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Analysis of Flap Failures in Microvascular Head and Neck Reconstructions: 11-Year Single-Center Results

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Abstract

Background Free flap reconstruction is the gold standard in head and neck reconstructions. The current article analyzes failed free flaps in the head and neck region during an 11-year period in a single center aiming to discover factors that could be influenced in order to reduce the risk for flap failure.

Methods During the 11-year study period, 336 patients underwent free flap reconstruction at Tampere University Hospital, Tampere, Finland. The patients' average age was 62 years (range 14–92 years). Note that 201 (61.5%) of the patients were women and 135 (38.5%) men. Medical records were reviewed for demographics, comorbidities, neoadjuvant and adjuvant therapies, free flap type, area of reconstruction, and intraoperative and postoperative complications. Statistical analyses were performed.

Results Ten (3%) of the 336 free flaps failed. Patients' age, comorbidities, smoking, dosage of anticoagulation, free flap type, or the location of the defect did not influence the risk of flap failure. All lost flaps were postoperatively followed by clinical monitoring only. In contrast, 89% of all flaps had both Licox (Integra LifeSciences Corp, NJ) and clinical follow-up postoperatively. In six (60%) of the failed cases, a second free flap surgery was performed as a salvage procedure, with a survival rate of 83.3%.

Conclusion Our free flap success rate of 97% is in accordance with that of other centers that perform head and neck reconstructions. According to our findings, free flap reconstructions can be successfully performed on elderly patients and patients with comorbidities. Smoking did not increase the flap loss rate. We encourage the use of other methods in addition to clinical monitoring to follow the flaps after head and neck free flap reconstructions. All flap types used have high success rates, and reconstruction can be conducted with the most suitable flaps for the demands of the defect.

Keywords
- head and neck reconstruction
- free flap
- flap loss
- complications
- flap monitoring

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Free flap reconstruction has been successfully used in head and neck surgery for many years. The success of free flap reconstruction varies from 91.2[1,2] to 98.1%.[3–9] After the oncological resection of a tumor or in a case of trauma in the head and neck area, lost or damaged tissues must be reconstructed to achieve the best possible aesthetic and functional outcome for the patient. To succeed in these demanding reconstructions, an exact operative plan is needed. In the head and neck region, there are a myriad of fine-tuned functions that affect speech, swallowing, and breathing. In addition, the normal appearance of the face has a tremendous effect on the way the patient copes and functions socially. Therefore, before reconstruction, a thorough analysis of tissues and functions that will be lost must be undertaken, as just filling up the resected area with well-vascularized tissue is not enough. Indeed, a poorly planned reconstruction can be detrimental to the well-being of the patient.[9,10] Today, free flap reconstruction is the gold standard in head and neck surgery. The method enables the reconstruction of almost any tissue defect. However, such operations are labor-intensive, costly to the health care system, and strenuous for the patient. Therefore, each reoperation caused by free flap failure or complication prolongs hospitalization and places a significant financial burden on the health care system.

Even though the success rate of microvascular tissue transfer is high, it is still important to explore whether the results can be improved further. In the current study, we examine all head and neck free flap reconstructions carried out at Tampere University Hospital between January 1, 2006, and December 31, 2016. The objective of the study is to inspect all cases of free flap loss and to analyze whether there are specific factors that predict flap loss. If there are underlying factors behind flap loss, it is important we identify them and ascertain whether they can be altered preoperatively. We also examine whether the intraoperative need for reanastomosis or flap selection predicts the later loss of the free flap. Minor complications, such as wound healing issues, are beyond the scope of this study.

Methods

The medical records of 336 patients who underwent free flap reconstruction of the head and neck region between January 1, 2006, and December 31, 2016, at Tampere University Hospital were retrospectively reviewed. The records were reviewed for demographics, comorbidities, neoadjuvant and adjuvant therapies, free flap type, area of reconstruction, and intraoperative and postoperative complications. Statistical analyses were performed using IBM SPSS Statistics 25 (IBM Corp.). Cross-tabulations were used for categorical variable comparisons, with chi-squared test or Fisher's exact test, where appropriate. Differences between continuous, nonnormal variables were assessed with the Mann–Whitney test. In accordance with Finnish legislation, no informed written consent was required because of the retrospective register-based study design and because the patients were not contacted. Permission to access the medical records was granted by the Scientific Center of Tampere University Hospital.

Results

During the 11-year study period, 336 primary microvascular head and neck reconstructions were performed. The average age of the patients was 62 years (range 14–92 years), and 201 (59.8%) of the patients were women and 135 (40.2%) were men. Ten of the 336 flaps (3%) were lost. Patients' age, sex, or body mass index did not adversely affect free flap survival. Furthermore, chronic diseases, such as diabetes, hypertension, renal insufficiency, lung or liver diseases, hypercholesterolemia, morbus coronarius cordis, transient ischemic attack, or arteriosclerosis obliterans, also had no effect on free flap survival.

We divided the patients into four groups based on the dose of anticoagulation (low-molecular-weight-heparin [LMWH]) they received perioperatively: reduced dosage ($n = 104$), prophylactic dosage ($n = 192$), therapeutic dosage ($n = 6$), and no information about anticoagulation dosage ($n = 34$). In our study, the dosage of LMWH did not affect free flap survival ($p = 0.80$).

In the current study, 121 (36%) of the patients were active smokers. However, in the group of patients with lost flaps, only one patient was a smoker. Smoking did not therefore affect the risk of flap loss ($p = 0.22$). Forty-seven (14%) patients had had previous radiotherapy on the operative field, and only one of them suffered a free flap loss.

In two (20%) cases of flap loss, vascular reanastomosis was performed intraoperatively during the primary surgery, compared to 17 (5.2%) reanastomoses among the survived flaps. The need for reanastomosis did not predict future flap loss. In most cases ($n = 323$; 96.1%) only one venous anastomosis was performed. The number of venous anastomoses therefore did not influence free flap survival ($p = 1.0$).

In the postoperative follow-up period, 299 (89%) flaps were monitored with both Licox and clinical observation (color, capillary refill, hand-held Doppler ultrasound). Nine (2.7%) flaps were monitored with clinical observation only. In six (1.8%) flaps, a flow coupler (Synovis Micro Companies Alliance, Inc., AL) was used. In 13 (3.8%) cases, a combination of Licox and microdialysis was used for flap monitoring. For nine (2.7%) free flaps, the method of monitoring was not documented. There were altogether 18 take backs for the problems with flap viability and 8 of them could be salvaged. In the current study, all 10 lost flaps were followed with clinical observation only, and the problem with the flap viability was detected on the 2nd to the 13th postoperative day. Of the eight salvaged flaps the problem with the flap vascularity was detected with Licox in seven cases and in one flap with clinical observation. Of the salvaged flaps the problem was detected on postoperative day 1 (seven flaps) or 2 (one flap).

Fasciocutaneous flaps were the most used type of flap ($n = 245$; 72.9%). These were followed by bone flaps ($n = 60$; 17.9%) and muscle flaps ($n = 31$; 9.2%) (►**Table 1**). Neither flap type nor location of the reconstruction influenced flap survival (►**Table 2**). In six (60%) patients, the salvage procedure after flap loss was a new free flap. Five (83.3%) of these second free flaps were successful (►**Table 3**).

Table 1 The distribution of free flap types during the study period and the percentage of lost flaps of each flap type

	All flaps, *n* (%)	Lost flaps, *n* (%)
Fasciocutaneous flaps	245 (72.9)	4 (1.6)
ALT	23 (6.8)	1 (4.3)
RFA	222 (66.1)	3 (1.4)
Bone flaps	60 (17.9)	4 (6.7)
FB	41 (12.2)	3 (7.3)
CB	11 (3.3)	1 (9.1)
SB	8 (2.4)	0 (0)
Muscle flaps	31 (9.2)	2 (6.5)
VL	23 (6.8)	2 (8.7)
RA	5 (1.5)	0 (0)
LD	3 (0.9)	0 (0)

Abbreviations: ALT, anterolateral thigh flap; CB, crista bone flap; FB, fibula bone flap; LD, latissimus dorsi muscle flap; RA, rectus abdominis muscle flap; RFA, radial forearm flap; SB, scapula bone flap; VL, vastus lateralis muscle flap.

Table 2 Location of the defect to be reconstructed and the success rate of free flaps in each location

Area of reconstruction	All flaps, *n* (%)	Failed flaps, *n*	Flap success rate (%)
Oral cavity	155 (46.0)	3	98.1
Mandible	61 (18.2)	4	93.4
Maxilla	27 (8.0)	1	96.3
Face	25 (7.4)	2	92.0
Pharynx and larynx	68 (20.2)	0	100.0

Discussion

Free flap reconstruction is a highly reliable way to reconstruct various defects in the head and neck region. Microsurgery enables oncological resections that would not be possible without the reconstructions such complex defects require. In the literature, the success rate of the free flap surgeries varies from 91.2[1,2] to 98.1%.[3–9] In our study, the success rate was 97%, which is in accordance with the rates reported by other centers that perform microvascular head and neck reconstructions.

In the current study, it was shown that free flap reconstructions can be safely performed even in older patients and patients with comorbidities, without increased risk for flap failure. This finding is in accordance with previous studies conducted on older patients[11–17] and patients older than 75 years.[6,11–13] Indeed, our findings support the principle that a person's age per se is not a reason to refrain from free flap reconstruction. There are, however, some data indicating an increased risk of free flap loss in patients with peripheral vascular disease and cardiac disease.[16] In the present study, we did not find correlations between patients' comorbidities and the risk for free flaps loss. Therefore, we suggest that the comorbidities studied here should not automatically preclude certain patients from these major operations.

Anticoagulation is in standard use in our hospital when performing free flap surgery. We routinely use the prophylactic dosage of tinzaparin 4500 IU, but on certain patients the dose needs to be altered. We might, for example, need to reduce the dose if the patient is at higher risk for postoperative bleeding, or raise the dose if the risk of a thromboembolic event has increased. According to our results, anticoagulation can be safely tailored individually from the free flap survival perspective. However, this study does not take a stand on the need for anticoagulation and its dosage on other thromboembolic events associated with major surgery, for example, pulmonary embolism.

Smokers are overrepresented in the population of head and neck cancer patients. This connection has been confirmed by several studies.[18,19] The consumption of tobacco leads to elevated risk for head and neck cancer.[18–22] Before surgery, we always strongly encourage our patients to stop

Table 3 Salvage procedures after failed primary free flap reconstructions and their outcomes

	Age	Sex	Flap used	Area of reconstruction	Salvage procedure	Second flap survival	Final reconstruction
1	52	F	VL	Face	RFA	Failed	Secondary wound healing
2	22	M	CB	Mandible	RFA	Survived	RFA
3	59	F	FB	Maxilla	FB	Survived	FB
4	69	F	RFA	Face	Skin graft	No second free flap done	Skin graft
5	67	F	FB	Mandible	PM	No second free flap done	PM
6	51	M	RFA	Oral cavity	Direct wound closure	No second free flap done	Direct wound closure
7	59	F	FB	Mandible	RFA	Survived	RFA
8	30	M	ALT	Oral cavity	PM	No second free flap done	PM
9	83	F	VL	Mandible	VL	Survived	VL
10	61	M	RFA	Oral cavity	ALT	Survived	ALT

Abbreviations: ALT, anterolateral thigh flap; CB, crista bone flap; F, female; FB, fibula bone flap; M, male; PM, pedicled pectoralis major muscle flap; RFA, radial forearm flap; VL, vastus lateralis muscle flap.

smoking. However, even at the time of cancer diagnosis and upcoming major surgery, patients often find it impossible to stop. In the current study, it was shown that active smoking at the time of diagnosis and surgery did not increase the risk of free flap loss in the head and neck microvascular reconstructions. This finding supports the use of free flaps even on active smokers and is in accordance with the results reported by other authors.[1,16,23] Moreover, this finding is important in this heavy smoking population. However, there are still data suggesting smokers have a higher risk for minor complications after free flap reconstruction than nonsmokers.[19,24] We are therefore conducting a study on this same population to investigate whether smoking has an impact on minor complications, such as infections or wound dehiscence around the flap. We also emphasize to our patients that an important reason to abstain from smoking is that the smokers have lower rates of response during radiotherapy and significantly lower survival rates than nonsmokers.[19,25–29]

Preoperative radiotherapy with doses over 60 Gy and previous surgery are considered risks for free flap loss[1,6,23,30] and wound complications.[6] Radiotherapy causes macro- and microscopic alterations in blood vessels, which can subsequently lead to free flap loss.[31,32] In our population, 47 patients had preoperative radiotherapy on the operative field, and one of these patients suffered from a free flap loss. In the current study, preoperative radiotherapy could not be concluded as an independent risk factor for free flap loss.

In the majority of the cases in the current study (96.1%), there was only one venous anastomosis performed. There are, however, studies that support the use of two venous anastomoses.[4,5] In a series of 652 head and neck reconstructions no relationship was found between the number of venous anastomosis and flap complications. Neither did the selection of recipient venous system affect the risk of venous congestion and flap survival.[33] Our results suggest that in the head and neck region more than one venous anastomosis is not generally needed. We also found that the need for a reanastomosis during the primary surgery did not increase the risk for flap loss, and therefore did not predict major future problems with flap viability.

In most of our head and neck free flap reconstructions, we use both Licox and clinical monitoring to follow our flaps. In our practice the nurses perform the follow-up. Since monitoring with Licox is our routine custom, they have learnt to rely on the device. In all the flaps lost in our study, the only method of follow-up was clinical monitoring. Problems with flap vascularity were also detected reasonably late. On the contrary, in almost all flaps that could be saved after the problem with flap vascularity and following take back, the problem was detected with Licox. In these cases problem with flap viability was also detected earlier. These findings suggest that additional means of monitoring, for example, Licox, could have been of benefit in lost flap cases. Licox has been shown to be a reliable way of free flap postoperative monitoring.[34] In the head and neck region, the flaps might not always be easily visible and can be difficult to clinically follow. Therefore, an additional way to monitor the flap can be of benefit, especially in detecting the early signs of problems with the blood flow of the flap. When the problems are detected late, the flap cannot be salvaged. We also suggest that the staff conducting the follow-up should be educated to be as familiar with the clinical observation as with the device monitoring in order to detect clinical signs of concern as early as with the device. Furthermore, when using device monitoring only, the number of false positive cases can be a problem, and therefore we recommend the combination of clinical and device monitoring for the follow-up.

We also aimed to identify whether some flap types are safer and more reliable than others, and whether the area in the head and neck to be reconstructed is of relevance to flap survival. Fasciocutaneous free flaps were the most used type of flap, and of these, the radial forearm flap (RFA) was the main flap used. In numerous studies, RFA has been reported to be a highly reliable flap,[2,16,23,35,36] and our results are in accordance with those findings. We also found that although RFA showed the highest success rate, there was no statistical difference in the risk of flap loss between different flap types. Our findings conclude that all the flaps used in our study can be safely used, and the decision as to which one to use in each case can be based on the qualities of the defect, what is needed, and which flap best serves the purpose. According to our results, the region to be reconstructed had no influence on flap survival.

It has been reported that a second free flap is a viable option after primary free flap loss.[4,8,31] Our results support this finding. Although the success rate is not as high as in primary free flap reconstructions, a second free flap should be an option when a free flap is the best means of reconstruction and the patient's general condition is good enough for another major surgery.

Conclusion

In our population, free flap loss was a rare event, and the number of flaps lost was low. Furthermore, our results suggest that these demanding reconstructions can be reliably performed on older patients and patients with comorbidities. The proportion of smokers is high among the head and neck cancer patients, and it is therefore encouraging that smoking did not increase the risk for flap failure. All the flaps used are reliable, and the choice of the flap can be tailored according to the demands of the defect and based on the kinds of tissues that need to be reconstructed. The need for reanastomosis did not predict future problems with flap viability, and generally one venous anastomosis seems to be enough. To enhance early detection of flap viability problems, we recommend the use of a second method of follow-up in addition to clinical monitoring. A second free flap reconstruction after primary free flap loss can be recommended despite a marginally lower success rate.

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Conflict of Interest
None declared.

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