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REVIEW ARTICLE

Flap Selection in Head and Neck Cancer Reconstruction

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ABSTRACT

Advances in head and neck reconstruction techniques have improved the results in function and the aesthetic outcome. Several flaps with different composition are available for specific reconstruction to achieve optimum result. Sensate free tissue transfer, dental rehabilitation and epiphyseal transfer for pediatric mandible are also now possible to achieve better function. The specific choice of the flap according to the region of defect and important keypoints in harvesting and reconstruction strategy for head and neck cancer are based on our experience in the last two decades.

Keywords: Local flaps, Pedicled flaps, Free flaps, Maxilla and mandible reconstruction, Pharynx reconstruction.

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INTRODUCTION

In India, oral malignancies account for 35% of total malignancies.[1] Surgical excision of tumor and neck dissection forms the mainstay of treatment in addition to adjuvant chemotherapy and radiotherapy. The resulting anatomical defect, functional loss, cosmetic disfigurement and the accompaning psychosocial effects can be devastating to the patient. Reconstructive surgery plays a crucial role in improving the quality of life by restoring anatomical defect, achieving functional rehabilitation and aesthetic outcome. In 1963, McGregor introduced temporalis muscle flap for midface and lower face defect coverage.[2] In 1965, Bakamjian discribed the deltopectoral flap for coverage of the lower third of the face as well as of the oral and esophageal defects.[3] In 1979, Ariyan described pectoralis major myocutaneous flap for lower third of face.[4] These regional restrictions were abolished by free radial forearm flap which was discribed by Yang in 1981.[5] Thereafter, the use of microvascular tissue transfer has revolutionized the field of head and neck cancer reconstruction. Recent techniques like sensate free tissue transfer, dental rehabilitation and epiphyseal transfer for pediatric mandible can help us to achieve the ultimate goal of 'replacing like with like'.

MATERIALS, METHODS AND OBSERVATIONS

We retrospectively reviewed patients undergoing head and neck reconstruction for cancer and grouped them according to the regions (1) scalp, (2) upper face, (3) midface, (4) lip, (5) oral cavity, (6) mandible, and (7) neck and pharynx and choice of reconstruction (1) local flap, (2) pedicled flap, and (3) free flap.

Scalp

Vasculature of scalp ascends from periphery toward center (below upward) and it is essential to base the flap peripherally. Skin is raised in the loose areolar tissue plane above the galea aponeurotica layer. Recommended choice of reconstruction for scalp defects are as follows (Table 1).

Rotation Flap for Scalp Defect[6]

It is the most common flap done for small defects of the scalp. An isosceles triangle ABC is created. Pivot point D is located on the projection of line AC. Line CD must be 50% larger than AC. Midpoint of AD designed which becomes center of arc drawn from B to D (Fig. 1).

Upper Face-Eyelid

Eyelid reconstruction requires, both skin cover and conjunctival lining. Recommended choice of reconstruction for eyelid defects are as follows (Table 2).

Forehead Flap for Total Eyelid Defect[13]

Supratrochlear artery based median forehead flap is raised for eyelid reconstruction. Distal one-third of flap is raised in the subcutaneous plane. Frontalis muscle is included in the middle one-third of the flap. Subperiosteal plane is achieved in proximal one-third of flap to include the supratrochlear artery into the flap. Depilation is performed if flap is planned beyond the frontal hair line. Buccal mucosa is used for prelamination of forehead flap to replace conjunctiva. Flap inset is done over defect and division is done after 3 weeks (Fig. 2).

Midface

Nose

Nasal reconstruction involves restoration of the tip, dorsum, columella, and paired alae, sidewalls, and soft triangle subunits. Recommended choice of reconstruction for nose defects are as follows (Table 3).

Forehead Flap for Large Defect of Nose[18]

Exact pattern of the defect is marked over median forehead region. For reconstruction for total loss of nose,

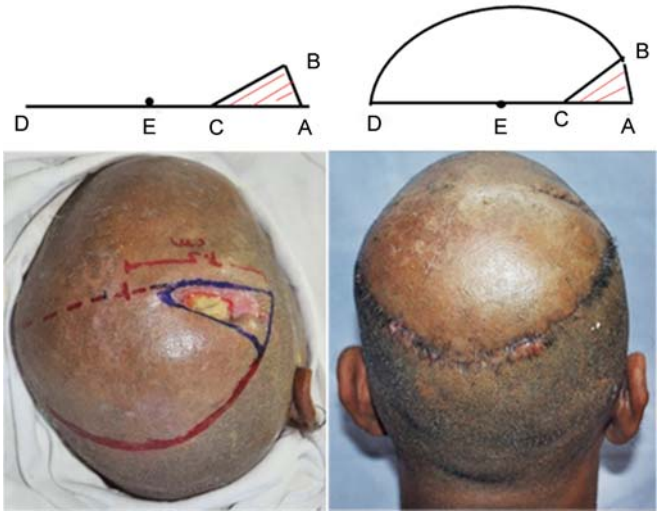

Fig. 1: Rotation flap for scalp defect

consideration is given for projection of the nose and flap design is made little larger. Short flap will result in foreshortened nose. Due consideration is given to provide nasal mucosal lining. Flap based on supratrochlear artery is raised and sutured over the defect. After 3 to 4 weeks, pedicle of the forehead flap is divided and contoured at the superior aspect of the defect. The proximal pedicle is untubed and repositioned back to the medial brow and sutured as inverted 'V' (Fig. 3).

Cheek

There is excess laxity of skin over cheek, thus local advancement flaps are preffered unless there is insufficient surrounding skin. Recommended choice of reconstruction for cheek defects are as follows (Table 4):

Rhomboid Flap for Superficial Cheek Defect[21]

Small superficial defects of cheek are managed with rhomboid flap. The defect is converted to rhomboid shape with 60° and 120° angles. The flap is planned in an area with loose skin to allow direct closure of the wound. The short diagonal BD is of the same length as each side and is extended by same length to point E. The line EF is drawn parallel to AD' and is of the same length. After the flap margins have been incised, the flap is transposed into the rhomboid defect. Primary closure of the donor site is done along the resting skin tension lines (Fig. 4).

Fig. 2: Forehead flap for lower eyelid reconstruction after excision of basal cell carcinoma

Fig. 3: Forehead flap for basal cell carcinoma over left nasal ala

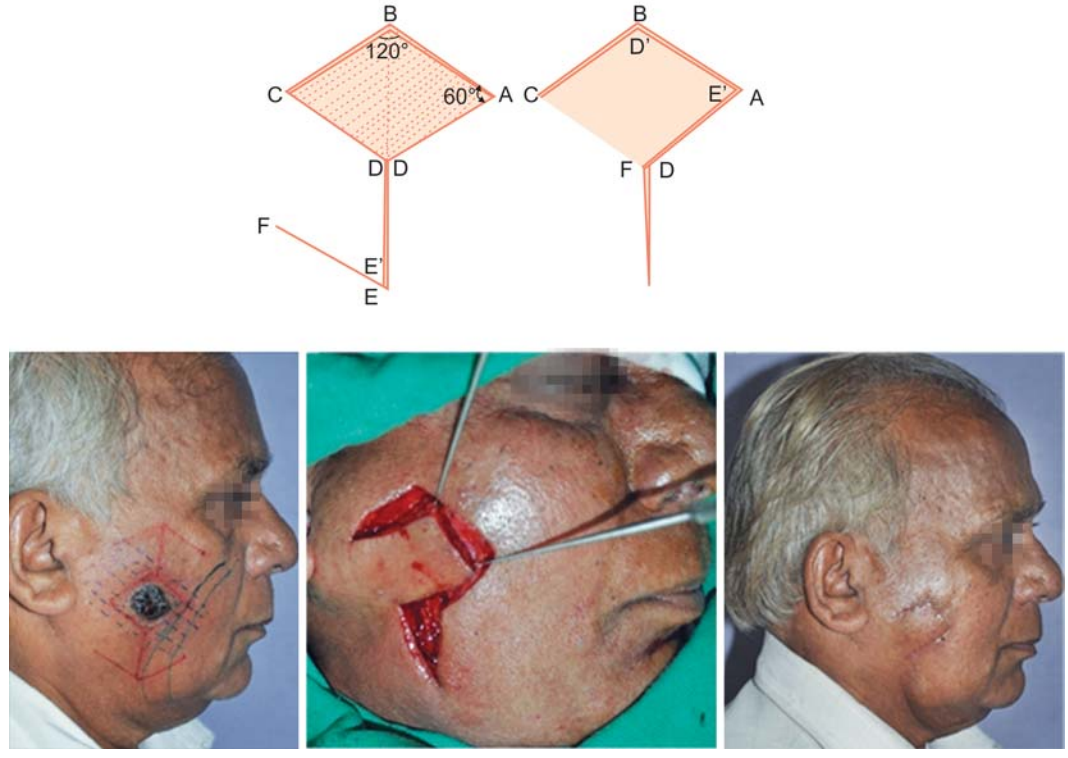

Fig. 4: Rhomboid flap for basal cell carcinoma of cheek

Table 1: Choice of reconstruction for scalp defects

Site	*Size of defect*	*Choice of reconstruction*
Scalp	<3 cm	Primary closure
	Up to 50 cm²	Rotation flap,[6] transposition flap, pinwheel flap, bipedicle advancement flaps, double opposing rotation flaps,[7] Orticochea four flap[8]
	>50 cm²	Free anterolateral thigh flap or Latissimus dorsi free flap[9]

Submental Flap for Intraoral and Cheek Defect[24]

Submental artery, direct branch of the facial artery supplies the submental flap and is located 5 to 6.5 cm distal to the origin of the facial artery. Inferior mandible border forms the upper flap margin. Size of the flap varying from 4 × 5 to 15 × 7 cm can be raised. Average flap extends from the ipsilateral to contralateral mandible angle. However, large flap than this dimension is also possible. The incision is made in the inferior margin of the flap directly through the platysma muscle. Then, the dissection is carried out with division of the anterior belly of the digastric muscle, which is included in the flap to ensure inclusion of the submental perforator (Fig. 5).

Deltopectoral Pedicled Flap for Cheek Defect[25]

Vascular supply of the flap is derived from the second to fourth musculocutaneous perforators of the internal thoracic

Table 2: Choice of reconstruction for eyelid defects

Site	*Size of defect[10]*	*Choice of reconstruction[10]*
Upper eyelid	Partial thickness, <50%	Primary closure, V-Y advancement
	Partial thickness, >50%	Full thickness skin graft
	Full thickness, <25%	Primary closure with canthotomy and advancement
	Full thickness, <75%	Hughes sliding tarsoconjunctival flap,[11] cutler-beard advancement flap,[12] Lower lid switch flap[10]
	Full thickness, >75%	Lower lid switch flap, forehead flap
Lower eyelid	Partial thickness, <50%	Primary closure, V-Y advancement
	Partial thickness, >50%	Full thickness skin graft, myocutaneous unipedicled Fricke flap and the bipedicled Tripier flap[13]
	Full thickness, <50%	Primary closure with canthotomy and advancement,Tessier's flap[14]
	Full thickness, >50%	Hughes sliding tarsoconjunctival flap, Mustarde cheek advancement flap,[13] nasolabial flap, forehead flap[13]

Table 3: Choice of reconstruction for nose defects

Site	*Size of defect*[15]	*Choice of reconstruction*
Nose	Small (<1.5 cm)	Full thickness skin graft
	Superficial defect (skin and subcutaneous tissue)	Bilobed flap,[16] V-Y advancement flap
	Adversely located defects (near nostril opening)	Nasolabial flap,[17] forehead flap[18]
	Large (>1.5 cm)	Nasolabial flap, forehead flap
	Composite defect including adjacent structures	Free radial artery forearm flap[19]

Table 4: Choice of reconstruction for cheek defects

Site	*Size of defect*	*Choice of reconstruction*
Cheek	Superficial	Full thickness skin graft, rhomboid flap,[21] bilobed flap,[20] cervicofacial advancement flap[22]
	Soft tissue defects	Temporoparietal fascia flap,[23] temporalis muscle flap[23]
	Small full thickness defects	Submental flap,[24] deltopectoral flap,[25] forehead flap,[26] free radial forearm flap[27]
	Large full thickness defects	Free radial forearm flap,[27] free anterolateral thigh flap[28]

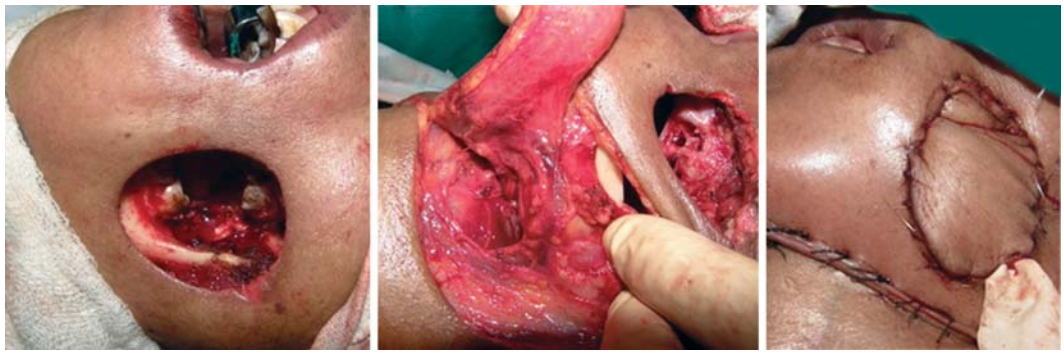

Fig. 5: Submental flap for intraoral and cheek defect

Fig. 6: Deltopectoral pedicled flap for cheek defect with strategic delay after excision of squamous cell carcinoma of oral cavity

artery. Flap extends horizontally from 2 cm lateral to the parasternal border to the anterior aspect of shoulder. The upper border follows the infraclavicular line beyond the deltopectoral groove onto the anterior shoulder. The inferior border is parallel to the superior border and may lie on the 4th costochondral junction. Flap is raised in the subfascial plane from distal to proximal direction. Delay of the flap is essential if it is required to extend beyond the anterior deltoid border. That portion of the flap extending beyond the deltopectoral groove is then elevated and resutured into the donor site before 10 days of definitive surgery (Standard Delay), or the outline of flap is incised and undermining

done in the triangle of infraclavicular fossa to divide the cutaneous branch of thoracoacromial artery (Strategic Delay). Extensive dissection toward feeding vessels of flap near the parasternal area is avoided. After 3 weeks of inset flap is divided (Fig. 6).

Superficial Temporal Artery Forehead Flap for Cheek and Intraoral Defect[26]

The forehead flap is based on frontal branch of superficial temporal artery. Entire forehead skin can be raised. Flap elevation begins at the distal flap margin located at outer canthus of the contralateral eye. Flap is raised in the loose areolar tissue plane above the galea aponeurotica layer. Flap includes skin from the anterior hairline to superior edge of the eyebrow. At the base of the flap near the outer canthus of the ipsilateral eye, the dissection proceeds from the superior aspect of the flap edge at the hairline toward the zygomatic arch. The parietal branch of the superficial temporal artery and associated vein are divided and dissection proceeds deep to the temporoparietal fascia inferiorly. It is also possible to elevate the flap superficial to the frontalis and corrugator muscles to preserve facial expression, however dissection is difficult and requires preservation of the frontal branch of the facial nerve. Flap division is done after 3 weeks of inset (Fig. 7).

Maxilla

Maxilla forms part of the midfacial elements and is connected to orbit, zygoma and nasal unit. It supports the overlying structures and contribute to the facial appearance and assists in functions such as mastication, deglutition, speech and orbital integrity. Reconstruction requires restoration of shape of the face, support to eyeball, barrier between the nasal sinuses and the anterior cranial fossa, palate and alveolus. Recommended choice of reconstruction for maxilla defects are as follows (Table 5).

Deep Circumflex Iliac Artery Flap for Maxilla Defect[29]

A line is drawn from the femoral artery at the midinguinal point to the inferior angle of the scapula. The cutaneous paddle (average size 8 × 18 cm) can be raised with the flap. Skin paddle is placed one-third caudal and two-third cephalad along the above line begining at the anterior-superior iliac spine extending posteriorly. Skin incision is first made in the upper margin of the flap, exposing the external oblique muscle fibers. Care is taken not to injure the musculocutaneous perforators. External oblique muscle is then incised 2 to 3 cm parallel to the iliac crest.

The incision is then continued medially and inferior to the anterior-superior iliac spine over the inguinal ligament to the inguinal canal. Medial and upward retraction of the

Fig. 7: Pedicled forehead flap for full thickness defect of cheek and buccal mucosa after excision of squamous cell carcinoma of buccal mucosa

Table 5: Choice of reconstruction for maxilla defects

Site	*Site of defect*	*Choice of reconstruction*
Maxilla	Alveolectomy	Obturator, iliac bone graft[29]
	Palatal defect	Free radial forearm flap, free anterolateral thigh flap,[30]
	Maxillectomy with intact orbital floor	Free fibula flap, free deep circumflex iliac artery flap,[29] free radial forearm osteocutaneous flap[31]
	Total maxillectomy with intact orbital content	Osteocutaneous free fibula flap[30]
	Maxillectomy with orbital exenteration	Free anterolateral thigh flap[30]

spermatic cord or round ligament of the uterus exposes the external iliac artery and vein. The deep circumflex iliac artery is identified as it takes origin from the external iliac artery. The fibers of the internal oblique and transversus muscle are divided and the vessel traced laterally to the level of the anterior superior iliac spine where the ascending branch is easily identified and divided. The artery is dissected as it courses laterally along the curvature of the iliac crest. Just below the vessel the iliac fascia and muscle are divided, thus exposing the inner surface of the ilium. The dissection continues until the desired length of iliac crest is reached.

The distal end of the deep circumflex iliac artery is divided and the borders of the iliac crest to be harvested are identified. Care is taken to avoid injury to the lateral cutaneous nerve of the thigh. Osteotomy sites are marked. Lower border skin incision is then taken and deepened through deep fascia of the thigh, gluteus maximus and medius and tensor fascia lata muscles 1 to 2 cm from their origin at iliac crest. Osteotomies are done to complete elevation of the bone. Deep circumflex iliac artery based composite flap is with skin, abdominal wall muscles and iliac crest bone. It can be used for reconstruction of the maxilla and mandible defect. Anatomical variation of vascular pedicle is common. Precaution to be taken during dissection of the flap. Flap vessels are anastomosed to facial vessels (Fig. 8).

Lip

Complex anatomic structure of the lips consists of skin, mucosa, minor salivary glands, muscles and neurovascular structures. The lips are an important esthetic feature of the lower face and are essential for maintenance of oral competence, speech articulation, facial expression and oral phase of deglutition. Aim of reconstruction of lip is to restore skin,muscle and mucosa, preserve competence and alignment of vermillion. Recommended choice for reconstruction of lip defects are as follows (Table 6).

Abbe Flap for Two-Third of Upper Lip Defect[32]

This inferior Labial artery based pedicled flap contains skin, orbicularis oris muscle and mucosa of lower lip. Width of the flap is half the width of the upper lip defect. Height of the flap should be the same as height of the defect. Pedicle of Abbé flap is placed at the midpoint of the defect. Donor defect is closed primarily. Pedicle division is done at 14 to 21 days.

Fig. 8: Deep circumflex iliac artery composite osteomyocutaneous flap for maxilla reconstruction in operated case of squamous cell carcinoma maxilla. Patient had dental rehabilitation with osteointegrated implants

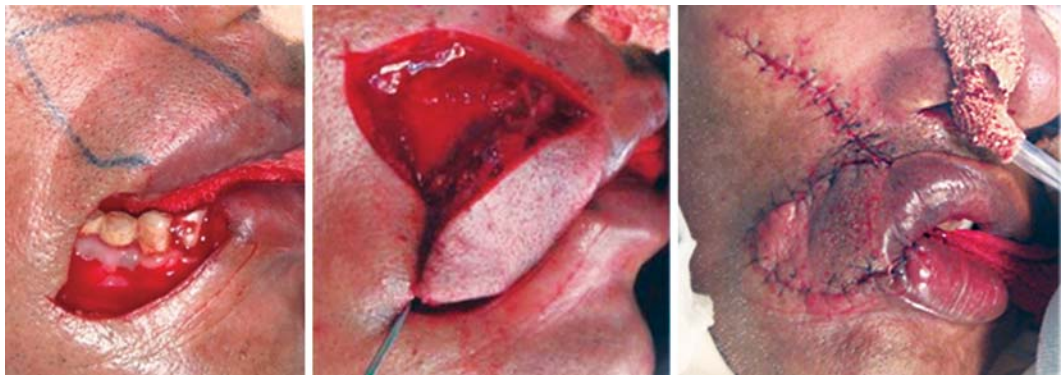

Fig. 9: Estlander flap for lower lip and commissural defect after excision of squamous cell carcinoma of lip

Table 6: Choice for reconstruction of lip defects

Site	*Site of defect*	*Choice of reconstruction*
Upper lip	<25% defect	Direct closure
	Intermediate (up to two-third)	Abbe flap,[32] Abbe-Estlander flap, Gillis flap,[33] Karapandzic flap, Webster crescentic advancement flap[34]
	Total	Free radial forearm flap
Lower lip	<30%	Primary closure
	Intermediate	Estlander flap, Karapandzic flap, Webster-Bernard flap, step flap,[35] Schuchardt flap, Unilateral nasolabial Fuzimori gate flap[36]
	Total	Free radial forearm flap,[33] lateral arm flap, bilateral nasolabial Fuzimori gate flap

Estlander Flap for Lower Lip and Commissure Defect[33]

This superior labial artery based flap is raised from lateral aspect of upper lip. Flap pedicle lies medially. Flap is rotated downward into lateral defect of the lower lip resulting in a rounded commissure (Fig. 9).

Karapandzic Flap for Lower Lip Defect[33]

Bilateral facial artery based flap is raised. Defect measuring 3/4th of the length of lower lip can be closed with this flap. The neurovascular bundle is preserved laterally on both sides (Fig. 10).

Free Radial Forearm Flap for Extensive Lip Defect[27]

Radial artery forearm flap is harvested from the flexor aspect of the forarm. Skin paddle is supplied by multiple perforators from the radial artery. Venae commitantes with the radial artery are sufficient for veinous drainage. However, superficial veins also can be reliably used for venous drainage. Forearm flap can be harvested with palmaris longus tendon which can be used for achieving oral competence.[37] Part of the radius bone also can be harvested with the flap for maxilla reconstruction.[31] Adequacy of vascular supply of the hand by ulnar artery should be confirmed by Allen's test prior to harvest of the flap.[5] Flap dissection is initiated in the subfascial plane from the ulnar side up to the septum near flexor carpi radialis tendon. Subsequent dissection is carried from the radial side in the subfascial plane up to the border of brachioradialis tendon. Care is taken to preserve the superficial veins with the flap and avoid damage to the superficial radial nerve passing from the undersurface of the brachioradialis tendon. Septum is then separated from the radius bone with sharp dissection. Radial artery is then divided at the distal edge of the flap. After dividing the distal pedicle at the wrist, the dissection is then continued from distal to proximal direction. Vascular pedicle can be dissected proximally up to the desired legth. A suprafascial dissection will avoid exposure of the tendon and damage to superficial radial nerve and reduce the donor site morbidity[38] (Fig. 11).

Lateral Arm Flap for Total Lower Lip Defect[39]

Multiple skin perforators from the posterior radial collateral artery supplies skin over the lateral aspect of arm. Line drawn from the deltoid insertion to lateral epicondyle of humerus forms the axis of the flap. An elliptical skin flap of average 12 × 6 cm can be raised along central axis of flap. Flap is elevated from the posterior margin in subfacial plane till lateral intermuscular septum. The triceps musle is separated from septum to expose posterior radial collateral artery. The posterior cutaneous nerve of the forearm is elevated with the pedicle to make it a sensate flap. Pedicle is dissected proximally till origin from the radial collateral artery. Anterior margin of flap is raised in subfacial plane above the brachialis muscle. The origin of brachioradialis

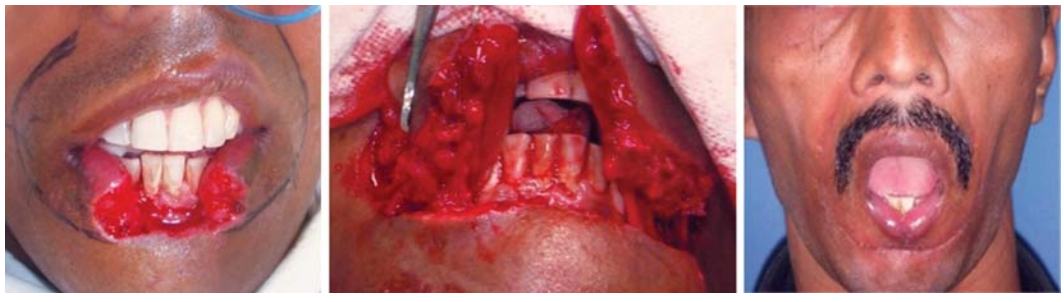

Fig. 10: Karapandzic flap for squamous cell carcinoma of lower lip excision

Fig. 11: Free radial forearm flap for extensive upper lip defect and nasal ala

Table 7: Choice of reconstruction for oral cavity defects

Site	*Site of defect*	*Choice of reconstruction*
Buccal mucosa	<2 cm	Primary closure
	>2 cm	Nasolabial flap,[40] submental flap, forehead flap,
	Large	Pectoralis major myocutaneous flap,[41] free radial forearm flap, free anterolateral thigh flap

is dissected from lateral septum. Distal end of the posterior radial collateral vessel is divided at the distal end of the flap. Unassumingly flap is bulky and will require defattening. This flap can also be used for reconstruction of small defect involving oral mucosa.

Oral Cavity

Recommended choice of reconstruction for oral cavity defects are as follows (Table 7):

Nasolabial Flap for Intraoral Mucosa Defect[40]

Inferiorly based nasolabial flap is raised from nasolabial fold in subcutaneous plane. The flap is usually based on perpendicular branches of the angular artery that course through the muscle and into the overlying skin. Facial artery is preserved during dissection and adequate tunnel is made in buccal mucosa to deliver the flap inside oral cavity. Part of the flap is deepithelialized at the base of the flap where it enters oral cavity to avoid a second operation for closure of the orocutaneous fistula (Fig. 12).

Pectoralis Major Myocutaneous Flap for Intraoral Mucosa Defect[41]

Thoracoacromial vessels supplying the flap traverses along the line perpendicular from midpoint of clavicle to the line joining the acromion process to xiphisternum and then

Fig. 12: Nasolabial flap for buccal mucosa defect after excision of squamous cell carcinoma

courses along this line toward xiphisternum. Entire skin over the pectoralis major muscle can be raised. However, small to moderate size flap is raised depending on the requirement for reconstruction of the oral mucosa defect alone or for mucosa and cheek skin defect where flap is folded to cover both the defect.

Commonly 6 × 7 cm skin paddle is raised with the flap. Caution is taken to avoid hair bearing skin in males and breast tissue in females. In female the flap can be located at the inframammary fold or on the medial side of the breast and in male it is located at the lower part of the parasternal location. Flap elevation is started from a lateral incision to expose the lateral border of the pectoralis major muscle. Dissection is then carried out under the pectoralis major muscle to include the thoracoacromial vessel. After the

Fig. 13: Bipaddle pectoralis major myocutaneous flap for skin and buccal mucosal defect

identification of the muscle and location of the feeding vessel is confirmed, the planned skin paddle is incised. The muscle is then detached medially and laterally preserving the vascular pedicle. In case deltopectoral flap is harvested at the same time with this flap, internal mammary perforators are preserved by leaving sufficient amount of pectoralis muscle near the parasternal border (Fig. 13).

Tongue

It is necessary to achieve three-dimensional reconstruction of tongue for function of deglutition and speech. Function of the tongue after reconstruction depends mainly on the remaining residual tongue tissue. Recommended choice of reconstruction for tongue defects are as follows (Table 8).

Free Radial Forearm Flap for Hemiglossectomy[42]

Radial artery forearm flap can be used for hemiglossectomy to subtotal glossectomy defect. Flap designed in omega shape (Ω) with wider base for the base of the tongue and floor of the mouth. Total glossectomy requires reconstruction of the floor of the mouth with a pentagonal shaped flap.[43] Anterolateral thigh flap can also be used for floor of the mouth reconstruction in total glossectomy (Fig. 14).

Mandible

Mandible reconstruction is essential restoration facial contour, adequate oral continence and deglutition and dental

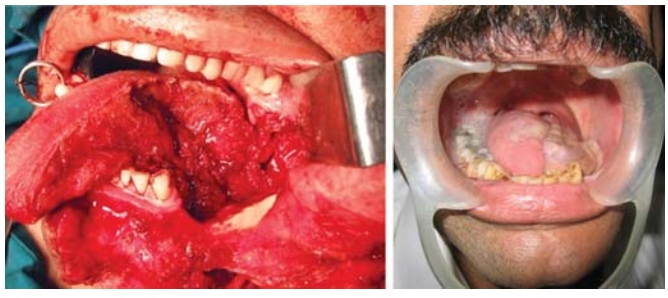

Fig. 14: Free radial forearm flap for hemiglossectomy and marginal mandibulectomy in case of squamous cell carcinoma of tongue

rehabilitation. Fibula flap is workhorse for mandible reconstruction. Fibula flap can be raised along with skin (osteocutaneous) or with skin and muscle (osteomusculocutaneous) depending on the requirement. Deep circumflex iliac artery composite flap can be used for lateral or hemimandibulectomy defect. However, recommended choice of reconstruction for mandible defects are as follows (Table 9).

Free Fibula Osteocutaneous Flap for Mandible Reconstruction[44,45]

Flap is harvested under tourniquet with patient in supine position and knee flexed at 135° and hip at 60° and leg internally rotated. Skin perforators are marked in the middle third of the leg along the axis about 3 cm parallel and behind the line drawn from fibula head to lateral malleolus. Skin paddle is marked around the perforator. Incision is taken

Table 8: Choice of reconstruction for tongue defects

Site	*Size of defect*	*Choice of reconstruction*
Tongue	Hemiglossectomy	Free radial forearm flap,[40]
	Subtotal glossectomy	Free anterolateral thigh flap
	Total glossectomy with floor of mouth	Pentagonal free anterolateral thigh flap[41]

Table 9: Choice of reconstruction for mandible defects

Site	*Size of defect*	*Choice of flap*
Mandible	Central 1/3rd	Free fibula flap[44,45]
	Lateral defect	Free fibula flap, deep circumflex iliac artery flap
	Hemimandibulectomy	Free fibula flap, pectoralis major myocutaneous flap
	Total mandibulectomy	Free fibula flap

Table 10: Choice of reconstruction for neck defects

Site	*Size of defect*	*Flap of choice*
Neck	Small	Platysma flap, deltopectoral flap
	Large	Free anterolateral thigh flap,[28] pedicled latissimus dorsi myocutaneous flap, pectoralis major myocutaneous flap

along the posterior border of the flap margin and extended downward direction in curvilinear manner for better exposure. Soleus muscle is separated from fibula and septocutaneous perforators preserved while cutting posterior intermuscular septum . Flexor hallucis muscle is dissected from the fibula leaving a cuff of muscle over it. Perforators supplying the skin paddle are traced to their origin at the peroneal vessels. Anterior skin incision along the flap margin is then taken and flap is raised in the subfascial plane up to the septum. Peroneal muscles dissected off from the fibula in the similar manner and peroneal nerve is protected at the upper end.

Anterior intermuscular septum is then incised and extensor digitorum longus and extensor hallucis longus muscle is separated from the fibula. Interosseous membrane is then incised at the distal osteotomy site and peroneal vessels are exposed and divided. Osteotomy of the fibula is performed at the distal and proximal site and interosseous membrane is incised along the divided fibula segment. Tibialis posterior muscle is then divided in layers exposing the peroneal vessels. Peroneal vessels dissected proximally up to the desired length. Osteotomies are planned according to mandible defect. Contoured plate is fixed to fibula and pedicle is divided. Peroneal vessels are anastomosed to facial vessels according to side of defect (Fig. 15).

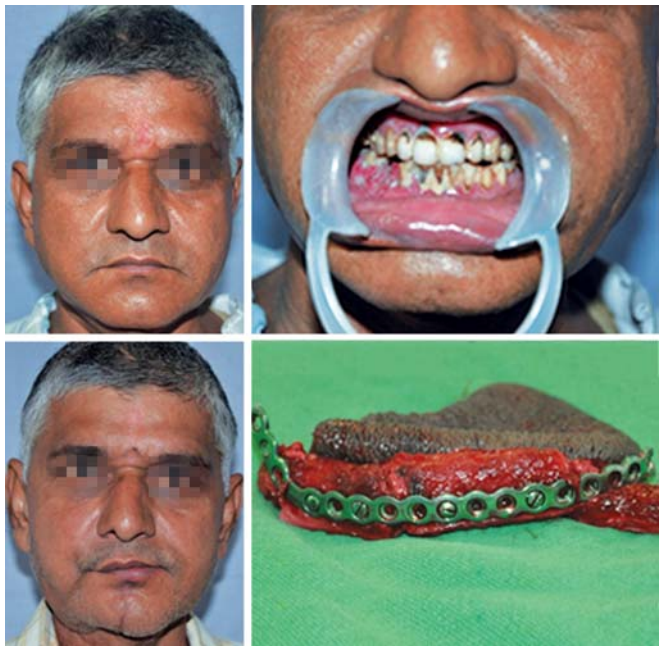

Fig. 15: Mandible reconstruction for right hemimandibulectomy in squamous cell carcinoma of lower gingivobuccal sulcus

Neck

Recommended choice of reconstruction for neck defects are as follows (Table 10).

Anterolateral Thigh Flap for Large Defect of Neck and Intraoral Mucosa[28]

Flap is based on septocutaneous (or musculocutaneous) perforators of the descending branch of lateral circumflex femoral artery. Average flap size of 10 × 8 cm can be raised and the defect can be closed primarily. Large flap with dimension of 30 × 12 cm can also be raised. Straight line from the anterior superior iliac spine to the superolateral border of the patella is marked. A circle with radius of 3 cm drawn at the mid-point of this line. The perforators supplying the skin are in the lower outer quadrant of the circle. Anterior incision is taken first and the perforators are identified and traced to the origin from the descending branch of lateral circumflex femoral artery in the intermuscular septum between the vastus lateralis and rectus femoris muscle. The descending branch of lateral circumflex femoral vessels are dissected to the origin for gaining the desired vascular pedicle length. Posterior incision is then taken and the flap is raised in the suprafascial plane up to the entry of the perforforator. Cuff of fascia is included with the flap around the perforator.

This flap can be used for small to large oral mucosal defect or for both mucosa and skin defect. Large extensive defect can easily be reconstructed with this flap.

Fig. 16: Free anterolateral thigh flap for neck and intraoral mucosa defect after failed pectoralis major myocutaneous flap

Anterolateral thigh flap in most patients particularly in females is thick. It can be thinned by excision of excess subcutaneous fat at the periphery without jeopardizing the perfusion for better in setting of the flap. Flap is bulky and requires thinning at the time of primary operation or later. The vastus lateralis muscle is nourished by the same pedicle and can also be harvested with the flap needed in various reconstructions (Fig. 16).

Pharynx

Recommended choice reconstruction for pharynx defects are as follows (Table 11).

Anterolateral Thigh Flap for Anterior Wall Defects of Pharynx[46]

Anterolateral thigh flap will require thinning at the time of primary operation to allow water tight closure. Proximally flap is anastomosed with the base of tongue and posterior pharyngeal mucosa. The anterior wall of the cervical esophagus is split longitudinally for approximately 1.5 cm to spatulate the distal anastomosis to enlarge the distal anastomosis and minimize the risk of ring stricture. A triangular lip is created at the distal margin of the flap and inserted into the longitudinal split of the esophagus to complete the spatulation.

Table 11: Choice reconstruction for pharynx defects

Site	*Size of defect*	*Choice of reconstruction*
Pharynx	Anterior wall	Free anterolateral thigh flap,[46] pectoralis major myocutaneous flap, free radial forearm flap
	Circumferential	Free anterolateral thigh flap, free radial forearm flap, free jejunal flap

Anterolateral thigh flap for pharynx reconstruction is preferably raised with two perforators with two separate skin paddles. One skin paddle is used for pharynx reconstruction and the second skin paddle is turned outward to resurface the neck for flap monitoring. If two skin paddles are not available, then monitoring of the flap can be done with a implantable Doppler or with a hand held Doppler.

DISCUSSION

Choice of reconstruction is based on defect size, requirement for type of tissue, function and appearance, associated physical condition of the patient and availability of resources. Primary reconstruction has several benefits. Soft and pliable tissue allows reconstruction with better function and appearance. Secondary reconstruction at times in specific condition may have limited advantage. However, primary reconstruction is preferred for reasons mentioned above and to reduce morbidity.

The smaller tissue defects may enable primary closure or can be satisfactorily reconstructed with local random pattern flaps or axial flaps. Limited reach and downward pull of the pedicled flap may lead to distal flap necrosis and wound gape. It is also difficult to achieve three-dimensional reconstruction or cover of extensive tissue defects with pedicle flap. It also at times demands for a multistage procedure and may result in delay in implementing the adjuvant therapy like radiotherapy in the postoperative period.

Microsurgical free tissue transfer overcomes all these drawbacks. However, it requires surgical expertize, prolonged operating time and vigorous monitoring. But with availability of adequate microsurgical training, safe anesthesia techniques, two team approach can overcome these disadvantages in tertiary care center. Reliable single stage with two team approach in head and neck reconstruction result in better predictable outcome. However, co-morbid factors in some patients may restrict its use and compel to use alternative methods of reconstruction.

Several flaps with various composition are available for reconstruction. Reconstruction can be planned with a particular flap depending on the reconstruction need for bone and soft tissue. Osseous flaps will require osteotomy at appropriate site for contouring to fit in to the defect (as osteotomy of fibula bone in to different segments to achieve proper contour in mandible reconstruction) and skin flap will need thinning and molding to fit in to three-dimensional contour of the defect.

Advances have occured in head and neck reconstruction due to better understanding anatomical composition of various flaps. Sensory recovery at the reconstructed site is essential for better function. Oral mucosa sensation helps in improving patient's quality of life by giving sensary feedback during mastication, swallowing and phonation. Radial forearm free flap can be made sensate by coapting the lateral or medial antebrachial cutaneous nerve with the flap to the donor sensory nerve in the neck.[47] Similarly, anterolateral thigh flap can be made sensate by incorporating the lateral cutaneous nerve of the thigh with the flap.

Fig. 17: Primary osteointegrated titanium implants insertion in free fibulas flap for mandible reconstruction

Conventional denture is difficult to use with reconstructed mandible and maxilla with fibula flap due to different morphology and lack of support from adjacent natural dentition. In mandible and maxilla reconstruction, dental rehabilitation is possible by using osseointegrated implants. It is a two stage procedure in which titanium implants are inserted to integrate into bone for 3 months. Abutment is attached after the implant is integrated inside the bone. A fixed prosthesis can be fabricated on these abutments[48] (Fig. 17). Dental care is easy with the implants.

To permit growth of the reconstructed mandible, fibula epiphyseal transfer has been uesd in children. Proximal epiphyseal plate and proximal one-third of diaphyseal shaft of fibula, based on anterior tibial artery, is used for pediatric mandible reconstruction.[49]

Prefabricated flaps has a great role in head and neck reconstruction. Desired composition of the flap can be prefabricated by incorporating mucosa, bone, cartilage, implants or soft tissues. Prefabrication of flap will require long period and may not be suitable for use in an acute situation demanding immediate reconstruction.

CONCLUSION

Newer development in head and neck reconstruction techniques has helped in improving the patient's quality of life as well as it has given reliable and effective strategies to restore form, function and aesthetic outcome.

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