A tailored approach to oromandibular reconstruction in patients with compromised lower limb vessels.

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Abstract:

Background: The fibula osteocutaneous free flap is the first choice flap for most surgeons reconstructing segmental defects of the mandible. Abnormalities affecting the lower limb vasculature occasionally preclude fibula harvest and either an alternative bony reconstruction is considered or the segmental defect must be left unreconstructed. This study compares outcomes for segmental reconstruction of the mandible between patients reconstructed with a fibula flap, and those with an osseous free flap from another donor site where the fibula flap was unsuitable either for donor site or defect reasons.

Methods: Adult patients who had segmental reconstruction of the mandible between January 2008 and June 2014 were included. Details of the defect and reconstruction were recorded. Outcomes for patients who had fibula flaps (group 1) were compared with those who had an alternative reconstruction for defect reasons (Group 2) or because they were unsuitable for fibula harvest due to compromised leg vessels (Group 3).

Results: 152 patients were included comprising 57 (27.5%) patients in Group 1; 75 (49%) in Group 2; and 20 (13%) in Group 3. The overall flap success rate was 97% and the late recipient site complication rate was 19%. There was no difference in flap success or complication rate between the groups.

Conclusions: Where unfavourable preoperative vascular studies preclude the fibula flap, or where another donor site is more suitable due to the nature of the defect,

successful bony reconstruction of the mandible can still be achieved with no compromise in either flap success or recipient site complication rate.

Introduction:

Since its description by Hidalgo[1] as a method of reconstructing the mandible, the fibula osteocutaneous free flap has increased in popularity and is now the first choice free flap for most surgeons reconstructing segmental defects of the mandible[2-5]. It allows transfer of a long segment of bone with or without a skin paddle and is easily adapted to the shape of the mandible. The pedicle length is good and simultaneous harvest is possible. The main limitations are the bone height and the limited manouverability of the skin paddle. When a deeper segment of bone is desirable or where there is a large complex soft tissue component to the defect, the iliac crest or scapula may be more appropriate.

The fibula flap is pedicled on the peroneal artery and vein and these vessels can normally be safely harvested with the fibula bone. Atherosclerotic disease or traumatic deformity affecting the tibial vessels or rarely, congenital anomalies eg peronea magna (dominance of the peroneal artery with hypoplasia or absence of the tibial vessles), may mean that the peroneal artery becomes the dominant blood supply to the foot and lower leg. In these circumstances, sacrifice of the peroneal artery for flap harvest could have devastating vascular consequences for the foot[6-9]. Furthermore, congenital absence or atherosclerotic disease of the peroneal artery may compromise successful bony transfer. Lower limb vascular abnormalities of sufficient concern to dissuade the surgeon from fibula harvest have been reported in up to 25% of patients[10]. For this reason, lower limb vascular assessment is essential prior to fibula flap harvest. Some authors consider clinical assessment to be

sufficient in most cases[11]. However, the widespread availability of magnetic resonance angiography which provides highly detailed information on the lower limb vasculature without the morbidity of conventional angiography has resulted in it being routinely adopted in many centres[9,12]. Where the imaging is not favourable and fibula flap harvest is inadvisable, osseous reconstruction of the mandible can still be achieved using an alternative donor site[4, 13-15]. In practice, the choice depends on the experience and preference of the surgeon. Where other composite free flaps are deemed inappropriate or are not within the skillset of the reconstructive surgeon, soft tissue reconstruction of the mandible has been reported[4,16-18] This is associated with a less satisfactory aesthetic and functional outcome[16,17]. Posterior defects are more forgiving of this approach[4,18] than anterior defects where failure to reconstruct results in the “Andy Gump” deformity[19] and in severe cases the patient may be tracheostomy and feeding tube dependant.

This paper reports our experience with segmental reconstruction of the mandible since January 2008, when routine magnetic resonance angiography was introduced as a prerequisite for fibula flap harvest and examines the approach to reconstruction of the mandibular segmental defect where preoperative lower limb evaluation is unfavourable.

Methods:

Adult patients (>16yrs) who had segmental reconstruction of the mandible between January 2008 and June 2014 in a single UK institution were identified from the theatre records. The aetiology, site of the defect, flap type, flap outcome and complications were recorded from the case notes and imaging. The length of the defect requiring reconstruction was recorded from the pathology records. The position of the mandibular defect was classified as follows[20]: lateral defects were Class I if posterior to the canine tooth and Class II if they also involved the canine. A class III defect involved both canines but did not involve either angle and a class IV involved both canines and one or both angles. A defect were the condyle was also removed was classified in the same way but with the additional designation “c”. The MRA reports of patients who had any reconstruction other than fibula flap were reviewed and any abnormalities recorded. Outcome was considered as early and late. Early outcomes at the reconstructed site were measured by length of hospital stay and flap success. Late outcomes at the reconstructed sites were quantified by frequency of readmission or return to theatre and were recorded as:

1. Readmission
2. Plate removal
3. Bone removal
4. Plate exposure
5. Infection

Donor site morbidity was not included. Patients were divided into 3 groups: Group 1 were patients where a fibula flap was planned and clinical assessment and favourable MRA imaging allowed the fibula flap harvest to proceed as planned. Group 2 were patients with a mandibular segmental defect where the fibula was not considered the ideal reconstruction based on patient or defect factors. They had their defect reconstructed with vascularised scapula, iliac crest or radius. Group 3 patients were planned for fibula flap reconstruction of their defect but unfavourable MRA imaging of the lower limb vasculature meant the plan was changed to reconstruction using a different bony flap. Outcomes for the three groups were compared.

Results:

Of 153 patients with segmental mandibular defects during the study period (January 2008 to June 2014), 152 patients (89 males and 63 females) had composite reconstruction of their defect and were included. One patient with significant medical comorbidities was deemed not suitable for composite free flap reconstruction and was excluded from the study. Patient characteristics are presented in Table 1 and outcomes are presented in Table 2. The overall flap success rate was 97% (147/152). There was complete flap failure in 5 patients (2 fibula and 3 radius). In the case of the 2 fibula flap failures, bony reconstruction was achieved with the contralateral fibula in one case and a radius in the other. Osseous reconstruction was not achieved for the 3 patients who had failure of their radius flap. In addition there was skin paddle loss in a further 5 (Fibula 2 and Scapula 3) patients requiring bone coverage with a fasciocutaneous free flap (1/5) or local advancement flap/mucosalisation of underlying muscle (4/5). The characteristics of the flap failure/ partial failure group are presented in Table 3. The late complication rate was 19%. There was no difference in flap failure or complication rate between the groups.

The fibula flap was the planned reconstruction in 77 (51%) patients. In the remaining 75 (49%), a flap other than the fibula was planned from the start based on patient and defect factors (**Group 2**). Of the 77 planned fibula flaps, 57 (74%) had favourable MRA imaging of the lower limb vasculature and had their defect reconstructed with a fibula flap as planned (**Group 1**). There was unfavourable MRA imaging in 20 (26%) patients and these patients had a composite reconstruction other than the fibula flap (**Group 3**). Of the 20 patients, one had peronea magna, 18

had severe peripheral vascular disease and one had a combination of peripheral vascular disease and hypoplasia of the posterior tibial arteries.

Discussion:

This study compares outcomes for segmental reconstruction of the mandible between patients reconstructed with a fibula flap, and those with an osseous free flap from another donor site where the fibula flap was unsuitable either for patient or defect reasons. The results demonstrate that although in most cases the fibula may be the donor site of first choice for mandible reconstruction, where unfavourable preoperative vascular studies preclude it, or where another donor site is more suitable due to the nature of the defect, successful bony reconstruction of the mandible can still be achieved with no compromise in either free flap success or recipient site complication rate. The overall composite flap success rate of 97% confirms the high success rates associated with reconstruction of the mandible reported in other units internationally[2,4,14].

This is the first study that we are aware of to compare outcomes for fibula flap mandible reconstructions with alternative bony reconstruction where preoperative assessment precludes fibula harvest. The study is strengthened by the consecutive nature of the patients – only one patient with a segmental defect of their mandible during the study period did not receive a bony reconstruction - and the fact that all 4 donor site options have been used in roughly similar proportions.

The limitations of this retrospective study are apparent. Data was retrieved from theatre records, case notes, postoperative radiographs and pathology reports which were not always recorded in a standardised format. Some details such as position or

length of the defect were occasionally missing from the operation or pathology reports and historical digital postoperative imaging which would have provided clarification, was not always saved by the hospital. Furthermore, a relatively short follow up period for patients treated in the final year of the study period means that the late complication rate may not be completely reliable as these problems often do not manifest themselves until sometime after completion of postoperative radiotherapy.

The overall composite flap success rate of 97% is comparable to that published by other large units[2,4,14] and shows an improvement in our composite free flap survival rates for mandible reconstruction on those previously published: 89% for mandibles reconstructed from 1993-2001 and 95% from 1998-2001[15]. This reflects the learning curve associated with the introduction of any new reconstructive technique. There was complete loss of 5 flaps – 3 radius and 2 fibula flaps. We do not believe that the radius is any less reliable than the other 3 donor sites but it's use as bony flap of "last resort" for older patients with significant medical comorbidities may introduce some selection bias. The mean age of patients in the flap failure subgroup was 74 years (range: 50-86years) compared with 62 years for the overall cohort ($p = 0.04$).

There were no complete flap losses for iliac crest or scapula donor sites during the study period although 3 scapula skin paddles were lost. The scapula is now our first choice reconstruction where the fibula is contraindicated due to peripheral vascular disease[21] and so unsurprisingly was the most common reconstruction used for patients in Group 3. It is hoped that as we continue to refine our technique for this flap, our skin paddle success rate may also approach 100%.

The late recipient site complication rate of 19% is similar to other studies. Shaw et al[15] have previously reported results for an earlier cohort from our unit, showing that late recipient site complication rate is not influenced by donor site choice so it was not surprising that there was no difference between the groups in this study. The only significant factor influencing readmission and late fixation related complication rate was whether the patient had previous radiotherapy ($p = 0.05$).

While precise donor site morbidity was not measured for this study, no catastrophic complications (eg ischaemic foot) occurred. The fibula donor site complication rate for this cohort has previously been published[22].

The possibility of congenital anomalies, traumatic deformity or peripheral vascular disease affecting the tibioperoneal trunk mean that preoperative vascular assessment of the lower limb is essential prior to fibula harvest and in our unit all patients being considered for fibula flap harvest undergo MRA examination of their lower limbs. The proportion of patients in this study where the fibula was excluded due to unfavourable preoperative MRA (26%) is higher than expected. While a high incidence of peripheral vascular disease due to heavy smoking and a western diet may be contributory, the main reason is the units readiness to use alternative donor sites such as the scapula or iliac crest in cases where the preoperative imaging is anyway suggestive of vascular compromise.

Our approach to mandible reconstruction contrasts with that in many other centres where patients who are not suitable for a fibula flap are either not reconstructed or receive a soft tissue only flap[4, 16-18] Hanasano et al[4] compared outcomes for soft tissue and bony reconstruction of posterior mandible defects. Although there was no

significant difference in length of operation, hospital stay or donor site complication rate, they propose an algorithm whereby bony reconstruction of posterior mandible defects be reserved for young, healthy patients with favourable soft tissue components to their defects. While not attempting bony reconstruction of posterior mandibular defects may very rarely be a prudent compromise, eg ORN in the severely vessel depleted neck, in most cases patients will benefit from reestablishment of bony continuity. The bone of the mandible provides a scaffold for the soft tissues of the oral cavity thus maintaining the airway, allowing functional mastication and swallowing, and intelligible speech. It is responsible for the bony contour of the lower third of the face and anchors the teeth. Failure to reconstruct the bone for posterior defects is generally better tolerated than for anterior defects but there are still significant functional and aesthetic implications[4,16,17] The lower face loses its contour, and asymmetry develops due to the unopposed activity of the contralateral lateral pterygoid muscle. Normal occlusion of the remaining teeth is lost due to this medial rotation at the remaining functioning condyle and dental rehabilitation is not possible resulting in impaired mastication.

We advocate osseous reconstruction of the mandible for all segmental defects where the patient is deemed fit for free flap surgery. While it may be technically more difficult to reconstruct with bone, the donor site morbidity, operating time and length of hospital stay are similar compared with soft tissue reconstruction and the outcome is undoubtedly better. Flap selection is based on individual defect and donor site characteristics. Familiarity with all 4 commonly used donor sites for vascularised bone transfer means that when preoperative assessment precludes fibula harvest, reconstruction of the mandible can still be achieved. This approach has allowed us to

optimise the oromandibular reconstruction of almost 100% of patients with segmental mandibular defects while minimising the potential for either significant donor site complication or flap failure.

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Table 1: Patient Characteristics. No. of patients (%)

Characteristic	Overall (n=152)	Group 1 (n=57)	Group 2 (n=75)	Group 3 (n=20)
Mean (SD) Age	62 (13), n=149	63 (11), n=55	60 (14), n=74	67 (13)
Median (IQR) Age	63 (55-71)	63 (54-70)	62 (54-69)	69 (60-75)
Sex: Male	89 (59)	29 (51)	48 (64)	12 (60)
Diagnosis:				
Malignant tumour	118 (78)	41 (72)	61 (81)	16 (80)
ORN	22 (14)	11 (19)	8 (11)	3 (15)
Benign pathology	11 (7)	5 (9)	5 (7)	1 (5)
Trauma	1 (1)	0	1 (1)	0
Donor site:				
Fibula	57 (38)	57 (100)	0	0
Scapula	37 (24)	0	29 (39)	8 (40)
Iliac crest	33 (22)	0	27 (36)	6 (30)
Radius	25 (16)	0	19 (25)	6 (30)
Defect:				
Class I	65 (43)	24 (42)	36 (48)	5 (25)
Class IC	3 (2)	0	2 (3)	1 (5)
Class II	43 (28)	19 (33)	16 (21)	8 (40)
Class IIC	1 (0.6)	1 (2)	0	0
Class III	30 (20)	11 (19)	17 (23)	2 (10)
Class IV	10 (6)	2 (3.5)	4 (5)	4 (20)
Mean (SD) Length /cm	8.4 (2.9), n=111	8.8 (3.0), n=44	7.9 (2.3), n=54	8.7 (4.5), n=14
Median (IQR)	7.5 (6.5-10.0)	8.0 (7.0-10.4)	7.1 (6.3-9.8)	7.3 (5.5-10.0)

Table 2: Outcomes. No. of patients (%)

	Overall (n=152)	Group 1 (n=57)	Group 2 (n=75)	Group 3 (n=20)	P value*
Early complications:					
Complete flap loss	5 (3)	2 (3.5)	2 (2.6)	1 (5)	0.83
Skin paddle loss	5 (3.5)	2 (3.5)	2 (2.7)	1 (5)	0.83
Length Hospital stay /days: Mean	22, n=125	23, n=49	21, n=60	24, n=16	
Median (IQR)	18 (14-25)	19 (13-24)	18 (14-25)	23 (10-31)	0.85
Late complications:					
Readmission	27/149 (18)	12/54 (22)	12 (16)	3 (15)	0.67
Plate removal	21/149 (14)	9/54 (17)	10 (13)	2 (10)	0.80
Bone removal	3/149 (2)	1/54 (2)	0	2 (10)	0.02
Plate exposure	6/149 (4)	1/54 (2)	4 (5)	1 (5)	0.51
Infection	14/147 (10)	6/53 (11)	6 (8)	2/19 (11)	0.73
Any late complication:	29/147 (20)	12/53 (23)	13 (17)	4/19 (21)	0.77

*Fishers Exact, apart from Mann-Whitney test (Hospital Stay)

Table 3: Flap failures:

	Flap	Age	Aetiology	Site	Soft tissue component	Previous neck dissection or RT	2nd Flap
Complete flap loss N=5							
1	Fibula	50	SCC	3	Mucosa	Both	Radius
2	Fibula	70	Osteonecrosis	L	No	Neck	Fibula
3	Radius	83	SCC	2	Skin + mucosa	No	Pec major
4	Radius	80	SCC	1	Mucosal	No	No
5	Radius	86	SCC	1	Mucosal	No	No
Skin paddle loss N=5							
1	Fib	71	SCC	1	Mucosal	No	No
2	Fib	74	SCC	1	Mucosal	No	No
3	Scapula	48	SCC	1	Mucosal	No	No
4	Scapula	62	SCC	3	Skin + mucosal	No	Radial fasciocutaneous
5	Scapula	75	SCC	2	Skin + mucosa	No	No