Head and neck reconstruction

Head and neck cancers are among the rarer types of cancer presenting in the UK. However, oncological resection can cause significant morbidity in these patients, so reconstruction has a crucial role in the management of such patients to improve their postoperative quality of life.

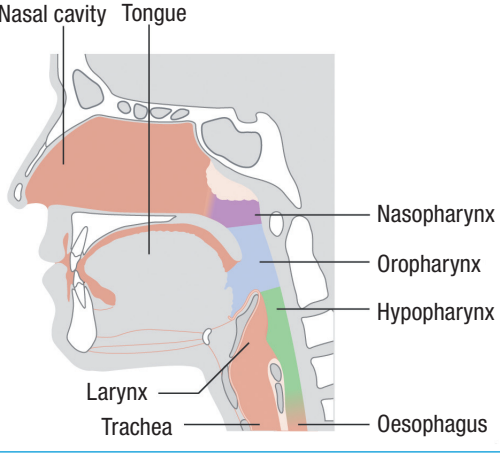
Head and neck cancers are rare in the UK, but they can have devastating effects on patient function and aesthetics. Oncological resection of head and neck cancers can cause sizeable defects in anatomically sensitive areas, providing a challenge to the reconstructive surgeon. All head and neck cancer patients are managed within the expertise of a multidisciplinary team comprising representatives from relevant surgical specialties (ear, nose and throat, maxillofacial and plastic), oncology, radiology, pathology, palliative care, dental technicians, speech and language therapy and clinical nurse specialists. At present there is no standard screening test for head and neck cancer.

Epidemiology

The two most important risk factors for development of head and neck cancers are alcohol and tobacco use. A study from the United States showed that at least 75% of all oral and pharyngeal cancers were caused by smoking and drinking (Blot et al, 1988). In cases of oropharyngeal cancer, there is also a strong association with infection by human papilloma virus (HPV), in particular HPV-16 (Chaturverdi et al, 2011).

The incidence of several types of head and neck cancers has risen since 1990 while the overall mortality has fallen (National Cancer Intelligence Network, 2010). *Figure 1* demonstrates the sites of head and neck cancer. Of all head and neck cancers oral cavity cancers are most common. In the UK there were approximately 7600 people diagnosed with oral cancer in 2013, which represents 2% of all cancer cases (Cancer Research UK, 2016). The approximate ratio of males to females is 2:1 and over 45% of cases occur in those aged 65 years and over (Cancer Research UK, 2016).

Figure 1. Sites of head and neck cancer. From Cancer Research UK (2011).



Primary tumour sites

Cancers of the head and neck include cancers of the oral cavity, nasal cavity, the pharynx (nasopharynx, oropharynx and hypopharynx), the larynx and salivary glands. Most head and neck cancers are squamous cell carcinomas arising from the squamous epithelium lining the mucosal surfaces of the head and neck.

Types of cancer

Table 1 illustrates different types of head and neck cancer. It is important to note that all these cancers are rare in the UK.

Head and neck cancer guidelines

The National Institute for Health and Care Excellence (2004) published extensive guidelines regarding the management of head and neck cancer with seven key recommendations:

1. Cancer assessment and treatment should be coordinated by cancer networks and concentrated in cancer centres
2. Multidisciplinary teams will be essential to the service
3. The referral process for cancer should be streamlined with dedicated clinics for neck lumps
4. Support services, such as speech and language therapists and restorative dentists, are vital in the journey from pre-treatment until rehabilitation is completed
5. Local support teams should be present to coordinate community care with specialist care

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Table 1. Types of head and neck cancer

Head and neck cancer	Risk factors and pathology
Eye cancer	Approximately 530 cases per year in the UK. Most common type in UK is melanoma
Nasal and paranasal sinus cancer	Risk factors are human papilloma virus and smoking. 60% of cases are squamous cell carcinomas
Nasopharyngeal cancer	Very rare in UK
Oral and oropharyngeal cancer	Main risk factors are smoking tobacco, high alcohol intake, poor diet, human papilloma virus, sun exposure. One in three people with lip cancer work outdoors. 90% of mouth cancers are squamous cell carcinomas
Laryngeal cancer	Risk factors are poor diet and human papilloma virus. 95% are squamous cell carcinomas
Oesophageal cancer	Rare under the age of 45 years. Main risk factors are alcohol and tobacco. 50% squamous cell carcinomas, 50% adenocarcinoma
Salivary gland	3% of all head and neck tumours. Risk factors are increased age (50 years and over), human papilloma virus and exposure to radiation. Majority of salivary gland tumours are benign

From Cancer Research UK (2011)

Table 2. Preoperative tests

Test		Indication
Bloods	Full blood count	All head and neck patients having a general anaesthetic
	Urea and electrolytes	All head and neck patients undergoing major procedure
	Calcium	Patients undergoing laryngectomy or thyroid/parathyroid surgery
	Liver function tests	Patients with history of excessive alcohol use
	Coagulation screen	All patients undergoing major procedure, patients with abnormal liver function tests, patients taking anticoagulants
	Sickle screen	Patients of African descent
Electrocardiogram		Baseline investigation for any patient over 40 years of age, any patient with history of cardiovascular disease
Chest radiograph		All patients with respiratory symptoms
Lung function tests		All patients undergoing thoracotomy, all patients with chronic pulmonary disease

adapted from Montgomery et al (2009)

6. Information collection and audit should be supported and undertaken by the multidisciplinary teams
7. Development and expansion of research should be encouraged with use of multi-centre clinical trials where appropriate.

ENT UK is a professional body representing ear, nose and throat and its related specialties. It founded a head and neck committee in 2009 to promote the highest standards of medical and surgical treatment for head and neck cancer patients. Their next set of guidelines (5th Edition Head and Neck Cancer Multidisciplinary Management Guidelines) are to be published in 2016 and this should be a key reference document for all those involved in this specialty.

Preoperative workup

Thorough preoperative assessment is essential as patients with head and neck cancer often have existing medical comorbidities. *Table 2* outlines the basic investigations required before surgical management of a patient with head and neck cancer and *Table 3* outlines patient factors that should be optimized preoperatively including review by appropriate health-care professionals. Imaging in the head and neck patient is crucial for diagnosis, staging and planning treatment. *Table 4* illustrates common imaging modalities used for different cancers.

Staging

The tumour, node, metastases (TNM) system was developed in 2002 by the American Joint Committee on Cancer. The TNM staging of head and neck cancer varies according to the primary site of the tumour and is used to guide treatment and prognosis. The 5-year survival rate for localized disease varies from 56% in cancer of the hypopharynx to 89.6% for cancer of the lip (Thorne et al, 2006). Metastatic disease has a far worse prognosis with a 5-year survival rate of 12.9% for the hypopharynx to 40% for lip cancer (Shah et al, 2012). The investigations listed in *Table 4* are used in the staging process.

Treatment

Following staging and discussion within the multidisciplinary team, treatment comprises one or more of surgical resection, neck dissection, radiotherapy, chemotherapy and rehabilitation. There are a number of complications associated with head and neck surgery because of the intricate anatomy of the region. Intraoperative complications include bleeding, carotid artery injury, air embolus, pneumothorax and nerve injury. Early complications include necrosis of skin flaps, carotid artery blow out or chyle leak (caused by damage to the thoracic duct). Late complications include dysfunction as a result of resection of head and neck structures (such as difficulty with swallowing, mouth continence or speech), scar contractures, neuroma, facial oedema and shoulder pain syndrome. Radiotherapy can also cause significant morbidity when used in the head and neck region. The next section will detail the reconstructive options available in the head and neck region.

Reconstruction of the head and neck

Aims of reconstruction

The head and neck region is a challenging area to reconstruct. Any reconstruction in this area is highly

visible and there are a number of specialized structures such as the eyelids, ears, nose, lips and tongue. The goals of reconstructive surgery in the head and neck are to restore normal anatomy and function. This includes restoration of speech, swallowing and oral continence with detail paid to restoring appearance and facial features.

When considering reconstructive options it is important to assess which tissues are missing, e.g. one or a combination of skin, subcutaneous tissue, muscle or bone, and thereafter plan how to replace these layers. This article gives an overview of the reconstructive ladder and outlines common reconstructive options for different anatomical areas. A more detailed explanation of the reconstructive ladder is given in the first article in this symposium (p. 328).

Reconstruction options using the reconstructive ladder

The following section outlines the various options available when considering reconstruction of the head and neck region. As the complexity of the reconstructive procedure increases, surgical and recovery times lengthen, in addition to increased morbidity from donor sites. The need for postoperative radiotherapy can also affect choice of reconstruction as radiation therapy can increase postoperative complications, such as delayed healing and scarring (Bourget et al, 2011). If a patient is likely to require adjuvant therapy a delayed reconstructive procedure may take place once therapy is complete.

Rhomboid flap

Figure 2 gives an example of a local flap used in head and neck reconstruction. A rhomboid flap is a useful flap that can be performed under local anaesthetic and is commonly used on the temple to reconstruct defects created after excision of small skin cancers. It was first described by Limberg in 1946 and has been subsequently modified by different authors.

Table 3. Preoperative patient optimization

Risk factors	Health-care professional	Indication
Airway	Anaesthetist	Plan for type of intubation and postoperative care required, including use of an intensive or high dependency bed
Nutrition	Dietician	Optimize any deficiencies, especially albumin. Low preoperative serum albumin level is a predictor of raised morbidity and mortality with rates of 65% and 29% respectively in any surgical patient with an albumin level lower than 21 g/dl
Smoking	Smoking cessation service	Smoking increases the risk of postoperative respiratory complications and microvascular free flap failure
Alcohol	Alcohol dependency service	Assess patients with alcohol dependency for alcohol liver disease or alcoholic cardiomyopathy and monitor closely for delirium tremens. The incidence of delirium tremens is approximately 9% in these patients and is associated with higher postoperative morbidity and mortality (Neyman et al, 2005)

Table 4. Preoperative imaging

Imaging modality	Indication
Computed tomography	Assessing bony involvement, nodal metastasis and extracapsular spread
Magnetic resonance imaging	Tumours of skull base, nasopharynx, soft and hard palates and parapharyngeal space
Ultrasound	Tumours of salivary glands or thyroid, lymph node metastases
Panendoscopy	Used in patients with unknown primary and nodal enlargement caused by metastases
Positron emission tomography	Node negative neck and known head and neck primary, advanced head and neck cancers
Isotope scanning	Thyroid malignancies

Figure 2. **a.** Design of a modified rhomboid flap around a basal cell carcinoma. **b.** Schematic to illustrate standard rhomboid flap reconstruction.

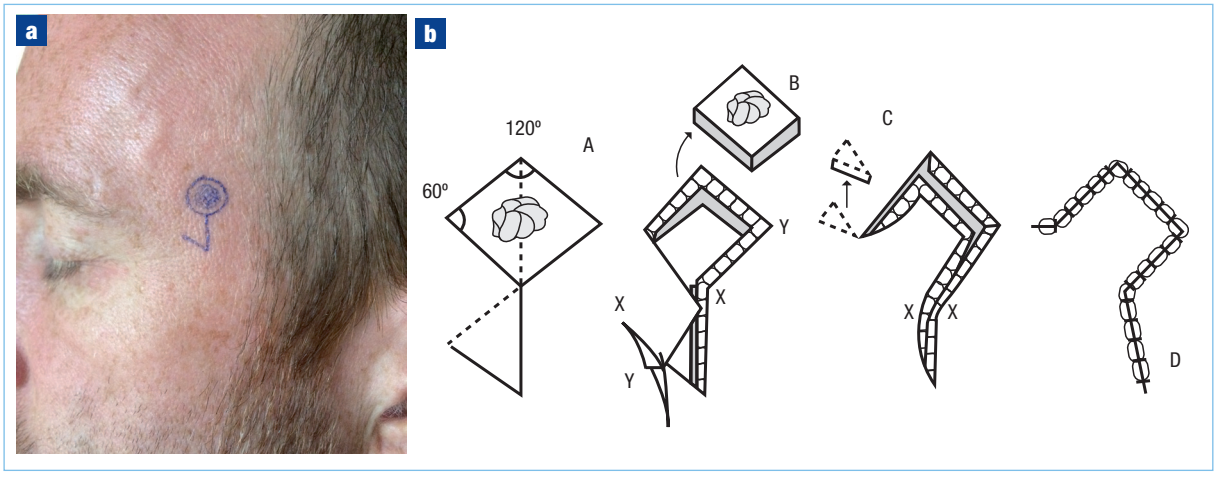

Figure 3. **a.** Design of a forehead flap in nasal reconstruction, circular defect on tip of nose in blue, flap drawn in blue on forehead with supplying vessels in red. **b.** Schematic to illustrate raising and inset of a forehead flap.

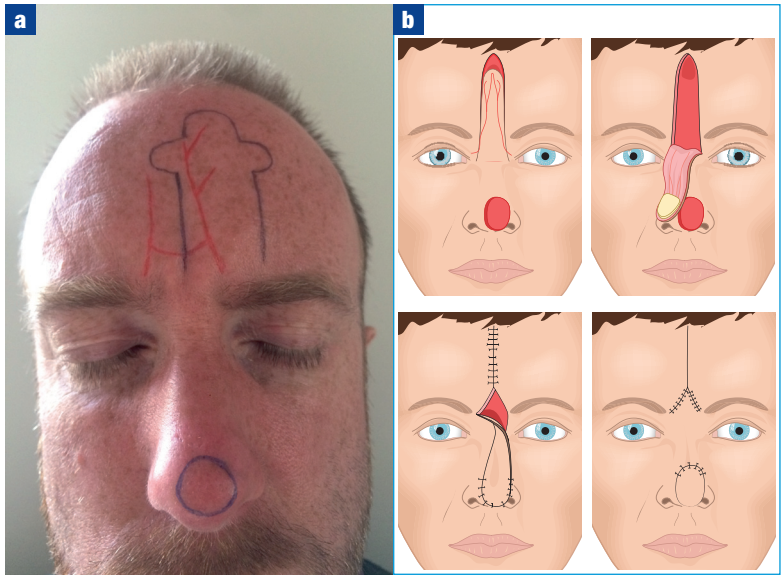

Table 5. Reconstructive options using the reconstructive ladder

Options	Advantages	Disadvantages
Direct closure	Quick procedure and recovery, no delay in adjuvant treatment. Minimal scarring (and no donor site)	Only possible for small defects, e.g. not advisable if the lip defect is greater than a third
Skin grafts	Relatively quick procedure and recovery. Acceptable aesthetic outcome	Small superficial defects only. Graft failure. Tight scars – not advised where contractures will impede function, e.g. lip reconstruction
Local flaps	Replaces defect with similar tissue minimizing functional or aesthetic issues ('like for like'). Can be done as day case procedure	Only possible for small to moderate size defects. Examples include mucosal flaps, tongue flaps, palatal flaps, bilobed flaps, rhomboid flaps
Regional flaps	Useful for larger defects. Flap can contain skin, subcutaneous tissue, muscle, fascia or a combination of all providing a more robust flap	Large donor site and subsequent morbidity. Usually requires inpatient stay. Partial or complete flap failure. Longer procedure and recovery time, impact on adjuvant therapy. Examples include nasolabial flap, temporalis muscle and fascia flaps, forehead flap, deltopectoral flap, pectoralis major flap, latissimus dorsi flap, trapezius flap
Distant (free) flaps	Useful for larger defects. Flaps can reconstruct multiple tissue planes including bone	Large donor site and subsequent morbidity. Requires inpatient stay. Partial or complete flap failure. Longer procedure and recovery time, impact on adjuvant therapy. Examples include radial forearm flap, lateral arm flap, rectus abdominis flap, anterolateral thigh flap, jejunal flap, fibula flap, deep circumflex iliac artery flap

Forehead flap

Figure 3 demonstrates an example of a regional flap used in head and neck reconstruction. The forehead flap is thought to have first been described by Sushruta in 600 BC for reconstruction of a nasal defect. It is still used today to reconstruct the nose and covers defects of the midface, eyelid and orbit. The flap contains skin, subcutaneous tissue and fascia and is raised on both or one of the supratrochlear or supraorbital arteries. It can be rotated 180° to lie over the nose. The flap is inset and then divided approximately 3 weeks later once it has established its own blood supply from surrounding tissues.

Distant (free) flaps

The commonly used recipient vessels in the head and neck are the branches of the external carotid artery and either the anterior facial vein or external jugular vein. Common free flaps used to reconstruct the head and neck region are listed in *Table 5*. The fibula, radial forearm and deep circumflex iliac artery flaps are useful as they can provide vascularized bone to reconstruct bony defects in the head and neck.

Reconstruction options by anatomical defect

Cutaneous lesions of the scalp, face and neck

Regarding the scalp only small cutaneous lesions can be directly closed; moderate-sized lesions require skin grafting or local flaps, and larger lesions can require free flap reconstruction. A variety of reconstructive options are available for cutaneous lesions of the face and neck, as per the reconstructive ladder.

A pectoralis major flap uses the flat, fan-shaped pectoralis major muscle and can be raised as a muscle flap or a musculocutaneous flap (*Figure 4*). It was first described by Ariyan in 1979 for use in head and neck reconstruction. The flap has a variety of uses as a pedicled flap in reconstruction of the head and neck region, intrathoracic area and sternum, in addition to its use as a free flap. For the head and neck area the pectoralis major flap is raised on the thoracoacromial vessels and the muscle divided from origins at the clavicle and sternum and its insertion at the bicipital groove of the humerus. The muscle has the potential to cover the head and neck region up to the level of the inferior orbital rim (Mathes and Nahai, 1997). The pectoralis flap is very reliable and easy to raise although it can sometimes appear bulky over the clavicle and the incorporation of a skin paddle with the flap leaves a large donor area deformity.

The rectus abdominis flap is a hugely versatile flap used to reconstruct a variety of defects. It was first described by Mathes and Bostwick in 1977 for abdominal wall reconstruction. The rectus abdominis muscle measures 25 cm by 6 cm and has two dominant vascular pedicles, the superior and inferior epigastric artery and vein. A relatively large skin paddle can also be raised with the muscle orientated in either a vertical or transverse direction.

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Midface and maxilla

Defects in this area can be complicated to reconstruct because of their complex functional and aesthetic requirements. It is advisable for patients to be seen preoperatively by both the surgeon and a prosthodontist. This allows an accurate assessment of the likely defect and type and size of any prosthesis required. Following this the team can decide which type of free flap will be required, if any, and plan where and how the prosthesis is to be attached.

Reconstruction of the bony contours of the midface can use either a free vascularized bone graft with a soft tissue paddle or an implant with a free musculocutaneous flap. If a large amount of vascularized bone stock is required a free fibula flap is a useful option but it provides a small soft tissue paddle. A free scapula provides a larger soft tissue paddle but less bone stock. A PEEK (polyetheretherketone) implant is an example of an alloplastic implant commonly used in complex reconstructions since the implant can be customized to the patient. Surgical prostheses or obturators (*Figure 5*) can also be used in conjunction with or in the absence of reconstruction.

Oral cavity and pharynx

The radial forearm flap is a workhorse flap of head and neck reconstruction and is based on the radial artery in the forearm. It was first described in 1981 by Yang et al in China. This flap can be used to reconstruct the tongue, floor of mouth, hard palate and lip or reconstruct complex tubular structures such as the oesophagus or larynx. The flap contains skin, subcutaneous tissue and fascia and can be designed to incorporate a section of the radius too. It is relatively simple and quick to raise and, as the flap can be folded, can be used to reconstruct a variety of three-dimensional defects. However, this flap does leave a significant donor deformity on the volar aspect of the forearm with a resulting unsightly scar.

The anterolateral thigh flap was first described by Song in 1984 and is a fasciocutaneous flap raised from the lateral aspect of the thigh. The dominant pedicle supplying the flap comprises branches of the descending branch of the lateral circumflex femoral artery (Song et al, 1984). The flap can include skin, subcutaneous tissue, fascia and/or muscle. A skin paddle of up to 18 cm by 25 cm can be raised with the flap, making it useful for tubular reconstruction of the oesophagus or pharynx. Given its size and ease of raise the anterolateral thigh flap has become a popular choice of flap in head and neck reconstruction.

Mandible

Mandibular defect repair usually requires bone and soft tissue with reconstruction of the intraoral lining and external skin. Bony reconstruction can take the form of plates and non-vascularized bone graft (commonly from iliac crest, fibula or ribs) or a free vascularized bone graft. In those patients requiring radiotherapy or those with a central mandibular defect a free vascularized bone graft with or without soft tissue is required. The outcomes from free vascularized bone flaps are far better than the other options. The free fibula and deep circumflex iliac artery flaps are the most commonly used flaps for reconstruction of mandibular defects. These two flaps are technically demanding to raise and the total operative time for flap harvest and insetting can be 4–6 hours. There are variable free flap failure rates for mandibular reconstruction reported in the literature.

The gold standard reconstructive technique for the mandible is considered the free fibula flap since it provides a good quantity of bone and the flap can be osteotomised to provide a shape resembling the mandible. This flap was first described by Hidalgo in 1989. When raising a free fibula flap a segment of bone up to 25 cm long may be harvested with a skin paddle measuring up to 8 cm by 15 cm (Shah et al, 2012). The flap is based on the peroneal artery.

The deep circumflex iliac artery flap is raised on the deep circumflex iliac artery, a branch of the external iliac artery. The flap can consist of skin, subcutaneous tissue, muscle and also bone, through harvest of a section of iliac crest.

Figure 4. Schematic illustrating raising of pectoralis major pedicled flap.

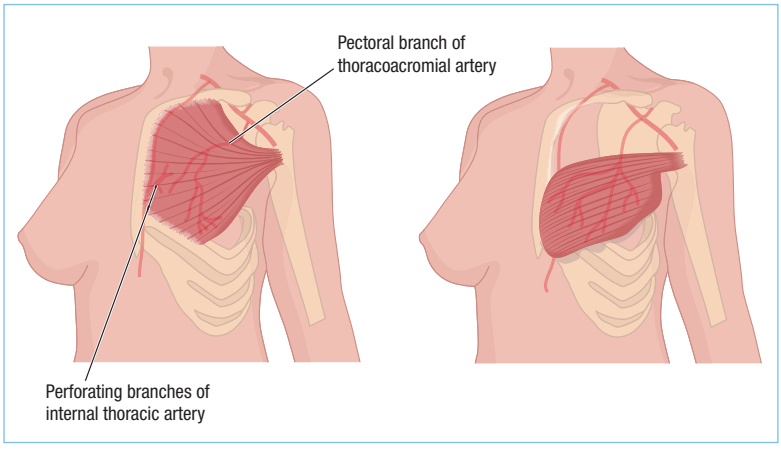

Figure 5. Example of an obturator used to close a defect created in the maxilla and roof of mouth.

KEY POINTS

- Head and neck cancers are rare in the UK.
- Oncological resection can cause significant morbidity.
- Preoperative workup is essential as patients often have coexisting morbidities.
- The aim of reconstruction is to restore normal anatomy and function.
- Functional rehabilitation is essential postoperatively.

FURTHER INFORMATION

- National Cancer Research Network www.ncin.org.uk
- Cancer Research UK www.cancerresearchuk.org/home
- Macmillan Cancer Support www.macmillan.org.uk
- Throat Cancer Foundation www.throatcancerfoundation.org
- Mouth Cancer Foundation www.mouthcancerfoundation.org/
- Head and Neck Cancer Alliance www.headandneck.org

Functional rehabilitation

Head and neck cancer patients can suffer from significant morbidity associated with their primary oncological resection and it has been reported that up to a third of patients with head and neck cancer suffer from persistent pain (Shah et al, 2012). There are also increased rates of depression and suicide. Up to one quarter of hospital-based suicides are attributable to cancer patients and a fifth of these have head and neck cancer (Thorne et al, 2006).

It is therefore crucial for head and neck patients to undergo rehabilitation with physiotherapists and the speech and language team to maximize their function postoperatively. Counselling services are also a recommended part of the multidisciplinary team and charities such as Macmillan Cancer Support provide an invaluable resource for such patients. For patients in whom long surgical reconstructive procedures are contraindicated, maxillofacial prosthetists provide an essential service and can manufacture a variety of prostheses to augment the facial skeleton.

Secondary surgery is also often indicated in these patients to enhance their function and manage complications. Patients with a total laryngectomy can opt for a tracheoesophageal puncture and prosthesis for rehabilitation of aphonia. The outcome of this procedure is superior to other available options (Clements et al, 1997). Patients with facial nerve injury can be offered nerve grafting and rehabilitation. Other procedures include delayed osseointegrated implants or revision of their flap to improve aesthetic outcomes. Free flap failure has been reported up to 4% in the literature and can be managed by either a secondary free flap, local flap or conservative measures (Okazaki et al, 2007).

Conclusions

Head and neck cancer is rare in the UK but the oncological resection required can cause significant morbidity in affected patients. Surgical reconstruction and rehabilitation is essential to restore basic functions such as oral continence and speech. There are a variety of reconstruction techniques available to restore anatomy and function in these patients based on the types of tissue missing and the size of the defect. It is essential to use a multidisciplinary team to plan management of these patients and conduct treatment in a specialized cancer centre. **BJHM**

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Conflict of interest: none.

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