ORIGINAL ARTICLE

MUSCLE-SPARING ABDOMINAL FREE FLAPS IN HEAD AND NECK RECONSTRUCTION

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Abstract: *Background.* Our aim in this retrospective case series was to review the indications, results, and complications of abdominal muscle–sparing free flaps in head and neck cancer reconstruction.

Methods. A retrospective review of all head and neck cancer defects reconstructed with abdominal muscle–sparing free tissue transfers from 1999 to 2004 was performed. Data collected included patient demographics, etiology and site of the defect, reconstructive technique, flap size, recipient vessels, complications, reconstructive technique, and clinical follow-up.

Results. Sixteen patients underwent reconstruction with the deep inferior epigastric perforator (DIEP) flap ($n = 11$), the superficial inferior epigastric artery (SIEA) flap ($n = 4$), or the superficial circumflex iliac artery (SCIA) flap ($n = 1$). Average age was 61 years (range, 41–77 years). The average hospital stay was 7.6 days (range, 6–14 days). The average defect size was 74.5 cm^2 (range, 30–240 cm^2). No subsequent abdominal wall hernias or other donor site complications occurred after a mean follow-up of 21 months.

Conclusions. Muscle-sparing abdominal free flaps are attractive options for head and neck cancer reconstruction. The SIEA and SCIA free flaps have the distinct advantage of eliminating abdominal hernias and other morbidity related to the excision of rectus abdominus fascia or muscle. In addition, the incisions are very low on the abdomen and are more cosmetically pleasing to the patient. ©2006 Wiley Periodicals, Inc. *Head Neck* **28:** 802–807, 2006.

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Microvascular free tissue transfer has revolutionized the reconstruction of head neck defects by providing better cosmetic and functional outcomes than local and regional flaps for large deficits. The numerous types of free flaps available for reconstruction provide options to the reconstructive surgeon who must then select the best tissue match while trying to minimize the resultant donor site morbidity. Traditionally, head and neck defects that require a large amount of soft tissue bulk have been reconstructed with the free myocutaneous rectus abdominis muscle flap similar to the free transverse rectus abdominis muscle (TRAM) flap used in breast reconstruction. However, removal of the rectus muscle is accompanied by frequent donor site morbidity, specifically abdominal wall weakness and herniation. In an effort to decrease donor site morbidity without sacrificing cosmesis, Koshima and Soeda[1] described the deep inferior epigastric artery perforator (DIEP) flap in 1989. This flap consists of skin and subcutaneous tissue only and is based on perforators of the deep inferior epigastric artery. Dissec-

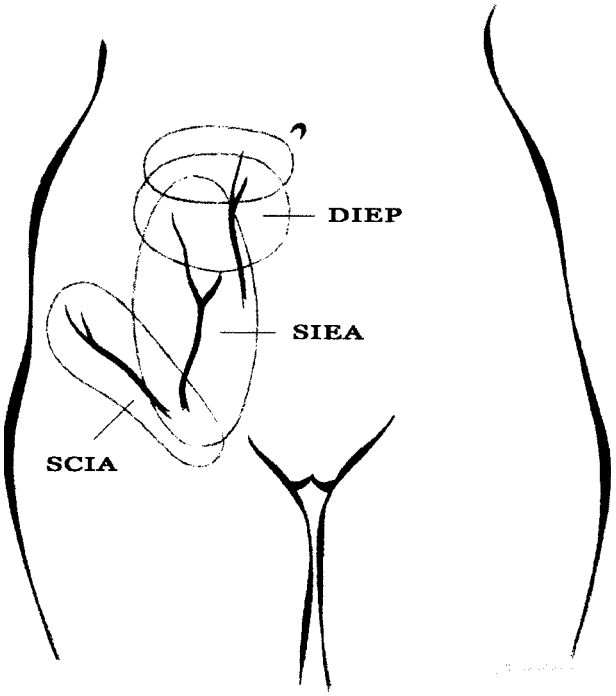

FIGURE 1. Illustration of the typical superficial inferior epigastric artery (SIEA), deep inferior epigastric perforator (DIEP), and superficial circumflex iliac artery (SCIA) free flap harvest territories for head and neck cancer defects (illustration by Erin Donaldson).

tion through the anterior rectus sheath and rectus abdominis musculature is still necessary; however, the technique results in reduced abdominal wall complications compared with the TRAM free flap.[2,3] It has since become the free flap of choice for breast reconstruction and is widely reported in the literature.[2–7] Subsequently, the use of superficial inferior epigastric artery (SIEA) free flaps, which completely spare the rectus abdominis muscle and fascia, has also become popular in breast reconstruction. The superficial circumflex iliac artery (SCIA) free flap also requires no muscle or fascia dissection but is used more infrequently because of small vessel caliber.

Abdominal muscle–sparing free flaps (Figure 1) have the tremendous convenience of not needing to reposition the patient for harvest. In addition, donor site complications are more benign compared with other fasciocutaneous flaps. Radial forearm flaps, lateral arm flaps, and thigh flaps all have potentially worse cosmetic sequelae. In addition, tendon exposure in the case of radial forearm free flaps may result in decreased hand function.

Despite the widespread application of abdominal muscle–sparing flaps, they have not been widely used in head and neck cancer reconstruction. This study reviews a series of patients with head and neck cancer who received muscle-sparing abdominal free flaps to describe indications, outcomes, and complications of this reconstructive technique.

MATERIALS AND METHODS

Study Design. This study is a retrospective case series of patients with head and neck cancer who underwent reconstruction with DIEP, SIEA, or SCIA free flaps after tumor extirpation from 1999 to 2004. All cases were performed at either the Medical University of South Carolina or the Ralph H. Johnson VA Medical Center in Charleston, SC. The electronic medical records were reviewed to obtain the following data: age, sex, etiology and site of defect, location, flap size and dimensions, recipient vessels, perioperative and postoperative morbidity, reconstructive technique, length of hospital stay, and clinical follow-up. Institutional review board approval was granted before the initiation of the study.

Operative Technique.

Superior Inferior Epigastric Artery Flap. After head and neck cancer extirpation, the dimensions of the excised specimen were obtained in every case. Suitable donor vessels were then identified within the neck. Before flap harvest, the superficial inferior epigastric vessels were marked out with the assistance of Doppler ultrasound. A flap of the desired dimensions was designed based on these vessels. An incision was then made and the artery identified to assess the caliber of the vessel. If the vessel was of sufficient caliber, the harvesting of the SIEA flap would continue. The artery and accompanying veins were then dissected out until sufficient length and caliber were achieved. The remainder of the circumference of the skin around the proposed flap was then incised and extended through subcutaneous tissue until the superficial fascia of the abdominal wall musculature was encountered. The fascia was not disturbed. The flap was then elevated and dissected until only attached by the blood vessels.

The operating microscope was then introduced to the head or neck wound field, and final preparation of the appropriate artery and vein was performed. Once good inflow was determined, the vessels were irrigated with heparinized saline solution.

The flap was then harvested, taking care to ligate the proximal vessels securely, and transferred to the neck wound. With the aid of the operating microscope, end-to-end anastomosis between the flap vein and neck vein was performed. The flap was then carefully debulked and trimmed to match the required dimensions of the defect. The flap was inset using interrupted, 3-0 Vicryl sutures and followed with primary closure of the donor site.

Deep Inferior Epigastric Perforator Flap. When a perforator flap was harvested, a flap of the desired dimensions was drawn over the right or left rectus abdominis muscle centered on a periumbilical perforator marked with Doppler ultrasound. Usually flap selection was based on size, orientation of the defect, or, in one case, unsuitable SIEA vessels. The skin island was incised down to the anterior rectus fascia and raised laterally until encountering the beginning of the lateral perforators. Anywhere from one to three perforating vessels were identified. These were dissected into the anterior rectus fascia and parenchyma of the rectus abdominis muscle until perforators were noted to be joining or sufficient pedicle length and caliber was obtained. Segmental motor nerves to the rectus abdominis muscle were preserved whenever possible. The pedicle was then transected, the proximal end in the abdomen ligated securely, and the flap transferred to the neck in a similar fashion. For closure of the donor site, the rectus fascia was closed with interrupted 1-0 polydioxanone suture. The abdomen was undermined and the umbilicus reimplanted if necessary. The defect was then closed primarily.

Superficial Circumflex Iliac Artery Flap. This flap was designed around the lower abdomen and groin supplied by the territory of the SCIA. Once again, preoperative marking with the assistance of Doppler ultrasound is useful. The skin island was incised and dissection carried down to the fascia. Dissection continued until the SCIA and vein were identified. The pedicle was followed to its anastomosis with the femoral artery and vein. Here, the vessels were transected, the stumps securely ligated, and the flap was transferred to the neck where the inset proceeded in a similar fashion. The donor site was closed in a transverse fashion.

RESULTS

Sixteen patients successfully underwent reconstruction with the DIEP free flap ($n = 11$) (Figure 2), the SIEA free flap ($n = 4$), or the SCIA free flap ($n = 1$) (Table 1). An SIEA flap was planned on patient 9, but after the vessels were traced proximally to obtain sufficient caliber, it was thought that the resulting pedicle was too long to be used safely within the neck wound. This case was converted to a DIEP free flap reconstruction. Average age was 60 years (range, 41–77 years). The most common defect reconstructed was subtotal glossectomy ($n = 10$) (Figure 3), followed by large facial defects from radical resection of skin and parotid gland ($n = 3$) (Figure 4), lateral pharyngectomy ($n = 1$), floor of mouth ($n = 1$), and craniofacial resection involving nasal root skin ($n = 1$). Overall, the average hospital stay was 7.6 days (range, 6–14 days). The average number of perforators used in the DIEP flaps was 1.5 (range, 1–3). The average defect size was 74.5 cm^2 (range, 30–240 cm^2). The most commonly used recipient vessels were the facial artery and facial vein ($n = 10$). In this series of patients, there were no instances of flap loss, although patient 10 did have some venous congestion develop that resolved with leech therapy after 2 days. This patient also underwent an emergency craniotomy for subarachnoid bleeding that prolonged his hospital stay (14 days). Patient 15 required vacuum-

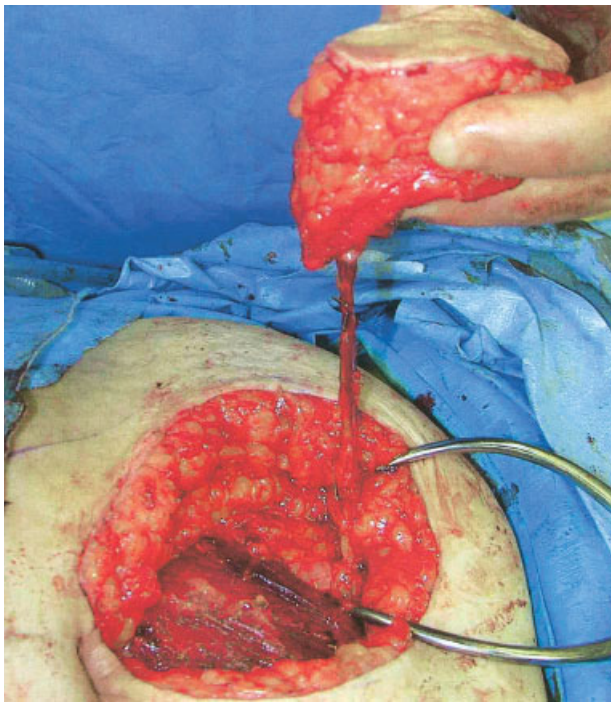

FIGURE 2. A deep inferior epigastric perforator flap harvest based on one perforator vessel for a partial glossectomy defect. Preservation of the rectus muscle and its motor nerves is of utmost importance to prevent possible abdominal herniation. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

Table 1. Patients.

Patient no./age, y/sex	Primary tumor	Treatment	Defect size	Anastomoses	Perf #	Follow-up, mo
1/66/M	T2N0M0 SCC oropharynx	Subtotal glossectomy, RMT, Tonsil, ipsi MRND	8 × 7.5 cm	DIEA/STA,STV	3	14
2/48/F	T2N0M0 ACC oral tongue	Subtotal glossectomy, ipsi MRND	10 × 7 cm	SIEA/ITA,LV		2
3/77/M	T2N0M0 SCC oropharynx	Subtotal glossectomy, RMT, Tonsil, ipsi MRND	7 × 6 cm	DIEA/FA,FV	1	25
4/58/M	T2N1M0 SCC supraglottis	Subtotal glossectomy, laryngectomy, (b) MRND	6 × 7 cm	DIEA/FA,FV		17
5/76/M	T3N1M0 SCC oropharynx	Subtotal glossectomy, tonsil, ipsi MRND	8 × 5 cm	DIEA/FA,FV	2	16
6/41/F	T3N2CM0 SCC FOM	FOM, (b) SOHND	6.5 × 7.5 cm	DIEA/STA,EJ	1	71
7/45/F	T3N0M0 SCC oral tongue	Subtotal glossectomy, ipsi SOHND	5 × 6 cm	DIEA/FA,FV	1	65
8/58/F	T3N0M0 SCC oropharynx	Subtotal glossectomy, tonsil, ipsi SOHND	5 × 7 cm	DIEA/FA,FV	2	16
9/64/F	T4N2CM0 SCC facial skin	Radical parotidectomy, auriculectomy, ipsi MRND	12 × 11 cm	DIEA/FA,FV	1	14
10/69/M	T4N0M0 SCC sinonasal	CFR with 8 × 4 cm nasal root skin	8 × 4 cm	DIEA/FA,FV	1	11
11/60/M	T4N0M0 SCC facial skin	Total parotidectomy, auriculectomy, ipsi MRND	12 × 13 cm	SIEA/FA,FV		10
12/70/M	T3N1M0 SCC oropharynx	Subtotal glossectomy, tonsil, ipsi MRND	5 × 6 cm	DIEA/FA,FV	1	16
13/64/M	T4N2CM0 SCC supraglottis	SG laryngectomy, partial glossectomy, (b) MRND	10 × 7 cm	SIEA/LA,FV		9
14/59/M	T4N2BM0 SCC oropharynx	Lateral Pharyngectomy, RMT, tonsil, ipsi MRND	10 × 11 cm	SIEA/LA,LV		9
15/48/M	T4N1M0 BCC facial skin	Radical parotidectomy, auriculectomy, ipsi MRND	15 × 16 cm	DIEA/STA,EJ	2	18
16/77/M	T2N0M0 SCC oropharynx	Subtotal glossectomy, tonsil, ipsi SOHND	6 × 9 cm	SCIA/FA,FV		20

Abbreviations: Perf #, number of perforators; M, male; SCC, squamous cell carcinoma; RMT, retromolar trigone; MRND, modified radical neck dissection; DIEA, deep inferior epigastric artery; STA, STV, superior thyroid artery and vein; F, female; ACC, adenoid cystic carcinoma; SIEA, superficial inferior epigastric artery; ITA, inferior thyroid artery; LA, LV, lingual artery and vein; FA, FV, facial artery and vein; FOM, floor of mouth; SOHND, supraomohyoid neck dissection; CFR, craniofacial resection; EJ, external jugular vein; SG, supraglottic; BCC, basal cell carcinoma.

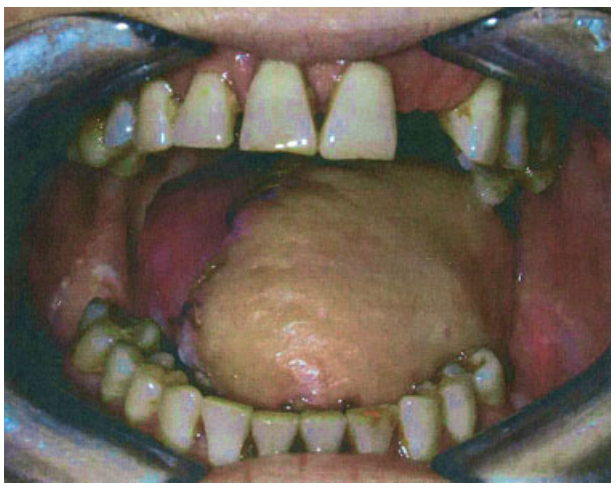

FIGURE 3. The deep inferior epigastric perforator flap 6 weeks after free tissue transfer to the partial glossectomy defect. This flap provides excellent bulk for tongue reconstruction. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

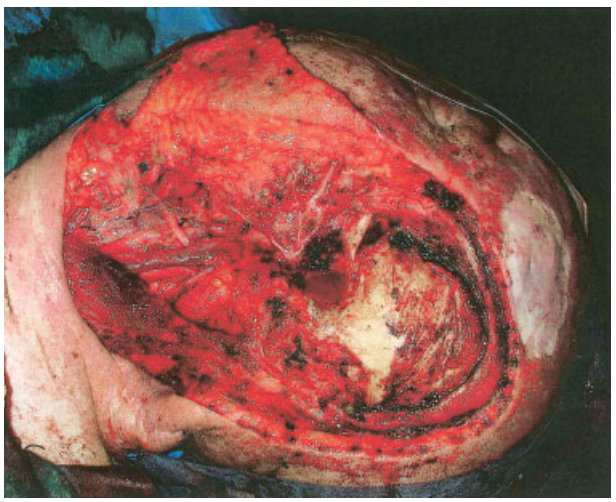

FIGURE 4. A large facial skin defect after resection of cutaneous squamous cell carcinoma, total parotidectomy, and total auriculectomy. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

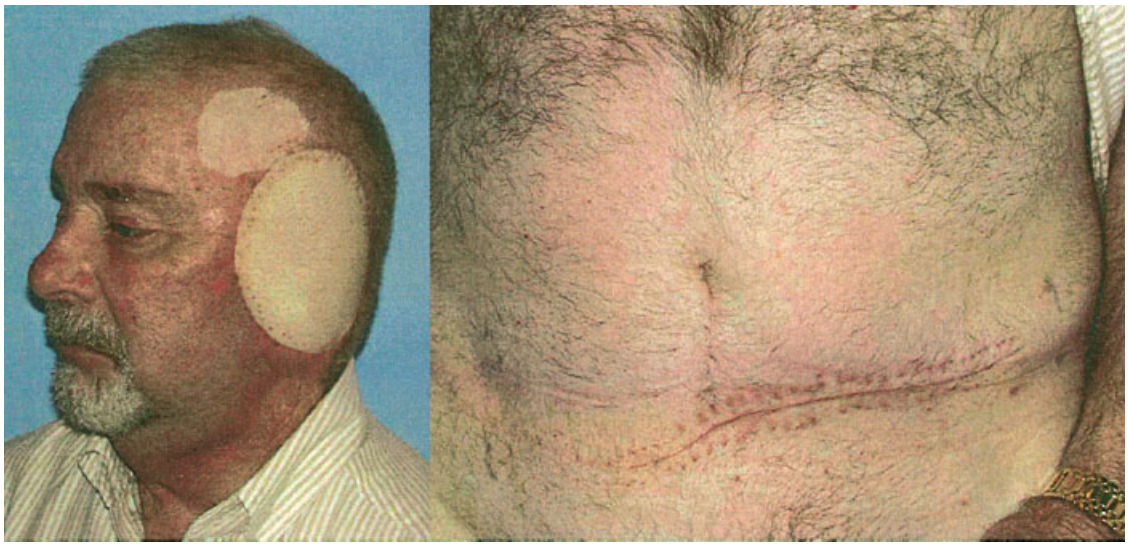

FIGURE 5. The same patient (left) 6 weeks after reconstruction with the superficial inferior epigastric artery flap. The donor site (right) is very well hidden, similar to an abdominoplasty scar. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

assisted closure of his donor site secondary to a large flap harvest (15 cm × 16 cm). Cosmetic and functional results were similar for all patients (Figure 5). There were no cases of wound infection, hematoma, or deep vein thrombosis. There were no subsequent abdominal wall hernias or other abdominal complications after a mean follow-up of 21 months.

DISCUSSION

Microvascular surgery has drastically altered clinical and functional outcomes for patients faced with large defects after head and neck cancer ablation. Although the myocutaneous rectus abdominis free flap has been a workhorse flap for large deficits in the head and neck, the associated morbidity is well established. Because muscle atrophy occurs readily after microvascular transplantation, this leads one to wonder whether muscle harvest is necessary at all. The vast experience with DIEP and SIEA flaps in breast reconstruction provide evidence that the harvest of skin and subcutaneous tissue abdominal free flaps significantly reduce donor site morbidity, hospital stay, cost, and operative time.[2,3] Similarly, this study suggests that use of these flaps in head and neck reconstruction result in minimal donor site morbidity after 21 months of follow-up and a comparable length of hospital stay (7.8 days) to more traditional free flap head and neck reconstructions. In addition, the DIEP flap provided more than sufficient coverage for even the largest head and neck deficits. Koshima et al[8,9] note that the skin territory of one single dominant perforator makes up the maximum dimensions of 35 cm in length and 25 cm in width. Although DIEP flaps require somewhat tedious intramuscular dissection, the bulk of the muscle is spared. Although the dissection may result in denervation and weakening of the rectus muscle, every effort is made to preserve all motor nerves. Incision of the rectus fascia creates a risk of abdominal wall weakening and herniation; however, this complication was not observed in this series but has been reported in the literature.[10]

To decrease the risk of donor site morbidity even further, the SIEA flap harvests lower abdominal skin and fat without breaching the rectus sheath. In the absence of violation of the anterior rectus sheath, there is no potential for abdominal herniations or functional deficit. The SIEA free flap donor site is cosmetically superior, because this incision is closed transversely in the lower abdomen (similar to an abdominoplasty scar). In addition, flap harvest is not as demanding, because a superficial dissection in the femoral triangle is all that is required. This reduces the chances of damaging the pedicle. The SIEA flap can also be thinned safely below Scarpa's fascia allowing a thinner, more pliable flap for some defects.[11] Despite these advantages, some features can discourage harvest of this flap. The pedicle is a primary concern, because it is short and has a smaller diameter than a pedicle based on the DIEA. These vessels have high variability and often are not of sufficient caliber for anastomoses in the head and neck. The average caliber

of this vessel of a SIEA flap is reported as 1.4 mm, with a mean pedicle length of 4 cm[12] compared with a mean caliber of 3.6 mm and pedicle length of 10.3 cm[13] in the DIEP flap. Therefore, greater care and technical skill are required to reconstruct with SIEA free flaps. Although some authors[11,14] believe that free SIEA flaps carry the same volume and quality of tissue as the free rectus abdominis or DIEP flaps, clearly the variability in vessel size makes this vascular territory inconsistent. In addition, absence of the SIEA is common and reported anywhere from 13% to 40% in some studies.[11,12,15] Unlike the DIEP flap, the vessels emerge from the subcutaneous tissue on the inferior border of the flap, whereas perforator flaps are on the deep surface of the tissue. Recipient vessels have to accommodate this pedicle location and can make orientation of the flap challenging. Reconstruction with this flap requires an experienced microvascular surgeon for appropriate anastomosis and orientation. Other contraindications to SIEA flap harvest include prior high ligation of the long saphenous vein, inguinal hernia repair, or previous groin dissection. Despite all of these difficulties, as demonstrated with patient 9, when the SIEA flap is planned and the pedicle is not sufficient, the reconstruction can always proceed to a DIEP flap.

Typically, when one vascular territory is small on one side of the abdomen, the other is likely to be larger. In our experience, it is rare that large DIEP perforators will be found in the same setting with a large SIEA. Clearly, unless a very long pedicle is needed, the SIEA is the superior choice and should be used first. Unfortunately, in breast reconstruction, we only find it to be suitable about 25% of the time. However, when it is not suitable, the DIEP almost always is. In addition, head and neck reconstruction flaps, even large ones, generally require only a tiny fraction of the tissue needed for a breast flap, thereby decreasing the possibility of fat necrosis. Almost any head and neck flap is likely to have more than adequate venous drainage with almost any size vein.

Reconstruction with the SCIA flap, although infrequent, has the advantages of a relatively short superficial dissection for the pedicle vessel, quick flap elevation time, easy contouring and thinning, a well-concealed donor site, and minimal donor-site morbidity. The obvious disadvantage is the higher technical skill required for anastomosing vessels that approach less than 1.0 mm in diameter.[16] One patient in our series was reconstructed with this flap secondary to excessive obesity. The DIEP and SIEA flaps were avoided because of the enormous amount of defatting that would be necessary to achieve a less bulky reconstruction.

In conclusion, muscle-sparing abdominal free flaps are excellent for reconstructing soft tissue defects after head and neck cancer resection. Regardless of which free flap is used, abdominal soft tissue harvest can always be performed without rectus muscle and, therefore, lessens donor site morbidity.

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