Novel flaps for head and neck reconstruction

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Abstract

The head and neck region is important both functionally and aesthetically and its reconstruction poses a formidable challenge for plastic surgeons. A perforator flap is a flap of skin or subcutaneous tissue supplied by a vessel that perforates the deep fascia to gain access to flap. With improvement in our knowledge of the anatomy of blood supply to the skin, the perforator flaps have opened a whole new horizon for the plastic surgeon to choose flaps with better function and cosmesis. The locally available perforators enable flaps to be designed with excellent match in tissue characteristics. Perforator flaps limit donor site morbidity and as they are islanded complete inseting is possible in a single stage. The principal perforator flaps such as facial artery perforator flap, platysma flap and its variant the submental flap and supraclavicular artery flap used in the head and neck reconstruction are discussed. The more commonly used flaps are the free radial artery forearm flap and the anterolateral thigh flap while the novel ones are the thoracodorsal artery perforator flap, medial sural artery perforator flap and the toe-web flap for commissure reconstruction. The indications, reach and drawbacks of these flaps have been discussed in this review.

Keywords Novel flaps · Head and neck reconstruction · Perforator flaps

Introduction

The head and neck region being functionally and aesthetically important, its reconstruction poses a formidable challenge for the plastic surgeons. With the advent of microvascular surgery larger, complex defect can be reconstructed efficiently. The evolution from skin grafts to random pattern flaps to axial pattern flaps to specific perforator based flaps has increased the reconstructive options manifold.¹

A perforator flap is a flap of skin or subcutaneous tissue that is based on the dissection of a perforating vessel.² A perforator is a vessel that has its origin in one of the axial vessels of the body. It passes through certain structural elements of the body, besides interstitial connective tissue and fat, before reaching the subcutaneous fat layer.³

Pioneering work in the clinical application of perforator flaps was done by Koshima et al.⁴ and the perforator flap era truly began in 1989 when he first reconstructed floor of mouth using the inferior epigastric artery skin flap.⁴ Contributions from numerous other authors further refined the perforator flap concept. Notable among them are Allen, Blondeel, Angrigiani, Neligan, Morris, Wei and others.^{5–7} Any clinically relevant perforator has the potential to be harvested as either a pedicled perforator flap or a free flap. This article reviews some novel flaps based on this concept. Perforator flaps probably hold the future of head and neck reconstruction.

Facial artery perforator flap

The perioral and perinasal regions are commonly involved areas in benign and malignant tumour excision.⁸ The

goals of reconstruction are to restore both function and cosmesis of the lip and nose. Several methods including regional flaps and free tissue transfer have been used but local tissues are ideal donor sites due to matching colour, texture and hair characteristics, especially in men. The conventional superiorly based nasolabial flap,⁹ island nasolabial flaps and V–Y advancement flaps have been the workhorses for reconstruction in these regions. The supply of all of these flaps is from the perforators of the facial artery.^{10,11}

Since it is difficult to identify the perforators by doppler ultrasonography due to the proximity of the facial artery¹⁰ only the course of the facial artery is marked preoperatively using the doppler. The flap is designed near the angle of mouth since maximum perforators of the facial artery arise in this region. The plane of dissection is the subcutaneous tissue where perforator is identified. A small cuff of tissue is left surrounding the perforator which not only aids in its dissection but also aids in preserving the venous drainage of the flap. The pedicle may be freed right down to the facial vessels to improve its reach. The flaps are transferred to the defect either by rotation up to 180°, V–Y advancement or by a subcutaneous tunnel depending on the requirement of the defect.^{8,12}

By harvesting an islanded perforator flap the reconstruction can be carried out as a single stage procedure since no readjustment is required at the donor site. This can result in better cosmesis as the flap donor site and mobility of the flap is adjusted according to the location of the perforator.

Platysma flap

Myocutaneous platysma flap was first described by Futrell et al.¹³ and later by Coleman et al.¹⁴ The flap is based on the submental branch of the facial artery and the skin paddle is situated over the lower part of the sternomastoid muscle just above the clavicle. From this position an arc of rotation based on facial and submental vessels takes the flap up to the malar region, upper lip and into the oral cavity.¹⁵

Although many applications of this flap have been reported,^{16,17} it has been used mostly for defects around lower lip. Bauer T et al.¹⁸ have reconstructed full-thickness defect of the upper and lower lip including the corner of the mouth using a modification of the myocutaneous platysma flap wherein they have used the bifurcation of the facial and submental artery in a fork shape to simulate the oral commissure. The donor-site defect was closed primarily in a V–Y manner.

Submental artery perforator flap

The submental island flap first described by Martin et al.¹⁹ is based on the submental artery, a branch of the

facial artery, arising about 5–6.5 cm from the origin of the facial artery after it exits from the submandibular gland. Faltous et al. did an anatomic study describing the course of the submental artery which ran deep to the anterior belly of the digastric muscle in 70% and superficial to it in 30% of cases.²⁰

It provides a good color and texture match for reconstruction of facial defects (Figs. 1a–d). In cases that require neck dissection for involved lymph nodes, using a flap which transfers contents of submental and submandibular triangles may not be oncologically safe. However, in cases which are clinically and ultrasonographically negative for neck nodes and in whom a prophylactic neck dissection is planned, a perforator-based submental flap may be harvested leaving behind the anterior belly of digastric and the fibro fatty tissues of the neck.²¹ The skin territory can be as large as 10 cm × 16 cm as per the anatomical studies.²⁰ The flap is drained by the submental vein, which drains into the facial vein. The ability to close the donor site primarily with a hidden scar is an additional advantage. In obese patients and patients with overhanging jowls this can have the effect of facial rejuvenation as well. A flap can be designed using retrograde blood flow by dividing the facial vessels proximal to the origin of the submental artery. Karacal et al. have used this technique in six patients for periorbital soft tissue and socket reconstruction with good results.²² The reach of this flap is up to temporal region and intraorally for defects of buccal mucosa. It has been used to reconstruct defects of the lip and oral commissure along with other flaps such as the nasolabial flap²³ and free toe web flap.²⁴ Demir Z et al. have used the submental island flap for closure of postoperative pharyngocutaneous fistula in nine male patients. All donor sites were closed primarily

Figure 1. (a) Parotid tumour. (b) Large defect after parotidectomy. (c) 15 × 6 cm flap marked. (d) Post-op photograph (10 days).

and all patients successfully recovered their swallowing function.²⁵

Supraclavicular artery flap

This flap originally described by Lamberty²⁶ is based on supraclavicular artery, a perforator which arises from either the suprascapular artery or the superficial cervical artery. A flap of size 6 cm × 16 cm can be safely raised on this vessel. The markings of the flap are border of the clavicle anteriorly, the tip of shoulder over the deltoid muscle posteriorly, lateral aspect of the upper arm laterally and a line running parallel to the anterior incision ending at the midpoint of the anterior border of the trapezius muscle.²⁷ The supraclavicular artery can be identified pre-operatively by a handheld Doppler probe and the flap designed around its axis.²⁸

This flap has been used as a pedicled flap for neck region,²⁹ for facial reconstruction in noma surgery³⁰ and also reported to be used as expanded supraclavicular flap prefabricated with thoracoacromial vascular pedicles.³¹ The donor site is closed primarily after extensive undermining.

Free flaps

The most common free flaps for soft tissue reconstruction in the head and neck region including intraoral defects are the radial artery forearm free flap and the anterolateral thigh flap.

The drawback of the radial artery forearm flap (FRAFF) is the loss of one major vessel of the hand and the donor site morbidity which is usually cosmetic but sometimes can be functional if the brachioradialis and flexor carpi radialis tendons are exposed or infected. In obese patients it may be difficult to harvest a thin flap. There are alternatives to the FRAFF such as the medial sural artery perforator free flap and the thoracodorsal artery perforator free flap which have increased the armamentarium of the plastic surgeon. These provide thin and pliable skin of large dimensions.

Thoracodorsal artery perforator flap

Thoracodorsal artery perforator flap is a very versatile flap for resurfacing various soft tissue defects.⁵ It is essentially a latissimus dorsi flap harvested without taking the muscle. The perforator supplying the skin is marked pre-operatively using colour doppler sonography and even sensate flaps have been described using posterior divisions of the lateral cutaneous branches of the intercostal nerves harvested with the flaps.³² The perforator is dissected out and harvested with the thoracodorsal

artery and used as a free flap for head and neck reconstruction. Thoracodorsal artery perforator flap has a reliable blood supply and can be made as large as 10 cm × 25 cm.³³ While there are certain advantages of this flap such as a hidden donor site, a thin pliable flap without muscle and less morbidity,⁵ the disadvantage is the inability to simultaneously harvest the flap during head and neck tumour resection.

Medial sural artery perforator flap

In 2001, Cavadas PC et al first described the medial sural artery perforator flap.³⁴ The flap is harvested from the calf region and is thin, pliable, with a long vascular pedicle and results in limited donor site morbidity. Even a two team approach is possible as the flap can be harvested in the supine position with the hip abducted and knee flexed. The perforator pierces the medial head of the gastrocnemius muscle to reach the skin. The most likely location of the perforator is at a point between the popliteal crease superiorly, midline of the calf medially and distal limit of the muscle belly of the medial gastrocnemius medially. The perforator is identified using a hand held doppler probe. Flap is marked around the perforator and almost 12 cm × 14 cm flaps have been harvested. The incision is deepened to include the deep fascia and the intramuscular course of the perforator is dissected out till the origin of the perforator from the medial sural artery. The medial sural artery is also dissected to gain pedicle length (9–16 cm) and calibre to facilitate the anastomosis. Kao et al.³⁵ found no statistical difference in the success rate of the radial artery forearm free flap when compared to the medial sural artery free flap suggesting its use as a good alternative for reconstruction of small defects in the head and neck region. While the donor site morbidity is far lesser than with the free radial forearm flap, the technical difficulty in dissection of the perforator and the relative unfamiliarity of the pedicle are limiting factors for its popularity.³⁵

Toe web flap for commissure reconstruction

A first-web flap from the foot can be used to reconstruct the oral commissure as both have anatomic similarity, i.e. the forked design. The dorsalis Pedis artery can be included to increase the dimension of the flap as well as the calibre and length of the vascular pedicle. This flap has been used to cover the mucosal as well as the external skin defect with reconstruction of the angle of the mouth.³⁶ Koshima et al.²⁴ have used it to address the mucosal defect and the commissure and submental flap for skin cover. They claim to achieve better cosmesis and function compared to conventional techniques.

Conclusion

The limited donor site morbidity and the versatility of the choice of flaps are the main advantages of a perforator flap. Microvascular surgeons have even gone on to use it as freestyle free flap by anastomosing perforators. This is

technically difficult and also the pedicle length available is very small. The present decade has seen significant advances in the perforator flap surgery. With improvements in the pre-operative assessment and 3-D localization of perforators using CT angiography and MRI, perforator flap surgery is sure to gain more popularity.

References

1. Saint CM, Wong C et al. Perforator theory. *Plast Reconstr Surg*. 2009;124(5):1529–1544
2. Taylor GI. The ‘gent’ consensus on perforator flap terminology: preliminary definitions. *Plast Reconstr Surg*. 2003;112:1383–1387
3. Lyons AJ. Perforator flaps in head and neck surgery. *Int J Oral Maxillofac Surg*. 2006; 35:199–207
4. Koshima I, Soeda S. Inferior epigastric artery skin flaps without rectus abdominis muscle. *Br J Plast Surg*. 1989;42:645–648
5. Angrigiani C, Grilli D, Siebert J. Latissimus dorsi musculocutaneous flap without muscle. *Plast Reconstr Surg*. 1995;96:1608–1614.
6. Wei FC, Jain V, Suominen S, Chen HC. Confusion among perforator flaps: What is a true perforator flap? *Plast Reconstr Surg*. 2001;107: 874–876.
7. Blondeel PN, Morris SF, Hallock GG, et al. (eds) *Perforator flaps: anatomy, technique and clinical applications*, St. Louis, Quality Medical, 2006.
8. Demirseren ME, Afandiyev K et al. Reconstruction of the perioral and perinasal defects with facial artery perforator flaps *Journal of Plast Reconstr Aesthet Surg*. 2009;62:1616–1620
9. Wesser DR, Burt Jr GB. Nasolabial flap for losses of the nasal ala and columella. Case report. *Plast Reconstr Surg*. 1969;44: 300–2.
10. Hofer SO, Posch NA, Smit X. The facial artery perforator flap for reconstruction of perioral defects. *Plast Reconstr Surg*. 2005;115:996–1003.
11. Pribaz JJ, Meara JG, Wright S, et al. Lip and vermilion reconstruction with the facial artery musculomucosal flap. *Plast Reconstr Surg*. 2000;105:864–872; Feinendegen DL, Langer M, Gault D. A combined v-y advancement turnover flap for simultaneous perialar and alar reconstruction. *Br J Plast Surg*. 2000; 53:248–250.
12. D’Arpa S, Cordova A et al. Free style facial artery perforator flap for one stage reconstruction of the nasal ala. *J. Plast Reconstr Aesthet Surg*. 2009;62:36–42.
13. Futrell JW, Johns ME, Edgerton M T et al. Platysma myocutaneous flap for intraoral reconstruction. *Am J Surg*. 1978;136:504.
14. Coleman III, JJ, Jurkiewicz MJ, Nahai F et al. The platysma musculocutaneous flap: Experience with 24 cases. *Plast Reconstr Surg*. 1983; 72:315.
15. Cormack GC, Lamberty BGH (eds) *The Arterial Anatomy of Skin Flaps. Facial Artery-submental branch Platysma musculocutaneous flaps*. 2nd edn, Churchill Livingstone, 1994;330–332.
16. Moschella F, Cordova A. Platysma muscle cutaneous flap for large defects of the lower lip and mental region. *Plast Reconstr Surg*. 1998; 101:1803.
17. Papadopoulos ON, Gamatsi IE. Platysma myocutaneous flap for intraoral and surface reconstruction. *Ann Plast Surg*. 1993;31:15.
18. Bauer T, Schoeller T, Rhomberg M, Piza-Katzer, Wechselberger G. Myocutaneous Platysma Flap for full-thickness reconstruction of the upper and lower lip and commissural. *Plast Reconstr Surg*. 2001; 108(6):1700–1703.
19. Martin D, Pascal JF, Baudet J, Mondie JM, Farhat JB, Athoum A et al. The submental island flap: a new donor site. Anatomy and clinical applications as a free or pedicled flap. *Plast Reconstr Surg*. 1993; 92:867–73
20. Faltous A, Yetman Randall J. The submental artery flap: an anatomic study. *Plast Reconstr Surg* 1996; 97:56–62.
21. Uppin SB, Ahmad QG, Yadav P, Shetty K. Use of the submental island flap in orofacial reconstruction – a review of 20 cases. *J Plast Reconstr Aesthet Surg*. 2009;62: 514–519.
22. Karacal Naci, Ambarcioglu Omer, Topal Umut, et al. Reverse flow submental artery flap for periorbital soft tissue and socket reconstruction. *Head Neck*. 2006;January:40–45.
23. Mahendra Daya, Mahomva Oliver, Madaree Anil. Multistaged reconstruction of the oral commissures and upper and lower lip with an island submental flap and a nasolabial flap. *Plast Reconstr Surg*. 2001;108: 968–71
24. Koshima I, Inagawa K et al. Combined submental flap with toe web for reconstruction of the lip with oral commissure. *Br J Plast Surg*. 2000;53:616–631
25. Demir Zuhtu, Velidedeoglu Hifzi, Celebioglu Selim. Repair of pharyngocutaneous fistulas with the submental artery island flap. *Plast Reconstr Surg*. 2005;115:38–44
26. Lamberty BGH. The supraclavicular axial patterned flap. *Br J Plast Surg*. 1979;32:207–212
27. Cormack GC, Lamberty BGH (eds). *The arterial anatomy of skin flaps. supraclavicular artery – axial pattern flap*, 2nd edn, Churchill Livingstone, 1994;458–460.
28. Rashid M, Zia-ul-Islam M et al. The ‘expansile’ supraclavicular artery flap for release of post-burn neck contractures. *J Plast Reconstr Aesthet Surg*. 2006;59:1094–1101.
29. Vu QV, Ogawa R, Tran VA, Yaku-soku H. A case of neck scar contrac-

- ture reconstructed using a pedicled supraclavicular flap. *Plast Reconstr Surg.* 2008;121:350–352.
30. Hartman HM, Philip A, Damme V, Sauter H, Sinikka H, Suominen H. The use of the pedicled supraclavicular flap in noma reconstructive surgery. *J Plast Reconstr Aesthet Surg.* 2006;59(4):337–342.
 31. Margulis A, Agam K, Icekson M, Dotan L, Yanko-Arzi R, Neuman R. The expanded supraclavicular flap, prefabricated with thoracoacromial vessels, for reconstruction of post-burn anterior cervical contractures. *Plast Reconstr Surg.* 2007;119(7):2072–2076.
 32. Lin CT, Yang KC, Hsu KC, Liu WC, Chen JS, Chen LW. Sensate thoracodorsal artery perforator flap: a focus on its preoperative design and harvesting technique. *Plast Reconstr Surg.* 2009(123):163–174.
 33. Guerra AB, Metzinger SE, Lund KM, Cooper MM, Allen RJ, Dupin CL. The thoracodorsal artery perforator flap: clinical experience and anatomic study with emphasis on harvest techniques. *Plast Reconstr Surg.* 2004;114:32.
 34. Cavadas PC, Sanz-Gimenez-Rico JR et al. The medial sural artery perforator free flap. *Plast Reconstr Surg.* 2001;108:1609–1615;discussion 1616–1617.
 35. Kao HK, Chang KP et al. Comparison of the medial sural artery perforator flap with the radial forearm flap for head and neck reconstructions. *Plast Reconstr Surg.* 2009;124(4):1125–1132.
 36. Naasan A, Quaba AA. Reconstruction of the oral commissure by vascularised toe web transfer. *Br J Plast Surg.* 1990;43:376–8.