Health-related quality of life, surgical and aesthetic outcomes following microvascular free flap reconstructions: an 8-year institutional review

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ABSTRACT

INTRODUCTION Microvascular free flap reconstruction has revolutionised the reconstruction of complex defects of traumatic, oncological, congenital and infectious aetiologies. Complications of microvascular free flap procedures impact negatively on patient post-operative course and outcome.

METHODS We performed a retrospective analysis of 102 consecutive patients undergoing 108 free flap procedures at a tertiary referral centre over an 8-year period. Logistic regression analysis was used to identify factors predictive of free flap complications. Health-related quality of life (HRQoL) and aesthetic outcomes were assessed using the Short Form 36 questionnaire and a satisfaction visual analogue scale respectively.

RESULTS In total, 108 free tissue transfers were performed; 23% were fasciocutaneous free flaps, 69% musculocutaneous and 8% osteoseptocutaneous. The overall flap success rate was 92.6%. Over a third of patients (34.3%) had flap-related complications ranging from minor wound dehiscence to total flap loss. ASA (American Society of Anesthesiologists) grade ≥ 2 (OR: 16.9, 95% CI: 15.3–18.1, $p < 0.009$), history of smoking (OR: 6.1, 95% CI: 5.5–7.2, $p < 0.049$), body mass index $\geq 25 \text{ kg/m}^2$ (OR: 21.3, 95% CI: 20.8–22.1, $p < 0.003$), low albumin (odds ratio [OR]: 2.2, 95% confidence interval [CI]: 1.2–3.9, $p < 0.003$) and peripheral vascular disease (OR: 6.9, 95% CI: 5.9–7.5, $p < 0.036$) were identified as factors independently predictive of free flap complications.

CONCLUSIONS Patients undergoing uncomplicated free flap surgery and those reporting superior post-operative flap aethesis have higher HRQoL scores. Microvascular free tissue transfer has revolutionised our approach to the reconstruction of complex defects, providing a safe, reliable procedure to restore functionality and quality of life for patients.

KEYWORDS

Free tissue transfer – Microsurgical reconstruction – Quality of life – Aesthesia – Complications

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There has been a renaissance in free flap techniques and the tissue types employed in reconstruction of complex bony, mucosal and soft tissue defects.^{1,2} Free tissue transfer has been transformed from a laborious, technically demanding procedure to a safe, reliable and highly successful standard of care.^{3,4} The ability of free flaps to provide single-stage immediate reconstructive options has generated much interdisciplinary interest in the oncologic and trauma settings.^{5–7} The application of free flap reconstruction has expanded beyond the realm of the young healthy patient to include the complexity associated with varying pathologies. As a result, the scope for free flap-related complications has risen dramatically.⁵ Complications from microvascular free flap procedures impact negatively on post-operative course and final outcome.⁸ The identification of risk factors predic-

tive of flap-related complications is crucial to the prevention of flap failures.

The therapeutic goals of reconstructive surgery are: first, to rebuild anatomy and preserve external appearance; second, to restore function; and third, to achieve an optimal quality of life for patients.⁶ While the functional and aesthetic outcomes of free flap procedures have been extensively examined, assessment of health-related quality of life (HRQoL) as an evaluation endpoint remains largely underevaluated.^{9,10}

In an environment of limited healthcare resources, it is imperative that patients are selected appropriately for therapeutic interventions to optimise outcomes and the quality of healthcare delivery.¹¹ The aim of this study was, first, to examine the surgical outcomes and complications in a

cohort of free flap reconstructions and, second, to identify patient, disease and treatment-related factors predictive of free flap complications. Finally, we sought to assess HRQoL and aesthetic satisfaction scores following free flap reconstructive surgery.

Methods

Study design and sample

A retrospective analysis of 102 consecutive patients undergoing 108 microvascular free flap reconstructions between July 2003 and January 2011 at the Mater Misericordiae University Hospital was performed. The Hospital Inpatient Enquiry Scheme computer system was used to identify our patient cohort. The medical records of all patients in the cohort were reviewed for patient, disease and treatment-related variables.

Patient-related variables included age, sex, pre-operative ASA (American Society of Anesthesiologists) grade and duration of hospitalisation. Disease-related variables included aetiology of the defect, mechanism of injury and injury severity score if pertaining to trauma. Treatment-related variables included overall operating time, flap ischaemia time, primary/delayed reconstruction and pre-operative irradiation. Pertaining to the donor site, flap classification and free flap donor tissue were noted. Recipient site variables included defect location, arterial and venous anastomotic vessels.

Flap-related complications included partial and total flap loss, arterial and venous thrombosis, venous congestion, haematoma, seroma, fat necrosis, wound edge necrosis and dehiscence, infection, scar hypertrophy and donor site paraesthesia and herniation. Flaps requiring revision secondary to post-operative thrombosis were assessed in terms of time to re-exploration and ultimate flap outcome. Medical complications to include cardiovascular and respiratory compromise were also noted. A body mass index $\geq 25\text{kg/m}^2$, history of smoking, ischaemic heart disease, peripheral vascular disease, diabetes mellitus, hypercoagulation disorders, peri-operative blood transfusions, pre-operative hypoalbuminaemia and anaemia were considered potential risk factors for complications. Pre-operative anaemia was classified as haemoglobin $<7\text{g/dl}$ in females and $<8\text{g/dl}$ in males, as previously validated.¹²

Questionnaires

Post-operative HRQoL and aesthetic outcomes were assessed using the Short Form 36 (SF-36®) health survey¹⁵ and a visual analogue (VAS) scale¹⁴ respectively. HRQoL measures the extent to which a patient's day-to-day life is affected by his or her health and includes the physical, emotional and social impact of disease.¹⁵ The acute version of the SF-36® assesses eight aspects or domains of HRQoL during the past week: physical functioning, role limitations due to physical problems, pain, health perception, vitality, social functioning, role limitations due to emotional problems and mental health. Physical and mental component summary scores (PCS and MCS respectively) were created using standard norm-based scoring methods.¹⁶

The SF-36® has been extensively validated and has been previously used in outcome assessment of interventions in plastic and reconstructive surgery.^{17,18} The scales were scored numerically from 0 (lowest level of functioning) to 100 (highest level of functioning). Mean scores for all eight domains, including the PCS and MCS, were compared in patients who experienced post-operative flap-related complications and those who did not. The Norwegian SF-36® acute version 1.0 was used in this study.

Aesthetic outcome

Using a 100mm scale ranging from 0 (complete dissatisfaction) to 100 (complete satisfaction), patients were asked to score post-operative aesthetic satisfaction with their free flap, marked with an 'X'. Patients scoring $\geq 80\text{mm}$ were categorised as 'satisfied' with the aesthetic result and those scoring $<80\text{mm}$ deemed 'less satisfied', as previously validated.¹⁹ Mean scores for each SF-36® domain were compared for patients satisfied with their aesthetic outcome and those less satisfied.

Surgical technique

All microvascular reconstructions were performed under the direction of one experienced surgeon (KC) at one institution. Flap selection was based on defect analysis and donor site preference specific to patient-related factors and not on defect aetiology. Surgery consisted of: i) radical debridement/tumour resection, ii) exposure of recipient vessels, iii) flap harvest, iv) microsurgical anastomoses, and v) flap inset. Depending on the number and quality of patent vessels, vicinity to the defect and pedicle length, microvascular anastomoses were performed in an end-to-end (99 flaps) and end-to-side (9 flaps) technique using an interrupted stitch nylon 8/0 suture. Drains were routinely applied.

All patients made their initial post-operative recovery in the high dependency unit with temperature management therapy (Bair Hugger®; Arizant Healthcare Inc, Eden Prairie, MN, US). Flap monitoring included clinical observation (capillary refill, congestion, colour), surface temperature readings, Doppler sonography and pinprick testing. Antibiotic prophylaxis was commenced at anaesthetic induction and continued for 72 hours. Intra-operatively, 2,500iu of low molecular weight heparin (LMWH) (tinzaparin) was administered. Thromboembolic prevention was initiated on admission by fitting antiembolism compression stockings and subcutaneous LMWH was commenced on day 1 post-operatively until the patient was ambulatory. Post-operative red cell transfusions were permitted when haemoglobin levels were $<8\text{g/dl}$ or when the patient became symptomatic. The endpoint for surgical success was the absence of free flap-related complications following free flap reconstruction.

Statistical analysis

Descriptive statistics demonstrating patient characteristics were presented using means with standard deviations (SD) or numbers with percentages. To evaluate the influence of patient, disease and treatment factors on flap-related complications, Fisher's exact test or the chi-squared test were used as appropriate. A p -value of <0.05 was considered sta-

tistically significant. Factors considered significant on univariate analysis were selected for subsequent multivariate analysis. Logistic regression calculated the respective odds ratio (OR) at 95% confidence intervals (CI). The Newman-Keuls test was used for appropriate post-hoc analysis.²⁰ SF-36® and VAS scores were compared using a two-tailed t-test for independent samples. Statistical analyses were performed with SPSS® version 15.0 (SPSS Inc, Chicago, IL, US).

Results

Patient demographics

From July 2003 to January 2011, 108 consecutive free tissue transfers were performed for reconstruction of complex defects of varying aetiology in 102 patients. The mean age of the cohort was 46.7 years (range: 17–81 years), with a male preponderance (male-to-female ratio: 4:1). The mean follow-up period was 42 months (range: 6–86 months). At the most recent follow-up, 23.5% of patients (24/102) had died. The mean duration of hospitalisation was 31.2 days (range: 4–118 days). The mean time to surgery from initial presentation was 10.4 days (range: 0–86 days). Delays to surgical procedure were mainly attributed to pre-operative workup and delays in referral of trauma patients. The plastic surgery team was the primary care team for 39.2% of patients (40/102).

Collaborative procedures were performed with the otolaryngology team for 40.2% of patients (41/102), the trauma and orthopaedics team for 16.7% of patients (17/102) and teams from other specialties for 3.9% of patients (4/102).

Defect aetiology, location and free flap classification

Free flap reconstruction was performed as a primary procedure in 47.0% of patients (48/102) and this was the therapeutic strategy for 62.5% of tumour resection defects (40/64). Secondary or delayed reconstructions were performed in 53.0% of patients (54/102). Of the free flap recipient sites, 45.4% (49/108) were head and neck, 19.4% (21/108) were breast, 19.4% (21/108) were lower limb and 15.7% (17/108) were other sites (Table 1). Indications for free flap reconstruction at this institution were tumour resection defects in 62.7% of patients (64/102), defects resulting from trauma in 22.5% of patients (23/102) and other indications in 14.7% of patients (15/102) (Fig 1).

Figure 1 Aetiology of complex defects requiring free flap reconstruction at the Mater Misericordiae University Hospital, Dublin

Figure 2 Classification of free tissue transfer and identification of donor sites used in the reconstruction of complex defects
DCIA = deep circumflex iliac artery flap; DIEP = deep inferior epigastric perforator flap; RFFF = radial free forearm flap; ALT = anterolateral thigh flap

Overall, 108 free flap reconstructions were performed: 44.4% (48/108) were musculocutaneous, 44.4% (48/108) were fasciocutaneous and 8.3% (9/108) were osteoseptocutaneous free flaps while 2.8% (3/108) were others to include jejunal, vertical rectus abdominis myocutaneous and toe pulp free flap reconstructions (Fig 2). A quarter of free flaps

Table 1 Location of reconstruction site					
Location	Tumour	Trauma	Osteomyelitis	Chronic wound	Others*
Head/neck	49	0	0	0	0
Upper limb	1	12	0	0	3
Lower limb	0	10	8	2	1
Breast	21	0	0	0	0
Trunk	1	0	0	0	0

*Congenital deformity, compartment syndrome

Table 2 Factors predictive of free flap complications on univariate analysis (chi-square test used for cross-tabulations)

Factor	Number of flaps	Complication rate	p-value
ASA grade			
1	44 (43.1%)	3 (6.8%)	0.0001
≥2	58 (56.9%)	32 (55.2%)	
Smoking history			
Yes	48 (47.1%)	25 (52.0%)	0.0001
No	54 (52.9%)	10 (18.5%)	
Age			
>70 years	16 (15.7%)	7 (43.8%)	0.109
≥70 years	86 (84.3%)	28 (32.6%)	
Body mass index			
<25kg/m²	56 (54.9%)	12 (21.4%)	0.0001
≥25kg/m²	46 (45.1%)	23 (41.1%)	
Diabetes mellitus			
Yes	22 (21.6%)	13 (59.1%)	0.022
No	80 (78.4%)	22 (27.5%)	
Albumin			
<3.5g/dl	53 (52.0%)	25 (47.2%)	0.0001
≥3.5g/dl	49 (48.0%)	10 (20.4%)	
Red cell transfusion			
Yes	28 (27.5%)	16 (57.0%)	0.008
No	74 (72.5%)	19 (25.7%)	
Anaemia			
Yes	30 (29.1%)	17 (56.7%)	0.007
No	72 (70.9%)	22 (30.6%)	
Irradiation			
Yes	26 (25.5%)	16 (61.5%)	0.01
No	76 (74.5%)	25 (33.0%)	
Flap ischaemia time			
<2 hours	60 (58.8%)	16 (26.7%)	0.003
≥2 hours	42 (41.2%)	23 (54.8%)	
Peripheral vascular disease			
Yes	23 (22.5%)	14 (60.9%)	0.015
No	79 (77.5%)	9 (11.4%)	
Overall operating time			
<10 hours	72 (70.6%)	25 (34.7%)	0.141
≥10 hours	30 (29.4%)	16 (57.1%)	
Surgical timing			
Primary	48 (47.0%)	22 (45.8%)	0.161
Delayed	54 (53.0%)	17 (31.5%)	
Flap classification			
Myocutaneous	48 (44.4%)	14 (29.2%)	0.061
Fasciocutaneous	48 (44.4%)	16 (33.3%)	
Osteoseptocutaneous	9 (8.3%)	4 (44.4%)	
Other	3 (2.7%)	1 (33.3%)	
Prior donor site scar			
Yes	41 (40.2%)	18 (43.9%)	0.502
No	61 (59.8%)	25 (41.0%)	

(25.9%, 28/108) were classified as radial free forearm flaps and this was the most commonly employed free flap in our patient cohort (Fig 2). Some patients (3.9%, 4/102) required more than one free flap for effective defect reconstruction. The mean operating time from cut to suture was 8.45 hours (range: 2.5–15.2 hours). The mean intra-operative flap ischaemia time was 79.6 minutes (range: 33–180 minutes).

Complications and risk factors

The overall free flap reconstruction success rate at our institution was 92.6% (100/108). Eight patients had total flap failure to include three free fibular flaps, two transverse rectus abdominis myocutaneous free flaps, one anterolateral thigh free flap and one jejunal free flap. These occurred immediately to 86 hours post-operatively. At re-exploration, three patients were found to have an arterial thrombosis and five patients a venous thrombosis at the microvascular anastomotic site. Immediate treatment included thrombolytic therapy, namely heparinised saline and high dose streptokinase. Failure of medical therapy led to interventional embolectomy and revised microvascular anastomosis. Salvage flaps were performed for two patients with optimal outcome.

Pertaining to risk factors for flap failure, all of these patients were undergoing tumour defect reconstruction, all were smokers and three underwent prior neoadjuvant radiotherapy. Partial flap loss was experienced by 4.9% of patients (5/102). The extent of partial flap necrosis ranged from 5% to 15% of total flap volume. These patients underwent partial debridement at re-exploration surgery and did not require further defect reconstruction.

Over a third of patients (34.3%, 35/102) had free flap specific complications. The most common flap-related complications were thrombosis at the microvascular anastomotic site (22.9%, 8/108), wound infection (17.1%, 6/108), wound edge necrosis (17.1%, 6/108), venous congestion (11.4%, 4/108), seroma (11.4%, 4/108) and others (14.3%, 5/108) (Fig 3). General post-operative complications during hospitalisation (9.8%, 10/108) are summarised in Figure 4. There were three peri-operative mortalities: two patients suffered

Figure 3 Free tissue transfer-related complications encountered in the post-operative period

Figure 4 General post-operative complications, non-flap related

CVA = cerebrovascular accident; PE = pulmonary embolism; LRTI = lower respiratory tract infection; UTI = urinary tract infection

Table 3 Factors predictive of free flap complications on multivariate analysis (logistic regression analysis)

Factor	Odds ratio	95% confidence interval	p-value
ASA grade ≥ 2	16.9	15.3–18.1	0.009
Smoking history	6.1	5.5–7.2	0.049
Body mass index $\geq 25\text{kg/m}^2$	21.3	20.8–22.1	0.003
Diabetes mellitus	0.6	0.2–2.3	0.557
Hypoalbuminaemia	2.2	1.2–3.9	0.003
Red cell transfusion	0.1	0.1–0.2	0.092
Anaemia	9.8	9.7–11.3	0.159
Irradiation	0.7	0.3–1.0	0.704
Flap ischaemia time	4.8	2.2–7.1	0.091
Peripheral vascular disease	6.9	5.9–7.5	0.036

Table 4 Short Form 36 quality of life scores for patients with versus those without complications

Subscale (n=68)	Mean raw scores		p-value*
	Complications (n=30)	No complications (n=38)	
Physical functioning	51.0 (SD: 7.8)	56.1 (SD: 12.6)	0.17
Role limitations (physical problems)	44.5 (SD: 10.4)	54.7 (SD: 13.4)	0.023
Bodily pain	55.7 (SD: 14.3)	58.6 (SD: 14.5)	0.577
General health	54.7 (SD: 12.4)	64.1 (SD: 8.6)	0.021
Vitality	58.3 (SD: 11.6)	65.1 (SD: 11.2)	0.09
Social functioning	56.2 (SD: 13.9)	56.6 (SD: 13.1)	0.93
Role limitations (emotional problems)	59.8 (SD: 11.2)	59.9 (SD: 10.7)	0.984
Mental health	62.2 (SD: 10.5)	65.5 (SD: 11.1)	0.393
Physical component score	47.6 (SD: 10.2)	55.5 (SD: 12.8)	0.047
Mental component score	64.0 (SD: 11.1)	64.5 (SD: 11.6)	0.9

SD = standard deviation

*Independent samples t-test

respiratory arrest secondary to aspiration pneumonia and a third patient sustained a fatal pulmonary embolism. All three patients underwent free fibular reconstructions of head and neck defects following tumour resection.

A total of 108 free flaps performed by a single surgeon (senior author) were included in the logistic regression model to identify factors predictive of free flap complications. On univariate analysis, patient-related factors associated with flap complications included ASA grade ≥ 2 ($p < 0.0001$), history of smoking ($p < 0.0001$) and body mass index (BMI) $\geq 25 \text{ kg/m}^2$ ($p < 0.0001$). Disease-related factors associated with flap complications included diabetes mellitus ($p = 0.022$), hypoalbuminaemia (defined by serum albumin $< 3.5 \text{ g/dl}$) ($p < 0.0001$), anaemia (defined by haemoglobin $< 7 \text{ g/dl}$ in women; $< 8 \text{ g/dl}$ in men) ($p = 0.007$), neoadjuvant irradiation ($p = 0.01$) and peripheral vascular disease ($p = 0.015$). The treatment-related factors associated with flap complications included post-operative red cell transfusions ($p = 0.008$) and an intra-operative flap ischaemia time of ≥ 2 hours ($p = 0.003$) (Table 2).

Factors significant on univariate analysis were selected for multivariate analysis using logistic regression. On multivariate analysis, ASA grade ≥ 2 (OR: 16.9, 95% CI: 15.3–18.1, $p < 0.009$), history of smoking (OR: 6.1, 95% CI: 5.5–7.2, $p < 0.049$), BMI $\geq 25 \text{ kg/m}^2$ (OR: 21.3, 95% CI: 20.8–22.1, $p < 0.003$), pre-operative hypoalbuminaemia (OR: 2.2, 95% CI: 1.2–3.9, $p < 0.003$) and peripheral vascular disease (OR: 6.9, 95% CI: 5.9–7.5, $p < 0.036$) were independently predictive of free flap complications (Table 3). A post hoc statistical power calculation for multiple regression analysis was completed for our sample. Given the observed R^2 value (0.79) for the multivariate model, the estimated power with ten predictors, an alpha of 0.05 and a sample size of 102 was 1.0. It was therefore presumed we had sufficient power to evaluate the variables of largest effect under investigation.

Quality of life

Of the 78 living patients invited to complete the SF-36® questionnaire and aesthetic satisfaction VAS, the response rate was 87.2% (68/78). The mean level of functioning scores for each SF-36® domain were obtained. Of the 68 respondents, 30 (44.1%) had flap-related post-operative complications. Mean raw scores were significantly higher for those patients with flap-related complications in the 'role limitations (physical problems)' domain ($p < 0.023$), the 'general health' domain ($p < 0.021$) and the physical component score ($p < 0.047$) compared with those with no complications (Table 4).

Aesthetic satisfaction

Of the 68 respondents, 82.4% (56/68) were satisfied with their post-operative flap aesthesis. Patient-scored aesthetic satisfaction ranged from 21mm to 100mm on the VAS. With respect to defect location, the mean aesthetic satisfaction score for head and neck reconstructions was 5.6mm (SD: 3.7mm), with 27/49 patients (55.1%) satisfied with their aesthetic result. The mean aesthetic satisfaction following breast reconstruction was 76mm (SD: 25mm), with 15/21 patients (71.4%) satisfied with their aesthetic result. The mean aesthetic score following upper limb reconstruction was 49mm (SD: 38mm), with 10/16 patients (62.5%) satisfied with their aesthetic result. The mean aesthetic score following lower limb reconstruction was 91mm (SD: 22mm), with 20/21 patients (95.2%) satisfied with their aesthetic result. One patient underwent reconstruction of a trunk defect and scored 65mm for aesthetic result.

Regarding defect aetiology, the mean aesthetic score for patients undergoing reconstruction of tumour resection defects was 61mm (SD: 35mm), with 50/72 patients (69.4%) satisfied with their aesthetic result. The mean aesthetic satisfaction score for patients undergoing reconstruction

Table 5 Short Form 36 quality of life scores for patients who were satisfied versus less satisfied with aesthetic outcome

Subscale (n=68)	Mean raw scores		p-value*
	Less satisfied (n=12)	Satisfied (n=56)	
Physical functioning	47.4 (SD: 11.6)	56.7 (SD: 8.3)	0.011
Role limitations (physical problems)	51.0 (SD: 12.7)	45.6 (SD: 12.4)	0.25
Bodily pain	49.3 (SD: 12.5)	61.4 (SD: 13.4)	0.017
General health	59.1 (SD: 13.5)	57.3 (SD: 7.5)	0.588
Vitality	61.9 (SD: 11.3)	60.1 (SD: 8.6)	0.842
Social functioning	56.8 (SD: 11.6)	56.1 (SD: 11.2)	0.896
Role limitations (emotional problems)	61.3 (SD: 9.8)	57.4 (SD: 12.5)	0.344
Mental health	65.2 (SD: 10.4)	61.1 (SD: 11.1)	0.32
Physical component score	45.8 (SD: 9.7)	55.6 (SD: 12.2)	0.04
Mental component score	64.1 (SD: 12.4)	64.5 (SD: 10.6)	0.916

SD = standard deviation

*Independent samples t-test

of traumatic wounds was 65mm (SD: 33mm), with 16/22 patients (72.7%) satisfied with their aesthetic result. Two patients underwent reconstruction of chronic wounds and scored a mean of 87mm for aesthetic result.

Of the 35 patients with flap-related complications, 22 responded to the VAS questionnaire on aesthetic satisfaction. The mean aesthetic satisfaction score for this subgroup of patients was 75mm (SD: 22mm), ranging from 21mm to 96mm. A total of 33 patients responding to the VAS questionnaire had no free flap complications. In comparison, the mean aesthetic satisfaction score for this subgroup of patients was 83mm (SD: 25mm), ranging from 30mm to 100mm. No correlation between presence of complication and aesthetic satisfaction variables was observed (Spearman's rho: $r=0.12$, $p=0.32$).

Mean raw scores were significantly higher in those respondents satisfied with aesthetic outcome in the 'physical functioning' domain ($p<0.011$), the 'bodily pain' domain ($p<0.017$) and physical component score ($p<0.04$) of the SF-36® in comparison with those less satisfied with post-operative flap aesthesia (Table 5).

Discussion

Following its first successful application by Roberts in 1961,²¹ free tissue transfer has revolutionised the reconstruction of complex defects of varying aetiology. Over the past two decades, the development of free tissue transfer techniques has enabled the prompt restoration of physiological function in a safe, effective and reliable manner.⁶ Previously perceived unreliability of this microvascular reconstructive technique has been largely disproved with free flap success rates exceeding 90% in a number of large clinical series.^{2,7,22} Such high success rates have profoundly challenged reconstructive principles and, in many instances, reversed some well

established dogmas of wound care, cancer resectability and salvage of mutilated extremities.²³

Functional outcome assessments following microvascular reconstructive procedures have reported promising results.^{24,25} However, flap-related complications and the consequences of free flap failure are devastating for the patient, warranting the advancement of applied peri-operative techniques to limit morbidity.²⁶ The identification of patient and treatment-related factors predictive of post-operative morbidity and mortality, in a free flap cohort, have been examined previously.⁷ However, more specifically, identification of factors predictive of flap-related complications is the first step in the optimisation of therapeutic outcome and the prevention of flap failure. In order to assess any surgical intervention, analysis of HRQoL is the key benchmark in the evaluation process. Nevertheless, this outcome remains largely underevaluated.⁵

The outcome analysis of our large single surgeon series of consecutive free flap reconstructions reveals a free flap success rate of 92.6% and 34.3% of patients experiencing flap-related complications. These findings corroborate the current international literature and support the role of free tissue transfer as the accepted standard of care in the reconstruction of complex defects.^{4,27-29}

While meticulous surgical technique has been recognised as a crucial factor in achieving high success rates, various patient and treatment-related factors have been identified as significantly predictive of free flap complications.³⁰ In concordance with the current literature,^{28,31} we identified cigarette smoking and BMI $\geq 25\text{kg/m}^2$ as patient-related factors independently predictive of flap-related complications in our patient cohort.

Our study further identified ASA grade ≥ 2 as a key patient-related variable associated with flap-related complications. This is further confirmed on multivariate analysis,

tissue oxygen perfusion and at maintaining nutritional requirements to achieve adequate collagen synthesis and angiogenesis.

Regarding treatment-related factors, radial forearm, fibula and rectus abdominis free flaps comprise the most frequently employed donor tissues for reconstruction of a wide variety of intraoral, pharyngo-oesophageal, breast and traumatic soft tissue defects.⁴ Similarly, the radial forearm flap was the most commonly employed donor tissue in this patient cohort. These free flaps share common attributes contributing to their high reliability. Radial forearm, fibula and rectus abdominis flaps all have long vascular pedicles containing large calibre vasculature.⁴⁵ In this setting, microvascular anastomoses are much less prone to thrombosis when the external diameter exceeds 1mm and this factor has been attributed independently to the high free flap success rates⁴⁴ as reflected in this study.

The use of interposition vein grafts to achieve vascular pedicle length extension has been associated with an increased risk of peri-operative flap thrombosis and, ultimately, flap failure.^{28,45} Additionally, the use of salvage free flap reconstruction following primary flap failure is an established risk factor for free flap-related complications. Since 5 of the 108 reconstructions (4.6%) required interposition vein grafts and only two salvage free flaps were performed, we were unable to assess the effect of these treatment-related factors on our outcome measure.

HRQoL is recognised as a dynamic concept and patients' attitudes vary with psychological phenomena such as adaptation, coping, expectancy and life events (eg cancer and trauma).⁴⁶ While there has been much focus on outcomes following oncologic reconstructions, there is a paucity of data pertaining to outcomes from aetiologies such as traumatic soft tissue defects, chronic wounds and osteomyelitis. In this cohort, patients with flap-related complications reported lower mean 'role limitations (physical problems)' and 'general health' SF-36® scores compared with patients with an uncomplicated recovery. These lower physical component outcomes may reflect functional impairment in those patients with a complicated post-operative recovery.

Furthermore, patients scored highly for flap aesthetics satisfaction in the post-operative period. Importantly, those less satisfied with flap aesthetics reported lower mean 'bodily pain' and 'physical functioning' scores. This outcome may be representative of significant pain and functional impairment in the post-operative setting within this subgroup. We hypothesise that these scores may be attributed to globally low scoring secondary to psychosocial phenomena or perhaps correlated with defect size, location, aetiology or flap-related complications.

We recognise several limitations to this study. First, we acknowledge the inherent frailties associated with a retrospective analysis. Additionally, the cross-sectional nature of this study means that causality cannot be determined. This was an outcome analysis of a single surgeon consecutive series of free flap reconstructions at a number of anatomical sites with differing aetiologies. Ideally, outcomes assessment would be defect site specific. However, the numbers were insufficient for statistical analysis in this study. A fur-

ther limitation was the sole use of HRQoL and VAS questionnaires in the post-operative setting without pre-operative comparison.

Conclusions

Microvascular free tissue transfer has revolutionised our approach to the reconstruction of complex defects, providing a safe, reliable procedure to restore functionality and quality of life for patients. Patients undergoing uncomplicated free flap surgery and those reporting superior post-operative flap aesthetics had higher HRQoL scores. We have identified risk factors predictive of flap-related complications. We propose that optimisation of surgical planning and appropriate patient selection can improve surgical outcomes, HRQoL and aesthetic satisfaction, ultimately advancing the quality of care delivered to patients undergoing free flap reconstructive surgery.

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