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Secondary free tissue transfer in head and neck reconstruction

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Summary *Background:* The incidence of head and neck cancer (H&N) continues to increase together with the need for reconstructive surgery. Head and Neck microsurgeons are likely to encounter challenging secondary free flap surgery on the background of failed primary flaps, radiotherapy treatment or recurrence. The aim of this study was to review our experience of treating such cases in a tertiary referral centre in the United Kingdom.
Methods: We performed a retrospective analysis of all patients undergoing sequential free flap surgery for head and neck defects in our unit during 2010–2017. Parameters recorded included indication for surgery, type and sequence of reconstruction, recipient vessel use and post-operative complications.
Results: We identified 17 patients who underwent 39 free tissue transfers for the reconstruction of head and neck defects (five transfers were performed at other units). The radial forearm and anterolateral thigh flaps were most commonly used. Almost a quarter of patients underwent three or more free flap reconstructive procedures. In over a third, the same vein and artery were used for subsequent anastomoses, and we used five vein grafts over 68 anastomoses. There were no flap failures recorded.
Conclusions: Secondary free flaps in the head and neck are required for a variety of aetiologies and can have success rates similar to those for primary free tissue transfers with minimal morbidity and mortality. Free tissue transfer is the best reconstructive option in H&N patients and should still be considered the first choice option in salvage cases until the patient's donor sites have been depleted.

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Introduction

Over the last decade, the worldwide incidence of cancer has increased by 33% and was responsible for nearly 9 million deaths in 2015 alone.[1] Head and neck cancer accounts for approximately 5% of all cases in Europe, and its incidence has also increased by a third since the early 1990s.[2] Ablative surgery and reconstruction with free tissue transfer has become the gold standard for oral cancers, and we have recently demonstrated that, over the last decade, there has been an increase of more than 50% in this modality of treatment in the UK.[3] More importantly, we have shown that free flap survival is closely linked to patient morbidity and, ultimately, mortality.[3] Microsurgical reconstruction of the head and neck is challenging, especially in patients presenting with recurrence, previous neck dissection, a failed primary flap or adjuvant radiation therapy due to decreased tissue vascularity, paucity of recipient vessels and surgical scarring. As free tissue reconstruction provides patients with superior functional outcomes, use of a secondary flap must always be considered in salvage cases.[4] Thus, it is likely that the burden of 'secondary' free flap reconstruction is likely to increase for head and neck microsurgeons. However, experience in this challenging reconstructive area remains limited, with very few series reported in the literature. In this article, we report our experience of treating these patients in a tertiary referral centre in London, UK.

Methods

We identified patients undergoing head and neck reconstruction using a free flap at the Department of Plastic Surgery, Imperial College Healthcare Trust, Charing Cross Campus, between January 2010 and December 2017. Any patient requiring further free flap surgery to the head and neck region was included in our study group. This included patients who were referred to our unit after receiving treatment elsewhere.

Review of inpatient notes and the electronic Cerner system provided data of patient age, gender, medical history, indication for surgery (including tumour histology), types of flaps used for each reconstruction, donor vessels used for anastomosis at each operation and patient outcomes.

Results

Between January 2010 and December 2017, 17 patients received a secondary free flap reconstructive procedure, and within this group, a further four patients required a third/fourth free tissue transfer. One of these patients had previously undergone two failed free flaps in succession at another unit. In total, these 17 patients underwent 39 free tissue transfers for head and neck defects, of which 34 were conducted in our unit. Table 1 illustrates a summary of patient details, indications and types of flaps utilised for reconstruction. Figure 1 illustrates the pre-, intra- and immediate post-operative appearance of a patient undergoing their third free flap reconstructive procedure following osteoradionecrosis.

In this cohort, the most common primary diagnosis was squamous cell carcinoma (SCC) ($n=12$). The other diagnoses included sarcoma ($n=2$), infection ($n=2$) and neuroblastoma ($n=1$). The indication for a secondary or a further free flap was most commonly infection ($n=6$) or tumour recurrence ($n=6$). Other causes included tracheoesophageal fistula formation ($n=3$), partial or total flap loss ($n=2$), exposed bone/plate ($n=2$), non-union of the mandible ($n=1$), osteoradionecrosis ($n=1$) and incomplete primary tumour excision ($n=1$).

Table 2 illustrates the number and types of free flaps used amongst this group. Radial forearm flaps were most commonly used ($n=14$), followed closely by the anterolateral thigh flap ($n=13$) and free fibula ($n=8$).

The sequence and types of free flaps used for each stage of reconstruction are outlined in Table 3. The free flaps used for primary reconstruction include radial forearm flap ($n=7$), anterolateral thigh flap (ALT) ($n=5$), free fibula flap ($n=2$), free jejunum ($n=2$) and DCIA flap ($n=1$). The free flaps used for the second reconstruction included radial forearm ($n=6$), ALT ($n=7$), fibula ($n=3$) and lateral arm flap ($n=1$). For tertiary reconstruction, flaps included radial forearm ($n=1$), ALT ($n=1$) and fibula ($n=1$). Two patients required four flaps, and these were both free fibulas ($n=2$).

We investigated the recipient vessels to delineate whether the same or a different vessel was used for subsequent free flap anastomosis (Tables 4 and 5). For venous anastomoses, the facial vein and the internal jugular vein were most commonly used for the primary anastomosis ($n=10$). For subsequent venous anastomoses, we were able to anastomose to the same vein used in the primary reconstruction in four cases. The facial artery was most commonly utilised for arterial anastomoses ($n=7$). For subsequent arterial anastomoses, we were able to anastomose to the same artery as used in the primary reconstruction in seven cases. Table 6 illustrates the use of vein grafts in our series. Four patients required vein grafts in their venous anastomoses, and one patient required a vein graft for their arterial anastomoses. This equates to five incidences of vein graft use over the 68 anastomoses (34 flaps conducted in our unit) in our series.

In this series, there were 9 recorded complications that were grouped according to the Clavien-Dindo classification.[5] There were four grade I complications: two patients had neuropraxia of the marginal mandibular nerve, one patient developed a small sinus that closed spontaneously and one patient had dehiscence of the flap that was allowed to heal. There were two grade II complications, where patients had post-operative infections that required treatment with intravenous antibiotics. There were three grade III complications, where patients developed marginal flap necrosis (two of which needed a local flap to treat). There were no complete flap failures or grade IV or V complications observed in this series (Table 7).

Discussion

Microsurgical reconstruction of head and neck following ablative surgery on the background of a previous failed flap, adjuvant or neoadjuvant radiotherapy or neck dissection

Table 1 Summary data.

Patient	Age*	Sex	Pathology	Stage	Primary indication	Primary free flap	Secondary indication	Secondary free flap	Tertiary indication	Tertiary flap	Quaternary indication	Quaternary flap
1	50	F	SCC	T1N0M0	Palate	L RFF	Tracheoesophageal fistula	R RFF				
2	55	M	SCC	T1N0M0	Retromolar	RFF	SCC FOM (R)	R ALT	SCC mandible (R)	L ALT		
3	53	M	Sarcoma	T4N0M0	Maxillary sinus	L ALT	Sarcoma maxilla (R)	R ALT				
4	62	M	SCC	T2N0M0	Right FOM	L RFF	FOM SCC (R)	R RFF				
5	45	F	Infection	N/A	Maxillary sinus	Unknown	Unknown	Unknown	Infection	L RFF	Infection	R fibula
6	75	F	SCC	T4N0M0	FOM	L RFF	Mandibular fracture/non union	L fibula				
7	52	F	SCC	Unknown	FOM	R ALT	Retromolar	R Fibula	Exposed fibula/mandible	Lateral arm	ORN mandible	L fibula
8	58	M	SCC	Unknown	FOM	L fibula & L RFF	Flap failure	R RFF	Infected plate	R fibula		
9	75	F	SCC	T2N0M0	FOM/retromolar trigone	L RFF	Infected plate	L ALT				
10	66	M	SCC	T4N2bM0	FOM/tongue base	R ALT	Incomplete excision	L fibula				
11	39	F	Sarcoma	T4N0M0	Maxilla	DCIA	Partial flap loss	ALT				
12	54	M	SCC	T3N2cM0	Hypopharynx	Jejunum	Tracheoesophageal fistula	R RFF				
13	56	F	SCC	T4N0M0	Maxillary sinus	L ALT	SCC (R)	R ALT				
14	49	M	Infection	N/A	Maxilla/nasal septum	R ALT	Infection	L ALT				
15	64	M	SCC	T4aN2bM0	Pharynx	Jejunum	Tracheoesophageal fistula	L RFF				
16	59	M	SCC	Unknown	ORN mandible	Fibula	Exposed plate	R ALT				
17	53	F	Neuroblastoma	T4N1M0	Skull base	L RFF	Osteomyelitis skull base	R RFF				

* Age (in years) at first presentation; SCC squamous cell carcinoma; L left; R right; FOM floor of mouth; RFF radial forearm flap; ALT anterolateral thigh flap; DCIA deep circumflex iliac artery flap; ORN osteoradionecrosis; Unknown patient referred from another unit & notes unavailable; N/A not applicable

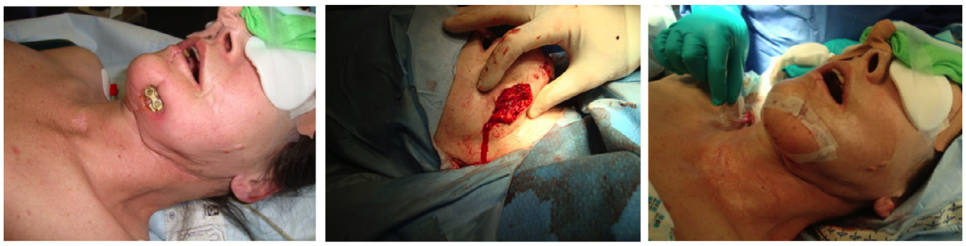

Figure 1 Pre-, intra- and immediate post-operative appearance of a patient undergoing their third free flap reconstructive procedure.

Table 2 No types F flaps used.

Free flap type	Primary procedure	Secondary procedure	Tertiary procedure	Quaternary procedure	Total number
Radial forearm	7	6	1	0	14
ALT	5	7	1	0	13
Fibula	2	3	1	2	8
Jejunum	2	0	0	0	2
DCIA	1	0	0	0	1
Lateral arm	0	1	0	0	1

Table 3 Sequence & types FF.

Patient	Primary	Secondary	Tertiary	Quaternary
1	L RFF	R RFF		
2	RFF	R ALT	L ALT	
3	L ALT	R ALT		
4	L RFF	R RFF		
5	*Unknown*	*Unknown*	L RFF	R fibula
6	L RFF	L fibula		
7	R ALT	R fibula	Lateral arm	L Fibula
8	L fibula & L RFF	R RFF	R fibula	
9	L RFF	L ALT		
10	R ALT	L fibula		
11	DCIA	ALT		
12	Jejunum	R RFF		
13	L ALT	R ALT		
14	R ALT	L ALT		
15	Jejunum	L RFF		
16	Fibula	ALT		
17	L RFF	R RFF		

Unknown: flap conducted at another unit and notes unavailable.

Table 4 Vein anastomoses.

Primary anastomosis	Secondary anastomosis	Number of patients
Facial vein	Facial vein	3
Facial vein	IJV	1
Facial vein	STV	1
IJV	IJV	1
IJV	Facial vein	4
SJV	EJV	1
STempV	Facial vein	1

IJV internal jugular vein; STV superior thyroid vein; EJV external jugular vein; STempV superficial temporal vein.

Table 5 Arterial anastomoses.

Primary anastomosis	Secondary anastomosis	Number of patients
Facial artery	Facial artery	6
Facial artery	STA	1
STA	STA	1
STA	Occipital artery	1
Occipital artery	Facial artery	1
STempA	Occipital artery	1

STA superior thyroid artery; STempA superfical temporal artery.

Table 6 Vein grafts.

	Venous anastomoses	Arterial anastomoses
Secondary flap	$n=3$	$n=1$
Tertiary flap	$n=1$	0
Quaternary flap	0	0

Table 7 Failure rate.

Stage of reconstruction	No of patients
Secondary flap	0
Tertiary flap	0
Quaternary flap	0

Failure = partial or total failure of flap.

can be challenging. The limited literature published on this subject shows great variability in free flap survival, with some studies demonstrating success rates of only 73%.[6-9] Some surgeons may thus advise against a secondary free flap reconstruction given that free tissue transfer failure has a negative impact on short-term prognosis and also on patient

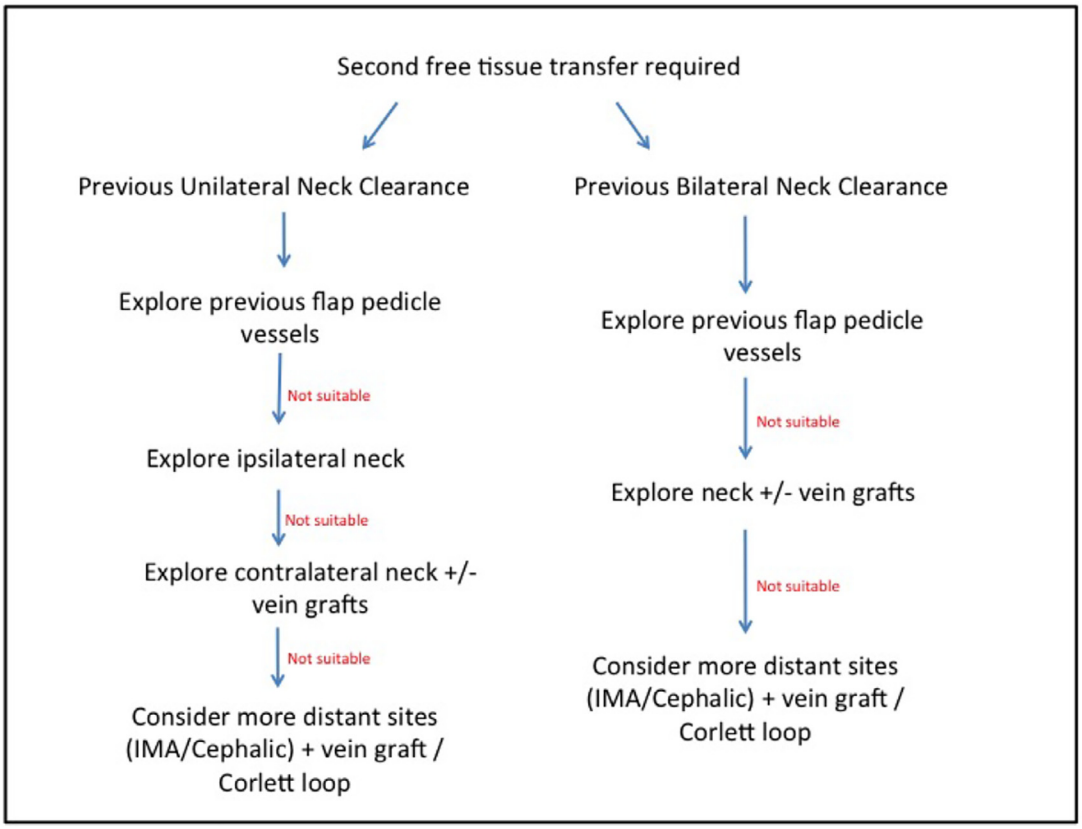

Figure 2 Algorithm for vessel selection in sequential head and neck flap patients.

survival.[6] In this study, we have shown that in salvage cases, secondary free flap success rates can be as good as primary free flaps, and therefore, we advocate the use of free transfer in this group of patients. We have demonstrated that patients can have up to four free flaps transferred to the head and neck region with minimal morbidity. We propose that microsurgical reconstruction should always be considered in salvage scenarios unless suitable donor sites have been exhausted.

In this series of 17 patients, there were 34 free flap reconstructive procedures with a 100% success rate. One patient required tertiary and quaternary surgery for flap loss at a referring unit. Despite the complexity of the operations, there were no deaths reported in this series, which demonstrates the feasibility and relative safety of performing secondary free flaps. This series also further demonstrates the importance of free flap survival in patient outcome. We strongly believe that the excellent patient survival observed in this study is correlated to free flap success rates as we have previously published.[3]

Some authors purport lack of availability of recipient vessels in sequential free flap surgery due to previous surgery or radiation therapy.[7,8] However, we have found that the majority of arterial anastomoses can utilise the same recipient vessel. With regard to the vein, the IJV or facial vein was suitable for use in the majority of cases. We prefer to carry out an end-to-side anastomosis on the IJV, and further microsurgical anastomoses are possible either caudal or cephalad to the previous anastomosis. If this was not possible, there is the option of using vein grafts or the contralateral vessels in the face or neck. Reconstructive microsurgeons carrying out secondary free flaps in the head and neck region must be proficient and confident with the use of vein grafts, as this study has demonstrated that they are required in one in fourteen anastomoses. We have also had to utilise 'distant' venous recipient vessels such as the cephalic vein as previously described.[9,10] One of our senior authors has previously anastomosed a free tissue pedicle to the internal mammary artery at the level of the second rib.[11] Thus, this study demonstrates that to achieve a high success rate in salvage cases, more complex microsurgical techniques are required than that in primary cases.

Following our experience, we have developed an algorithm to aid surgeons in choice of recipient vessel in patients requiring sequential free flap reconstruction (Figure 2). In those patients who have had a previous unilateral neck dissection, we recommend first exploring the previous flap pedicle vessels; if these vessels are not available, we suggest exploration of the contralateral neck vessels, progressing onto more distant sites for anastomosis as the last resort. In patients with previous bilateral neck dissection, we also recommend exploration of the previous flap pedicle, and if there are no vessels in the neck bilaterally with or without the use of vein grafts, we suggest using distant anastomotic sites.

This study has shown that there are a variety of indications for a secondary free flap in the head and neck region, which include local recurrence, osteoradionecrosis,

skin necrosis secondary to adjuvant radiotherapy and a failed primary free flap. Secondary free flap reconstruction is feasible and safe despite the varying indications and hence should be considered until the donor site has been depleted. The secondary free flap must be tailored to the defect, and we used a number of flaps including the anterolateral thigh, radial forearm, free fibula and lateral arm flap. Thus, head and neck microsurgeons who wish to reconstruct such defects must have a wide variety of free tissue transfers in his or her armamentarium.

Conclusion

Reconstruction following head and neck cancer ablative surgery is challenging. Free flap reconstructive surgery provides the best functional outcomes in this group of patients. In experienced units, secondary free flaps can have success rates similar to those for primary free tissue transfers and thus should be considered until donor sites have been exhausted. We believe secondary flaps in head and neck surgery are a technically feasible and safe procedure to ensure functional and aesthetic reconstruction in these patients.

Conflict of interest statement

None.

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None.

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