The Role of Folded Multi-Island Vertical Rectus Abdominis Myocutaneous Flap in Reconstruction of Complex Maxillectomy and Midfacial Defects

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Abstract

The rationale and outcomes for reconstruction of complex maxillectomy and midfacial defects using a folded multi-island VRAM flap (MI-VRAM) are analyzed in this study.

A retrospective review of prospectively collected database was conducted on all VRAM free flaps used in head and neck reconstruction from 2013 to 2019. A total of 39 cases were identified, of which 21 patients underwent immediate VRAM flap reconstruction for complex maxillectomy and midfacial defects. Variables including age, sex, pathologic subtypes, tumor staging, type of resection, defect classification, adjuvant therapy, complications, follow-up time and reconstructive details were collected.

Single skin-island VRAM was used in 10 (47.6%) patients. 11 (52.4%) patients required the use of folded MI-VRAM flap. In 6 (28.6%) patients a triple skin-island VRAM (TSI-VRAM) was used and 5 (23.8%) received a double skin-island VRAM (DSI-VRAM). The average size of harvested skin paddle was 15x7.2 cm. Secondary flap contouring was required in 6 (28.6%) patients. There were no cases of total flap loss and no major donor site complications recorded.

Folded MI-VRAM flap is a reliable method for reconstruction of complex maxillectomy and midfacial defects. It provides multiple independent skin islands with excellent plasticity and abundant volume of tissue for restoration of facial contours.

Key words: maxillectomy, midface, reconstruction, free flap, multi-island vertical rectus abdominis myocutaneous flap

Introduction:

Complex maxillectomy and midfacial defects after extensive cancer resection represent a challenging task for the reconstructive surgeon. These three-dimensional defects involve multiple aesthetic and functional subunits of the face and have great impact on patients' quality of life.[1] Surgical resection of the maxilla creates an undesirable communication between oral and nasal cavity which impedes on normal mastication and glutition. An exposed orbital cavity, following orbital exenteration, is socially challenging and can be the source of life-threatening infections that can easily spread to the anterior and medial cranial fossa.[2] Furthermore, the resection of skin, bone and soft tissue of the midface causes disfiguration and represents a major psychological problem. It is, therefore, not surprising that impaired function and degraded facial appearance are the most common subjective issues reported by patients undergoing these procedures.[3]

The golden standard of midfacial reconstruction includes oronasal separation, orbital obliteration, restoration of facial contours and restitution of missing epithelial surfaces.[4] An ideal reconstructive option should be least time consuming, while meeting the requirements for multi-laminated epithelial surfaces and complex three-dimensional layout of midfacial defects. The advantage of autologous free tissue transfer for maxillary reconstruction has been well documented.[4-6] Many authors emphasize practicality and a single stage-single flap immediate procedure is favored by most.[7] A variety of reconstructive options have been described, including the use of multiple free flaps, combined free and pedicled flaps, single folded multi-island free flaps, composite and chimeric free flaps.[5-13]

Vertical rectus abdominis myocutaneous free flap (VRAM) is easy to harvest and offers abundant amount of pliable soft tissue that is conformable to suit complex maxillectomy and midfacial defects.[12] Numerous transmuscular perforators of the deep inferior epigastric artery and vein (DIEA/DIEV) enable raising this flap with multiple separated skin islands, providing independent epithelial surfaces for three-dimensional inset. Multi-island vertical rectus abdominis myocutaneous free flap (MI-VRAM) has been described as a reliable flap in the reconstruction of multiple sites of the head and neck.[12] Herein, the rationale and outcomes for reconstruction of complex maxillectomy and midfacial defects using a folded MI-VRAM flap are analyzed.

Patients and methods:

The study was waived approval by the University Hospital Center Bioethical Review Board adhering to the current revision of the Declaration of Helsinki and the International Conference on Harmonization Good Clinical Practice (ICH GCP). A retrospective review of prospectively collected database was conducted on all VRAM free flaps used in head and neck reconstruction in a single referral tertiary center from 2013 to 2019. A total of 39 cases were identified, of which 21 patients underwent VRAM flap reconstruction for complex maxillectomy and midfacial defects following cancer resection. Immediate postablative reconstruction was performed in all patients by a team of two surgeons. All patients signed informed consent forms after initial evaluation. Variables including age, sex, pathologic subtypes, tumor staging, type of resection, defect classification, adjuvant therapy, complications, follow-up time and reconstructive details were collected. Indications and outcomes were reviewed. Patients reconstructed simultaneously with a second free flap or any composite or chimeric free flap were excluded. The 2010 Brown classification of maxillectomy defects was used as the main classification system in this research. Patients with defect class II, III, IV, V and VI were included in the study.[13]

Surgical technique:

Multi-island VRAM flaps were designed using a template prefabricated at the resection site. They were raised in situ as either a double skin-island free flap (DSI-VRAM) or a triple skin-island free flap (TSI-VRAM) based on multiple transmuscular perforators of the DIEA and DIEV by excising the intervening skin and subcutaneous fat down to the anterior rectus fascia. The cuts were beveled towards the fascia to incorporate maximal number of perforators. Flaps were then brought to the recipient site, folded along the longitudinal axis and sutured using the skin islands to reconstruct missing epithelial surfaces of the orbit, lateral nasal wall, cheek skin and palate. In case of palatal defect, the proximal skin island was sutured intraorally. The DIEA and DIEV were used for microvascular anastomoses in all flaps. All donor site defects were closed primarily, without the use of mesh, by meticulous suturing of the remaining cuff of anterior rectus fascia and abdominal skin.

Results:

The study included 21 patients treated from 2012 to 2019 for complex maxillectomy and midfacial defects following cancer resection by using vertical rectus abdominis myocutaneous free flap (VRAM). Patient age ranged from 35 to 91 years (mean 62.1), with two thirds being male. Demographic data, resection and reconstruction details are listed in **Table 1.**

A single skin-island VRAM was used in 10 (47.6%) patients; 8 (38.1%) patients with class V orbitomaxillary defect, necessitating the obliteration of orbital cavity and surrounding bony defect; 1 (4.7%) patient with class IId infrastructural defect and 1 (4.7%) with class VI defect involving the lateral nasal wall. 11 (52.4%) patients required the use of a folded multi-island VRAM (MI-VRAM) that was applied when multiple epithelial surfaces and greater tissue volume restoration was needed. In 6 (28.6%) patients a TSI-VRAM was used to reconstruct class IV defects following total maxillectomy, orbital exenteration and palatal resection. 5 (23.8%) patients received a DSI-VRAM for class III, V and VI defects including the infrastructure of the maxilla and the cheek skin, orbit and the lateral nasal wall, and partial or total maxillectomy with orbital content preservation. The average size of harvested skin paddle was 15 x 7.2 cm but varied significantly depending on the extent of the defect.

A titanium mesh was used to reconstruct the orbital floor in 3 (14.3%) patients, with no cases of restricted ocular mobility, postoperative diplopia or enophthalmos. Secondary suction-assisted lipectomy and/or debulking for flap contouring was required in 6 (28.6%) patients. The rate of surgically induced complications was 28.6%. One patient with extended class V defect presented intraoperatively with a CSF leak that was treated with a double-layered fascial patch and fibrin glue. Spontaneous resolution of an orbitocutaneous fistula was observed in one patient with class V orbitomaxillary defect. Surgical exploration for postoperative hematoma was needed in one patient. Another patient required revision of microvascular anastomoses due to venous congestion. There were no cases of total flap loss recorded in the study. One distal skin island loss occurred in TSI-VRAM reconstructed patient due to revision surgery for intraorbital recurrence. This orbital defect was covered with a skin-grafted temporalis muscle flap. There was one case of partial skin island necrosis of DSI-VRAM due to excessive secondary debulking, which was debrided and closed primarily. No major donor site complications were recorded, with prolonged wound healing observed in one patient. Length of hospital stay ranged from 8 to 35 days (mean 15.6 days).

All 9 patients with class III and IV defects including palatal resection, restored soft or unrestricted oral diet within 6 weeks of reconstruction. Postoperatively 6 of those patients underwent dental rehabilitation through the use of prosthesis. 10 (47,6%) patients received adjuvant radiotherapy and 5 (23,9%) were treated with concomitant chemoradiotherapy. When applied, aggressive adjuvant radiotherapy was well tolerated by MI-VRAM flaps in all of the patients with almost no permanent sequellae of the treatment. Postoperative recurrence was observed in 4 (19%) patients which subsequently succumbed to disease. Average follow-up was 26.2 months, with a range from 2 to 63 months.

Case 1

A 64-year-old male patient with advanced T3N0M0 basal cell carcinoma of the lower eyelid and periorbital skin exhibited signs of gross orbital invasion, bulbar infiltration and zygomatic bone destruction at presentation. Orbital exenteration with zygomatic bone resection and limited suprastructure maxillectomy was performed. Class V orbitomaxillary defect was reconstructed using a single skin-island VRAM flap. Superficial temporal artery and vein (STA/STV) were used as recipient vessels for microvascular anastomoses. Postoperative long-term follow-up showed good reconstructive outcome in terms of facial contour. The patient remains disease free after 5 years of follow-up **(Figure 1).**

Case 2

A 56-year-old female patient with a T4aN0M0 squamous cell carcinoma of the right maxilla presented in advanced stage of the disease with signs of bony destruction of the inferior, medial and anterolateral wall of the maxilla. The tumor showed gross invasion of premaxillary soft tissue and cheek skin. MRI scans revealed minor erosion of the orbital floor, without obvious orbital invasion. A total maxillectomy with orbital content preservation and the resection of soft tissue and skin of the cheek was performed. Class IIIb defect was reconstructed with a folded double skin-island VRAM (DSI-VRAM), with proximal skin island used for cheek reconstruction and distal island oriented for intraoral lining. A titanium mesh was placed to reconstruct the orbital floor. Facial artery and vein (FA/FV) were used as recipient vessels for microvascular anastomoses. The patient received adjuvant radiotherapy. The reconstruction yielded excellent functional and aesthetic results in terms of oronasal separation, cheek skin replacement and midfacial volume restoration despite secondary muscular atrophy due to denervation. Dental rehabilitation was carried out with the use of prosthesis and the patient restored unrestricted oral diet. The patient remains disease free 3 years after surgery **(Figure 2).**

Case 3

A 59-year-old male patient presented with a T4aN0M0 adenoid cystic carcinoma of the left maxilla exhibiting overt palatal destruction and orbital invasion, with signs of reduced ocular mobility. MRI scans further revealed orbital fat and muscle involvement and pterygopalatine fossa invasion. A total maxillectomy, orbital exenteration and pterygopalatine fossa evacuation were performed creating class IVb complex maxillectomy defect. A folded triple skin-island VRAM (TSI-VRAM) was used as immediate procedure to close the defect. Proximal skin island was placed intraorally for oronasal separation, intermediate island was used for lateral nasal wall lining and distal island to obliterate the orbital cavity. FA and FV were used for microvascular anastomoses. The patient received adjuvant radiotherapy and was able to restore full oral diet with excellent cosmetic effect, that was not significantly diminished by secondary muscular atrophy even after 4 years of regular follow-up. The patient remains disease free **(Figure 3).**

Discussion:

There have been several systems of classification proposed in the literature for maxillectomy and midfacial defects.[14] Many authors attempted to present an ideal algorithm of reconstruction, regarding the extent of the defect, type of the procedure performed, and prosthodontic rehabilitation.[8-14] However, all of these systems have diverse points of perspective, with few interconnections and, therefore, a universally accepted protocol for maxillary and midfacial reconstruction has not yet been established. Advances in microvascular free tissue transfer enabled more complex and technically refined procedures, with considerably better reconstructive outcomes than several decades ago.[15,16] The rationale in choosing the optimal reconstructive option should be personalized, keeping in mind defect characteristics, patient performance status and social background. Both composite and soft tissue multi-island free flaps have been described for maxillary and midfacial reconstruction. As opposed to multiple free flaps, the benefits of a single multi-island free flap include a single donor site and minimized perioperative risk due to shorter length of the procedure. In this research we present our experience in using single, double and triple skin-island VRAM flap in maxillary and midfacial reconstruction.

Versatility of VRAM flap and its clinical application in head and neck reconstruction have been well established.[12,17,-19] Dual vascular supply through superior epigastric (SEA) and deep inferior epigastric artery (DIEA) ensures excellent perfusion of the adjacent angiosomes and enables “turbocharging“ of the VRAM flap in cases where extremely large quantity of tissue is needed.[20] Constant anatomy of DIEA and its substantial caliber, averaging up to 3.4 mm at the point of origin, are the main reasons why it is usually used for microvascular anastomosis in VRAM flap. Furthermore, DIEA has predominant contribution to abdominal skin perfusion, reporting an average of 81 transmuscular perforators of the DIAE to the abdominal wall, most of which were localized in the periumbilical region. The vast array of perforators and robust vascular supply enable raising multiple separated skin islands over the entire course of the rectus muscle, creating a multi-island VRAM flap. Freedom of movement of independent cutaneous islands makes this flap suitable for three-dimensional inset. Due to large amount of muscle and adipose tissue it also provides adequate volume to restore midfacial contours, even without the osseous component involved.[17]

Another multi-island soft tissue flap reported for midfacial reconstruction is the radial forearm free flap (RFFF).[21] However, RFFF lacks bulkiness for dead space obliteration and its use is limited to through-and-through cheek and perioral defects. An osseocutaneous RFFF, incorporating a segment of the radius, can be applied to selected defects of the palate and maxillary infrastructure with orbital preservation and medium volume deficit. The associated donor site morbidity, primarily fracture of the radius, and limited bone stock available for harvesting are major drawbacks in wide application of this RFFF modification.[21]

The use of anterolateral thigh flap (ALT) as multi-island soft tissue flap or as chimeric flap has been described for maxillary and cranial base reconstruction.[22] Compared to VRAM and RFFF, the ALT has limited number of perforators. Raising a double-island

ALT on a single perforator is possible by deepithelization of the intervening skin. However, this procedure carries a risk of compromising the perfusion to distal skin and its three-dimensional layout is limited.

Composite flaps are well documented in midfacial and maxillary reconstruction. The use of vascularized bone enables restitution of facial contours and is predisposing factor for the use of osseointegrated dental implants. Fibular osseocutaneous free flap (FOCFF) presents an excellent source of well vascularized bone and its use in maxillary reconstruction has been extensively researched. Facial contour can be achieved by sequentially osteotomizing the fibula to create a layered fibular flap. Bone segments are folded upon themselves to fill the entire height of the midfacial osseous defect as previously described.[10] Cutaneous perforators of the FOCFF are sparse, making this flap less permissive to raising multiple independent skin islands.

Deep circumflex iliac artery flap (DCIA) has been proposed in postablative reconstruction of the midface as an ample source of corticocancellous bone, muscle and skin that allows for three-dimensional inset.[13,14] The main flaw of this flap is the shortness of its pedicle that sometimes necessitates the use of venous extension grafts. This carries greater risk for vascular incident and prolongs the duration of the procedure.

Subscapular artery system of flaps is well described for maxillary reconstruction, predominantly as a chimeric flap incorporating the scapular and latissimus dorsi flaps.[10] Vascular anatomy of subscapular artery system enables raising multiple independent islands of different tissue based on one pedicle that ensures optimal three-dimensional inset and fine volume replacement. Although rewarding, it is also technically demanding to raise and hinders a two-team approach, substantially lengthening operation time and perioperative risks.[22]

There are many advantages of MI-VRAM flap in midfacial and maxillary reconstruction. It provides simultaneous intraoral lining, skin defect coverage, obliteration of dead space and midfacial volume restoration. The flap is easy to harvest and allows for a two-team approach. Donor site morbidity is generally low, however postoperative bulging or herniation may occur. The average length of the DIEA is 7.8 cm from its origin to its entrance into the rectus muscle, and can be further extended by transmuscular dissection to an average of 17.7 cm.[17] This enables the use of central or contralateral neck recipient vessels for microvascular anastomoses and is important in treating previously operated patients with vessel depleted neck. VRAM flap is also very reliable, with lowest rate of vessel thrombosis (2.5%) and flap failure rate (0.9%) of all free flaps described.[22]

Reports on the use of MI-VRAM in head and neck reconstruction are infrequent. The flap has been described as a double (DSI-VRAM) or triple (TSI-VRAM) skin-island flap and there are no publications reporting the use of more than 3 islands over the rectus muscle. However, anatomical studies have shown that flaps with 4 or more skin islands could be raised due to copiousness of transmuscular perforators. Cordeiro and Santamaria developed a classification system of midfacial defects based on extent of maxillectomy and volume restoration requirements.[7] They advocate MI-VRAM flaps for reconstruction of total maxillectomy defects with/without orbital exenteration (type IIIa and IIIb defects) yielding excellent functional and cosmetic results. In the largest published series of 46 patients Patel et al. described the use of MI-VRAM flap in the reconstruction of midface, lower face and neck.[12] They have shown that this flap has met all the challenges of reconstruction in multiple sites of the head and neck with great outcomes and low surgically induced complication rate of 15%. Another study suggested the use of MI-VRAM flap for reconstruction of posterolateral oromandibular defects, showing that good functional outcome can be achieved by using this soft tissue flap even in composite defects with high dynamic requirements.[22]

Folded MI-VRAM flap is a reliable method for reconstruction of complex maxillectomy and midfacial defects. It provides multiple independent skin islands with excellent plasticity and abundant volume of tissue for restoration of facial contours. This flap is also easy to harvest, with minimal donor site morbidity and has a robust vascular supply. Patients reconstructed with MI-VRAM flap usually exhibit good functional and aesthetic outcome, despite muscular atrophy, mainly due to large proportion of adipose tissue involved in the flap. Secondary contouring procedures may be necessary in some patients. The flap hinders the use of osseointegrated dental implants which is one of the rare downfalls of this reconstructive option.

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Conflict of Interest

The authors have no conflict of interest to declare.

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Tables and Figures

Table 1. Patients' characteristics (supplement)

Figure 1

A) T3N0M0 cutaneous basal cell carcinoma of the lower eyelid and periorbital skin. B) Class V orbitomaxillary defect. C) Orbital exenteration, zygomatic bone resection and limited suprastructure maxillectomy performed. D) Single skin-island VRAM flap. E) Patient 1 year postoperatively, (F) frontal view.

Figure 2

A) T4aN0M0 squamous cell carcinoma of the maxilla. B) Class IIIb defect. C) Extended total maxillectomy with orbital content preservation performed. Titanium mesh inserted for orbital floor reconstruction. Resection of premaxillary soft tissue and cheek skin. Destruction of inferior, medial and anterolateral wall of the maxilla. D) Double skin-island VRAM (DSI-VRAM). E) Patient 2 years postoperatively, F) frontal view.

Figure 3

A) T4aN0M0 adenoid cystic carcinoma of the maxilla with orbital invasion. B) Class IVb defect. C) Total maxillectomy, orbital exenteration and pterygopalatine fossa evacuation performed. Destruction of inferior, superior, posterior and anterolateral wall of maxilla. Orbital fat and muscles infiltrated. D) Triple skin-island VRAM (TSI-VRAM). E) Patient 3 years postoperatively, F) frontal view.