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Original article

Pre-operative evaluation of the lower extremity prior to microvascular free fibula flap harvest

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The microvascular free fibula flap, is currently one of the preferred methods for reconstruction of the oromandibular defect. The patency of the major vessels in the donor limb should be evaluated before the fibula is harvested because the blood supply can be inadequate to safely utilise this flap. The best method of evaluating, pre-operatively, the lower limb vasculature is controversial. Femoral angiography has been considered as the gold standard, however, the current literature advocates less invasive methods of assessment such as magnetic resonance angiography and colour flow Doppler. A postal questionnaire was sent to all members of The British Association of Head and Neck Oncologists asking details of the preferred method of lower limb vascular assessment prior to fibula flap harvest. Of 137 responses, 48 performed free fibula flaps. Of these 48 surgeons, the preferred method for evaluation was palpation of pulses combined with either angiography (40%) or Doppler on the ward (38%). None of this subgroup of surgeons utilised colour flow Doppler as a first line investigation despite this being available to 67% of responders. This survey highlights the diversity in pre-operative assessment amongst surgeons performing fibula flaps for head and neck malignancy. Few relied on clinical examination alone; however, the less invasive methods of vascular imaging were seldom utilised.

Key words: Microvascular free fibula flap – Reconstruction of the oromandibular defect – Lower limb vascular assessment – Postal questionnaire

Microvascular free tissue transfer is one of the preferred methods for reconstruction of head neck defects following ablative oncological surgery. The fibula flap is particularly useful for defects requiring soft tissue as well as bone. Taylor *et al*, in 1975, was first to describe the free fibula flap for the reconstruction of an open fracture of the lower extremity,[1] and Hidalgo, in 1989, reported its use in the

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Table I: Pre-operative investigations

	Initial tests performed		Dorsalis pedis pulse absent		Available tests	
	n = 48	%	*n* = 48	%	*n* = 48	%
Palpation of pulses	47	98	–	–	48	100
Doppler on ward	18	38	3	6	41	85
Doppler vascular laboratory	8	17	4	8	33	69
Digital subtraction angiography	6	13	3	6	42	88
Colour flow Doppler	0	0	4	8	32	67
Arterial angiography	19	40	13	27	45	94
Magnetic resonance	4	8	0	0	26	54

The table gives details of the pre-operative investigations carried out by the surgeons performing fibula flaps. Numbers of responders and percentages are shown for the investigation used initially, the investigation used when the dorsalis pedis pulse is absent, and for the availability of each investigation at each hospital.

reconstruction of segmental mandibular defects.[2] The blood supply to the fibula flap is based on the peroneal artery and the venae comitantes. Various vascular abnormalities have been recognised which would preclude its use as a free flap,[3] notably absence of a peroneal artery (0.1% of the population) and arteria magna, a condition in which the peroneal artery supplies most of the blood supply to the foot. Acquired abnormalities include trauma and atherosclerosis.[4] The life style of patients presenting with head and neck cancer tends to make them more prone to atherosclerosis secondary to their smoking habits. Angiography has been considered the gold standard investigation. However, the relatively low incidence of vascular abnormalities and potential complications following angiography has led several authors to favour less invasive means of assessment (e.g. colour flow Doppler and magnetic resonance angiography).[5,6]

A postal survey of members of The British Association of Head and Neck Oncologists was carried out with the purpose of identifying the current methods of pre-operative vascular assessment prior to free fibula flap harvest.

Materials and Methods

A questionnaire consisting of nine questions concerning pre-operative evaluation of the patient prior to free fibula flap harvest (Appendix 1) was circulated to members of The British Association of Head and Neck Oncologists. The Association is made up of mainly surgeons, radiotherapists, and medical oncologists. From the mailing list, it was impossible to identify which members were surgeons and which were not, so all members of the Association were sent a questionnaire. No reminders were sent following the initial correspondence. From the questionnaire, it was possible to identify those surgeons who performed microvascular surgery and those utilising free fibula flaps.

Results

There were 353 questionnaires distributed to the active members of The British Association of Head and Neck Oncologists of which 137 completed responses were returned (38.8%). There were 124 surgeons, eight radiotherapists, two pathologists, one public health practitioner, one clinical oncologist (radiotherapist and chemotherapist) and one medieval historian. Of the 124 surgeons, 72 (58.1%) performed microvascular free tissue transfer and of these 48 (66.6%) perform free fibula flaps for mandibular reconstruction. Of the surgeons performing fibula flaps, 46 performed between 1 and 10, one surgeon had performed 12, and one had recorded performing 60 over the past year.

The pre-operative investigations amongst the 48 surgeons undertaking fibula flaps is shown in Table 1. Forty-six (96%) palpated for the dorsalis pedis and 43 (90%) palpated for the posterior tibial. The femoral pulse was palpated by 31(65%) and the peroneal by 16 (33%). The most common combination of pulses palpated for was the posterior tibial and dorsalis pedis (88% of total). Following the clinical evaluation of peripheral pulses, the two most common investigations were arterial angiography (40%) and Doppler on the ward (38%). Despite their availability, vascular laboratory Doppler, colour flow Doppler, and magnetic resonance angiography were not utilised as first line investigations.

When the dorsalis pedis pulse was absent, surgeons preference of pre-operative investigation changed (Table 1). Thirteen who had not previously requested femoral angiography would now do so. Of the 19 surgeons who would not perform any additional tests, 15 would have already performed angiography and the remaining four

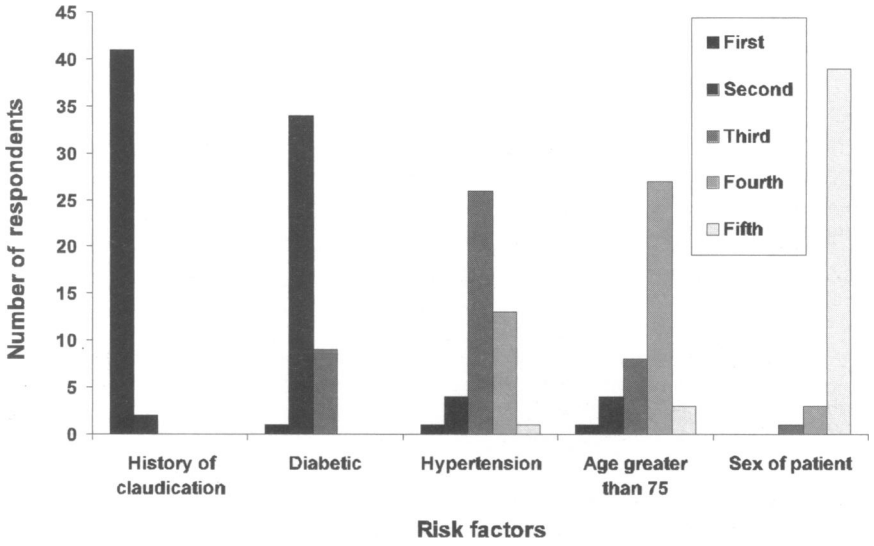

Figure 1 Rank order of five features in the medical history. The graph demonstrates the agreement of the surgeons about the 5 postulated risk factors which must be considered when considering a patient's suitability for a fibula free flap

would rely on digital subtraction angiography (one) vascular lab Doppler (two), and clinical examination only (one). Therefore, a total of 33 surgeons (67%) would use angiography if there is evidence of a absent dorsalis pedis pulse.

Clinicians were asked to place in rank order of significance five aspects of medical history: intermittent claudication, diabetes, age greater than 75 years, gender, and hypertension. Forty-one (93%) clinicians thought that a history of claudication was the most important (93%), and 34 (77%) ranked a history of diabetes as the second most significant factor. The gender of the patient was considered least important to 89% of those questioned (Fig. 1).

The last question concerned the choice of microvascular reconstruction should a fibula flap be contra-indicated (Table 2). The majority of microvascular surgeons who performed fibula flaps chose between a DCIA flap (63%) and composite radial (52%). Of the 24 surgeons who did not use fibulas, 71% favoured the composite radial.

Table 2 Alternative osseous flaps to the fibula

	Group 1		Group 2	
	n = 48	%	*n* = 24	%
Deep circumflex iliac	30	63	13	54
Scapula	19	40	5	21
Composite radial	25	52	17	71

Group 1 = other osseous flaps used by surgeons performing fibula flaps when a fibula is contra-indicated.
Group 2 = other osseous flaps used by surgeons who do not perform fibula flaps.
The table gives the number and percentage of alternative free flaps to the fibula which are used by microvascular surgeons when a fibula flap is contra-indicated.

Discussion

The microvascular free fibula flap is ideal for mandibular reconstruction because it is relatively easy of harvest and provides a large stock of bone with minimal donor site morbidity. However, lower limb ischaemia has been recognised as an infrequent catastrophic complication. The vascular pedicle of the fibula flap is based on the peroneal artery and several anatomic variations of the blood supply to the lower extremity have been described.[3,7] Absence of the peroneal artery arises in less than 0.1% of the population, and peroneal arteria magna – a condition in which the peroneal artery supplies most of the blood supply to the foot – has been described.[4] These two conditions make it impossible to utilise the fibula flap safely. In addition arterial occlusion of either the posterior tibial or anterior tibial artery secondary to atherosclerosis could pose a potential risk in patients with head and neck cancer who are heavy smokers.

The preferred method of evaluating the peripheral extremity prior to fibula flap harvest is controversial. Carroll and Esclamodo,[8] Young *et al*,[4] and Blackwell[3]

have advocated the use of arterial angiography prior to all fibula flap harvests because, in a series of 25, 28 and 19 consecutive patients respectively, they found significant abnormalities despite the presence of normal peripheral foot pulses. Carroll and Esclamodo[8] excluded four of 25 patients as candidates for fibula flaps because of occult severe peripheral vascular disease. Young *et al*[4] excluded three of 28 with abnormal arterial anatomy following angiography despite these patients having normal vascular examinations and Blackwell[3] found four of 19 patients were not suitable for fibula flap harvest. However, there are problems with angiography. It is expensive as a routine pre-operative investigation. Also it is invasive and has associated morbidity, e.g. haematoma formation, thrombosis, vessel injury, contrast reaction and embolism.[5] Less invasive tests include magnetic resonance angiography (MRA) and colour flow Doppler (CFD). Hayden *et al*[9] argued that MRA is as effective as angiography in identifying the vascular anatomy without the need for arterial cannulation. MRA does have its draw-backs including its cost, the need for special surface coil to enhance imaging, and poor patient tolerance due to claustrophobia. More recently, Futran *et al*[5,6,10] proposed CFD as an alternative to peripheral vascular examination. CFD would appear to be less costly, non-invasive and provide an adequate pre-operative assessment.

Further review of the literature, including the vascular surgery literature, indicates that less invasive testing such as duplex is as reliable as arteriography in detecting lower limb arterial disease. One recent study by Sensier *et al*[11] compared lower limb colour-coded duplex scanning with arteriography. In this study, the authors concluded that the evaluation of the infrapopliteal vasculature by ultrasound appeared to be an effective replacement of arteriography for the majority of patients. Another study by Aly *et al*[12] also compared duplex imaging to arteriography in evaluating lower limb arteries. They also concluded that duplex imaging is a reliable modality for evaluating the lower limb vasculature. The information obtained from duplex imaging and from other non-invasive tests such ankle/brachial index and waveform analysis would provide valuable information regarding the lower limb vasculature and could possibly decrease the need for the more invasive procedure of angiography.

In our postal survey, 124 surgeons replied of which 58% performed fibula free tissue transfer. It is probable that this response reflects adequately the surgical composition of The British Association of Head and Neck Oncologists. The findings of this postal survey suggest that, although most surgeons palpated for foot pulses prior to fibula harvest, few palpated for the peroneal artery (33%), which is the artery upon which the flap is based. The commonest pre-operative investigation was angiography (40%) and the newer less invasive methods, MRA and CFD, are not popular despite this technology being available to surgeons.

The surgeons' questions in this study considered that the fibula flap was not contra-indicated in elderly patients. It is our experience that this group tolerates the procedure very well, with little additional morbidity or length of hospital stay. It would appear from our survey that, in cases where a fibula flap is contra-indicated, the two favoured methods of reconstruction are the DCIA and composite radial flaps. Despite the relatively poor quality of bone available for implants and the morbidity associated with the radial flap,[13] notably radial bone fracture, this flap remains a popular alternative.

The best method of evaluating the blood supply to the lower limb prior to the harvesting of the fibula free flap remains controversial. In the UK, it would appear that there has been a reluctance to adopt the newer, less invasive, methods despite the literature supporting equal or similar diagnostic capabilities of the less invasive procedures such as colour coded duplex.

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References

1. Taylor GI, Miller DH, Ham FJ. The free vascularized bone graft: a clinical extension of microvascular techniques. *Plast Reconstr Surg* 1975; **55**: 533–44.
2. Hidalgo DA. Fibula free flap: a new method of mandible reconstruction. *Plast Reconstr Surg* 1989; **84**: 71–9.
3. Blackwell KE. Donor site evaluation for fibula free flap transfer. *Am J Otolaryngol* 1998; **19**: 89–95.
4. Young DM, Trabulsy PP, Anthony JP. The need for preoperative leg angiography in fibula free flaps. *J Reconstr Microvasc Surg* 1994; **10**: 283–7.
5. Futran ND, Stack Jr BC, Payne LP. Use of colour Doppler flow imaging for preoperative assessment in fibular osteoseptocutaneous free tissue transfer. *Otolaryngol Head Neck Surg* 1997; **117**: 660–3.
6. Futran ND, Stack Jr BC, Zaccardi MJ. Preoperative colour flow Doppler imaging for fibula free tissue transfers. *Ann Vasc Surg* 1998; **12**: 445–50.

7. Lippert H, Pabst R. *Arterial Variations in Man: Classification and Frequency*. New York: IF Bergman, 1985.
8. Carroll WR, Esclamodo R. Preoperative vascular imaging for the fibular osteocutaneous flap. *Arch Otolaryngol Head Neck Surg* 1996; **122**: 708–12.
9. Hayden RE, Carpentar J, Thaler E. Magnetic resonance angiography: noninvasive evaluation of potential free flaps. Presented at the *Annual Meeting of American Academy of Facial Plastic and Reconstructive Surgery*, 1993 Oct 1; Minneapolis.
10. Futran ND, Stack Jr BC, Zaccardi MJ. Preoperative colour flow Doppler imaging for fibula free tissue transfers. *Ann Vasc Surg* 1998; **12**: 445–501.
11. Sensier Y, Fishwick G, Pemberton M, Bell PRF, London NJM. A comparison between colour duplex ultrasonography and arteriography for imaging infrapoliteal arterial lesions. *Eur J Vasc Endovasc Surg* 1998; **15**: 44–50.
12. Aly S, Sommerville K, Adiseshiah M, Raphael M, Coleridge Smith PD *et al*. Comparison of duplex imaging and arteriography in the evaluation of lower limb arteries. *Br J Surg* 1998; **85**: 1099–102.
13. Urken ML. Composite free flaps in oromandibular reconstruction; review of the literature. *Arch Otolaryngol Head Neck Surg* 1991; **117**: 724–32.

Appendix 1

The questionnaire

Thank you for spending your time to complete this questionnaire. This questionnaire has been sent to all members of The British Association of Head and Neck Oncologists. Please tick the appropriate boxes:

1 Please identify your area of discipline.

Surgeon ❑ Radiotherapist ❑ Medical Oncologist ❑ Other (Please state)_____

2 Are you a surgeon performing microvascular free flaps?

Yes ❑ No ❑

If yes, please complete the questionnaire. If no please return the questionnaire in the self-addressed prepaid envelope.

3 How many fibula flaps have you performed in the past year for mandibular reconstruction?

Zero ❑ 1–10 ❑ 10–20 ❑ Greater than 20 ❑
Specific amount, (if known) _____
If you answered ZERO, please go directly to Question 9.

4 Which peripheral pulses, will you routinely clinically evaluate?

Femoral ❑ Dorsalis pedis ❑ Posterior tibial ❑ Peroneal ❑

5 Which pre-operative tests do you perform routinely on every patient prior to a fibula flap?

Palpation of peripheral pulses	❑	Doppler on ward	❑
Doppler in vascular lab	❑	Arterial angiography	❑
Digital subtraction angiography	❑	Magnetic resonance angiography	❑
Colour flow Doppler	❑		
Other (state)_____		None of the above	❑

6 If on clinical examination there is evidence of an absent dorsalis pedis, which further tests, if any, will you obtain?

Palpation of peripheral pulses	❑	Doppler on ward	❑
Doppler in vascular lab	❑	Arterial angiography	❑
Digital subtraction angiography	❑	Magnetic resonance angiography	❑
Colour flow Doppler	❑		
Other (state)_____		None of the above	❑

7 Which tests are currently available to you at your unit?

Palpation of peripheral pulses	❑	Doppler on ward	❑
Doppler in vascular lab	❑	Arterial angiography	❑
Digital subtraction angiography	❑	Magnetic resonance angiography	❑
Colour flow Doppler	❑		
Other (state)_____		None of the above	❑

8 Please rank in descending order of importance (1 most significant, 5 least significant) the most significant aspect of the medical history in regards to pre-operative assessment for a free fibula flap.

Age greater than 75 years	_____	Hypertension	_____
Diabetic	_____	History of claudication	_____
Sex of patient	_____		

9 If you do not use fibula flaps for mandibular reconstruction, or if there is a contra-indication to its use, which vascularized bone graft would you use instead?

Iliac crest osteocutaneous or osteomusculocutaneous flap	❑
Scapula	❑
Composite radial	❑
None (I perform non-vascularized bone grafts)	❑
Other (state) _____	