



## SUPRACLAVICULAR FLAP FOR HEAD & NECK RECONSTRUCTION

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The supraclavicular flap is a perforant pedicled fasciocutaneous flap with a reliable axial pattern, based on the supraclavicular artery. It is centered over the shoulder joint, extending from the supraclavicular region up to the lateral surface of the upper arm, overlying the deltoid muscle. It is well suited to restore lining and volume of head and neck defects, while preserving good function and acceptable cosmetic outcomes.

The supraclavicular flap was first described by *Lamberty* in 1979<sup>21</sup>. However, because of a high incidence of distal flap necrosis, its use was limited at that time. In 1997, *Pallua and Machens*<sup>3</sup> described a modification of the flap, which was successfully used to reconstruct eight cases of neck contractures. They later published anatomical studies which helped the flap to regain respectability. Its use and indications have increased since then.

### Surgical anatomy

#### Arterial vascular anatomy

**Transverse cervical artery (Figure 1):** The transverse cervical artery branches off the thyro-cervical trunk in 60-95% of cases<sup>1,5</sup>. In the remaining cases, it originates from the first part of the subclavian artery. It courses along the base of the posterior neck and travels deep to the lateral part of the inferior belly of the omohyoid muscle. The diameter of the transverse cervical artery ranges from 2.5-3.5mm<sup>5</sup>. It supplies the trapezius muscle and the skin over the shoulder through direct cutaneous branches located cephalad to the clavicular insertion of the muscle<sup>2</sup>.

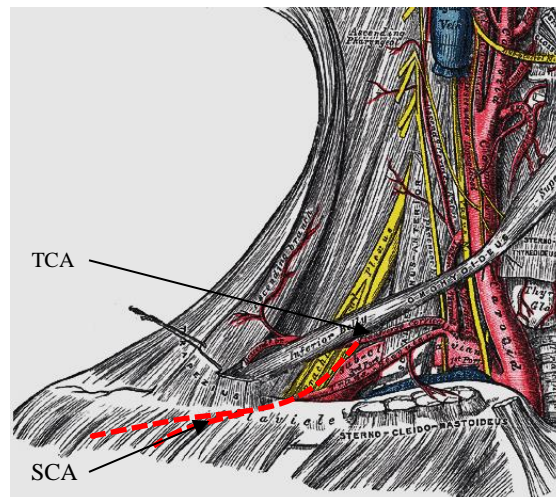


Figure 1: Typical anatomy of transverse cervical (TCA) and supraclavicular artery (SCA)

**Supraclavicular artery (Figure 1):** The supraclavicular artery generally originates from the transverse cervical artery<sup>5,12</sup>. Infrequently it arises from the suprascapular artery<sup>1,4,5</sup>. The supraclavicular artery has a diameter between 1-1.5mm<sup>5,7,14</sup>. In 70-90% of cases its origin is in the area of mid-third of the clavicle<sup>5,18</sup>. In the remaining cases, it branches in the area of the lateral third of the clavicle. The supraclavicular artery then travels perpendicularly from the transverse cervical artery and pierces the deep fascia of the deltoid muscle 30mm distally<sup>5,14</sup>. Before reaching this point, it can give off one or two small branches<sup>5</sup>. After its exit from the deep fascia, it runs in a superficial plane (Figure 2) and continues its course over the acromioclavicular joint, at the junction of the middle and lateral thirds of the clavicle. At this level, the artery generally divides into numerous branches over the deltoid muscle (Figure 3). These branches develop multiple anastomoses with the vascular network of the thoracoacromial artery<sup>14</sup>, the posterior circumflex humeral artery<sup>1</sup> and the

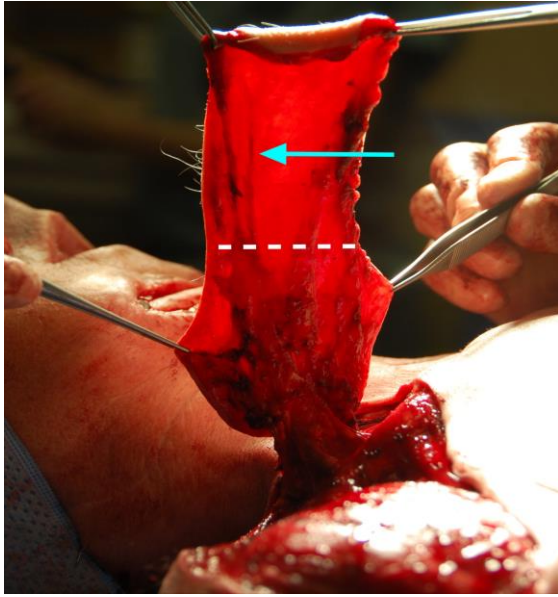


Figure 2: After the supraclavicular artery (arrow) exits from the deep fascia (area under the dotted line), it runs in a superficial plane

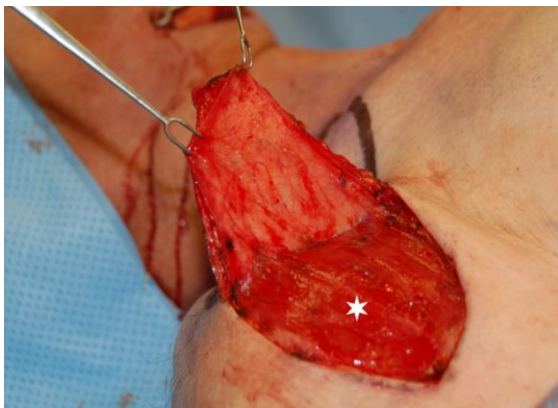


Figure 3: The supraclavicular artery generally divides into numerous branches over the deltoid muscle (white star) at the junction of the middle and lateral thirds of the clavicle

superficial branch of the transverse cervical artery <sup>14</sup>.

These vessels form a consistent number of perforators interconnected by direct and indirect linking vessels through the subdermal plexus. Over the deltoid muscle, the direct linking vessels support the distal supraclavicular artery and drive the blood

flow from the artery to the perforators. After the insertion of the deltoid muscle, their numbers decline and the vascularisation of the distal flap relies principally on indirect linking vessels and recurrent flow. Thereby, beyond this point, the vascularisation follows a random pattern and a higher incidence of necrosis is seen <sup>14</sup>. Accordingly, as described by Pallua and Noah <sup>22</sup>, the angiosome extends from the supraclavicular region to the ventral surface of the deltoid muscle and ranges up to 10cm in width and 22cm in length.

### Skin landmarks

The origin of the supraclavicular artery where it branches off the transverse cervical artery, is located in a triangle bounded inferiorly by the clavicle, medially by the posterior border of the sternocleidomastoid muscle and laterally by the external jugular vein <sup>3</sup> (Figure 4). It is found approximately 2.5-4cm above the clavicle <sup>7</sup> and on average 2cm posterior to the sternocleidomastoid muscle <sup>22</sup> and 6.5-10cm from the sternoclavicular joint <sup>5,7,18,22</sup>.



Figure 4: The origin of the supraclavicular artery is located in a triangle bounded inferiorly by the clavicle (white line), medially by the posterior border of the sternocleidomastoid muscle (red line) and laterally by the external jugular vein (blue line)

### ***Venous anatomy***

Two *venae comitantes* usually accompany the supraclavicular artery. They usually drain into the transverse cervical vein (Figure 5). One of the two veins may drain alternatively into the external jugular vein. They provide venous drainage to the skin proximal to the deltoid origin.

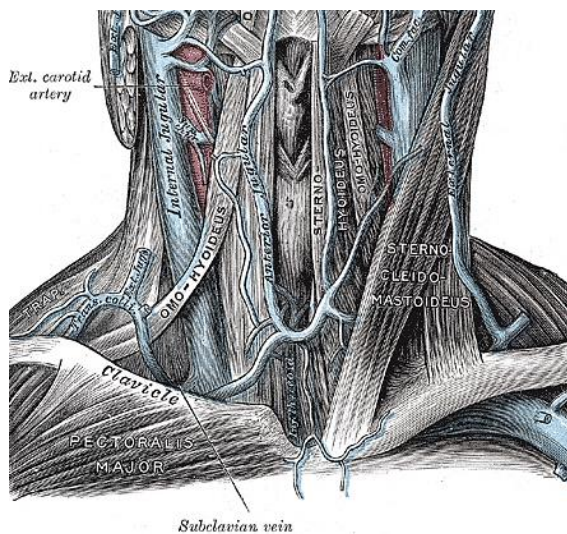


Figure 5: Transverse cervical vein

Distal to the deltoid's origin, the skin is drained by the subdermal veins, which in turn drain into either the cephalic vein or the comitant vein of the brachial artery <sup>14</sup>. There is also a secondary venous drainage for the skin over the deltoid via the perforating veins to the circumflex humeral veins.

### ***Nerve anatomy***

The 3<sup>rd</sup> and 4<sup>th</sup> cervical nerves merge and then arborise into 3 to 5 branches, forming the supraclavicular nerves <sup>22</sup> (Figure 6). These branches provide sensation to the region of the flap over the shoulder. They also supply the skin of the lateral neck and upper chest. The major cutaneous nerve root from the supraclavicular nerves pierces the deep fascia centrally with respect to the sternocleidomastoid muscle <sup>15</sup>. As this nerve root advances toward the pedicle, it

gives two cutaneous branches, an anterior and a lateral branch. **The anterior branch is located 1-2cm anterior to the vascular pedicle and can sometimes be seen during flap harvest.**

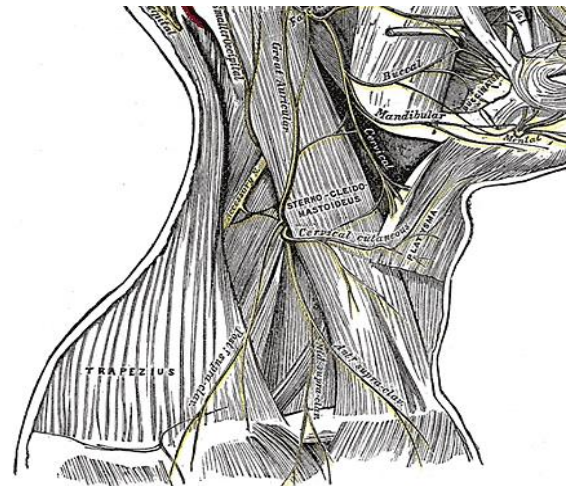


Figure 6: Medial, intermediate and lateral supraclavicular nerves

### **Properties of supraclavicular flap**

Raising a supraclavicular flap is a **simple and quick** procedure, usually done in less than an hour, and is a relatively **easy to learn** procedure. The flap is a good asset for the surgeon, as it is versatile and can correct multiple types of defects.

The flap is **highly reliable** and since the procedure is shorter than free flap reconstruction and does not require expertise in microsurgery, the supraclavicular flap is beneficial for high risks patients who can't sustain long operative time.

The supraclavicular flap is an excellent choice for reconstruction of skin defects in the lower face and neck because of a good **texture and color match** with the skin of the neck and lower face. It also has great **pliability** which makes it suitable for reconstruction of areas with high mobility, such as the neck and oral cavity. Also, since the skin in the supraclavicular area is generally **hairless**, it is an appropriate for

mucosal defects. The skin has a thin dermis and little fat, which accounts for the flap's *thinness* which makes it appropriate for reconstruction of contour sensitive areas such as the anterior neck and for pharyngeal defects in which a bulky flap may impair swallowing.

It can easily reach distant sites, such as the oropharynx, due to its *long pedicle* and *broad arc of rotation*. It can also be used for *large defects*, since the flap can reach a considerable size, with maximum dimensions of approximately *10 x 20 cm*.

### Indications

Historically the flap was used to reconstruct a variety of defects in the neck and lower third of the face, especially with release of scar contractures following burns, trauma or injuries with acid or Lye<sup>3,16</sup>. It is a good option for such defects because of its excellent colour match and the skin properties being similar to the surrounding skin. The flap can also be used for head and neck oncologic reconstruction such as defects of the oral cavity, oropharynx, hypopharynx, and tracheostoma, and following parotid and pharyngoesophageal resection<sup>4,12,13,17,20</sup>. It has also been reported for reconstruction of the pinna<sup>20,23</sup> and lateral skull base<sup>23</sup>. More recently the flap has been successfully used to reconstruct defects following excision of massive arteriovenous malformations of the lower face<sup>8</sup> and in *Noma* patients<sup>24</sup>. It can be used as a primary choice of reconstruction but can also safely be used as a salvage procedure either after radiotherapy or after another flap failure.

### Contraindications

The only absolute contraindication is when integrity of the pedicle has been compromised. This can occur in cases of radical neck dissection or neck dissection includ-

ing Level V where the transverse cervical artery has been ligated. Other surgery that may damage the pedicle are shoulder surgery and excision of skin cancers in the shoulder area. It was previously stated that previous radiotherapy for the neck was a contraindication. It has now however been demonstrated that the flap can be safely used even in the context of previous radiotherapy. If doubt exists concerning the integrity of the pedicle, it can be assessed using preoperative angiography.

### Preoperative investigation

Although not routinely required, computed tomography angiography can be performed to assess the integrity of the vascular pedicle or when there is doubt about the supraclavicular artery anatomy.

### Surgical technique

The supraclavicular flap can be employed as a rotation flap, tunnelled flap, supercharged flap or as a free microvascular transfer flap. If a neck dissection is performed, then vessels to the distal external jugular vein and the transverse cervical artery need to be preserved.

### Supraclavicular rotation flap

- Position the patient in a *supine* position with the *head turned to the contralateral* side
- Clean the entire neck and shoulder with an antiseptic solution
- **Drape** the patient to leave the neck, anterior chest and shoulder regions exposed
- **Draw** the *superficial landmarks for the supraclavicular artery* i.e. clavicle, external jugular vein and posterior border of sternocleidomastoid (*Figure 7*)
- Use a **Doppler probe** to identify the *supraclavicular artery* in the triangle

previously drawn, and mark its exact location on the skin (*Figure 7*)



*Figure 7: The origin of the supraclavicular artery is located in a triangle bounded inferiorly by the clavicle (white line), medially by the posterior border of the sternocleidomastoid muscle (red line) and laterally by the external jugular vein (blue line). The large "X" indicates the exact location of the supraclavicular artery, as identified by the Doppler*

- Use the **finger pinch test** to evaluate the elasticity of the soft tissue in the shoulder area to determine how much skin can be elevated and still allow primary closure
- **Draw the skin island** in an elliptical or fusiform design over the supraclavicular and shoulder / upper arm (*Figure 8*)
- **Include the point where the supraclavicular artery pedicle** was identified
- The base of the flap can be connected with the neck incision if needed (*Figure 8*)
- Design the size of the flap according to the defect to reconstruct; maximum size is approx. 12cm wide x 21cm long
- The insertion of the deltoid marks the farthest point that the flap can extend without concern for distal necrosis

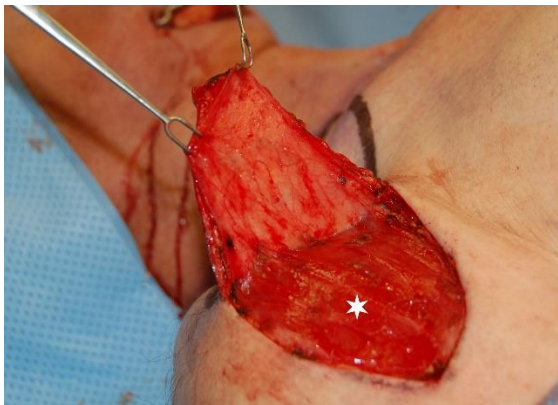


*Figure 8: Patient with plate extrusion following total mandible reconstruction with a fibula flap and radiation therapy. The bone was viable. A supraclavicular flap was used for coverage of the soft tissue defect following removal of the plate. The base of the flap can reach the neck incision. The hatched part of the flap was included to allow primary closure without a dog ear deformity and was meant to be sacrificed after flap inset*

- The flap can however be made longer if supercharged or pre-expanded
- Do not infiltrate the skin along the incision lines with a vasoconstrictor, as vasoconstriction might complicate assessment of flap perfusion
- With the skin island flap delineated, incise the skin down to the level of deep fascia (*Figure 9*)
- Elevate the flap by dissecting from distal-to-proximal in a subfascial plane over the deltoid muscle (*Figure 10*); although some authors prefer to dissect from medial-to-lateral<sup>3,17</sup>
- Elevate the flap using sharp (scalpel) dissection or needle monopolar electrocautery; when dissecting the proximal third of the flap, switch to bipolar electrocautery and cold dissection to avoid inadvertent injury to the supraclavicular artery

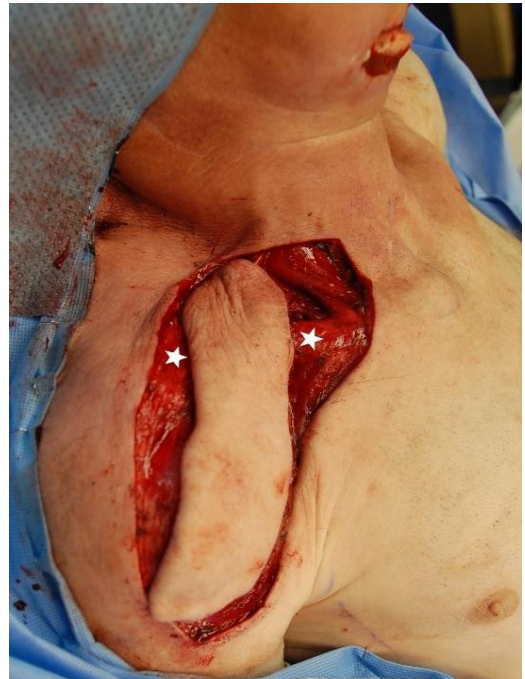


*Figure 9: With the skin island flap delineated, the incision is taken down to the level of the deep fascia*

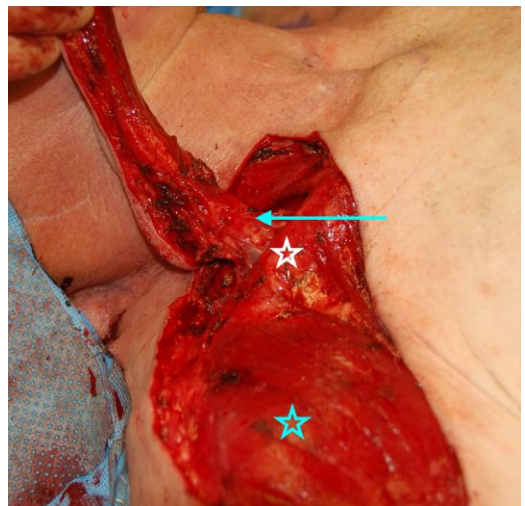


*Figure 10: At the junction of the middle and lateral thirds of the clavicle, the supraclavicular artery generally divides into numerous branches over the deltoid muscle (white star)*

- Elevate the flap over the periosteum of the clavicle (*Figure 11*)
- The **pedicle does not need to be skeletonised** unless extra mobility of the flap is required; a moderate amount of fat can be kept around the expected location of the supraclavicular artery to protect it from inadvertent damage and tension (*Figure 12*)
- If the pedicle needs to be skeletonised it can be precisely located with the help of a Doppler. The pedicle is then skeletonised and its attachments released



*Figure 11: Over the clavicle, the flap is elevated over the periosteum of the clavicle (white stars)*



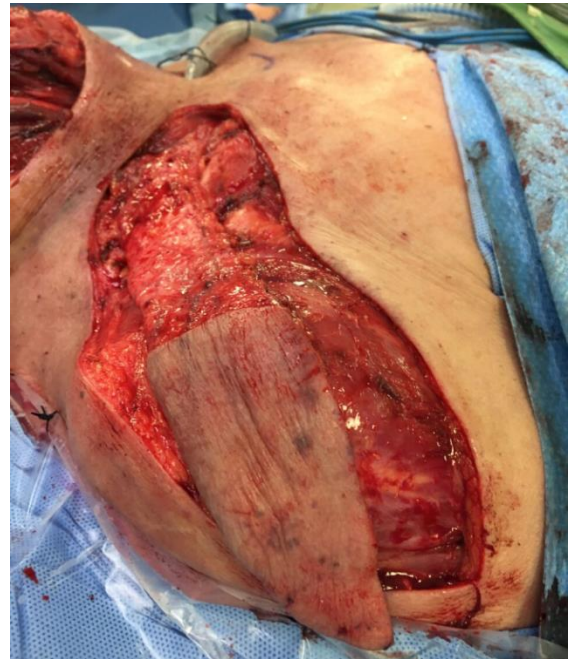
*Figure 12: A moderate amount of fat (arrow) can be kept around the expected location of the supraclavicular artery to protect it from inadvertent damage and tension. The blue star is on the deltoid and the white star on the clavicle*

- Another technique to protect the pedicle is to perform a subperiosteal dissection on the anterior surface of the clavicle (*Figure 13*)



*Figure 13: Subperiosteal dissection on the anterior surface of the clavicle to protect the vessel*

- Once the pedicle has been located, incise the skin island proximally
- With the flap completely elevated, trim the distal tip of the flap until proper bleeding is noted
- If the flap is to be tunnelled (*Figure 14*) or used to reconstruct a mucosal lining (*Figure 15*), the proximal portion is deepithelialised. Care must be taken to preserve part of the dermis to protect the subdermal venous plexus
- Rotate the flap to inset it into the defect
- The flap can tolerate 180<sup>0</sup> rotation at its origin from the transverse cervical artery (*Figures 16, 17, 18*)
- Shape the flap to fit the defect and suture it into place; the last part of the flap to incorporate in the defect is the distal extremity, as it will be trimmed and discarded if not needed
- Take care not to stretch or kink the pedicle; keeping some fat around it helps to protect the pedicle



*Figure 14: If the supraclavicular flap is tunnelled, the proximal part should be deepithelialised*



*Figure 15: For intraoral reconstruction, the deepithelialised area can be large; care must be taken to preserve part of the dermis to protect the subdermal venous plexus*



Figure 16: Extensive skin squamous cell carcinoma requiring wide local excision and functional neck dissection (Courtesy Dr Jackie Bibeau-Poirier)



Figure 17: The skin defect cannot be closed primarily. We elected to perform a supraclavicular flap to optimize colour match and contour



Figure 18: Insetting flap following 180° rotation. The donor site has been closed primarily

- Most donor sites can be closed primarily in a double layer fashion, using Vicryl 2-0 and staples (Figure 18); extensive undermining in a subcutaneous plane, anteriorly over the pectoralis major muscle and posteriorly over the trapezius muscle, is generally needed to close the donor site primarily
- Flaps that are wider than 10cm are difficult to close without excessive tension. Options for closure in this case are split-thickness skin graft or a local flap harvested from the dorsal region<sup>5,16</sup>
- A suction drain is usually left in the donor site
- The skin island is monitored with coloration, refill and temperature for the first 72h

### Tunnelled flap

The same technique is generally used for tunnelled flaps, with the added steps of deepithelialisation of the flap and creation of a subcutaneous tunnel for its transposition. Tunneling has the advantage of providing superior aesthetic results. As the flap is thin, compression is rarely an issue. However, care should be taken to create a wide tunnel for the pedicle to avoid compromising the blood flow to the distal flap. Therefore, tunnel flaps are not recommended in previous radiated necks or with scar tissue.

### Supercharged flap

The supraclavicular flap can be supercharged if a larger size is needed. The technique has been described using mostly the posterior circumflex artery. According to Vinh *et al.*<sup>5</sup>, the anterior humeral artery, lateral thoracic artery perforator or the thoracoacromial artery perforator can be appropriate for supercharging.



## **Free flap**

The application of the supraclavicular flap as a free flap has previously been described. Since the diameter of the supraclavicular artery is relatively small, its reliability is variable and we recommend using other options before reconstruction as a free flap is considered.

## **Complications**

**Superficial distal necrosis:** Superficial distal necrosis occurs in 4%-22% of cases <sup>2,5,16-19</sup>. Principal causes are excessive tension on the pedicle and inappropriately long flaps. Excessive tension may result from tight closure, tunnelling under scar or irradiated tissue, compressive dressings, postoperative neck oedema or any other factors that may impair vascularisation of the tip of the flap. Avoiding these may prevent distal flap necrosis. In most instances, the necrotic zones will reepithelialise naturally and no intervention is necessary.

**Total flap necrosis:** This is a dreaded complication, resulting from trauma to the supraclavicular artery during flap harvest. The incidence of total flap necrosis varies between 2 - 6% <sup>5,9,19,20</sup>. Small and tortuous arteries which are more difficult to locate are risk factors for inadvertent injury to the pedicle. The modified supraclavicular island flap, in which fascia and fat are left surrounding the vascular pedicle may be helpful to prevent total flap necrosis.

**Incisional dehiscence:** Incisional donor site dehiscence occurs as a result of insufficient undermining when closing the donor site or use of an excessively large flap which results in excessive wound tension. The dehiscence is usually minor and resolve with local wound care. Vacuum-assisted closure and skin graft are effective when the dehiscence is more significant.

**Haematoma:** This is a rare complication. It is important to recognize it promptly as it may prolong healing.

**Seroma:** Seromas develop in 0-15% <sup>9</sup> of cases and are generally treated with aspiration and wound care.

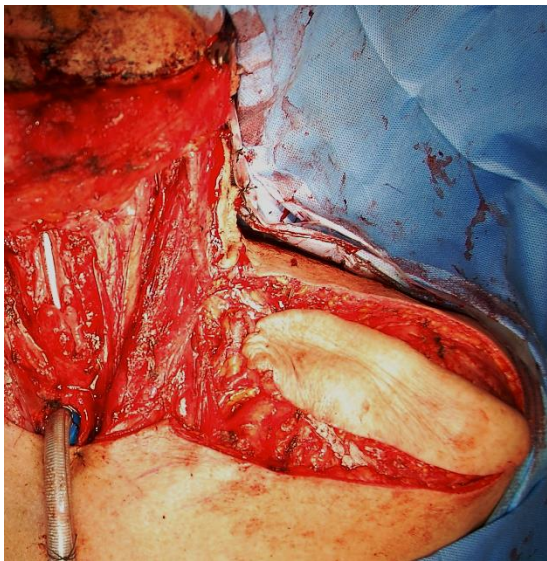
**Shoulder dysfunction:** There is minimal morbidity on the shoulder after the procedure. Few patients complain of shoulder pain after supraclavicular flap surgery and most of them respond well to anti-inflammatories and physiotherapy. Around 14-22% <sup>4,12,15,16</sup> of patients describe referred sensation to the shoulder with sensate stimulus of the flap such as touching the flap or swallowing when the flap is used for mucosal lining. No paraesthesia or numbness over the shoulder area has been reported. Since the flap includes only skin, fat and fascia, upper limb movement is preserved <sup>2,5,9</sup>. When a limitation is present, it is generally temporary <sup>2,9</sup> and results from excessive tension on the closure causing a sensation of tightness over the shoulder area. *Herr et al.*<sup>9</sup> prospectively studied the shoulder function of 10 patients following supraclavicular flap with objective parameters. They showed that muscle strength was good to excellent in 90% of patients and that the limitations present were mostly range of motion, especially external rotation. Nonetheless, most patients are satisfied with the shoulder function <sup>9,16</sup> and appearance <sup>5,16,20</sup>.

## Clinical Cases

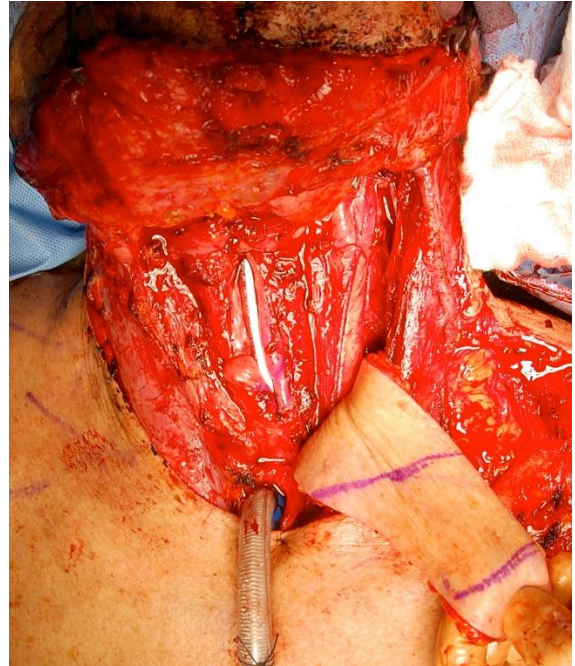
**Case 1:** A patient following total laryngectomy and partial pharyngectomy for hypopharyngeal cancer (*Figures 19-23*)



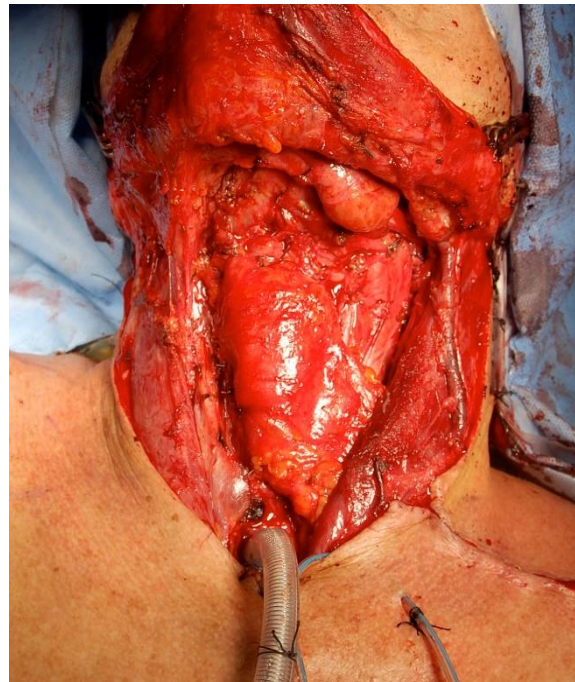
*Figure 19: Mucosal defect requires reconstruction with a flap to avoid stenosis*



*Figure 20: We elected to perform a left supraclavicular flap*



*Figure 21: The skin in the central part of the flap between the purple lines was used to reconstruct the mucosal defect. The distal and proximal parts of the flap were deepithelialised and used for coverage and protection of the carotid axis*



*Figure 22: Flap inset*



*Figure 23: Scar in an irradiated area, 6 months following surgery*

**Case 2:** 80yr-old female with cancer of buccal mucosa, inferior alveolus and floor of mouth involving skin. Underwent hemimandibulectomy, resection of skin and neck dissection. Reconstructed with pectoralis major (intraorally) and supraclavicular artery island flaps (external skin)



*Figure 24: Note cancer involving skin, and planning drawings of the pectoralis major and supraclavicular artery island flap*



*Figure 25: Supraclavicular artery island flap has been used to cover the skin defect, and pectoralis major for intraoral repair*

**Case 3:** Squamous cell cancer of ear treated with superficial parotidectomy, lateral temporal bone resection and selective neck dissection.



*Figure 26: Cancer destroying external ear and extending down ear canal*



Figure 27: Completed superficial parotidectomy, lateral temporal bone resection and selective neck dissection



Figure 28: Supraclavicular artery island flap used to cover the lateral skull base defect

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## Videos

<https://www.ahns.info/resources/education/video/supraclavicular-flap-video/>

## Other flaps described in *The Open Access Atlas of Otolaryngology Head & Neck Operative Surgery*

- [Pectoralis major flap](#)
- [Buccinator myomucosal flap](#)
- [Buccal fat pad flap](#)
- [Nasolabial flap](#)
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