Case Report/Series

Flaps or flat: a case report of double free flap survival after a prolonged cardiac arrest

Parintosa Atmodiwirjo, Mohamad Rachadian Ramadan, Michael Djohan, Nadira Fildza Amanda

pISSN: 0853-1773 • eISSN: 2252-8083
https://doi.org/10.13181/mji.cr.247422
Med J Indones. 2024;33:128–32

Received: January 27, 2024
Accepted: June 01, 2024

Authors' affiliations:
Department of Surgery, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo Hospital, Jakarta, Indonesia

Corresponding author:
Parintosa Atmodiwirjo
Division of Plastic Surgery, Department of Surgery, Faculty of Medicine, Universitas Indonesia, Cipto Mangunkusumo Hospital, Medical Staff Wing, Building A, 4th Floor, Jalan Diponegoro No. 71, Salemba, Central Jakarta 10310, DKI Jakarta, Indonesia
Tel/Fax: +62-21-1500135
E-mail: parintosa.atmodiwirjo@ui.ac.id

ABSTRACT

This case addressed patient and free flap survival after cardiac arrest with the contentious use of vasopressors amid concerns about potential vasoconstrictive effects on flap vitality. A 59-year-old male with mucoepidermoid carcinoma underwent post-total maxillectomy and double free flap reconstruction (free fibular flap and anterolateral thigh free flap). Intraoperatively, he experienced cardiac arrest after anastomosis due to hypovolemia or hypoxia, requiring external cardiac massage and vasopressor administration. Despite the initial restoration of circulation, subsequent cardiac arrest ensued, necessitating further resuscitation. Postoperatively, vasopressors were also administered due to hemodynamic instability. Contrary to concerns, both flaps demonstrated sustained vitality, challenging prevailing apprehensions about vasopressor-induced vasoconstriction compromising flap viability. This observation suggests that vasopressors may not significantly threaten flap viability, prompting reconsideration of hesitations and encouraging further investigation. The study advocates for a judicious evaluation of vasopressor administration in free flap procedures, enriching clinical considerations for optimal patient care.

KEYWORDS cardiac arrest, free tissue flaps, reconstructive surgical procedures, vasopressor agents

Free flap reconstruction has emerged as the preferred method for addressing extensive tissue loss following tumor resection in individuals with head and neck defects. This microsurgical approach entails intricate techniques to achieve optimal functional and aesthetic outcomes,[1] with a success rate ranging from 91% to 99%.[2] A double free flap, consisting of osteocutaneous and soft tissue components, is beneficial for managing complex composite defects. However, this approach extends the duration of the surgical procedure.

Despite meticulous preoperative preparations, perioperative complications may arise, including cardiovascular events such as cardiac arrest. Although rare, perioperative cardiac arrest is associated with 50% mortality due to reversible causes, including hypovolemic cardiac arrest that requires volume resuscitation.[3] Factors contributing to cardiac complications include prolonged duration of surgery, perioperative fluid changes, and manipulation of the upper respiratory tract. Moreover, comorbidities contribute significantly to the occurrence of

cardiac complications. A cohort study focusing on cardiovascular events following free flap surgery in the head and neck region reported a 12.5% incidence of postoperative cardiovascular events, with cardiac dysrhythmia being the most prevalent and cardiac arrest occurring infrequently.[4]

The management of cardiac arrest using advanced cardiac life support (ACLS) protocols requires the administration of vasopressors. The use of vasopressors is debatable because of concerns about potential vasoconstrictive effects leading to thrombosis and flap failure. However, contemporary perspectives assert that vasopressors does not adversely impact free flap survival.[5] Vasopressor usage is presumed to increase the risk of vasospasm in the free flap. A large cohort study showed no correlation between vasopressor and flap failure while indicating a protective influence against venous congestion.[6] This shift in understanding vasopressor utilization during free flap procedures underscores the evolving consensus on its safety and efficacy. Further research is warranted to refine these guidelines and to optimize the balance between perioperative hemodynamic stability and flap preservation. This report elucidates the resilience of double free flap surgery in difficult intra- and postoperative conditions, including cardiac arrest, severe anemia, and administration of vasopressors.

CASE REPORT

A 59-year-old male presented with a recurrent mass in the right zygoma that was first observed in 2019, for which he underwent surgery in the same year. He had a mucoepidermoid carcinoma on the left parotid artery, staged as T4bN0M0, according to the World Health Organization tumor staging. Following doxorubicin-5-fluorouracil-cisplatin chemotherapy, the disease remained stable. The left parotid mass measured 11 × 9 × 8 cm and exhibited an irregular surface, solid consistency, well-defined margins, immobility, and no pain or ulceration. The preoperative condition is shown in Figure 1a. He had no comorbidities and demonstrated normal preoperative peripheral blood count, hepatic and renal function, coagulation profile, and electrolyte levels. He received anthracycline chemotherapy thrice before surgery. Cardiac evaluation revealed unremarkable findings, including electrocardiography (ECG) and echocardiography. The ECG indicated normal sinus rhythm, axis, P-wave, PR interval, QRS complex, and the absence of ST changes or artifact waves. Echocardiography revealed no abnormalities, indicating satisfactory left and right ventricular systolic function, with an ejection fraction of 62.4% and a tricuspid annular plane systolic excursion of 19.5 mm. Therefore, he had no prior cardiac comorbidities. Diagnostic modalities, including computed tomography, contrast-enhanced magnetic resonance imaging, and biopsy, were also used for tumor characterization. Most importantly, informed consent was granted by him for publication purposes.

He was scheduled for post-total maxillectomy and reconstruction using a double free flap approach, incorporating the free fibula flap (FFF) and anterolateral thigh (ALT) free flap. A split-thickness skin graft (STSG) was used to close the secondary defects. The ischemic time durations for the FFF and ALT free flaps were 103 and 85 mins, respectively. Intraoperative bleeding amounted to 4,000 ml from tumor resection to the double free flap procedure, necessitating transfusions, including 1,074 ml of packed red blood cells (PRBCs) and 451 ml of fresh frozen plasma. He also received 6,000 ml crystalloid, 2,500 ml colloid, and 250 ml albumin during the surgery.

Notably, cardiac arrest occurred during the surgery, characterized by a supraventricular tachycardia (SVT) rhythm that changed into a ventricular tachycardia rhythm, observed 20 min after the anastomosis of the second flap. Seven cycles of ACLS protocol-guided cardiopulmonary resuscitation (CPR) were performed, which restored his return of spontaneous circulation (ROSC) state after 12 min. Subsequently, he experienced an episode of cardiac arrest 5 min after the initial ROSC, prompting an additional three cycles of CPR lasting 2 min before achieving a subsequent ROSC state. As per the ACLS protocol, 1 mg of epinephrine was administered during resuscitation. Due to the resuscitation efforts, some areas of the ALT skin flap were not sutured. He did not experience hypotension prior to the arrest. However, extensive blood loss may have decreased the cardiac output. The cardiac arrest was predicted to be caused by hypovolemia and hypoxia. The non-existing cardiac comorbidities confirmed the prediction, and intraoperative monitoring did not show abnormal ECG findings before he underwent SVT.

Figure 1. Clinical pictures of the patient. (a) Preoperative condition; (b) 1 month follow-up condition

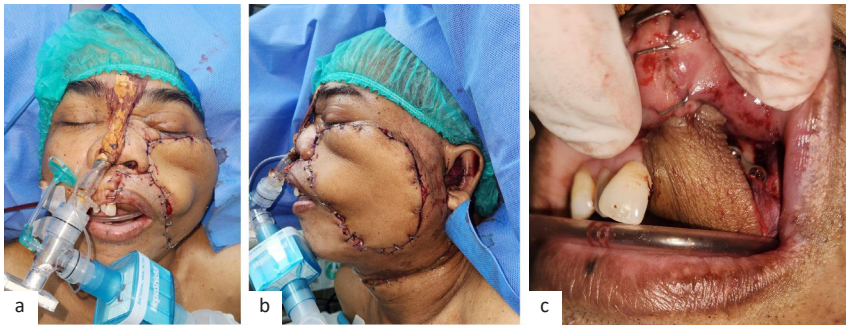

Figure 2. Immediate postoperative condition of the patient. ALT flap from anterior view (a) and lateral view (b). The flap was fixed using staplers. The FFF was placed intraorally (c). ALT=anterolateral thigh; FFF=free fibula flap

He was subsequently transferred to the intensive care unit (ICU) and placed on a ventilator utilizing the volume control mode, with the following specified parameters: fraction of inspired oxygen (FiO_2) at 50%, positive end-expiratory pressure at 5 cm H_2O, respiratory rate at 16 breaths per minute, and a peripheral oxygen saturation (SpO_2) level of 100%. Postoperatively, his hemodynamic status was characterized by a blood pressure of 95/42 mmHg and a heart rate (HR) of 78 beats per minute (bpm), with ongoing administration of epinephrine 0.5 mcg/kg/min and dobutamine 7.5 mcg/kg/min. Evaluation of both flaps 1 hour after surgery revealed sustained vitality with no evidence of active bleeding. Postoperative free flap condition can be seen in Figure 2.

On postoperative Day 1, both flaps exhibited positive clinical signs, with no evidence of active bleeding. However, a bluish discoloration was observed in the distal FFF. The ALT flap was secured using skin staplers. On the same day, he experienced hypovolemic shock and severe anemia, with a hemoglobin (Hb) level of 5.8 mg/dl. He continuously received an infusion of dobutamine 5 mcg/kgBW/min, norepinephrine 0.1 mcg/kgBW/min, and epinephrine 0.2 mcg/kgBW/min, which titrated gradually until Day 3. His ECG showed sinus arrhythmia with an HR of 138 bpm. The 12-lead ECG showed electrical waves in leads I, II, and III and augmented vectors right, foot, and left. The immediate after-surgery laboratory results revealed a cardiac troponin I level of 112.2 ng/ml. The following ECG showed sinus arrhythmia with an HR of 136 bpm and an inverted T wave in leads II and III before returning to sinus rhythm. The transient arrhythmia was attributed to the complications of ROSC.

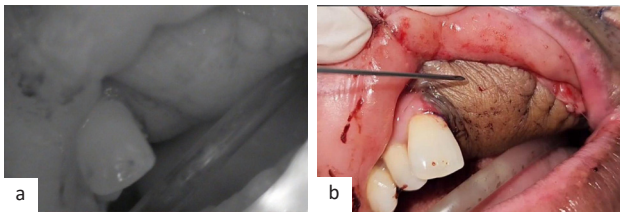

Figure 3. ICG result. Fluorescence was not seen at the FFF distal area (a), and color change was seen visually (b). ICG=indocyanine green; FFF=free fibula flap

After confirming improved stability on Day 2, the remaining unsutured skin flap was directly closed in the ICU. In response to severe anemia on Day 1, he received a 350 ml PRBC transfusion, yielding an Hb level of 7.8 mg/dl. Clinical assessment and indocyanine green (ICG) contrast evaluation confirmed the vitality of the double free flaps. Fluorescence was observed using a near-infrared camera, and it was evident on both flaps, excluding the distal FFF area, which remained non-fluorescent (Figure 3). The distal FFF area exhibited a bluish hue, probably due to constrictive closure.

On Day 3, his vital signs demonstrated increased stability but no progress at the bluish discoloration in the FFF, indicating the absence of ongoing flap compromise. Subsequently, a 300 ml PRBC transfusion was repeated, resulting in an Hb level of 8.9 mg/dl and stabilizing his condition. On Day 4, owing to a persistent bluish appearance at the distal part of the FFF, he received continuous heparin sulfate at a rate of 5,000 IU/hour. A final transfusion of 162 ml PRBCs was administered, resulting in an Hb level of 10.7 mg/dl. Concurrently, all the previously administered vasopressors were discontinued. He was monitored for 24 hours and maintained stability without supportive measures, facilitating transfer to the ward on Day 5. His condition remained stable, and he was discharged from the hospital on postoperative Day 7.

Outpatient care ensued for regular follow-ups, revealing no major complications at 1 month postoperatively (Figure 1b). Both flaps exhibited vitality, and STSG was 100%. Wound dehiscence was noted in the left neck without slough, pus, or active bleeding.

DISCUSSION

Dual or simultaneous free flap reconstruction in extensive defects is associated with potential intraoperative complications. Simultaneous free flap procedures may increase the risk of surgical complications and prolonged operation time. Nevertheless, in cases with substantial impact, employing a simultaneous free flap approach is essential because of its advantages, including ease of inset, superior reproduction of the 3D anatomy, and enhanced tissue matching for mucosal, bony, and cutaneous deficits. Furthermore, the double flap technique demonstrates lower minor and major complication rates than the combined free and locoregional flaps, particularly in head and neck scenarios.[7]

Intraoperative cardiac arrest is a critical complication with potentially fatal consequences that pose a threat to the flap and the patient's survival. For every five patients who experienced cardiac arrest and received free flap surgery, three survived due to cardiac tamponade, hypokalemia, and acute myocardial infarction,[8–10] and two died due to arrhythmogenic right ventricular cardiomyopathy and severe left ventricular dysfunction with ventricular fibrillation.[11,12] Meanwhile, cardiac arrest due to hypovolemia and hypoxia in free flap surgery has not been observed before now. Cardiac arrest causes metabolic alterations stemming from transient hypoxia, potentially leading to prolonged tissue damage. While the ACLS protocol advocates early external cardiac massage, its efficacy remains limited, achieving only 5–10% normal blood flow. However, introducing the vasopressor drugs demonstrates a notable enhancement, increasing blood flow by up to 40%.[13] In the present case, the patient had high troponin I level after cardiac arrest, though elevated troponin levels were observed in all ROSC; thus, they cannot be used to determine whether cardiac arrest was due to infarction or other causes.[14]

Sustaining intraoperative hemodynamic stability is crucial for maintaining adequate tissue perfusion pressure and facilitating successful free tissue transfer. Intraoperative hypotension is associated with unfavorable outcomes due to insufficient end-organ perfusion. Therefore, maintaining a mean arterial pressure target of ≥80 mmHg is frequently advocated.[15] While optimal hemodynamic targets for successful free flap procedures remain unclear, some cases showed perioperative fluid administration before surgery to prevent vasopressor use. However, vasopressors are not inferior to traditional hemodynamic support. Excessive fluid, particularly crystalloid fluid, may induce a procoagulant state, which increases the risk of venous thrombosis. It can also disrupt the microvascular function, potentially leading to free flap failure through hypercoagulability and local edema, compromising blood flow.[16]

Vasopressors, such as adrenaline, induce peripheral vasoconstriction, specifically in perforator-based free flaps.[8,17] While concerns about vasoconstriction hindering perfusion in double free flaps exist, a systematic review and meta-analysis contradicted this notion. Vasopressor use is correlated with increased flap vitality, reducing the relative risk of free flap failure without affecting other adverse events.[18]

Perioperative vasopressor administration optimizes hemodynamic management and prevents under- and over-resuscitation. Clinicians should recognize that judicious vasopressor use and meticulous fluid administration improve flap outcomes and mitigate systemic complications. Additionally, vasoactive agents with potent and selective beta-adrenergic activity, such as dobutamine and intermediate-dose dopamine, offer heightened

arterial pressure without a significant risk of peripheral or flap pedicle vasoconstriction and do not lengthen the hospital stay or alter the free flap survival outcome.[17,19,20]

The extended operative time, compounded by two cardiac arrests followed by the need for a continuous vasopressor due to hemodynamic shock, addressed the hemodynamic burden endured by the patient. Although the flap survived, necrosis was still observed. The precise etiology underlying the compromised portion of the flap remains ambiguous; determining whether it stemmed from the prolonged ischemic duration induced by cardiac arrest, administration of vasopressors, or intrinsic attributes of the flap necessitates further investigation. Therefore, this patient was observed to have a prolonged hospital stay. In addition to clinical traits, flap compromise can be observed earlier with vasculature imaging such as ICG. However, its high cost and limited availability at our center make it inaccessible in regular practice.

In conclusion, flap vitality should be secondary to the patient's survival in such procedure. Free flaps exhibit resilience under adequate distal perfusion, oxygenation, and adverse conditions. This report sheds light on the reliability and effectiveness of dual free flap utilization in head and neck reconstruction, building upon established knowledge in the field. Additionally, it contributes to understanding the efficacy of vasoconstrictors, which was previously contradictory. This finding supports the use of vasoconstrictors in similar cases.

Conflict of Interest

The authors affirm no conflict of interest in this study.

Acknowledgment

We extend our thanks to those who provided support and assistance in this study, particularly the family of the patient who are concerned and supported the authors to increase the patient's well-being.

Funding Sources

None.

REFERENCES

1. Guillemaud JP, Seikaly H, Cote DW, Barber BR, Rieger JM, Wolfaardt J, et al. Double free-flap reconstruction: indications, challenges, and prospective functional outcomes. Arch Otolaryngol Head Neck Surg. 2009;135(4):406–10.
2. Chen KH, Kuo SC, Chien PC, Hsieh HY, Hsieh CH. Comparison of the surgical outcomes of free flap reconstruction for primary and recurrent head and neck cancers: a case-controlled propensity score-matched study of 1,791 free flap reconstructions. Sci Rep. 2021;11(1):2350.
3. Hinkelbein J, Andres J, Böttiger BW, Brazzi L, De Robertis E, Einav S, et al. Cardiac arrest in the perioperative period: a consensus guideline for identification, treatment, and prevention from the European Society of Anaesthesiology and Intensive Care and the European Society for Trauma and Emergency Surgery. Eur J Anaesthesiol. 2023;40(10):724–36.
4. Ciolek PJ, Clancy K, Fritz MA, Lamarre ED. Perioperative cardiac complications in patients undergoing head and neck free flap reconstruction. Am J Otolaryngol. 2017;38(4):433–7.
5. Naik AN, Freeman T, Li MM, Marshall S, Tamaki A, Ozer E, et al. The use of vasopressor agents in free tissue transfer for head and neck reconstruction: current trends and review of the literature. Front Pharmacol. 2020;11:1248.
6. Fang L, Liu J, Yu C, Hanasono MM, Zheng G, Yu P. Intraoperative use of vasopressors does not increase the risk of free flap compromise and failure in cancer patients. Ann Surg. 2018;268(2):379–84.
7. Chen CL, Zenga J, Roland LT, Pipkorn P. Complications of double free flap and free flap combined with locoregional flap in head and neck reconstruction: a systematic review. Head Neck. 2018;40(3):632–46.
8. Pratt GF, Faris JG, Lethbridge M, Teh LG. Breast reconstruction with a free DIEP (TRAM) flap complicated by cardiac tamponade and arrest: a case report. J Plast Reconstr Aesthet Surg. 2009;62(3):e73–5.
9. Young L, Myers LL. Free flap reconstruction of oral composite defect complicated by intraoperative cardiac arrest: a case report. Microsurgery. 2013;33(3):236–8.
10. Kim J, So E, Kim HJ, Seo KS, Karm MH. Cardiac arrest due to an unexpected acute myocardial infarction during head and neck surgery: a case report. J Dent Anesth Pain Med. 2018;18(1):57–64.
11. Bicsák Á, Jellen A, Tuppy H, Poeschl WP. Sudden death after major head and neck cancer surgery due to undetected arrhythmogenic right ventricle cardiomyopathy (ARVC). Oral Maxillofac Surg. 2016;20(4):431–4.
12. Ha W, Kim KN, Ann SH, Yoon CS. Sudden cardiac death with myocardial infarction after free-flap lower extremity reconstruction. Chin Med J (Engl). 2017;130(4):499–500.
13. García-Purriños F, Martínez-Lozano F, Barrios A, Zayas GD. Survival of a micro-vascular free flap after a prolonged cardiac arrest. Eur Ann Otorhinolaryngol Head Neck Dis. 2015;132(5):307.
14. Agusala V, Khera R, Cheeran D, Mody P, Reddy PP, Link MS. Diagnostic and prognostic utility of cardiac troponin in post-cardiac arrest care. Resuscitation. 2019;141:69–72.
15. Gardner JR, Gau V, Page P, Dunlap Q, King D, Crabtree D, et al. Association of continuous intraoperative vasopressor use with reoperation rates in head and neck free-flap reconstruction. JAMA Otolaryngol Head Neck Surg. 2021;147(12):1059–64.
16. Taylor RJ, Patel R, Wolf BJ, Stoll WD, Hornig JD, Skoner JM, et al. Intraoperative vasopressors in head and neck free flap reconstruction. Microsurgery. 2021;41(1):5–13.
17. Kotsougiani D, Banz CM, Hundepool CA, Kremer T, Kneser U, Lehnhardt M, et al. Influence of postoperative vasoactive agent administration on free flap outcomes. Eur J Plast Surg. 2016;39:421–8.
18. Noori O, Pereira JL, Stamou D, Ch'ng S, Varey AH. Vasopressors improve outcomes in autologous free tissue transfer: a systematic review and meta-analysis. J Plast Reconstr Aesthet Surg. 2023;81:151–63.
19. Goh CS, Ng MJ, Song DH, Ooi AS. Perioperative vasopressor use in free flap surgery: a systematic review and meta-analysis. J Reconstr Microsurg. 2019;35(7):529–40.
20. Roche AM, Sterling M, El-Deiry MW, Wadsworth JT. Postoperative use of vasopressors in head and neck microvascular reconstruction. Otolaryngol Head Neck Surg. 2014;151(1_suppl):P62.