Review
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DELTOPECTORAL FLAP: AN OLD BUT USEFUL TECHNIQUE FOR HEAD AND NECK RECONSTRUCTION

Deltopektoralni režanj: stara, ali korisna tehnika za rekonstrukciju glave i vrata

NEVEN SKITARELIĆ[1,2,3], STIPE KALAC[1], BRANIMIR ŠUŠAK[1], NATAŠA SKITARELIĆ[1,2]

[1]General hospital Zadar, Zadar, Croatia
[2]Department of Health study, University of Zadar, Zadar, Croatia
[3]Faculty of Medicine, University of Rijeka, Rijeka, Croatia

*Author for correspondence /*Autor za dopisivanje*: izv.prof.dr.sc. Nataša Skitarelić, dr.med.
Odjel za zdravstvene studije, Sveučilište u Zadru, Splitska 1, 23000 Zadar
E-mail: naskitarelic@unizd.hr

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Summary

Head and neck cancer represents a significant portion of global cancer incidence. Reconstruction of defects in the face and neck has always been an extremely demanding challenge due to their anatomical complexity, with many vital structures located superficially. The cosmetic camouflage of these defects is often difficult due to their exposed location. Over the years, various reconstructive techniques have been developed to address these challenges, ranging from regional tissue flaps to free tissue transfers.

The deltopectoral flap is a fasciocutaneous flap raised from the anterior chest wall below the clavicle. The anatomy is reliable, and flap harvest is relatively easy. The deltopectoral flap can be used with great success for reconstruction of defects of the middle and lower thirds of the face, the oral cavity, the neck, and the oesophagus. The deltopectoral flap is thin, pliant, and very reliable, providing an excellent colour and texture match with the face and neck. On the other hand, it's technically easier and much faster to harvest and does not require microvascular experience.

Although the spectacular development of free flaps has radically changed the reconstruction of the head and neck, the deltopectoral flap still maintains a privileged place among the reconstructive tools for this region, especially in difficult situations. This is mainly due to its technical simplicity, high reliability, thinness, pliability, large size and time-saving. The role of the deltopectoral flap is as a good alternative to free flaps in head and neck surgery.

Ključne riječi:
glava i vrat, rekonstrukcija, deltopektoralni režanj

Sažetak

Karcinomi glave i vrata čine značajan udio u globalnoj incidenciji karcinoma. Rekonstrukcija defekata na glavi i vratu je izrazito zahtjevna s obzirom na složenu anatomiju i prisutnost brojnih, površno smještenih vitalnih struktura. Kozmetsko zbrinjavanje ovih defekata je zahtjevno s obzirom na njihovu uočljivu lokalizaciju. Tijekom godina razvijene su brojne rekonstruktivne tehnike za rješavanje ovakvih izazova, od regionalnih režnjeva do slobodnih tkivnih transplantata.

Deltopektoralni režanj je fasciokutani režanj koji se odiže s prednje stijenke toraksa, ispod klavikule. Anatomski odnosi i odizanje režnja je relativno jednostavno. Režanj se koristi uspješno za rekonstrukciju defekata srednjeg i donjeg dijela lica, usne šupljine, vrata i jednjaka. Deltopektoralni režanj je tanak, savitljiv i pouzdan te ima primjerenu boju i teksturu kože lica i vrata. S druge strane, tehnički je jednostavniji i brži za odizanje i ne traži iskustvo operatera u mikrovaskularnoj kirurgiji

Unatoč značajnom razvoju slobodnih tkivnih tranplantata, koji su znatno promijenili rekonstruktivnu kirurgiju glave i vrata, deltopektoralni režanj još uvijek ima značajno mjesto u rekonstruktivnim tehnikama za ovu regiju, osobito u zahtjevnim situacijama rekonstrukcije. To je prvenstveno zato jer je režanj tehnički jednostavan za odizanje, tanak, savitljiv i pouzdan te ima dovoljnu veličinu i omogućuje kraće trajanje operacije. Uloga deltopektoralnog režnja je u tome da služi kao dobra alternativa u kirurgiji glave i vrata, režnjevima sa slobodnim transplantatima tkiva.

INTRODUCTION

Head and neck cancer represents a significant portion of global cancer incidence, accounting for more than 660,000 new cases and 325,000 deaths annually.[1] Surgical resection, often the main treatment modality, results in complex defects that require meticulous reconstruction to restore both function and aesthetics.The reconstruction of defects in the face and neck has always been an extremely demanding challenge due to their anatomical complexity, with many vital structures located superficially.[2] The cosmetic camouflage of these defects is often difficult due to their exposed location although the majority of these tissue defects occur after ablative surgery for neoplasms.

Several methods for neck reconstruction are available in an attempt to restore the patient functionally and aesthetically, in an expeditious manner and with minimal surgical morbidity. Over the years, various reconstructive techniques have been developed to address these challenges, ranging from local tissue flaps[3,4,5,6] to free tissue transfers.[7,8,9]

The deltopectoral (DP) flap, also called the Bakamjian flap, was actually first described by Aymard in 1917.[10] Aymard described raising a medially based fasciocutaneous flap from the shoulder skin which was then tubed and used for staged nasal reconstruction.[10] In 1931, Joseph published illustrations of DP flap as vascularized pattern flaps.[11] The DP flap, however, did not spark much interest until it was reintroduced by Bakamjian in 1965. Bakamjian described a medially-based DP, which was first used for pharyngoesophageal reconstruction.[12]

DELTOPECTORAL FLAP ANATOMY AND VASCULARISATION

The DP flap is a fasciocutaneous flap raised from the anterior chest wall below the clavicle. The flap is delimited medially by the sternum and laterally by the deltopectoral groove, although in some cases it

can be extended 3–4 cm laterally in the acromioclavicular area. Superiorly, it is delimited by the clavicle and inferiorly by the inferior margin of the fourth rib.

Vascularisation is based on perforators of the internal thoracic artery (ITA). It is perfused by the first through fourth peristernal perforators of the ITA. The ITA originates from the subclavian artery and supplies the anterior chest wall and the breast. The blood vessels of the flap run on a plane superficial to the fascia that covers the pectoralis major and deltoid muscles; hence, the importance of lifting these flaps on a deep plane with respect to the fasciae of the deltoid and pectoralis major muscles. The distal portion of the flap, which lies over the deltoid muscle, is supplied by the deltoid perforators from the thoracoacromial trunk and by the anterior circumflex artery and vein.[13]

This flap is based on the parasternal fasciocutaneous perforating branches of the internal mammary artery, which perforate the intercostal muscles and the pectoralis muscle to reach the skin.[12,14,15] The blood supply to the anterior chest wall comes from perforators from the internal mammary artery that traverse each intercostal space; branches of the thoraco-acromial artery; musculocutaneous branches that traverse the deltoid muscle; the posterior intercostal vessels that give off perforators to the posterior, lateral, and anterior thoracic skin; and minor contributions from the lateral thoracic artery. The second and third perforators are usually the largest calibre and run with their associated veins in the intercostal interspaces approximately 2 cm lateral to the border of the sternum.[14,15]

Venous drainage of the flap is primarily with the venae comitantes of the perforators from the internal mammary artery. The venae comitantes drain into the internal mammary vein, which subsequently drains into the innominate vein.

The sensory supply to the deltopectoral skin is derived from the supraclavicular nerves of C3 and C4 and the anterolateral intercostal nerves of T2, T3, and T4. The ability to keep the sensory system intact depends greatly on whether a radical neck dissection is performed.[16]

THE TECHNIQUE OF FLAP HARVEST

The anatomy is reliable, and flap harvest is relatively easy. A superior incision is made below the clavicle, and an inferior incision is made at the level of the fourth intercostal space (**Fig 1**).[14] The flap is harvested by extending the incision through the dermis and subcutaneous layers to the pectoralis



Figure 1 Shematic view of the deltopectoral flap. Notice the mark near the sternum for perforators of the internal thoracic artery
Slika 1. *Shematski prikaz deltopektoralnog režnja. Oznake uz sternum prikazuju izlazišta perforatora unutarnje torakalne arterije*

fascia. Elevation of the flap is performed from a lateral to medial direction, with extreme care taken to stay at least 2 cm from the lateral border of the sternum to protect the vessels and blood supply to the skin paddle (**Fig 2**). It is perfused by the first through third peristernal perforators of the internal mammary artery.The fascia overlying the deltoid and pectoral major muscle should be included in the flap[14] to preserve the flap's blood supply (**Fig 3**). The perforator arteries from the internal mammary artery that reach the skin paddle as they exit the chest between the ribs along the sternum.

The muscle fibres will be exposed as the flap is elevated. A flap 10 cm in width and 20 cm in length can be reliably raised and used with a high likelihood of success. Longer flaps than 3-4 cm from the



Figure 2 The deltopectoral flap was elevated from lateral to medial
Slika 2. *Deltopektoralni režanj odiže se od lateralno prema medijalno*



Figure 3 The fascia overlying the deltoid and pectoral major muscle was elevated from muscules and included in the flap
Slika 3. *Fascija mišića koja prekriva deltoidni i pektoralni mišić odignuta je od mišića i uključena je u režanj*

delotpectoral groove should be delayed. It may even be extended to the posterior aspect of the shoulder if delayed.

When the end of the flap is inset for its intended purpose, the proximal portion of the flap that is not inset as part of the reconstruction may be tubed. The wound edge of the donor site are closed with standard deep and skin sutures in two layers, and suction drains are usually placed.

Three weeks after elevation, the flap may be divided with an inset of the base of the flap into the donor area, or the redundant flap may simply be excised (**Fig 4**).Skin grafting is usually required to close the donor site wound, and the resulting defect may be noticeable. The donor site is covered with a split-thickness skin graft, 0.015-inch thick and meshed 2:1. The skin graft is placed with an emphasis on the lateral shoulder coverage. There is very



Figure 4 Three weeks later after elevation, the deltopectoral flap is divided with inset of the base of the flap into the donor area
Slika 4. *Tri tjedna nakon odizanja, deltopektoralni režanj se presječe te se ostatak režnja vraća na donorsko mjesto*



Figure 5 Very little donor site morbidity
Slika 5. *Minimalne promjene na donorskom mjestu režnja*

little donor site morbidity and no significant functional deficits (**Fig. 5**). If the flap is to undergo secondary transection, the medial portion will return to the chest wall.

To improve the survival of the distal portions of the flap, a delay technique may be valuable. The risk of skin necrosis increases, the farther on to the shoulder the flap is extended, more than 5 cm from the delotpectoral grove. This flap may be delayed to increase its survival after rotation. The most common method is to complete the skin incisions and elevate the distal two-thirds of the flap. The skin flap is then returned to its normal anatomic position. After 10 to 14 days, it is reelevated and rotated into the reconstructive position.

OTHER DESIGNS OF THE DELTOPECTORAL FLAP

L-shaped deltopectoral flap with two epithelial surfaces

Several techniques were described for utilising the DP flap to cover a defect with two epithelial surfaces. In addition to the conventional DP technique, Bakamjian[17] and others[18] used to obtain an inner and outer lining in the two-stage L-shaped DP flap. In the first stage, the short limb of the "L" extending down along the upper arm was elevated and folded under the deltoid component to produce a buried skin flap. After the delay, the DP flap, now with two epithelial surfaces, was then raised and transferred to the defect.[17] The two epithelial surfaces were transferred at the time of the second procedure.

Another alternative solution to the requirement for a double epithelial surface is the use of a skin graft on the undersurface of the flap.[17] The graft may be buried at the time of an initial delay procedure.

Split deltopectoral flap

Krizek and Robson[19] described the vertically split DP flap that provides two epithelial surfaces. In this design, an incision is made along the longitudinal axis of the flap through the distal end of the skin paddle. This design allows for two separate segments that can be used for inner and outer lining restoration. This modification is safer, with respect to distal flap vascularity, than de-epithelializing a distal segment and folding the flap over on itself. This latter technique of a transverse fold at the distal segment of the flap creates more risk for vascular compromise as it requires a longer flap to be harvested, as well as placing the fold at the distal, less reliable portion of the DP flap.

Fenestrated deltopectoral flap

Some authors[20,21] described the placement of a fenestration in the distal portion of the DP flap for reconstruction of a tracheostoma. In using this technique, the surgeon must be mindful of the possibility of distal tip necrosis. However, the authors advised that the short arc of rotation required to reach the tracheostoma allows the design of a short flap, and therefore, the fenestra can be placed in a proximal, well-vascularized segment of the flap.

One stage tunneled de-epithelialized deltopectoral flap

Recently, two publication decribed the one-stage tunnelled de-epithelialized fasciocutaneous DP flap as an effective choice with acceptable outcomes for defect reconstruction following resection of locally advanced head and neck cancer.[22,23] The authors used it successfully in a curative or palliative basis, in relatively old patients with different comorbidities who require rapid treatment sequencing.[23]

Free Microvascular Transfer of the Deltopectoral Flap

The DP flap has also been used as a microvascular free flap (FF). Sasaki et al.[24] were able to achieve improved reliability of the DP free flap by incorporating a segment of the internal mammary vessel in the vascular pedicle. The base of the free DP flap is located over the perforating branches of the internal mammary vessels parasternally; the upper border corresponds to the clavicular line, and the lower parallels the upper and extends laterally across the apex of the anterior axillary fold. The base of the FF is designed with the second perforating branch located along its midline. As with other free fasciocutaneous flaps, it has greater versatility than the conventional pedicle flap, and staged procedures are avoided. The DP flap provides an ample source of good-quality skin suitable for facial reconstruction. Unlike the pedicled DP flap, which will not reach much beyond the zygomatic region, the deltopectoral free flap can be used for defects located throughout the head and neck region.

SURGICAL USE OF THE DELTOPECTORAL FLAP

The DP flap has proved to be a very useful flap for reconstruction of the face and neck defects in difficult conditions, especially in patients who are not ideal candidates for free flap reconstruction (**Fig 6, 7, and 8**). The deltopectoral flap can be used with great success for reconstruction of defects of the middle and lower thirds of the face, the oral cavity, the neck, and the oesophagus.[14,15,25,26] With proper planning, as well as delay techniques in select circumstances, the DP flap can be used for reconstruction of any part of the anterior head and neck below the zygoma. The DP flap has been used in a variety of settings, including, but not limited to, closure of dehiscent wounds and fistulas, restoration of compromised regions, including irradiated head and neck defects, and reconstruction of pharyngeal defects. In cases involving significant tissue loss, the robust nature of the flap helps cover and protect exposed major vessels and other vital structures with sufficient thickness.[27]

The medially-based DP flap, described by Bakamjian in 1965, was first used for pharyngoesophageal



Figure 6 Tumour of the chin and anterior neck
Slika 6. *Tumor brade i prednjega dijela vrata*



Figure 7 Large defect of the lower face and anterior neck, after tumour resection, measuring 16 cm × 13 cm
Slika 7. *Veliki defekt donjega lica i prednjega dijela vrata nakon resekcije tumora mjeri 16 cm x 13 cm*



Figure 8 Satisfactory appearance was achieved after reconstruction of postoperatively defect
Slika 8. *Zadovoljavajući izgled bolesnika nakon poslijeoperativne rekonstrukcije nastalog defekta*

reconstruction.[12] Chen et al.[25] described the use of the Bakamjian island flap for patch oesophagoplasty of the cervical oesophagus. This island flap was used on 12 patients who had short-segment oesophageal strictures, with successful resumption of oral nutrition in all patients.

Furthermore, reconstruction of complex head and neck surgical defects may require multiple flaps. The lack of a bulky muscular component makes it an excellent choice for replacing cutaneous defects. Manfor et al. in 2022.[7] used the microsurgical anterolateral thigh fasciocutaneous flap for reconstruction of the circumferential defect of the pharynx and proximal oesophagus. They are considering its malleability and the possibility of molding in a cylindrical shape. As for the skin defect, the fasciocutaneous deltopectoral flap was chosen. In contrast to Manfor, Kang et al.[28] use a DP flap in a case series that presents an alternative method for reconstruction of circumferential pharyngeal defects using a dual flap technique, with the rotated deltopectoral flap as the posterior wall of the neopharynx. This technique reconstructs the neopharynx with minimal soft tissue bulk in the central compartment space, creating a wider conduit for food passage. The anterior pharyngeal wall was reconstructed with a pectoralis major flap or a supraclavicular flap for the remaining patients.[28]

The DP flap is also indicated for management of complications, such as closure of salivary fistulas, release of neck contractures from burns, or skin necrosis from radiation therapy.[26]

The DP flap is a skin flap providing a suitable coverage for head and neck skin defects, especially for the treatment of burn complications of the neck. This flap is well integrated into its recipient site due to the similar colour and texture of the skin. The DP flap is easier to harvest than the supraclavicular island flap, and remains one of the best choices for the treatment of postburn contractures of the neck.[29]

Wang et al.[30] used expanded DP in patients with thermal burn scars, and type III and IV facial-cervical deformities. During stage one, skin soft tissue expander implantation surgery, according to the size and location of the lesion and defect, expanders with appropriate volume were placed to expand the deltopectoral area. During stage II flap pedicled transposition surgery, after the expander was expanded to the desired volume, the impaired tissue was removed, and the flap was designed to match

the size of the defect. The incision in the chest donor area was directly sutured and closed. After the flap survived, stage III flap delay and pedicle division surgery were carried out.

The DP flap is thin, pliant, and very reliable, providing an excellent colour and texture match with the face and neck. On the other hand, it is technically easier and much faster to harvest and does not require microvascular experience. Its only disadvantage seems to be the need to process the pedicle three weeks after the primary surgery.[2] Skin grafting to the donor site is not always necessary. When dealing with diabetic subjects, the DP flap should be limited with caution to the deltopectoral groove.[15] The DP flap is contraindicated when the internal mammary artery has been compromised, for instance, from previous cardiac surgery.[26]

DELTOPECTORAL FLAP AS A REGION PEDICLE FLAP IN THE ERA OF MICROSURGERY

The introduction of surgical free flaps has revolutionised reconstructive surgery and has become the preferred reconstruction method for most large head and neck oncologic defects.[9,31,32,33] It has enabled the harvesting of a large amount of revascularized tissue, which could be tailored to the defect. It also allows for more complex reconstructive procedures, simultaneously permitting more extensive head and neck resections.[8] The next frontier of innovation in FF reconstruction of the head and neck will prioritise custom, patient-specific reconstructions that consider the unique anatomic, functional, and aesthetic needs of each patient.[34]

A literature review showed variations in the success rate of FF operative reconstruction. Free flap failure rates vary from 0.8% to 10.6% in the literature.[35] However, flap failure is not consensual. Indeed, some authors consider the failure of a FF the need for revision of the anastomoses[36], the partial necrosis of the flap[21,32], while others do not.[37] Then, free flap failure rates are not standardised and difficult to compare. In the study of Hennock et al. 8% of flaps had to be removed for complete necrosis, and 5% were partially necrotic.[32] Cervical hematoma and infection had to be drained in 4% and 9% of cases, respectively.[32] On the other hand, complete necrosis of DP was only 3.2%.[15]

A successful outcome in microvascular surgery in the first place depends on the avoidance of technical errors during flap harvest and microvascular transfer. Microsurgical factors, and, in particular, the choice of venous anastomosis, appear to have a greater influence on the success or failure of a microvascularized transfer.[32,38]

In the last two decades, with the advancement of microsurgical techniques, FF have proved to be superior to the pedicle flaps in terms of versatility, superior esthetics, and functional outcomes.[9,34,36] However, they are often criticised for being associated with prolonged operating time and higher cost.[6,39] The success of any reconstruction necessitates proper preoperative planning and evaluation of the patients, and the choice of reconstructive technique should be devised according to their co-morbidities, site of lesion, and other various factors. With proper planning and technical expertise, both free and pedicled flaps can provide great esthetic and functional outcomes, hence improving the quality of life.[39]

The comparison of outcomes in patients who had undergone a pedicled flap or a FF reconstruction showed no statistically significant differences in terms of functional outcomes, flap necrosis, or complications.[3] Furthermore, multivariate regression analysis showed that only the existence of comorbidities remained an explanatory factor for complicated flap healing.[3] However, some pedicled flaps compare favourably to FF for some specific indications, achieving similar outcomes at a lower cost, and with less operative time.[40] Free flaps have been the preferred method for reconstruction after the resection of oral cavity cancer. However, pedicled flaps remain valuable alternatives in appropriate settings. With comparable complications and functional outcomes, while decreasing in costs, pedicled flaps are a useful alternative to free flaps in oral cavity cancer reconstruction. However, in an extensive defect (> 70 cm^2) free flaps are the reconstruction of choice for the preservation of swallowing function.[41]

Microvascular free flaps are considered the standard of care for reconstruction of head and neck defects.[9,23,33] However, there are possible limitations for their use regarding the defect site, patient, surgeon, and health care system. For example, the vessel-depleted necks, resulting from previous neck dissection, or severe atherosclerotic disease. Another issue is that patients pretreated with chemotherapy and/or radiotherapy, or presenting with recurrent diseases, may not be the best candidates for free flaps.[42]

Also, the microvascular free flaps require expertise in microvascular techniques with longer operating times and a higher rate of revision surgery. In contrast, the pedicled flaps are more accessible to both academic and community surgeons. Free flaps have logistic, financial, and training burdens on any health system.[43]

Taking into consideration such possible limitations of the microvascular free flaps, interest in the pedicled flaps has been rekindled in general, with special attention given to the workhorse in the head and neck reconstruction, the DP flap. The DP flap has been a subject of interest in reconstructive surgery for the last six decades, from the time when Bakamjian described its practical use in head and neck surgery.[12] There are many advantages of using the DP flap in the reconstruction of head and neck defects. It is technically simple with fast harvesting, thus it shortens both operative and anaesthesia time. It has a reliable blood supply and provides a large surface area for harvesting thin, pliable tissue with minimal bulk.[5] The procedure has an excellent colour and texture matching for the recipient site with minimal functional deficit in the donor site.[26] It can rotate and easily reach a defect up to the zygomatic arch, increasing its versatility. Of course, it can be raised in one stage through either de-epithelialization and tunnelling[23], with a single incision in the donor area[22], or excision of the skin between the recipient and donor site.[23]

Over the last decades, several flap variations have been developed, which further increase their versatility, allowing, when appropriate, the combination of a DP and a second flap. In this sense, we highlight, for example, associations of the DP flap with the pectoralis major flap[28], or with FF.[7] Therefore, even with the advent and advancement of microsurgery, the DP flap is very useful in many clinical scenarios.

CONCLUSION

Although the spectacular development of free flaps has radically changed the reconstruction of the face and neck, the deltopectoral flap still maintains a privileged place among the reconstructive tools for this region, especially in difficult situations. This is mainly due to its technical simplicity, high reliability, thinness, pliability, large size and time-saving. The role of the deltopectoral flap as a good alternative to free flaps in face and neck surgery is in the reconstruction of defects of the middle and lower thirds of the face, the oral cavity, the neck, and the oesophagus, closure of salivary fistulas, release of neck contractures from burns, or skin necrosis from radiation therapy. In cases involving significant tissue loss, the robust nature of the flap helps cover and protect exposed major vessels and other vital structures with sufficient thickness.

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