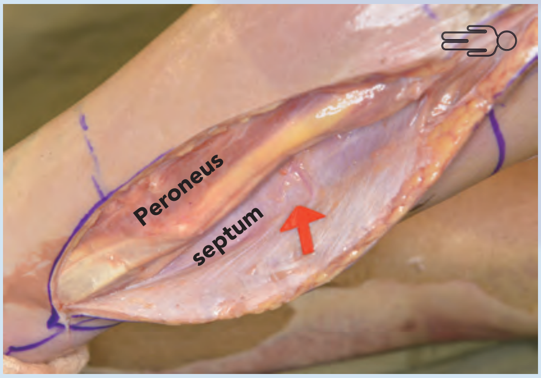
Peroneus
septum

Figure 3

Perforator (indicated above) running in the intermuscular septum

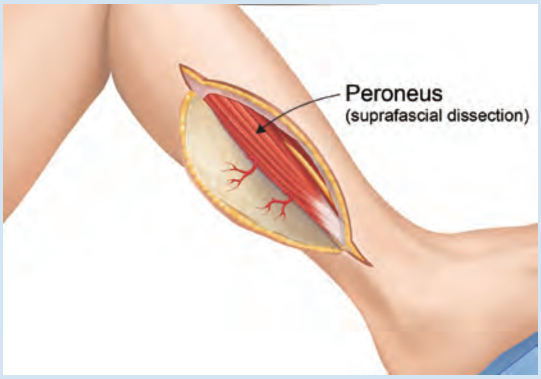
Peroneus
(suprafascial dissection)

Figure 4

Suprafascial dissection to protect the sural nerve

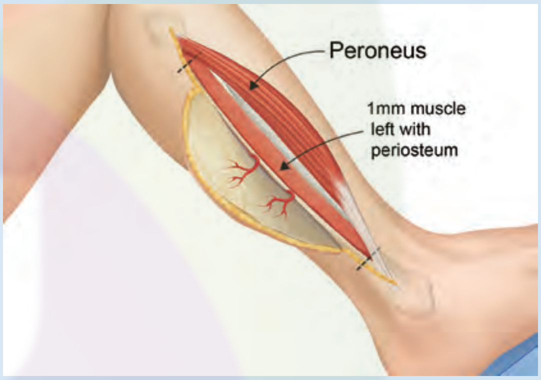
Peroneus
1mm muscle left with periosteum

Figure 5

Dissect the peroneal muscles away from the lateral surface of the fibula

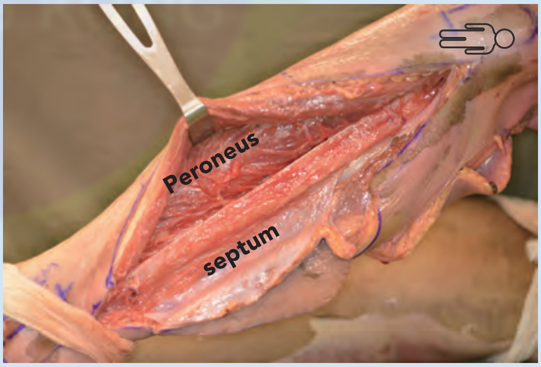
Peroneus
septum

Figure 6

Leaving a thin layer of muscle to ensure that the periosteum remains intact

FIBULA FLAP

be separated from the septum with gentle blunt dissection.

Dissect the peroneal muscles away from the lateral surface of the fibula in an anterior direction **Figures 5, 6** leaving a thin layer of muscle to ensure that the periosteum remains intact. When you reach the anterior edge of the fibula, incise the membrane (anterior intermuscular septum) all the way down to the ankle. You can also divide the muscles (extensor hallucis longus and extensor digitorum longus) and interosseus membrane (IOM) at this point if you are able to see them. **Figure 8**

Cut the distal fibula at your selected level. After you do so, note the proximity of the peroneal vessels and ligate or divide them.

If you have identified the common peroneal nerve, you can also cut the proximal fibula at this time to facilitate mobilization of the bone.

Return to the posterior aspect of the fibula and divide the muscle attachments here (flexor hallucis longus and tibialis posterior). **Figure 7** The peroneal vessels will be seen under this muscle layer. If you haven't already divided the IOM then return to the anterior fibula and divide it.

Divide the proximal fibula, if not already done (taking an extra segment can help to improve access to the proximal peroneal vessels), and trace the vessels to the bifurcation. **Figure 9**

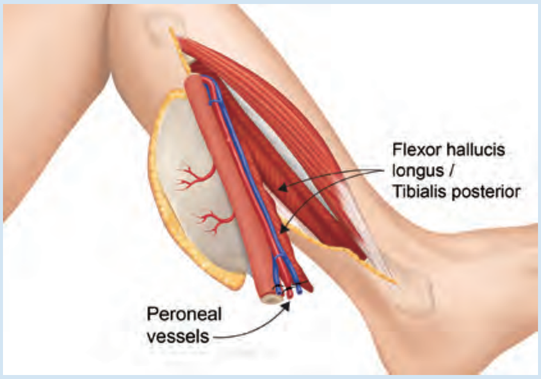
Flexor hallucis longus / Tibialis posterior
Peroneal vessels

Figure 7

Divide the FHL/PT from the posterior aspect of the fibula

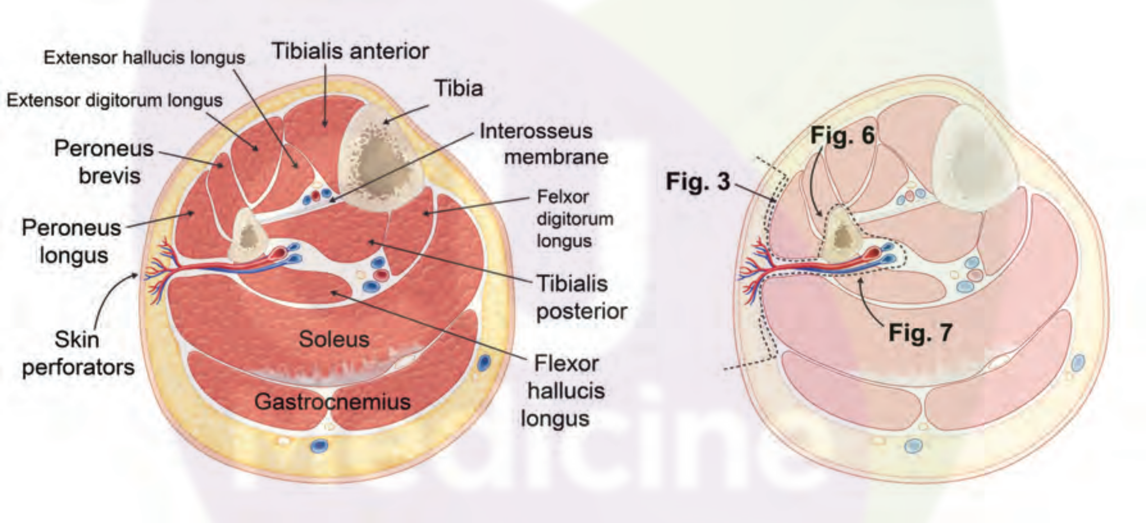
Extensor hallucis longus
Tibialis anterior
Tibia
Extensor digitorum longus
Interosseus membrane
Peroneus brevis
Felxor digitorum longus
Peroneus longus
Tibialis posterior
Skin perforators
Soleus
Flexor hallucis longus
Gastrocnemius
Fig. 6
Fig. 3
Fig. 7

Figure 8

Cross section of the leg

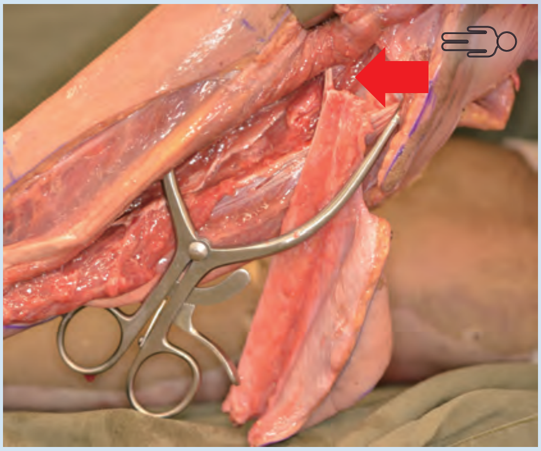

Figure 9

Both the proximal and distal fibula divided and the peroneal vessel exposed (indicated above)

KEY POINTS

1. The peroneal artery and vein supply the fibula bone and the overlying skin island.
2. The presence of pedal pulses (DP and PT) is usually sufficient as a screening test. An angiogram is rarely necessary.
3. It is conventional to leave 4 cm of bone superiorly to preserve the common peroneal nerve and 6 cm bone above the ankle joint.
4. The axis of the flap is located at the posterior edge of the fibula.
5. Identify the skin perforators at the posterior lateral intermuscular septum.
6. Leave a thin layer of peroneal muscle on the lateral surface of the fibula to ensure the periosteum remains intact.
7. Dividing the proximal fibula facilitates access to the proximal peroneal vessels.

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Deep Inferior Epigastric Artery Perforator Flap

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DEEP INFERIOR EPIGASTRIC ARTERY PERFORATOR FLAP

FLAP TERRITORY

The deep inferior epigastric artery perforator flap (DIEP) and superficial inferior epigastric artery (SIEA) flaps are free (fascio-) cutaneous flaps of the lower abdomen below the level of the umbilicus.

VASCULAR ANATOMY

The deep inferior epigastric artery (DIEA) arises from the distal external iliac artery, deep to the inguinal ligament and ascends superomedially towards the umbilicus, behind the rectus abdominis (RA) between the transversalis fascia and the peritoneum. In the majority of cases, the artery enters the muscle at its middle third and in less than 20%, at its lower third. It then usually branches into medial and lateral vessels that give origin to the rows of perforators to the skin. **Figure 1**

The superficial inferior epigastric artery (SIEA) often arises directly from the common femoral artery or may share a trunk with the superficial circumflex iliac artery (SCIA), 2-5cm below the inguinal ligament. It starts deep to the Scarpa's fascia and as it ascends, pierces the fascia to branch out relatively superficially within the subcutaneous fat. It does not perforate the RA muscle or its fascia. The venae comitantes (VC) to the SIEA are usually very small. A larger separate vein is often found more medial and more superficial.

If large enough, the SIEA can be used to harvest a flap instead of the DIEP but this vessel does not reliably supply tissue across the midline. The SIEA/SIEV can also be used for supercharging or superdraining of the DIEP flap.

FLAP ELEVATION

The patient is positioned supine. The perforators can be localized preoperatively

DEEP INFERIOR EPIGASTRIC ARTERY PERFORATOR FLAP

with a doppler probe or angiogram and usually lie close to the umbilicus.

The DIEP flap is designed in most cases as an elipse on the lower abdomen with the upper limit at the superior edge of the umbilicus and the lower limit above the pubic bone. The usual lateral limits are the ASIS. **Figures 2, 3** The donor defect is then closed in the manner of an abdominoplasty.

The contralateral flap is often raised first to get an idea of the position of the linea semilunaris and the larger perforators, however symmetry is not guaranteed.

The inferior skin incision is made with the initial aim of identifying the SIEA and SIEV between the 2 layers of the superficial fascia. **Figure 4**

The superior incision is then made with a periumbilical incision taking care to preserve the umbilical stalk, and the flap is then elevated at the fascial level from lateral to medial.

Begin to look for perforators once the lateral edge of the rectus muscle is reached. The anterior rectus sheath is incised around the chosen perforator(s) that are traced to the DIEA and its VC that run longitudinally on the deep surface of the rectus muscle. **Figure 5**

Expose the proximal DIEA and VC by retracting the inferior part of the rectus muscle medially. Continue dissecting until a sufficient length of pedicle has been obtained.

Trim the flap according to the requirements. The contralateral side is sacrificed first as it has the poorest vascularity. **Figure 6**

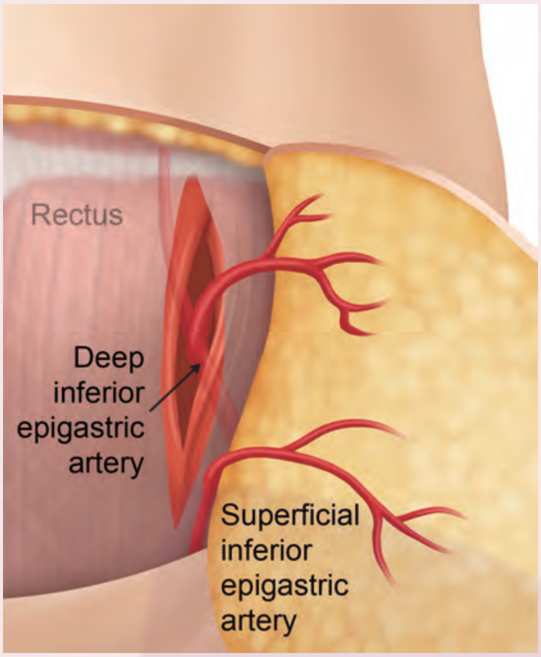
Rectus
Deep inferior epigastric artery
Superficial inferior epigastric artery

Figure 1

Vascular anatomy of DIEP flap

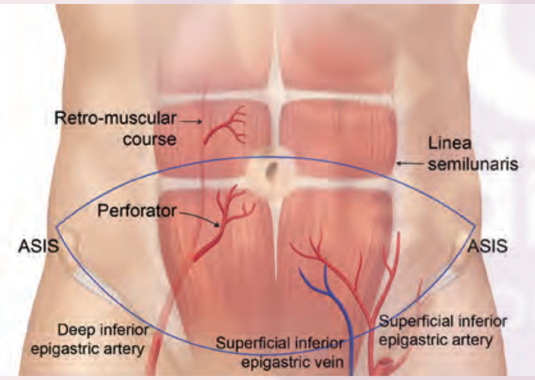
Retro-muscular course
Linea semilunaris
Perforator
ASIS
ASIS
Deep inferior epigastric artery
Superficial inferior epigastric vein
Superficial inferior epigastric artery

Figure 2

Design of DIEP flap

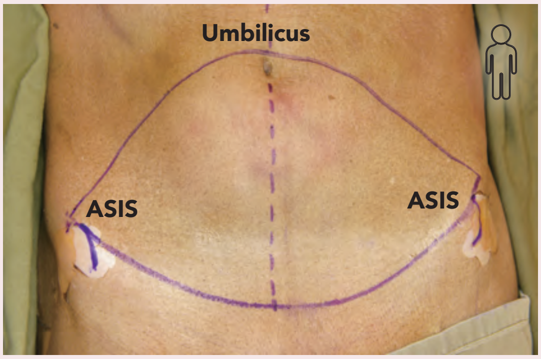
Umbilicus
ASIS
ASIS

Figure 3

Design of DIEP flap

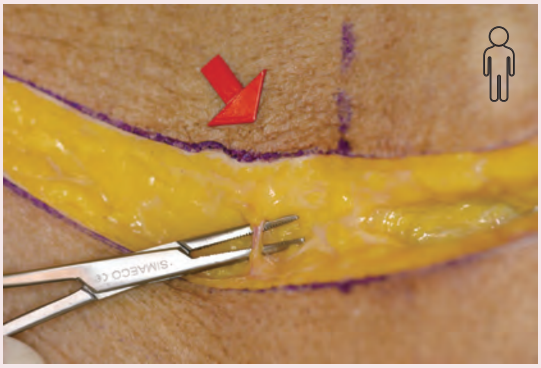

Figure 4

Superficial inferior epigastric artery (SIEA)

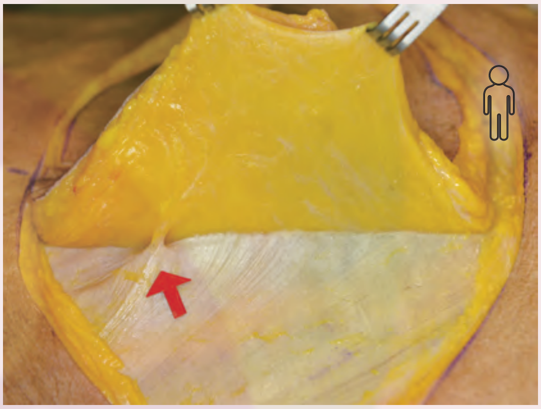

Figure 5

Suprafascial dissection and perforator identified

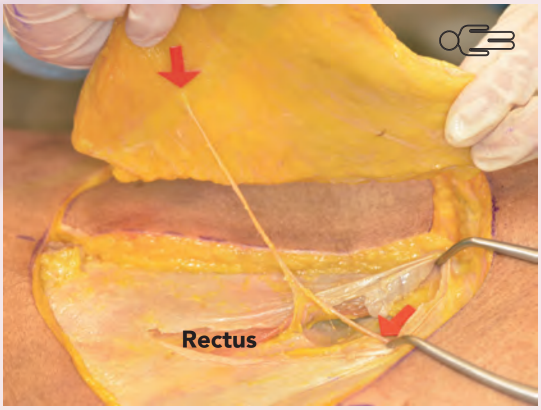

Figure 6

Perforator and DIEA identified and flap isolated

KEY POINTS

1. DIEP is a fasciocutaneous flap supplied by the deep inferior epigastric artery perforator.
2. The DIEP flap is designed as an ellipse on the lower abdomen with its boundaries at the superior edge of the umbilicus, the pubic bone and the ASIS.
3. The inferior skin incision is made first with the aim of identifying the SIEA and SIEV.
4. Begin to look for perforators once the lateral edge of the rectus muscle is reached.
5. Trim the flap according to the requirements. The contralateral side is sacrificed first as it has the poorest vascularity.

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MICROVASCULAR TECHNIQUES

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MICROVASCULAR TECHNIQUES

I. BACKGROUND

Microsurgery has become an essential technique in many surgical specialties.

Microsurgery is a complex task that requires hand-microscope-eye co-ordination, respectful handling of delicate tissues with microvascular instruments and steady surgical technique.

Microsurgical skills can be improved with regular practice. Mastering the technique is not possible when the surgeon is limited to observation and performing infrequent clinical cases.

Various models can be used to train and assess technical skills and dexterity. The medical profession is under increasing pressure to be able to objectively assess skills and competence.

II. MICROSURGICAL TECHNIQUE

A. BASIC AIMS

Water-tight anastomosis with the least number of sutures (arteries 1 mm in diameter ~5 to 8 and veins ~7 to 10)

Place sutures perpendicular to anastomosis and equally spaced.

Maximize patency by avoiding constriction or suturing walls together.

B. MICROSCOPE ADJUSTMENT

There is an ON-OFF switch on the main arm next to the brightest control. When you switch off the microscope during breaks, turn the brightness way down first as – this helps to reduce the risk of damaging the light.

MICROVASCULAR TECHNIQUES

There is a dial on top of the binocular eye pieces to adjust the interpupillary distance. Adjust this as needed to get a binocular image.

Gross focus is obtained by slowly moving the lens assembly up or down. There is a fine focus dial on the side of the base of the lens assembly.

The magnification is adjusted by the small dials either side of the lens assembly. The effective magnification is calculated by multiplying the figure on the dial with the objective magnification, usually 10x. Thus 0.4 is equivalent to 4x. Use the middle range of magnification rather than the highest as it is easier and has better depth of field.

C. END-TO-END ANASTOMOSIS

Vessel Exposure & Preparation

Adventitia is cleared from the vessel ends for about 2 mm to prevent accidentally incorporating it into the suture line.

"Circumcise" or pull the adventitia down over the vessel end, cut it and let it retract and then carefully trim in a circumferential fashion.

The vessel ends can be dilated to 1.5 times normal diameter. Do so judiciously in living tissue as there is a risk that this may injure the intima.

Freeing more of the vessel from the surrounding tissue may help to reduce retraction when you cut the vessel.

Sutures

8-0 to 10-0 Ethilon is used depending on the size and thickness of the vessels.

Take full thickness bites, approximately twice the thickness of the vessel and tie until the sutures are just visible.

Forcep tips can be gently placed in the

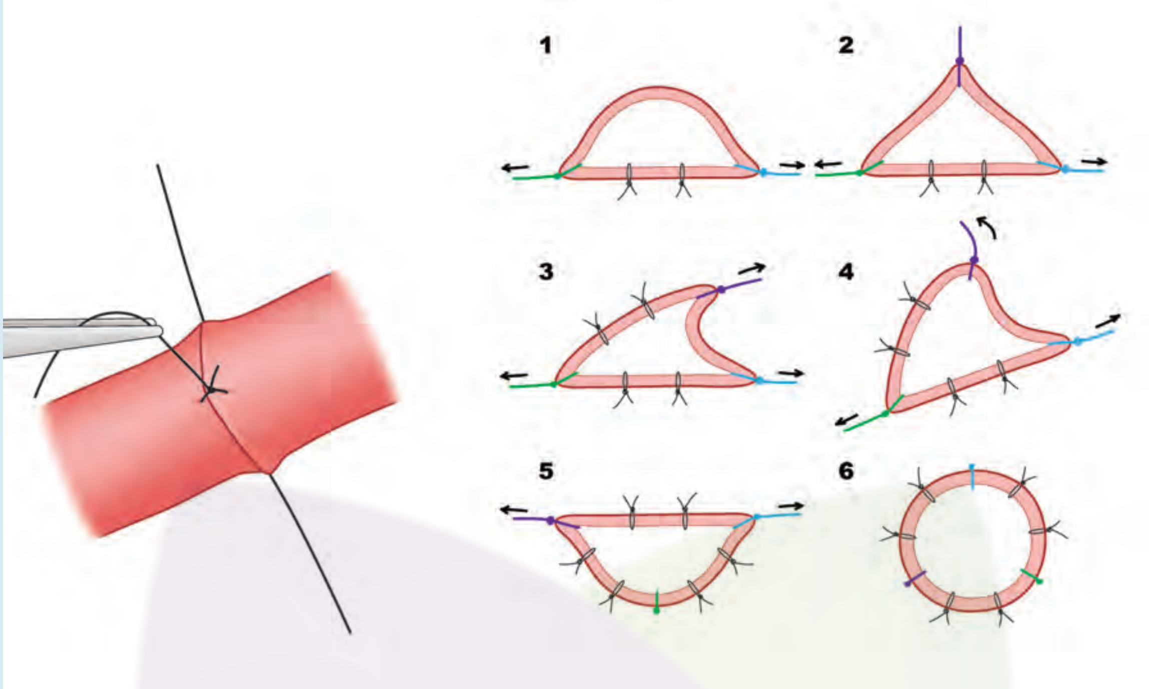

Figure 1

Three suture technique. The first two stay sutures are placed at 120 degrees to encourage the posterior wall to fall away from the anterior wall when traction is exerted laterally

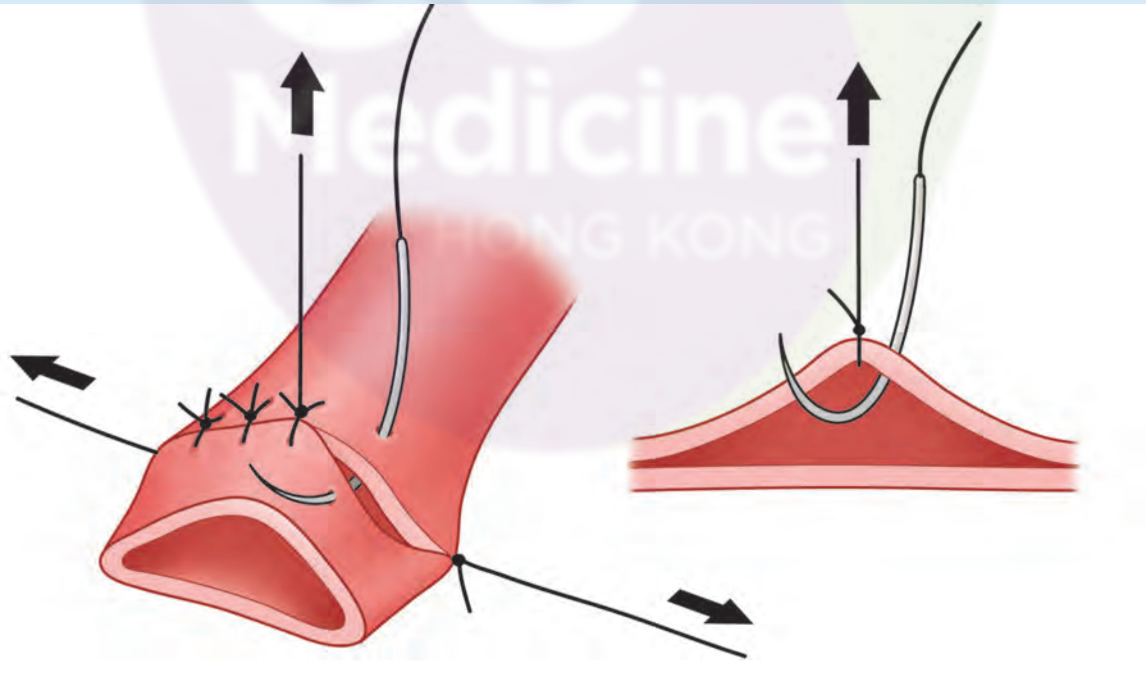

Figure 2

Use of traction and stay sutures to keep the back and front walls apart

MICROVASCULAR TECHNIQUES

lumen to protect the back wall and to provide counter pressure. Alternatively gently grasp the adventitia.

Interrupted sutures reduce constriction compared to continuous sutures.

Three suture technique

Place the first two stay sutures approximately 120 degrees apart on vessel's circumference. The back wall will fall away making it less likely to capture both walls. **Figure 1**

Leave the suture ends long for use as traction sutures. There are various ways of holding these sutures apart from a framed clamp, choose the method that suits you best. Complete the anterior wall. Use a central stay suture to help you manipulate the vessel ends. **Figure 2**

Rotate the anastomosis to expose the posterior vessel wall and place a traction stitch 120 degrees from the initial two traction stitches.

Place stitches in the remaining spaces to complete the anastomosis

Surgeon's knots are used for traction or stay sutures and simple square knots for the other stitches.

Back wall first

Clamps are not needed with this technique which allows an improved view of the back wall. The vessel does not need to be flipped over and it works well even in cavities. **Figure 3**

The first suture is placed in the back wall at the most difficult point to place a suture (for right handed surgeons), right-to-left, out to in and then in to out. An assistant can hold the vessel ends together while the knot is tied.

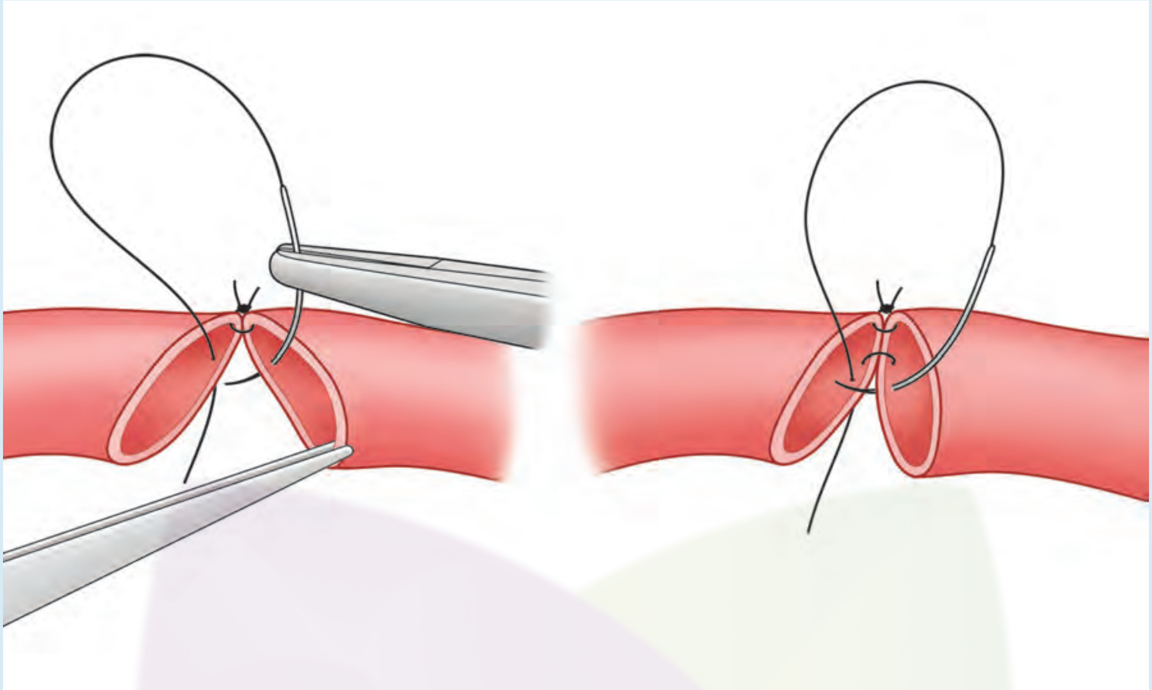

Figure 3
Back wall first technique showing the first few sutures.

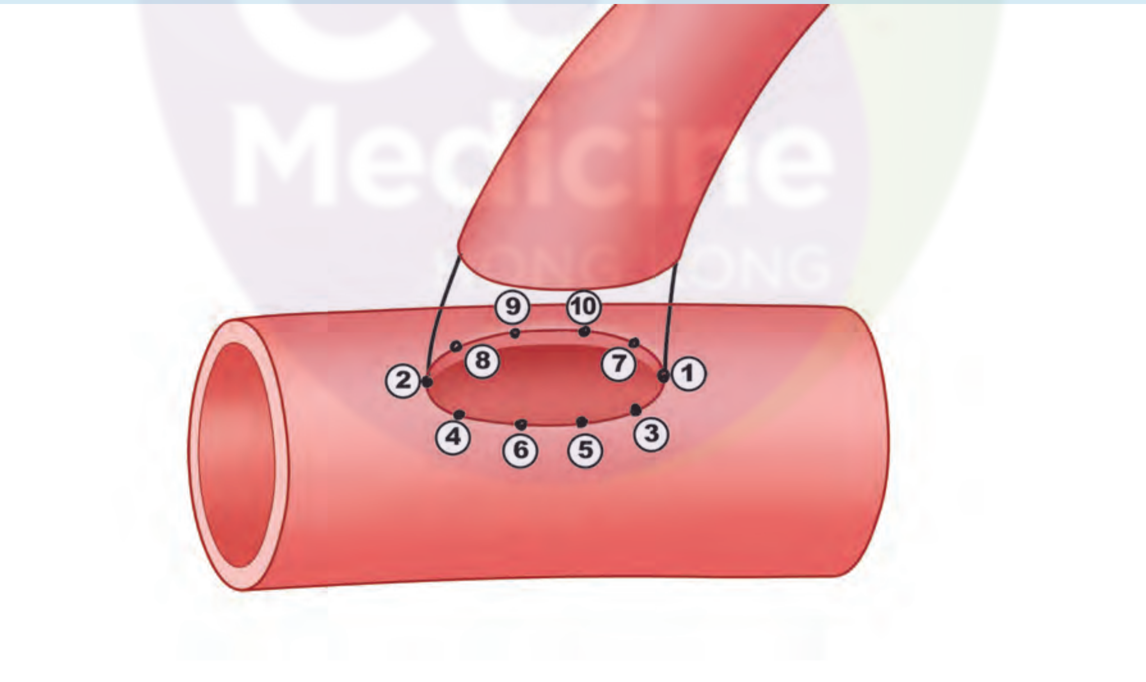

Figure 4
End to side anastomosis, front wall first technique

MICROVASCULAR TECHNIQUES

The remainder of the back wall sutures are placed left-to-right. The second suture should be close to the first and subsequent sutures can be spaced further apart. Make liberal use of saline to visualize the vessel intima. "Too few sutures" is easier to fix than "too many sutures". Front wall sutures are placed right-to-left.

D. END-TO-SIDE ANASTOMOSIS

The vessel is pinched up and a piece of wall is carefully removed. Aim for a hole that is about 1.5x the diameter of the vessel to be plumbed in. The flap vessel can be trimmed at an angle to improve flow though a perpendicular arrangement.

The first suture is placed in the right corner of the hole from right-to-left, out to in and in to out.

The placement of the second suture depends partly on the mobility of the vessels. A back wall first technique is useful when there is limited mobility.

Back wall first – subsequent sutures are placed along the back wall.

Front wall first – the second suture is placed at the left corner. **Figure 4**

KEY POINTS

1. Anastomoses should be water-tight with the least number of sutures.
2. Place sutures perpendicularly and with equal spacing.
3. Maximize patency by avoiding constriction or suturing vessel walls together.
4. Adventitia is cleared from vessel ends for approximately 2 mm to prevent incorporating it into the suture line.
5. Vessel ends can be dilated to 1.5 times normal diameter.
6. Take full thickness bites, approximately twice the thickness of the vessel and tie until the sutures are just visible.
7. Interrupted sutures reduce constriction compared to continuous sutures.

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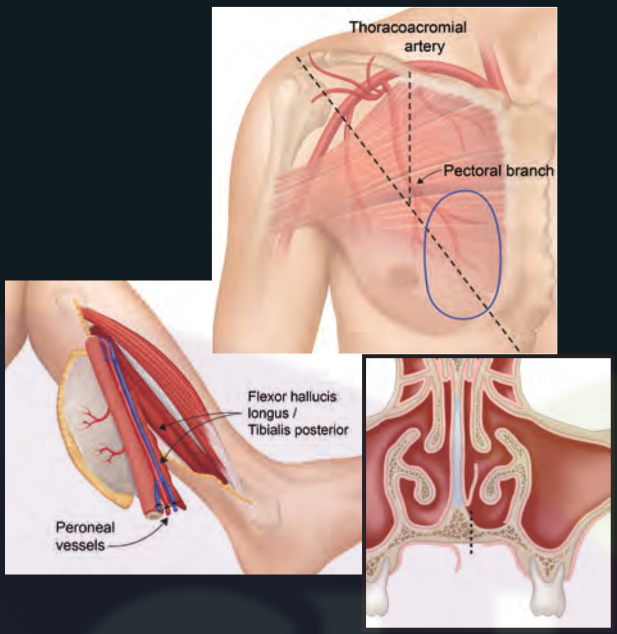

This dissection manual contains detailed descriptions and all-inclusive illustrations on the full range of surgical procedures in the head and neck. It also includes meticulous dissection technique guidance on reconstruction operations. The manual provides readily available access to valuable experience accumulated by expert Head and Neck surgeons. In compiling this manual the editors have delivered a comprehensive guide and reference both within the laboratory and when preparing for the operating room.

"The Head & Neck Dissection and Reconstruction Manual, compiled by the Chinese University of Hong Kong faculty, contains the key information that dissectors require to be able to proceed through the surgical steps of common head and neck and reconstructive surgery operations, and will be an important companion in the dissection room."

— **Johan Fagan**
Professor and Chairman
Division of Otorhinolaryngology
University of Cape Town

"We have created this manual to guide, complement and enhance value to be gained from the priceless opportunity of dissecting specimens of excellent quality. It is indeed a privilege to gain hands on experience in the totally safe setting of the laboratory."

— **Eddy WY Wong**
Associate Consultant, Department of ENT
Prince of Wales Hospital, Hong Kong

— **Andrew van Hasselt**
Professor of Surgery (Otorhinolaryngology)
The Chinese University of Hong Kong

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