Liverpool Opinion on Unfavorable Results in Microsurgical Head and Neck Reconstruction: Lessons Learned

James Brown[a,*], Andrew Schache[a], Chris Butterworth[b]

KEYWORDS

• Head and neck reconstruction • Pitfalls • Flap transfer • Microvascular anastomosis

KEY POINTS

- Soft tissue reconstruction of the oral cavity.
  - Resect oncologically, aware that maintenance of the patient's own tissue, with a maintained blood and nerve supply, is ideal.
  - Excess tissue in partial tongue reconstruction can result in poorer function.
  - The remaining oral tongue must have optimum movement.
  - Extensive oral tongue resections require more bulk so that the swallow is initiated with little chance of effective chewing because the functioning tongue is more essential than an occluding dentition.
  - The floor of the mouth and buccal tissues require a thin flap to allow good movement.
  - Think of the oral tissues and soft palate as horizontal with less need of a sphincteric affect and the rest of the oropharynx as vertical where the sphincteric effect is paramount.
- Mandibular reconstruction.
  - Segmental resections involving the anterior mandible present more significant challenges than the posterior mandible, where a variety of techniques are used. The height of remaining bone in the anterior mandible and its relationship to the circumoral musculature is critical in the degree of postoperative collapse and the likelihood of effective rehabilitation.
- Maxillary reconstruction.
  - For low level defects (Brown class I and II), maxillary obturation is effective especially if supported by osseointegrated dental and zygomatic implants.
  - Zygomatic implants can be used in conjunction with soft tissue free flaps to effectively rehabilitate patients without the need for composite reconstruction with the associated technical complications and additional morbidity.
  - Maxillary defects involving the orbital floor or contents (Brown class III and IV) require composite free flaps to effect a satisfactory facial reconstruction.
  - Collaboration with the team providing final rehabilitation and prosthetic support is essential before deciding on the reconstruction.

[a] Department of Head and Neck Surgery, Aintree University Hospital, Liverpool University, Liverpool, UK; [b] Maxillofacial Prosthodontics, Aintree University Hospital, Liverpool University, Liverpool, UK
* Corresponding author. Department of Head and Neck Surgery, Aintree University Hospital, Liverpool University, Lower Lane, Liverpool L9 7AL, UK.
E-mail address: brownjs@doctors.org.uk

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INTRODUCTION

We have been given a title that asks the Liverpool head and neck reconstructive group for an opinion on "unfavorable" microsurgical reconstruction and asks "what lessons have been learned."[1–4] This is a personal view, although these opinions have been formed after much collaboration with the coauthors and also additional surgeons involved with the care of the patient, nurses, speech therapists, dietitians, and radiation oncologists. Good reconstruction, which is long-lasting and resilient, makes an enormous difference to a patient who may frequently have lost aesthetics and function through ablative cancer surgery. Although evidence to support this is found in the literature in the form of outcome questionnaire and assessments, the most valuable perspective is derived from the personal experiences gained in the outpatient clinic during the prolonged process of review for this patient group.

It is important to understand the difference between reconstruction for a patient following ablative head and neck cancer surgery and those that have suffered maxillofacial injuries. Trauma patients have no choice in the predicament they find themselves and hope that the reconstruction will improve their final result in a normal life span. A patient with cancer requires to be consented to undergo a potentially damaging procedure in terms of function and aesthetics and hence the reconstructive option and predicted outcome becomes part of the process of consent. Chemoradiotherapy, as an alternative to ablative surgery for organ preservation especially in the larynx and oropharynx, is well-recognized and hence the difference in outcome and function is paramount and still controversial to some extent. Laced in with this argument is also the impact on survival by withholding ablative surgery. Most of our experience has been with the patient with head and neck cancer and so it is with these patients in mind that this article is written.

In my time in surgery I have trained many individuals in complex ablation and reconstruction for the patient with head and neck cancer including the skull base. As a young surgeon starting off, it is essential to achieve free flap transfer success to gain the support of skeptical colleagues, but mostly to fulfill your planned treatment of the patient. This advice is not as good as a training position where one can follow the actions of accomplished surgeons in avoiding and then dealing with poor outcomes.

Potential comorbidities that may either influence the decision to avoid free flap reconstruction or, alternatively, inform a more appropriate flap choice from the ideal in the primary site (ultimate form, function, and rehabilitation) include

1. Previous bilateral neck surgery
2. Previous radiotherapy and especially chemoradiotherapy to the head and neck
3. Previous failed microvascular techniques
4. Peripheral vascular disease
5. Type II diabetes
6. Sickle cell disease or coagulopathy

In such circumstances the risk of failure may be such that the surgeon and the patient believe that the risks outweigh benefit.

In our practice we are always careful when advising a patient on a reconstructive option when a neck dissection and radiotherapy have already been performed. In such cases it is essential to carefully consider a simpler option than a free flap with the caveat that if unsatisfactory then complex reconstruction can still be considered. In general there is ample evidence in the literature to show that flap failure is not related to obesity or old age, although surgical complications in general may have a more damaging effect on the patient's recovery.

Even in the modern era of microvascular reconstructive surgery there are only a few flaps that are used regularly and fibula is by far the most common option for composite reconstruction of the mandible.[5] Any microvascular reconstruction requires considerable skill and surgeons with this training should be confident in most free tissue transfer techniques including iliac crest, scapula, and the incorporation of perforator flaps for both these donor sites.[6,7] The quality of the primary site reconstruction and overall result for the patient is paramount, so selection of the most appropriate reconstruction from the point of view of good rehabilitation is essential, aided by a comprehensive armamentarium of flap options. In Liverpool, the optimum reconstruction to provide the best outcome is selected if the patient is sufficiently medically fit and psychologically prepared to consent for the proposed procedure. Essential in the decision regarding composite tissue loss is the role of the maxillofacial prosthodontist with a special interest in the oral and facial rehabilitation for these patients.

COMMENT ON NONMICROVASCULAR RECONSTRUCTION FOR THE PATIENT WITH HEAD AND NECK CANCER

The most important decision for the patient typically via a tumor board (North America) or multidisciplinary team (United Kingdom) is the offer of ablative surgery as part of their cancer treatment.

There must be clarity as to whether this is a curative or a palliative option because the resection and reconstruction are complex and the sequellae long lasting. The role of microvascular reconstructive surgery is discussed later; however, it is essential that the surgeon be aware of, and carefully consider, local and pedicled flap options that may be more appropriate depending on the defect and the comorbidity of the patient. This form of surgery is useful in dealing with complications of microvascular reconstructions where dehiscence, fistula formation, or flap loss may have occurred. Readers are no doubt aware of the varied and useful flaps available in the head and neck and chest region (see later) but I emphasize the introduction of the supraclavicular artery island flap and the internal mammary perforator flap, both of which are used around the lower neck in particular, to treat or reinforce attempts to close oropharyngocutaneous fistulas or problems around tracheal stomas. These flaps are well-described by Fernandes.[8] Nonmicrovascular reconstructive flap options include the following:

1. Forehead
2. Nasolabial
3. Submental island
4. Temporoparietal fascia
5. Temporalis muscle
6. Pectoralis major
7. Latissimus dorsi
8. Sternocleidomastoid
9. Trapezius
10. Supraclavicular island
11. Internal mammary artery perforator

We still use the forehead and glabella flaps, temporalis, and especially the temporoparietal flap for augmentation and treatment of dehiscence following successful free tissue transfers for the maxillectomy defect. I have found that most patients, depending on their age and expectations, do not wish additional major surgery if a reasonable result can be achieved more quickly and simply (**Fig. 1**).

AVOIDING POOR RESULTS AFTER SUCCESSFUL FREE FLAP TRANSFER FOR SOFT TISSUE RECONSTRUCTION OF THE ORAL CAVITY AND OROPHARYNX

Oral Cavity

It is not possible to reconstruct the tongue either in the oral cavity (mobile or anterior tongue) or the oropharynx, where we refer to it as the posterior tongue. In our experience the functional results after three-quarter or total oral tongue resection are often less detrimental than the similar extent of resection for the posterior tongue. Primary surgery with or without postoperative radiotherapy remains the standard of care for squamous cell carcinoma of the oral cavity and it is fortunate that the reconstruction of the tongue (up to three-quarter partial glossectomy of the anterior tongue), floor of the mouth, retromolar region, the buccal mucosa, and the oral mucosa in general is reliable, particularly with respect to free tissue transfer techniques.

In our practice the radial forearm fasciocutaneous flap remains at the forefront of our decision-making when segmental resection of mandible is not necessary. The main argument against the

Fig. 1. (*A*) Typical potential dehiscence site for a patient reconstructed with a vascularized iliac crest with internal oblique following a maxillectomy (class IIId). (*B*) Defect treated with a silastic cover giving a good result for eye support and general appearance. The patient did not wish a biologic flap solution.

use of this flap is the donor site morbidity, because often a skin graft is required to close the donor site, although sensation to the hand and normal hand function are preserved with care during the harvest. Certainly the lower arm is not a site favored by patients[4] and slow healing of the grafted site can result in an ugly scar. There was a period when we used the lateral arm flap[9] because this could be closed directly and because it is sited above the elbow, the scar remains less obtrusive (**Fig. 2**), but the ability to raise the flap during the resection is more limited and most surgeons looking for a radial alternative now favor a perforator flap raised from the anterolateral thigh[10] or the lower limb.[11,12] The main advantage of the lateral arm or lower limb perforator options versus the anterolateral thigh flap is that these flaps are thin and pliable making them ideal for oral soft tissue contour reconstruction.

Oropharynx

In the oropharynx the tongue, although less mobile, plays a vital role in the initiation and completion of a successful swallow and contributes to effective protection of the vocal cords and trachea. Fortunately chemoradiotherapy has shown equivalent disease control levels as primary surgery with or without postoperative radiotherapy and so in our practice we rarely offer extensive posterior tongue resection as a primary treatment option, if a free flap reconstruction is required. However, we use transoral laser surgery to resect smaller tumors in the oropharynx, which does not require free tissue transfer maintaining the sphincteric effect of the surrounding musculature so vital to function. Transoral laser techniques were popularized by Steiner and coworkers,[13] but these techniques also work well in the oropharynx with good disease control and functional outcomes. Reconstruction of the pharyngeal walls and soft palate is achieved and we have described the use of the superiorly based pharyngeal flap combined with a radial forearm flap, which we still use.[14] This allows healing and contracture to take place especially after postoperative radiotherapy and prevents anterior displacement of the flap away from the posterior pharyngeal wall with inevitable velopharyngeal incompetence. For most extensive oropharyngeal resections we previously used the rectus abdominus myocutaneous flap but now prefer the anterolateral thigh flap because this can easily be raised simultaneous to the resection and provides sufficient bulk to replace the posterior tongue allowing a safe swallow to be possible with potentially reduced donor site morbidity risk.

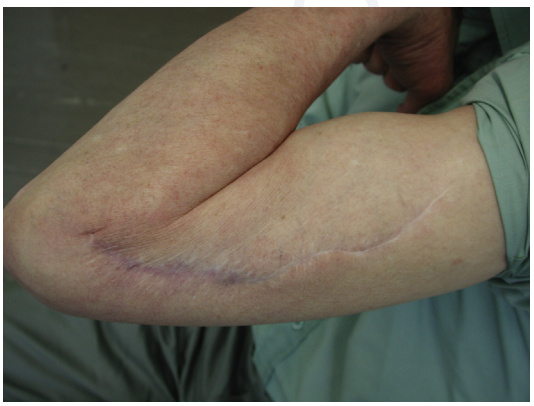

Fig. 2. The lateral arm donor site scar.

AVOIDING POOR RESULTS AFTER SUCCESSFUL FLAP TRANSFER FOR MANDIBULAR RECONSTRUCTION

In the microvascular reconstruction of the mandible the predominant donor sites are the fibula, iliac crest, scapula, and radial.[5] **Table 1** shows the flaps best suited to each defect of the mandible as recently classified.[5] In Liverpool we generally prefer the iliac crest to the fibula for dentate patients requiring a hemimandibulectomy (including the ipsilateral canine but not the condyle [class II], and for the central defect [class III]) to maintain adequate height to support the chin and implants. If the hemimandibulectomy requires a condylectomy (class IIc) then the fibula is easier to use given the increased bone length and reduced fullness in the condylar region. The fibula would also be our first choice for extensive mandibular defects in which both canines and at least one angle are resected (three corners of the mandible or more: class IV).[5]

There is a paucity of published data to support flap choice if the fibula is a compromised donor site, mainly as a result of peripheral vascular disease or occasionally an anatomic variant when the peroneal artery is the major blood supply to the foot. In the Liverpool region there is a high proportion of people from a lower socioeconomic base and a high level of smoking contributing to peripheral vascular disease in particular. We are in the process of publishing our experience with patients requiring mandibular resection for which a fibula is the preferred option but the magnetic resonance angiography that is performed for all these patients is unfavorable (C. Barry, et al, unpublished data, 2016). In this report we had 77 patients considered for a fibula but 20 (26%) of these had an unfavorable magnetic resonance angiography and were treated with scapula (eight cases), iliac crest (six cases), and radial forearm flaps (six

Table 1
Flap preference related to the length and type of mandibular defect

	Preference			
Class	**Most Favored**	**Second Best**	**Third Best**	**Least Favored**
I	Fibula, iliac crest, scapula equal merit			Radial
Ic	Fibula	Iliac crest	Scapula	Radial
II	Iliac crest	Fibula	Scapula	Radial
IIc	Fibula, iliac crest equal merit		Scapula	Radial
III	Iliac crest	Fibula	Scapula	Radial
IV	Fibula	Iliac crest, scapula equal merit		Radial
IVc	Fibula	Radial	Iliac crest, scapula equal merit	

If soft tissue loss is a major issue then often the scapula donor site is preferred, either using the circumflex scapula and well-supplied skin or a latissimus dorsi perforator flap and scapula tip if pedicle length becomes a problem.

Data from Brown JS, Barry C, Ho MW, et al. A new classification for mandibular defects after oncological resection. Lancet Oncol 2016;17(1):e23–e30.

cases). In this collection of data over 5.5 years during the period 2008 to 2014 there were 172 osseous free flaps of which 77 were fibulas, 37 scapulas, 33 iliac crests, and 25 composite radials demonstrating our departmental philosophy of offering the full range of composite flaps, with the defect dictating the flap choice rather than vice versa. There seems to be little difference in flap survival when large series are reported between the flap options. In 150 consecutive osseous free flaps reported from Memorial Sloan-Kettering from 1999 onward there were 135 fibulas, six radials, six scapulas, and three iliac crest demonstrating the reliance on the fibula donor site, albeit all the flaps were successful.[15] During development of the recently published classification,[5] I reviewed 167 papers from 1990 to 2013 where more than 10 mandibular reconstructions were included, and can report the overall flap failure rates for those reported, of 128 of 3317 (3.9%) for fibula, 51 of 789 (6.5%) iliac crest, 20 of 481 (4.1%) radius, and 18 of 460 (3.8%) for scapula from 145 publications. This indicates a marginally higher failure rate for the iliac crest, which may be associated with the small caliber of the vessels and the technically more demanding harvest. These small differences mean little to patients during consent and there are many other reasons for failure apart from the chosen donor site depending on the case. From these data it is clear that the success of composite free tissue transfer in mandibular reconstruction is generally a safe procedure with a low flap failure record. Compromising choice of flap to ensure flap survival is not supported by the high success rates for all routinely used composite free flaps.

It has been argued that the morbidity associated with some donor sites is unacceptable and especially in relation to the split radius and full-thickness iliac crest. The experience gained from using each of these flaps within our unit does not support this suggestion. Although not blinded to the flap type, an external orthopedic auditing of our practice[16] demonstrated similar outcomes for the patients irrespective of composite flap donor site. I have never regretted using the iliac crest and internal oblique donor site in head and neck reconstructive surgery. In Liverpool we still use the composite radial forearm flap even though we have reported a high donor site fracture rate of 17%,[17] but that predated evidence from Villaret and Futran,[18] which showed that prophylactic platting of the radius protected the patient from this debilitating fracture. The composite radial forearm flap remains useful to restore mandibular continuity but the bone, although well-vascularized, if raised from the ulnar side is thin and dental rehabilitation is compromised. This flap, however, is useful in edentulous (Cawood and Howell class V-VI) ridges,[19] especially if the fibula is not available and implant rehabilitation is not deemed to be important for the patient.

Irrespective of the flap option, be careful not to faithfully reconstruct the size of the mandible especially in edentulous or partially dentate patients. The maxilla tends to lose bone in an anteroposterior direction becoming more posterior in position compared with the facial tissues. In the mandible bone is lost from superior to inferior so that the jaw remains in the same facial position, which means it is generally advisable to reconstruct in a more posterior position for the mandible (**Fig. 3**). This has advantages because the oral tissues and the facial envelope are under less tension, and a likely improved facial profile.

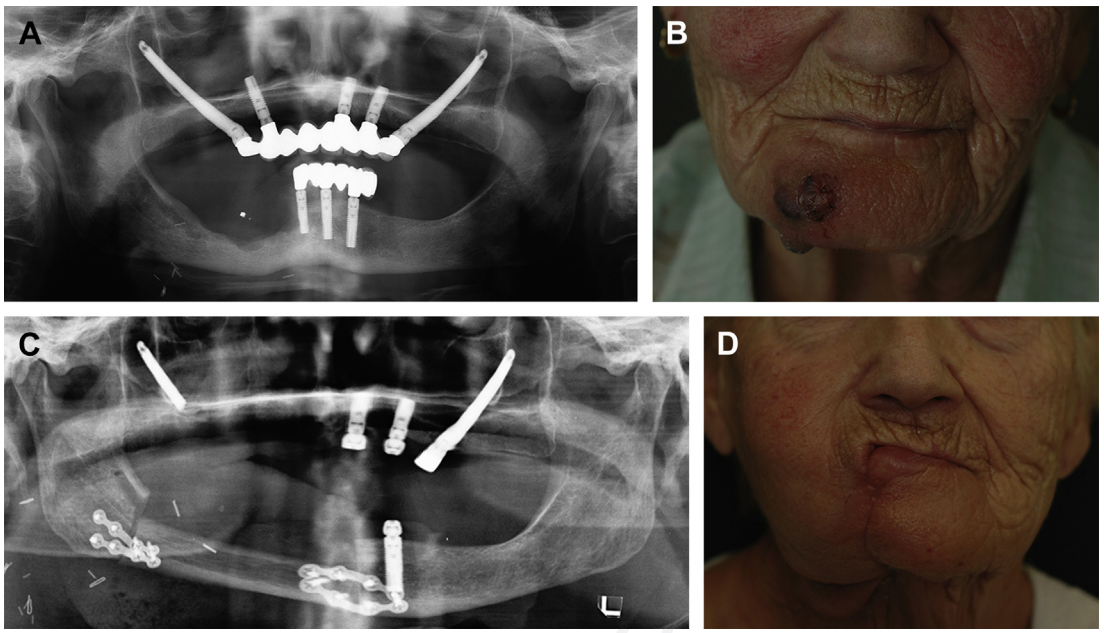

Fig. 3. This woman had already had a submental island flap for carcinoma-in-situ affecting the right buccal mucosa and then developed a far more aggressive squamous cell carcinoma invading the mandible and the mental skin. (*A*) Preoperative orthopantomogram shows a squamous cell carcinoma causing bone loss in the right premolar region. Note the previous rehabilitation with zygomatic and piriform implants to retain an upper full denture. (*B*) Facial view showing invasion of the facial skin. (*C, D*) In this case it was possible to reconstruct the mandible in a more posterior position allowing the closure of the facial skin and fibula skin used intraorally.

AVOIDING POOR RESULTS AFTER SUCCESSFUL FLAP TRANSFER FOR RECONSTRUCTION OF THE MAXILLA AND MIDFACE

It is clear in the literature and from my own experience that reconstructing the maxilla and midface is complex and there are several suggestions of how best to achieve optimum results for the patient.[20–22] **Table 2** summarizes the Liverpool ethos toward maxillary and midface defect reconstruction based on the *Lancet* classification (**Fig. 4**).[23]

Table 2
Flap type preference related to the extent and type of maxillectomy

	Flap Preference			
Class	**Most Favored**	**Second Best**	**Third Best**	**Least Favored**
Maxillectomy				
I	Fibula	Iliac crest	Scapula	Radial
II	Iliac crest and fibula equal merit unless high perinasal bone loss		Scapula	Radial
III	Iliac crest	Fibula	Scapula	Radial
IV	Iliac crest and scapula tip equal merit		Fibula	Radial
Midface				
V (soft tissue only)	ALT	Rectus	Latissimus dorsi	Radial
VI	Composite radial for periorbital defect and prosthetic rehabilitation for rhinectomy		Scapula tip	Fibula

Class I cases are unlikely to need reconstruction because a partial dental prosthesis can effectively deal with the alveolar defect.

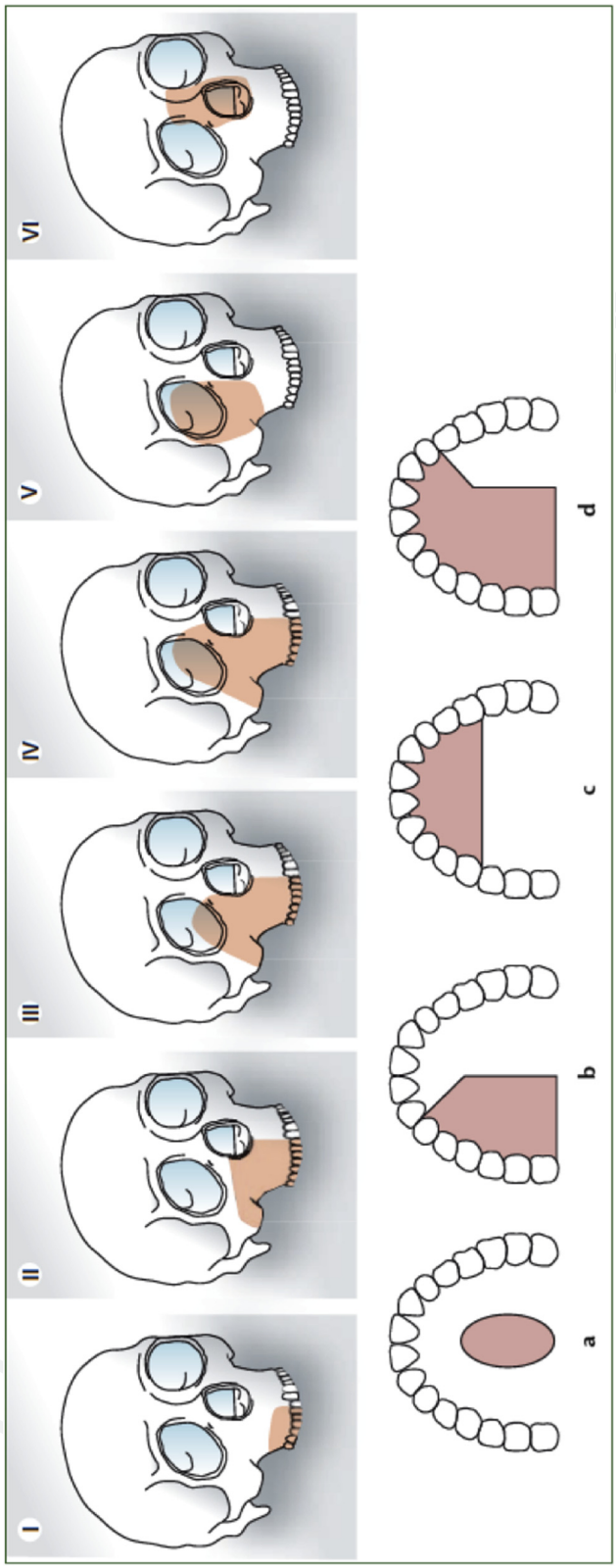

Fig. 4. Classification. Class I low maxillectomy not involving the maxillary sinus. Class II low maxillectomy not involving the orbit or nasal region. Class III high maxillectomy involving orbital floor but retaining the orbit. Class IV high maxillectomy including the orbit. Class V orbitomaxillary. Class VI nasomaxillary. (*Data from* Brown JS, Shaw RJ. Reconstruction of the maxilla and midface: introducing a new classification. Lancet Oncol 2010;11(10):1001–8.) Q13

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CLASS I (LOW-LEVEL MAXILLECTOMY NOT INVOLVING MAXILLARY SINUS)

Free tissue transfer is generally not needed for class I defects because these do not cause an oroantral fistula if laterally located. If the defect is central, however, then it may be advantageous to reconstruct the loss on the nondental part of the hard palate but only a soft tissue flap is needed (**Fig. 5**).

CLASS II (LOW-LEVEL MAXILLECTOMY NOT INVOLVING THE ORBITAL OR NASAL BONES)

Similarly there is good evidence that with implant-retained obturation excellent results are obtained for all class II defects not involving the orbit.[24] These should be considered carefully with the maxillofacial prosthodontist and due discussion with the wishes of the patient and family. These are relatively low defects with little change to the external appearance or the orbit and so the main factor to be restored is the dentition to enable adequate chewing and dental appearance. The advantage of obturation from the start is that the final result is achieved more rapidly. Although immediate implants can be placed at the time a free flap is placed, the orientation and usefulness are limited unless significant computed tomography–based preoperative planning is undertaken.[25] The choice of flap depends on how much nasal support is lost in the resection and the placement of implants with a favorable implant/soft tissue interface is often improved with a muscle as opposed to a skin flap. Excellent results are achievable with fibula and iliac crest with internal oblique but there is definitely a place for soft tissue flap reconstruction together with the immediate placement of zygomatic implants (**Fig. 6**). In our practice the scapula tip[26] does not provide bone that is reliably implanted and would be an unlikely choice in a similar way to the composite radial forearm. If the patient had an unfavorable comorbidity, then obturation with immediate implant placement is our preferred option. A definitive bar retained obturator prosthesis is usually provided within 2 weeks in an immediately loaded prosthodontic protocol.

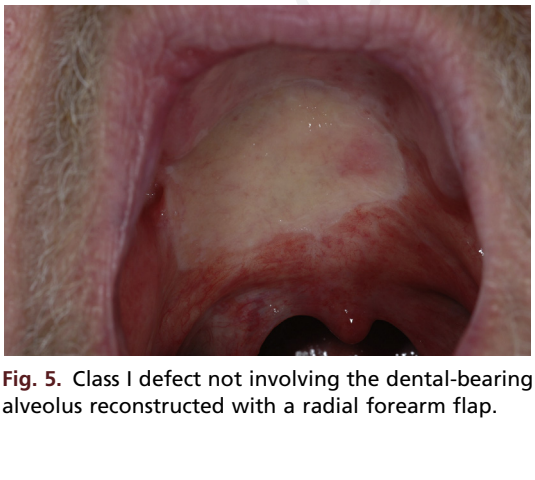

Fig. 5. Class I defect not involving the dental-bearing alveolus reconstructed with a radial forearm flap.

CLASS III (HIGH-LEVEL MAXILLECTOMY RETAINING THE ORBIT)

If there is no substantial loss of overlying skin then the most satisfactory reconstruction that can provide adequate bone for implants, good support for the orbital floor reconstruction, and a satisfactory long-term result is the iliac crest with internal oblique muscle.[27,28] I have not used the scapula tip with teres major, latissimus dorsi muscle, or serratus anterior for the class III defect mainly because the bone is not sufficient to take implants reliably and longer term results have been disappointing. Most of these patients require postoperative radiotherapy for squamous cell resection and the blood supply to the iliac crest through the deep circumflex iliac artery and the ascending branch ensure reliable healing and reduces the risk of nonunion.

CLASS IV (HIGH-LEVEL MAXILLECTOMY AND ORBIT)

This defect includes the removal of part of the dental alveolus and the maxilla, and includes an orbital exenteration. This means that there is no need to provide reliable support for the orbital floor to reduce the risk of contracture, ectropion, and enopthalmos, which greatly simplifies the reconstruction and opens the options. Much depends on whether prosthetic and prosthodontic rehabilitation is planned for the oral cavity and orbit and we still favor the iliac crest with internal oblique, which provides an excellent orbital cavity and enough good bone for an implant-retained upper denture. Without the need for a full or partial upper denture then other options can work well, although the fibula provides little appropriate soft tissue in the orbital region.

CLASS V (ORBITOMAXILLECTOMY)

With the loss of the eye a prosthesis must be considered unless the patient is happy with a patch. If a prosthesis is planned then it is advantageous not to fill the orbit so as to allow space for the prosthesis to be placed, often with the benefit of implants. There is no need to restore the bone contour because this can be restored with the prosthesis if the patient prefers. Once again the whole reconstruction is simplified because the alveolus and dentition remain intact; there is little need for facial nerve function except the

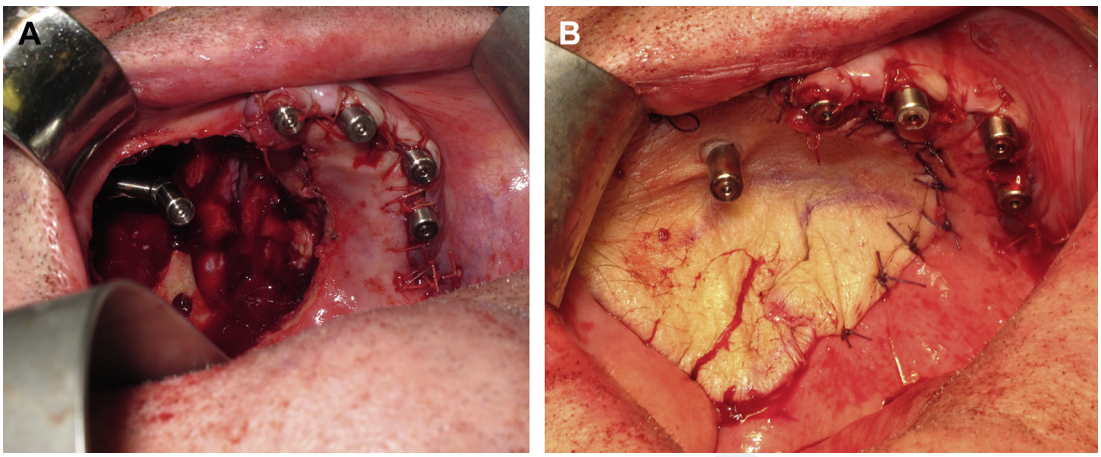

Fig. 6. A patient requiring a class IId defect reconstructed with the combination of a radial forearm flap to close the oronasal fistula and immediate implants including a zygomatic implant on the left side. (*A*) Defect and immediate implants placed. (*B*) Radial forearm flap used to close the oronasal fistula and provide an ideal interface between the implant and prosthesis.

mandibular branch often unaffected with this resection. It is really up to the choice of the surgeon working closely with the maxillofacial prosthetist (Fig. 7).

CLASS VI (NASOMAXILLARY)

This defect includes the standard rhinectomy, which is easily replaced with prosthesis if appropriate anchorage is planned at the time of the

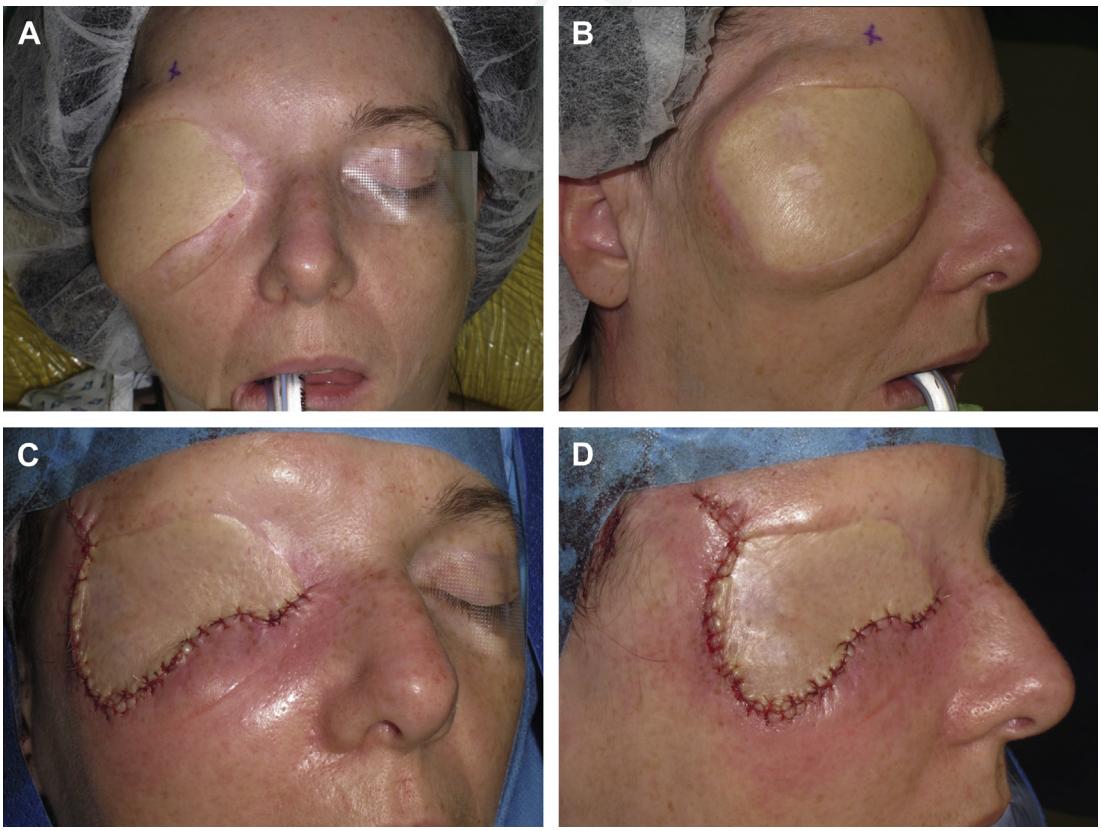

Fig. 7. Where very bulky flaps are used an initial debulking is often required before creating an orbital socket to accommodate the prosthesis. (*A, B*) Class V defect reconstruction with latissimus dorsi flap. (*C, D*) Postdebulking.

Fig. 8. Class VI rhinectomy defect restored with implant, retained nasal prosthesis. Note the importance of split-skin grafting to nasal floor and lateral aspects of the defect. (*A*) Postrhinectomy defect. (*B*) Immediate implants have been placed. (*C*) Implant-retained structure designed to hold the prosthesis. (*D*) Final result showing full nasal prosthesis.

resection. In our unit we favor the use of immediate horizontally placed zygomatic implants allowing for early loading of the prosthesis in function (**Fig. 8**). However, problems may arise when the resection is higher and includes the skin and bone separating the orbits. In this situation the lower part of the nose, sometimes including the alar region, can be retained, leaving a complex reconstruction. I take the composite radial forearm flap as my first option and I have included a case in the *Lancet* article in 2010,[23] which shows this principle very well. We have tried the scapula tip and latissimus dorsi muscle and overlying skin graft but this did not work well. It is essential to include a specialist oculoplastic surgeon in the resection and reconstruction to give the best chance of retaining a functioning lacrimal system on both sides. These cases emphasize the importance of a multidisciplinary approach for all head and neck reconstructive surgery.

SUMMARY

Microvascular reconstructive surgery requires a combined approach with sufficient number of cases and complexity to develop into a team to cover midface and maxilla and oral/oropharyngeal soft tissue and mandibular reconstruction. Short-term results are often reliable but be prepared to look at longer term results (greater than 2 years) when, after radiotherapy, less substantial and well-vascularized reconstructions may start to fail.

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