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# Anesthesia for Reconstructive Surgery of Head and Neck

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## 1. Abstract

Reconstructive head and neck surgery is the main determinant of postoperative quality of life for patients who have undergone surgery for neoplastic pathology, since good aesthetic and functional results are essential to reduce the incidence of complications. To a large extent, the success of these results depends on a team of anesthesiologists who have advanced knowledge in airway management, preoperative risk assessment and hemodynamic implications of the different oncological surgery techniques. Even knowledge of anesthetic techniques (total intravenous vs. inhalational) seems to reduce complications related to pulmonary pro-inflammatory phenomena and improve flap viability. Reducing the incidence of infections, fistulas, nutritional management and tracheostomes is part of the active role of postoperative care units directed by anesthesiologists in conjunction with other specialties, which in part reduces hospital morbidity and mortality, improving the prognosis of our patients. In conclusion, multidisciplinary management in this type of patient is essential to guarantee better postoperative results.

## 2. Introduction

Reconstructive surgery is one of the central pillars in the treatment of any type of cancer. However, it is possible that many of the professionals involved in this type of surgery are not aware of the extent to which anesthetic management can favour the success or failure of this type of surgery. Over the years the anesthetic practice has changed throughout the perioperative process. The perioperative medicine aims to improve surgical results and minimize the risk to the patient's life by optimizing their functional reserve. The following pages are intended to be a guide for the anesthesiologist who wants to offer better results to patients undergoing reconstructive head and neck surgery and for the plastic surgeons or ear, nose and throat surgeon (ENT surgeon) who wants to learn more about the interventions that the anesthetist can perform to improve their results.

## 3. Anatomy

Head and neck anatomy is complex, even more if we consider patients who have had it previously modified by surgeries and are going to get reconstructive surgery. We are going to summarize the most relevant issues for anesthetic management. Firstly, upper airway, which includes nose, pharynx and larynx will be reviewed. Then, lower airway will be reviewed.

The nose and the mouth are the beginnings of the airway. The nose is divided in two nares, which extends from the nostrils to the nasopharynx. They are divided one from a another by the nasal septum, which is composed by the ethmoid bone, the vomer bone and the septal cartilage. The cribriform plate of the ethmoid bone separated them from the basilar skull. Laterally,

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they are bound by three turbinate bones (conchae): superior, middle and inferior, which give rise to three spaces called "meatus", where the nasolacrimal duct and the paranasal sinuses drain. The turbinate bones have a rich vascular supply, which can be easily damaged during nasotracheal intubation and be a source of problems [1]. Due to the wide variety of reconstructive head and neck surgeries, it may be necessary for the anesthetist to manage the patient's airway through the nose, that it is, using a nasotracheal tube. It is not a matter of interest just for the anesthesiologist, but for the surgeon too [1], to be aware of the complications this kind of management can arise; this is because the surgeon help may be needed at the moment of after the intubation and they may be confronted with possible complications once the patient is on the ward. One of the most frequent complications is epistaxis, it is easily managed most of the times but there can be life threatening hemorrhages which must be rapidly cut down [2]; more frequently, epistaxis increases the difficult of the laryngoscopy maneuver due to the presence of blood on the oropharynx and hypopharynx. Bacteriemia after nasotracheal intubation [3] is also a frequent complication; although, it may be possible that incidence rates of bacteriemia after nasotracheal intubation does not differ from those after orotracheal intubation [4,5].

The pharynx extends from the choanae until the beginning of the larynx and the oesophagus. There are three well different sections [1]: the nasopharynx (from the choanae to the soft palate), the oropharynx (from the soft palate until the epiglottis' upper edge) and the hypopharynx (from the epiglottis until the beginning of the oesophagus, approximately at the same level of the hyoid bone). To assure patency all along the pharynx is the first step to maintain the patient's airway so that it can be possible to ventilate and oxygenate him. A troublesome anatomic structure at this level is the Waldeyer ring, which is composed of lymph nodes that can be hypertrophic and step up a level in the airway management difficult. It is important to remember distances between anatomic references, as it can help us to adequate the depth of the endotracheal tube, considering the possibility of a highly distorted anatomic scenario.

Larynx is an ensemble of muscles and ligaments which get it support all along a cartilaginous structure and the hyoid bone [1]. On it upper border, it is the continuation of the hypopharynx whereas on it down border it connects with the trachea. The cartilages that set up the larynx are thyroid, epiglottis, cricoid and arytenoid cartilages (Figure 1).

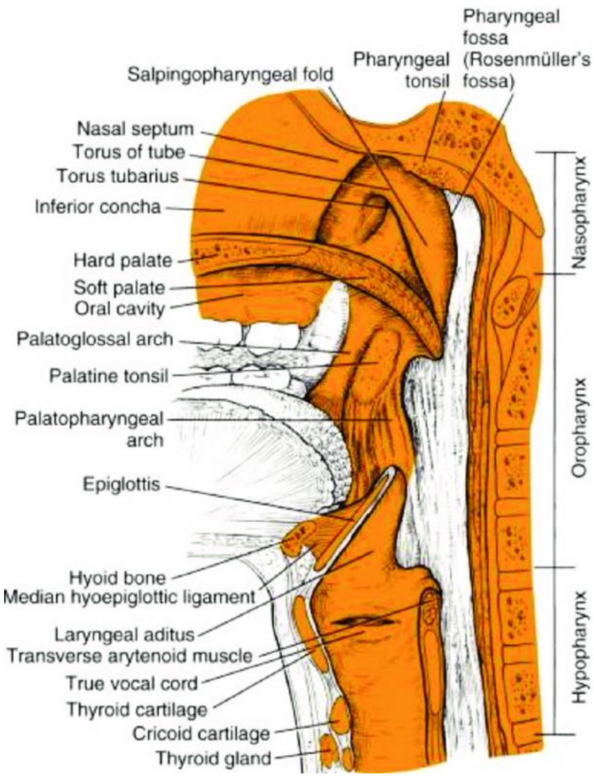


**Figure 1**: Anatomy of head and neck. Retrieved from Parul S, Uli H. Cummings Otolaryngology. Páginas. 2015; 1432.e4-1453.e4.

All of them are ensemble among them and with the hyoid bone, which is the structure where the trachea gets its anchor. Between thyroid and the cricoid cartilages there is the cricothyroid ligament, where an emergency front of neck airway is performed. The set of tracheal cartilages are of high clinical relevance for the anesthesiologist, both for the information it can provide during the management of the airway and for the maneuvers that are carried out when manipulating them. On the other hand, there are two maneuvers that depend on knowledge of the laryngeal anatomy: the

Sellick maneuver and the BURP (Backward, Upward and Rightward Pressure) maneuver. The Sellick maneuver [6,7] is used during what is known as “rapid sequence induction”, which is applied in patients in whom surgery cannot be delayed despite not having fulfilled the fasting time considered necessary for avoid an episode of bronchial aspiration. It consists of pressing the cricoid cartilage against the back of the neck, once the patient is asleep, increasing the pressure in the upper part of the oesophagus. This pressure increase would prevent the regurgitation of food debris that could be found in the stomach after anesthetic induction of the patient. To date, it is quite questioned and more than half of anesthesiologists do not use it [8]. Another useful maneuver during airway management, which requires manipulation of the thyroid cartilage, is the “BURP maneuver [9]. When performing this maneuver, a better visualization of the glottis is achieved, which facilitates intubation [10]; although simple to execute, the airway manipulator must remember its existence and request an assistant to carry it out, placing his hand himself according to what he observes in direct laryngoscopy.

The airway control we are interested in two questions. One of them is cricothyrotomy, for which it is necessary to topographically identify where the thyroid and cricoid cartilage meet, so that a safe airway can be established through its membrane. The other relevant issue is the Cormack-Lehane classification [7,11], which was described for the first time in 1984 and allows determining the degree of difficulty of direct laryngoscopy. Two cartilages are mainly involved in this classification: the epiglottis and the arytenoid cartilages. Grade I allow direct vision and intubation without problems, while later grades imply the need for greater skills on the part of the anesthetist and the use of accessory instruments that allow them to achieve a successful intubation in one way or another. The epiglottis will be a constant element in all of the grades but for grade IV, while arytenoid cartilages will allow us to differentiate grade II from grade III.

Finally, it is important to remember that larynx’ innervation is carried out by branches of the X cranial nerve or the pneumogastric nerve: this are the recurrent laryngeal nerves [1]. They carry out the motor innervation of the intrinsic muscles of the larynx and sensory from the vocal cords to the upper part of the trachea. The inferior pharyngeal constrictor and cricothyroid muscles are innervated by the superior laryngeal nerves, which carry on solely motor innervation. The sensory innervation of the vocal cords is carried by the internal laryngeal nerve, a branch of the superior laryngeal nerve. This anatomical review is relevant since, during thyroid surgery or adnexal masses or even during intubation, these nerves can be damaged, which would lead to problems in phonation or, if the nerves are damaged bilaterally, it makes breathing difficult. [12-14]

The trachea begins at the level of the cricoid cartilage [1]. It is made up of cartilaginous rings in its anterior part and in its posterior part it is smooth, its posterior wall supposes only the smooth muscle that surrounds it as another ring. This conformation allows the trachea to decrease its calibre in response to certain stimuli. During flexion and extension of the neck, the trachea may shorten or elongate, respectively [15,16]; therefore, endotracheal tube movements must be monitored during patient positioning, as selective intubation or accidental extubation may occur.

## 4. Airway Management

Airway management is a basic aspect of the daily practice of anesthesiology teams. This aspect is relevant for the ENT surgeon for two reasons: first, because it shares the field of work with the anesthetist; second, because his help may be asked for the diagnosis or management of the compromised airway: either on a scheduled or emergent basis. Therefore, it is mandatory that a good communication between the anesthesia an surgery team is established, something we will highlight all along this section.

The National Audit Project 4 (NAP-4) [17], carried out in the United Kingdom by the Royal College of

Anesthetists and the Difficult Airway Society, was a study in which serious complications secondary to airway management were identified and its cause. Of all cases examined, 40% (n = 72) were related to some type of otorhinolaryngological pathology, which represents a high percentage associated with a specific group of patients. This indicates the high risk of these patients and the need for a joint presurgical evaluation by the surgeon and the anesthetist. In patients who are going to undergo reconstructive head and neck surgery, on many occasions we can find significant alterations in the anatomy of the oral cavity, pharynx, larynx or trachea, which can make management even more difficult of the patient by the anesthesia team.

At the presurgical anesthesia consultation a broad general medical history and thorough examination of head and neck must be done in these patients. Most of these patients' cancer are related to alcohol and tobacco, so they can also have developed chronic obstructive pulmonary disease, hypertension, some degree of liver and coronary artery disease and they are predisposed to pneumonia due to mechanical ventilation. Patients who are diagnosed or seems to have obstructive sleep apnea (OSA), must undergo a careful assessment, as their pharyngeal anatomy may predispose them to a "can't intube, can't oxygenate" situation which could have been prevented. Previous anesthesia and surgery records will be of interest for surgeries ahead, as they will provide information about postsurgical changes we should expect or about previous difficult airway management. The latter is considered one of the most valuable predictor of subsequent difficult airway management.

Physical examination of head and neck is mandatory on these patients. Mallampati score, upper lip bite test, evaluation of the tongue and dentition, facial hair (beard or moustache), neck mobility and thyromental distance (>6.5 cm indicates an acceptable laryngoscopy view) [18] should be performed. At the same time, we may also check for changes that could have occurred due to radiotherapy, tumours or previous surgeries. Head and neck cancer patients' upper aerodigestive tract mucosa may be friable and present with edema, these conditions should be addressed before a direct laryngoscopy is made, as it can lead to a heavy bleed.

At the preoperative consultation, we should also check for complementary studies, particularly for computed tomography (CT) or magnetic resonance imaging (MRI), as they will help us to determine location, size and morphology of the obstruction due to the tumour or to previous surgeries. Sometimes, ENT surgeons had previously performed and recorded, at their consultation, indirect laryngoscopy that can give us a better idea of the scenario we will find at the critical moment.

In most cases, the airway could be classified as "easy to manage" or "basic"; it means that anesthesia resident with basic training would be able to maintain a patent airway, either by means of a face mask, by supraglottic devices, or by endotracheal intubation. Certain patients may present what the American Society of Anesthesist (ASA) [19] defines as "a clinical situation in which a conventionally trained anesthesiologist experiences difficulty with facemask ventilation of the upper airway, difficulty with tracheal intubation, or both."; that is, a difficult airway. Studies show some variability in the incidence of unanticipated airway. While the ASA's "Practice Guidelines Management for Difficult Intubation" report an incidence between 1- 3%, a 2005 review article of 35 articles found this incidence to rise to almost 6% [20].

The consequences of a difficult airway are serious and, in many cases, fatal. Among them we can find hypoxia (and what derives from it: brain damage, heart damage and death), hypoventilation, oesophageal intubation, broncho aspiration, trauma to the airway and awakening of the patient [17]. Even if an adverse event is not generated as such, it can have repercussions that we could say "not tangible". Patient may not understand the risk posed by their difficulty in airway manage; this will lead to it not being communicated in subsequent anesthetic inductions and its surgical safety in the future being compromised. Difficult airway usually implies additional difficulty and stress for anesthetist.

The NAP-4 [17] emphasizes the need to establish a main plan, whose objective is to obtain a patent airway, safe and with the minimum possible damage, regardless of how it is established. Likewise, it influences and highlights the importance of developing secondary plans, in case the main plan fails. In this sense, various medical associations have developed algorithms that facilitate decision-making in the event that the first airway plan fails, whether the airway is initially easy or difficult. Despite these algorithms, which we will develop below, a recent analysis [20] of the ASA database "Anesthesia Closed Claims Project", on claims in relation to difficult airways, showed that 73% of cases, the airway had been mismanaged and in those cases in which a surgical airway was required, it was late in 31%. Emphasizing once again the added difficulty that ENT patients have and especially those who must undergo reconstructive surgery (which may involve important anatomical alterations), a close collaboration between the patient, ENT surgeon and anesthetist.

Among the various management proposals, we highlight three: the ASA [18] and DAS (difficult airway society) [21] clinical practice guidelines for the management of difficult airways and the "Vortex" proposal [22].

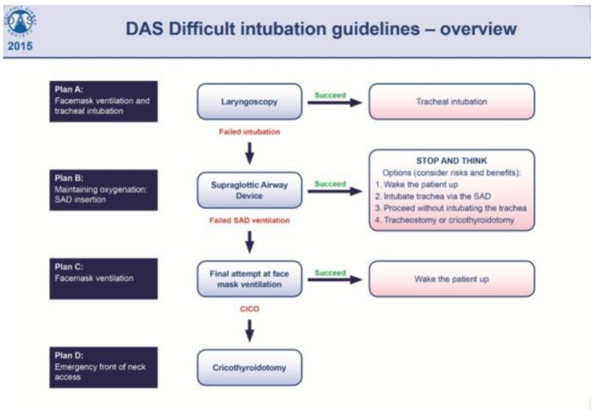


**Figure 2:** DAS difficult intubation guidelines. Retrieved from C. Frerk. British Journal of Anesthesia. 2015; 115: 827-847.

In a global way, the management is always based on three points: facial mask, laryngeal mask and endotracheal tube. As can be seen in the DAS and ASA algorithms (Figure 2 and 3), they assess the possibility of awake intubation and on the other, carry out the usual sequence, consisting of sleeping the patient and proceeding to manage the airway. In both cases, as the algorithms progress, it is necessary to be clear that oxygenation of the patient comes first, regardless of how it is achieved. Although, with a more intuitive and less schematic drawing, it is a concept very similar to that proposed by the "Vortex approach": the three pillars of airway management are available, we will go to the bottom of the vortex with the negative consequences that this implies.

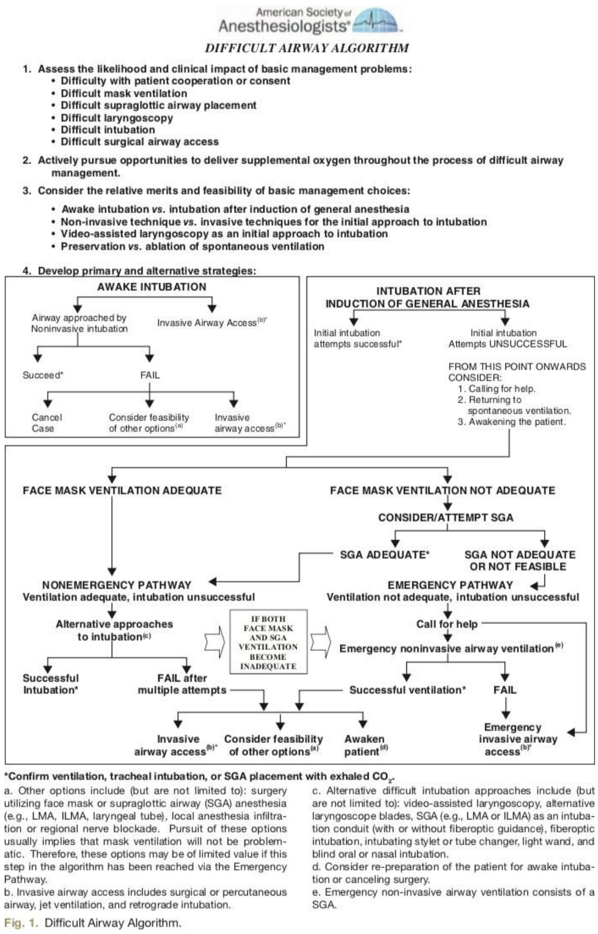


**Figure 3:** ASA difficult intubation guidelines. Retrieved from American Society of Anesthesiology. Inc. Lippincott Williams & Wilkins. Anesthesiolgy. 2013; 118.f

Here we will describe some of the techniques that can be found on these management proposals; we propose the reader return to the algorhythms once he has finished with these technical descriptions and try to learn them by heart, so he can quickly recognize a situation and be able to follow the correct step.

Sometimes, particularly if there is a potentially difficult airway, it is advisable to perform an examination of the airway in the awake patient. To do this, it will be necessary to perform a very careful direct laryngoscopy by a skill full operator after the patient has been lightly sedated and topical lidocaine has been sprayed all over the mouth and the oropharynx aiming to reduce patient's discomfort but avoiding the compromise of patient's spontaneous breathing; it is also important to remark that it is important to explain the overall technique to the patient and during the performance, each step we take. This awake examination, which obviously is not mandatory, can help us whether to proceed with the standard procedure (this is, induction of general anesthesia and oro or naso-tracheal intubation) or keep in mind other approaches.

Awake intubation can successfully be achieved either using orotracheal or nasotracheal route. As well as during awake examination, a judicious sedation all along with topical lidocaine is mandatory so that the patient be able to collaborate but allow the procedure. Traditionally, awake intubation as been done using bronchoscopies, since the introduction of the flexible fibreoptic bronchoscopies these had been the most used. At awake nasotracheal intubation using fibrobronchoscopy, we should first advance the endotracheal tube until the 15 cm mark, remove the connector and then use the fibrobronchoscopy to guide the insertion of the tube into the trachea. Lately some studies [23,24] have shown the efficacy of video laryngoscopy to successfully perform this technique. Video laryngoscopy enable shorter intubation times in comparison with flexible bronchoscopy and there is not an increase in adverse events.

In reconstructive head and neck surgery rarely will we find urgent situations in which an urgent tracheostomy is needed but, from time to time, we may find scheduled surgeries in which the best approach is to perform an awake tracheostomy under local anesthesia and light sedation. These patients usually have been operated multiple times and the anatomy is strongly distorted, so there is an increased risk that induction of general anesthesia can lead to a "can't intubate, can't oxygenate" situation. For this reason, is important also not to excessively sedate the patient while the ENT surgeon is performing the tracheostomy, thus avoiding upper airway obstruction. Once again, we highly recommend a good communication between anesthesia and surgery teams in these patients.

Other options to achieve an adequate airway ae rigid bronchoscopy and retrograde intubation. Both are rarely used. Rigid bronchoscopy, which is a hollow stainless-steel tube through which a rigid telescope is located, is indicated as one of the rescue tools if the operator gets to a "can't intubate, can't oxygenate" situation, according to the ASA algorithm [19]. Retrograde intubation may be useful in patients with very restricted cervical mobility, any cause of limited mouth opening or upper airway masses; it is based on the Seldinger technique: first of all, puncture of the cricothyroid membrane with a needle; the needle is then directed cervical and a wire is passed through the larynx until it comes out through the nose or the mouth; then, the endotracheal tube is advanced over the wire, blindly, into the trachea [25].

Even though all these resources, it is still possible that the anesthesiologist cannot intubate. Guidelines recommend that a maximum of three attempts are done, an another one by a different operator. Repeated attempts will lead to augmented edematous mucosa, bleeding and worsening of subsequent attempts. If one definitely gets to a "can't intubate" situation, then the main objective is maintaining an adequate oxygenation until it is possible to intubate the patient or to awake him. To maintain an adequate oxygenation, we will use bag-mask ventilation and probably will need the help of a oropharyngeal cannula. If successful bag-mask ventilation is achieved, further intubation attempts modifying the techniques employed can be done. While maintaining bag-mask ventilation, a flexible fibro-bronchoscopy can be passed through the upper port of the bag-mask (or a Patil endoscopy mask can be used) and then through the oropharyngeal cannula following a conventional fibrobronchoscopy intubation technique. If bag-mask ventilation fails then all guidelines recommendations are to employ a supraglottic device such a laryngeal mask airway (LMA). Even though LMA use has strongly increased in bag-mask ventilation failure, [26,27] it is not recommended to continue a head and neck reconstructive surgery with these devices, as they cannot be trusted as safe as an endotracheal tube in patient with modified anatomy and surgeries that may need head position changes during the procedure. Another option [28] is to perform a definitive intubation through the LMA device. This can be done advancing an optical fibrobronchoscopy through the LMA and then removing the LMA and the bronchoscopy; this technique may be improved if an intubation catheter like FROVA or Aintree is firstly positioned into the trachea guided by the bronchoscopy and then, after removing the latter, advancing an endotracheal tube through it. It is important to keep in mind that endotracheal tube size will be determined both by LMA and bronchoscopy sizes.

One of the issues that NAP-4 revealed is the late request for surgical airway accesses. Both the DAS and the ASA algorithms establish the steps to follow and in the event that a situation of “can't intubate, can't oxygenate” (CICO) is found, it is necessary to go to the hospital without delay surgical approach, since persisting in the oral approach to it will delay the surgical approach, surgeries will need the endotracheal tube to be placed in a definite way, which usually is planned with the ENT surgeon. When taping the tube in the position asked, we must ensure it is well fixed, as it may be displaced accidentally during surgery and the anesthesia team cannot quickly access to the airway; even though ENT surgeons can secure the airway if needed. Whether the position may be, we also must ensure that the tube and soft tissues, such as the nose, the lips or even the ears, are padded; during procedures, ENT surgeons can rest themselves or surgical material over patients, leading to wounds caused by excessive pressure if they are not which can have fatal consequences for the patient. There are two techniques to get a cricothyrotomy as a surgical airway: the surgical technique or the needle one. The first one is achieved after palpating an indentation in the skin, just between the cricoid and the thyroid cartilages. Then, a vertical skin incision is made and immediately after, a horizontal incision is made in the cricothyroid membrane. There is just a slight subcutaneous tissue between the skin and the cricothyroid membrane, so we will easily find it. After both incisions are made, a small tube or tracheostomy cannula is inserted and secured. After this, as soon as is possible, a proper tracheostomy must be made. The needle technique will allow us only to oxygenate the patient, but we will not be able to ventilate him, so further attempts of establishing a secure airway must continue; as it can be worked out of its limitations, this technique is limited to emergent situations where there is not appropriate equipment nor trained personnel. For this option we will use a large gauge intravenous catheter and needle: firstly, we will go through the membrane with the needle and the catheter and a syringe; when air is aspirated, we will advance the catheter into the airway and get the needle off. Finally, the catheter will be attached to an oxygen supply.

We will, once again, remember the fact that the airway is the surgical field. This implies that both anesthesia and surgery teams must adjust their needed to this situation. For anesthesia, this implies that most of the

properly protected. Finally, as endotracheal tubes (not tracheostomy cannulas) are in the middle of the surgical field, they sometimes can be damaged, particularly if laser surgery is ongoing; for this situations, stainless steel tubes are used, so that they cannot be damaged by laser. Also, these tubes are double cuffed and filled either with normal saline or metilen blue dyed normal saline; it may allow the surgeon to realize that at least one of the cuffs is damaged and then optimal ventilation could be compromised if the second one gets any harm.

## 5. Anesthesia Modalities and Results

One of the main surgeries performed in tumour reconstructive surgery are microvascular free tissue flaps. Success rates are usually very high between 95 and 99% [29], however postoperative complications are around 37.6% and 32.5% [30,31]. Clark et al. [30] reported several complications: pneumonia, stroke, congestive heart failure, myocardial infarction. Pulmonary complications are usually the most frequent [32]. Having a hemoglobin lower than 11 g / decilitre, tracheostomy and preoperative radiotherapy were the main factors associated with surgical complications [30].

Anesthetic management is essential to guarantee adequate surgical results [33]. The main objective consists of specific management that guarantees a blood pressure above 100 mmHg, low vascular resistance, high urinary output and adequate ventricular ejection. These factors appear to be important in ensuring the viability of the flap [34,35]. Yi-ting et al. wanted to study the impact of anesthetizing patients with inhalational vs intravenous general anesthesia (TIVA) to determine its impact on complications in free flap surgery.

The demographic data of that study were similar to those of previous studies, which suggested that head and neck patients are predominantly male, often have a history of smoking and are more likely to have comorbidities such as hypertension and diabetes mellitus [30,31]. Compared to the patients in a study by Clark and colleagues, most of patients were ASA class I& II (89.7% vs. 49.2% [30], respectively) and younger (mean age 52.64 years vs. 60.1 years [30]). These two factors may account for the absence of medical complications such as myocardial ischemia, congestive heart failure and stroke in our patients. The total mortality was 1.3%, which was comparable with that of other studies (Nobel et al. [31], 0.3% and the Clark et al. [30], 1.6%). 105 complications (65 medical and 40 surgical) developed after surgery. The overall complication rate was similar to that of a previous study [31] (33.65% vs. 32.6%).

Yi-Ting et al. Analyzed [36] 156 patients with head and neck cancer who underwent free flap surgery. Comparing the 96 patients who received TIVA to the 87 patients who received inhalation anesthesia, there were no differences in gender, age, classification of American Society for Anesthesiologists physical status (ASA), BMI, current smoking history, preoperative chemotherapy, preoperative radiotherapy or comorbidity such as hypertension and diabetes mellitus between two groups. Patients in the TIVA group needed significantly less intravenous crystalloid (4172.46 ± 1534.95 vs. 5183.91 ± 1416.40 ml, $p < 0.001$) or colloid (572.46 ± 335.14 vs. 994.25 ± 434.65 ml, $p< 0.0001$) administration to maintain hemodynamic stability which may have resulted in significantly lower central venous pressure (7.04± 3.13 vs. 8.53 ± 3.23 mmHg, $p = 0.0039$), less urine output (1509.86 ± 1063.95 vs. 2074.48 ± 1115.10 ml, $p = 0.0001$) and less total fluid balance(2316.30 ± 1056.73 vs. 3243.97 ± 1282.99 ml, $p < 0.0001$) Maintaining adequate hemodynamic conditions as well as maintaining hematocrit around 30%-35% [35] is a fundamental objective in microvascular flap transfer surgery. An increase in systemic vascular resistance is observed in the TIVA group and less damage to left ventricular afterload compared to sevoflurane, which reduces arterial tone [37,38]. All of this results in less use of crystalloids in the total intravenous anesthesia group with all the benefits it brings, for example in reducing extravascular losses and excessive fluid intake, which improves graft viability and reduces cardiopulmonary complications. as operative [6].

The most important finding in Yi-Ting et al. study [36] was that patients in the TIVA group had significantly associated with fewer postoperative pulmonary complications (18 vs.47, $p < 0.0008$). Indeed, it is reasonable to speculate that owing to the significantly lower perioperative fluid requirement in the TIVA group, less pulmonary complication developed postoperatively. Several studies suggested repeated fluid resuscitation could lead to increased postoperative medical complications [29,30]. The finding was in line with that of a study by Zhong et al. [39] that showed crystalloid was an independent risk factor for postoperative complications and suggested the crystalloid volume replacement rate should be between 3.5 ml/kg/hr and 6 ml/kg/hr. The difference of overall fluid balance may also lead to fewer pulmonary complications. In this study, overall fluid balance in the TIVA group (2316.30 ml ± 1056.73 ml) was significantly lower than that in the inhalation group, which was similar to the results of a recently published national survey in the United Kingdom [35].

Despite the obvious differences in fluid requirement, the anesthesia duration was shorter in the TIVA group (11.02 ± 2.84 vs. 11.70± 1.96 hours, p = 0.017). Patients with a more serious medical condition such as poor nutrition status and impaired cardiopulmonary function may not to be able to tolerate prolonged surgery and would be more likely to develop complications. The longer duration of anesthesia may be correlated with a more challenging and complicated operation along with greater intraoperative fluid shifts, which would tend to make patients vulnerable to pulmonary complications following aggressive fluid administration. However, the blood loss was similar between groups (p = 0.71) in Yi-Ting et al. study. In order to determine whether the shorter anesthesia duration or TIVA was correlated with lower pulmonary complication, these group adjusted covariates by multivariate regression analysis and found that TIVA correlated independently with lower postoperative pulmonary complications. (Odds ratio 0.41, p = 0.031). Therefore, patients who received TIVA in perioperative anesthesia management may benefit from less fluid resuscitation and may be less likely to develop pulmonary complications.

Propofol has been suggested to modulate the inflammatory response by attenuating endothelial damage produced by endotoxins [40,41]. This appears to have a protective effect on the lung by reducing the pro-inflammatory cascade. However, the anti-inflammatory protection and protection against reperfusion phenomena that can be seen during microvascular flap surgery still remains a controversial topic [42,43].

Some researchers may be concerned about the possibility of metabolic acidosis after prolonged propofol infusion, such as propofol infusion syndrome (PRIS), which would cause damage to a fresh anastomosis flap and increase. Although there is an association between PRIS and propofol infusion at doses higher than 4 mg.kg-1.H-1 When duration of use is greater than 48 h [44]. Yi-Ting et al. [36] study showed there was no difference in surgical complication rate between the two groups. TIVA has been applied in many kinds of surgery without the development of PRIS [45,46]. The main limitations of that study were its retrospective design and small sample size. Because this was a retrospective analysis, no causality could be inferred from our results. Future prospective controlled trials are needed to clarify the beneficial effect and causal associations of different types of anesthesia.

We suggest the use of TIVA on this kind of patient as there may be a 60% reduction on pulmonary complications and no significant surgical complication in free flap surgery for head and neck cancer has been reported.

## 6. Surgical Techniques

There are multiple classifications of flaps. Here, we are going to carry out a brief review of the four most relevant types of flaps according to vascularization, since we consider that, for the clinical practice of an anesthetist, they may be the most relevant [47] (Figure 4). Random cutaneous flaps. They are the most basic flaps; Vascularization depends on perforating arteries in the subdermal plexus. Its viability will depend exclusively on its perfusion pressure.

Axial pattern flaps (arterial septocutaneous). Vascularization is provided by an artery that penetrates the fascia and follows a predictable course. If this course is followed when dissecting the flap, a wide portion is generated whose viability is higher than with random cutaneous flaps. In the dissection, the subcutaneous fat should be included, since it will be where the septocutaneous artery is located. It is obvious that the possibility of this type of flap is given by the availability of direct cutaneous artery.

Fasciocutaneous flaps: viability is achieved through the fascial plexus, which is a group of perifascial structures. In this magma the perforating branches of the septocutaneous artery must be included, which are the ones that will allow the vascularization of the flap to be maintained. The size is variable. There are multiple classifications of this type of flap that we will not go into.

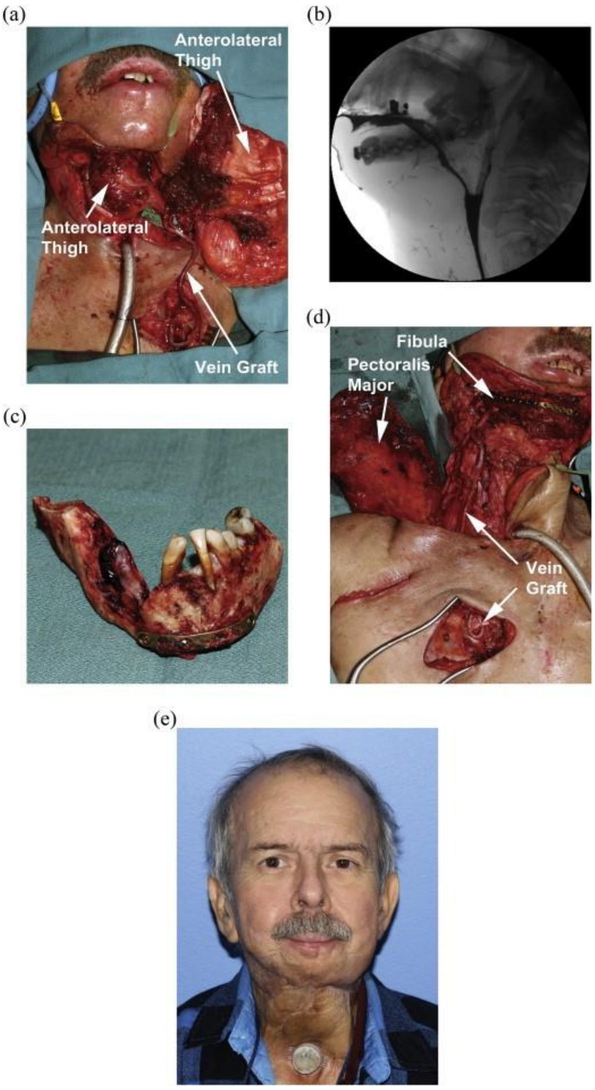


**Figure 4:** Success of sequential free flaps in head and neck reconstruction. Retrieved from Hanasono Matthew M, Corbitt Christian A, Yu Peirong, Skoracki Roman J. Journal of Plastic, Reconstructive and Aesthetic Surgery. Páginas. 2014; 67: 1186-1193.

Myocutaneous flaps. This type of flap includes the muscle. This allows keeping the vascular network of the skin and subcutaneous tissue intact and is nourished through arteries in the most distal areas of the flaps. There is evidence that increased blood flow and oxygen pressure allow better management of infections [48].

An essential aspect for the flap's success is adequate vascularization. Therefore, survival of the flaps will depend not only on an adequate selection of the same and a good surgical technique, but also on perioperative factors that alter vascularization, generally at the systemic level. We can differentiate between preoperative, intraoperative and post-operative factors. All of them are associated with increased morbidity, increased hospital stays and reoperation due to flap failure [49]. Here we will discuss the pre-surgical factors, while the other two will be discussed in the "Anesthesist management" section as they can modify the anesthetist's approach.

Presurgical factors are inherent to the patient; although of them can probably be modified in the long term, since they are secondary to the patient's lifestyle, it seems unlikely that they can be modified in the relatively short period of time between cancer surgery and head and neck reconstruction. A 2017 analysis of the National Surgical Quality Improvement Project database of the American College of Surgeons showed the most relevant pre-surgical factors in this type of surgery [50]. As in many other medical and surgical pathologies, diabetes is a risk factor (OR 2.5 with 95% CI 1.3- 4.2) for flap failure and other complications such as infection of the surgical wound, wound dehiscence, fistulas, etc. [50]. This analysis supports the conclusions of a previous study in which the medical records of 7890 patients with failed reconstruction of microscopic head and neck surgery were reviewed, in which they found that diabetic patients had an OR of 1.76 for postoperative complications [51].

The NSQIP complication analysis [50] showed that smoking was a risk factor for an increase in complications, although no serious complications developed. A later study also identified tobacco use as a pre-surgical factor that increases the risk of flap failure, with a risk of suture dehiscence OR 1.74 and OR for reoperation of 1.5 [52].

Two recent studies have studied the impact of age on reconstructive head and neck surgery. The first of these is a retrospective study in which 132 cases were reviewed, two groups of patients older or younger than 80 years [53]. The second study had a prospective design with cases and controls, with an N = 14 in each branch differentiated by age: older or younger than 90 years [54]. Both found that there were no statistically significant differences for an increase in morbidity associated with the flaps, although it is relevant to note that in both studies, admission to a nursing facility to receive specialized nursing care was higher in the older patients and this was statistically significant. The NSQIP analysis [50] also did not show that there were statistically significant differences for an increase in comorbidity in the elderly.

Finally, it is interesting to mention obesity as a pre-surgical factor. Retrospective analysis revealed that there was a higher incidence of complications in obese patients, however in none of the studies was this difference significant. Interestingly, a relationship between BMI and survival was found, so that the higher the BMI, the greater the survival [54,55].

## 7. Hemodynamic Management

As already mentioned, perfusion is the main issue which enables flap's survival. Both intraoperative and postoperative, an attempt should be made to maintain adequate perfusion pressure (PP) and low resistance to flow. To maintain an adequate tissue perfusion pressure in the flaps, it is essential to maintain an adequate systemic arterial pressure. Therefore, it is necessary to avoid hypotension, both occasional and sustained, since it increases the failure rate of the flaps [56].

Typically, the use of vasopressors to maintain adequate systemic blood pressure has been avoided [57]. Theoretically, since they are very small vessels, any minimal reduction in these could be fatal for the viability of the flap. However, there is currently evidence that supports the use of vasopressors without worsening surgical results [58-61]. The vasopressors studied, which were found to cause no deleterious effects, were ephedrine, phenylephrine, norepinephrine and dobutamine. Previously, based on the results of another study [62], the use of vasopressors such as norepinephrine had been avoided and the use of dobutamine had been favoured, which would generate an increase in systemic pressure by increasing cardiac output. In any case, it is convenient to remember that the use of vasopressors per se will not increase the survival of the flap [57], but rather that it will allow the solution of hypotension, the main risk factor for surgery failure; thus, its use should be individualized according to the clinical characteristics of each patient and administered cautiously.

In contrast, standard practice [57], consisting of administering large volumes to maintain adequate blood pressure, has been shown to cause a higher flap failure rate [63]. This may be due to edema of the tissues, which in turn causes an increase in tissue pressure. This results in the inability of the tissue perfusion pressure to maintain adequate oxygenation and nutrition of the tissues. They also observe that it is from 5.5 L in volume (without specifying whether they are crystalloids or colloids) when there are major postoperative complications and from 7 liters when more serious complications are observed. In any case, a judicious use of fluid therapy should be made [64], in the same way as with vasoactive drugs and a balance must be reached, since both hypovolemia and hypervolemia lead to poor clinical results.

## 8. Postoperative Care

Without postoperative antibiotic prophylaxis, the infection rate is 24 to 87% in free flaps from head and neck surgery. This can lead to flaps loss. Lagerman in a retrospective multicentre study suggests maintaining ampicillin sulbactam for one day postoperatively, unlike clindamycin, which increases this risk. This risk is also associate: an increase in BMI, diabetes, tracheostomy, malnutrition, prolonged surgical duration, inclusion of the flaps in the bone and previous radiotherapy, this risk is enhanced. It is not advisable to delay the use of antibiotics beyond 7 days.

The type of nutrition is an important decision in this type of patient. On many occasions, oral tolerance is delayed before 6 days due to the risk of debris, aspiration or fistula. Guidera et. al demonstrated in oral reconstructive surgery the absence of complications in the early oral tolerance group.

Ciolek et. al examined the cardiac complications of these patients in the postoperative period. The preoperative presence of peripheral vascular arteriopathy, history of PE, CHF and anticoagulation increased the risk of arrhythmias and coronary syndromes by 12.5%. In contrast, postoperative pulmonary complications seem not to be associated with preoperative risk factors [65].

## 9. Conclusion

The success rate of free flaps according to some series is 95%. Optimization of preoperative risk factors, intraoperative therapy fluid, antibiotic and early enteral / oral nutrition reduce postoperative complications. It is recommended that these patients be taken to specialized units where protocols are established and the number of patients allow a proper degree of knowledge. Communication between multidisciplinary teams, all along during the perioperative period, is essential to guarantee, not only the best surgical results, but also patient's safety as can be seen if the airway is not managed properly.

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