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特集 Prefabricated flapの新展開

頬部組織欠損に対するprefabricated flapの有用性

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Key words: prefabricated flap　肩甲骨下動静脈系遊離複合組織移植　顔面再建

はじめに

近年，身体各部位における皮膚血行形態の解明が進み，いまや皮弁挙上が不可能な部位はないといっても過言ではない。またそれに伴い皮弁の術式は多様化し選択の幅が広がってきた。しかし，特殊な再建目的のため皮弁選択が制限された場合，既存の血行形態に依存する形の選択肢では満足する結果が得られないこともある。その解決策の一つとして生まれたのがprefabricated flap[7)11)]である。この皮弁は，移植前に加えられた人為的操作により新たな血行形態を有しており，特殊な再建目的にも対応することができる。われわれは，中顔面の複雑な組織欠損に適応した肩甲下動静脈系遊離複合組織移植術において，一部の組織をprefabricated flapのvascular carrierとして利用することで，整容的にも優れた顔面再建が可能であることを報告した[6)11)]。本稿では，その術式の詳細を述べることとする。

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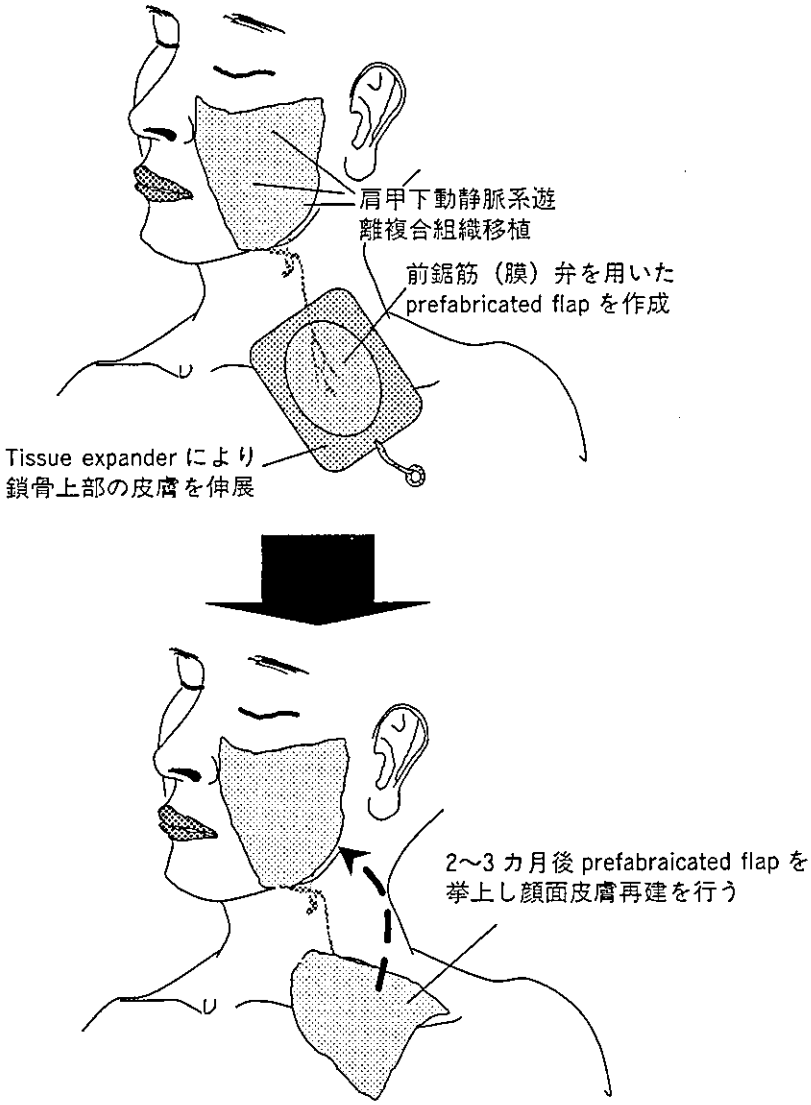
I 手術手技

1. Vascular carrierの移植およびexpander挿入

顔面の組織欠損に対して，再建目的に必要な構成成分からなる複合組織を肩甲下動静脈系を栄養血管とする皮弁として採取する。肩甲下動静脈を頚部の適切な血管に吻合することで移植する。利用し得る組織は，肩甲骨，肋骨，広背筋（皮）弁，肩甲皮弁などであり，その詳細は他の報告[1)9)13)]にゆずることとする。われわれの工夫した本術式は，この複合組織に肩甲下動静脈より分枝した胸背動静脈の前鋸筋枝およびそれに連なる前鋸筋（膜）弁を含ませ，これを鎖骨上部に作成するprefabricated flapのvascular carrierとして利用するものである（図1-a）。したがって，初回手術（肩甲下動静脈系遊離複合組織移植による顔面再建）の際に，頚部に皮膚切開を加え，頚部皮下トンネルと鎖骨上部に皮下ポケットを作成し，これに前鋸筋（膜）弁を誘導する。同時に，鎖骨部でのprefabricated flapの拡大を目的として，前鋸筋下にtissue expanderを挿入する。Expanderの大きさは，必要とされる皮膚の大きさに準じて選択されるが，通常500 cc前後の



(a) 肩甲下動静脈系遊離複合組織移植と prefabricated flap を用いた頬部組織欠損に対する整容的再建

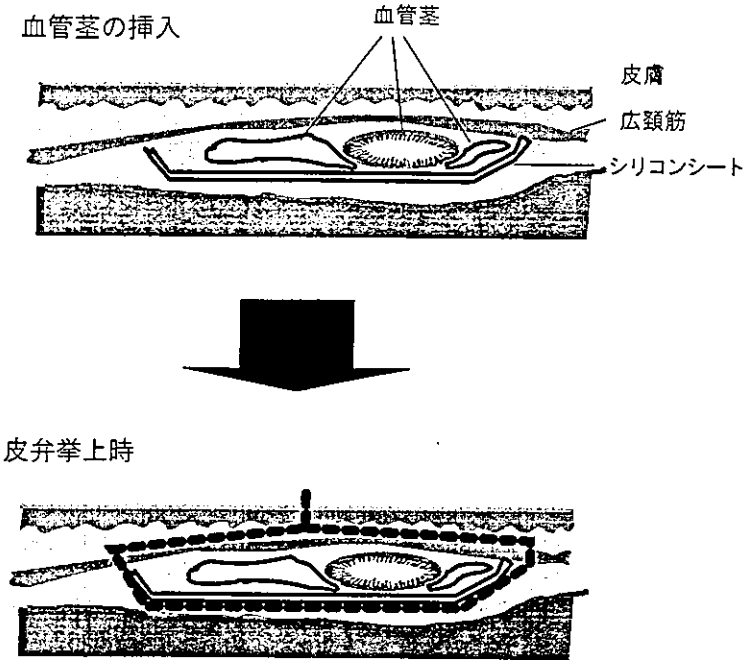
図 1　術式のシェーマ

容量であれば，頬部全体の被覆を目的とした皮弁の作成が可能である。Prefabricated flap の挙上時，皮弁の自由度を得るためには，十分な長さの血管茎を得ておくことが必要であるが，同時に prefabricated flap の移動時の血管茎剝離が容易となるような配慮も必要である。そこで，前鋸筋枝を通す皮下トンネルは広頚筋の下に作成し，初回手術の際に血管茎の下面にはシリコンシートで被覆している（図 1-b）。

2. Prefabricated flap の挙上

1 回目の手術より 1〜2 週間後に expander の生理食塩水注入を開始する。皮膚の色調や緊張に留意しながら 7〜10 日ごとに容量の 10% を目安に注入を行い，遊離組織移植後 2〜3 カ月で full inflation とした後，prefabricated flap として挙上する。術前にドップラー聴診器で移行した血管茎の走行を確認しておくことは重要である。

まず，前回の手術瘢痕に切開を加えて

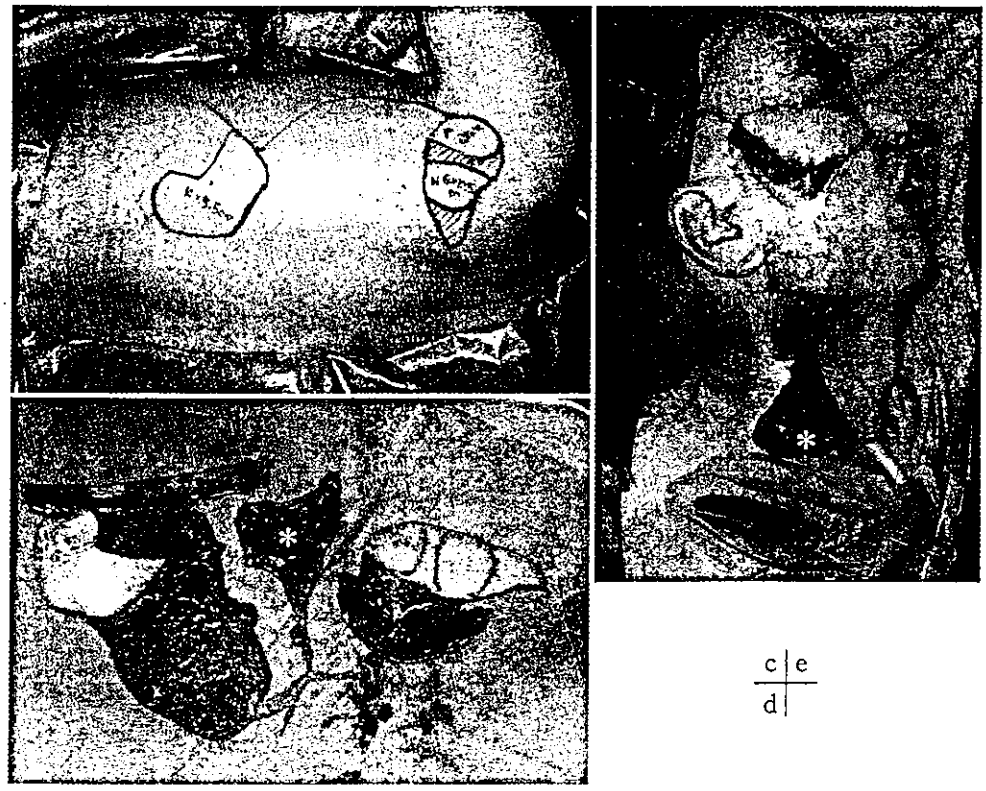


(b) 前鋸筋枝の頸部における挿入部位と挙上時の剝離面
図 1　術式のシェーマ

(a) 初診時所見
側頭部，頬部に皮膚欠損を認める（→）。
図 2　症例 1：54 歳，男，上顎癌切除後の顔面の変形
(Sakurai H, et al : Subscapular arterial system combined tissue transfer using secondary vascularization. Plastic Surgical Forum 19 : 324-326, 1996 より引用)

expander を除去する。その後，皮弁は中顔面皮膚欠損の形態に応じてデザインし，被膜下に透見できる血管茎を損傷しないよう留意して皮弁を挙上する。さらに皮下トンネル内に配置した血管茎の走行に沿って頸部皮膚に切開を加える。広頸筋上で幅約 2 cm 程度の

(b) 欠損部を開放した状態
鼻腔側面，口蓋，上顎骨，頬骨欠損を認める。



c | e
d |

(c) 皮弁デザイン
口蓋再建部分（P），鼻腔粘膜再建部分（N），広背筋皮弁（→）は一時的顔面皮膚再建に使用した。
(d) 採取組織
＊：前鋸筋膜弁
(e) 移植組織配置
前鋸筋弁（＊）を鎖骨上部に誘導する。

図 2　症例 1

(Sakurai H, et al : Subscapular arterial system combined tissue transfer using secondary vaccularization. Plastic Surgical Forum 19 : 324-326, 1996 より引用)

(f) 初回手術後40日
広背筋皮弁で再建した顔面皮膚（→）は周囲との色調の違いが目立つ。

(g) Prefabricated flapを右頬部に移動した状態

(h) 術後2カ月の状態
Prefabricated flap（→）により頬部皮膚の色調・質感は著しく改善した。

図2　症例1
(Sakurai H, et al: Subscapular arterial system combined tissue transfer using secondary vaccularization. Plastic Surgical Forum 19: 324-326, 1996より引用)

皮下剝離を行い，再度血管茎の走行をドップラー聴診器により確認する。血管茎の剝離は，確認した血管茎の走行に沿って幅約1～2 cmの広頚筋とともに，また下層では血管茎移行の際に留置したシリコンシートとともに挙上する（図1-b)。これにより，血管茎を安全かつ容易に剝離することができ，prefabricated flapの移動に十分な自由度が与えられる。皮弁を頬部の再建部位に移動させ縫着する。皮弁採取部は可及的に一次閉鎖する。

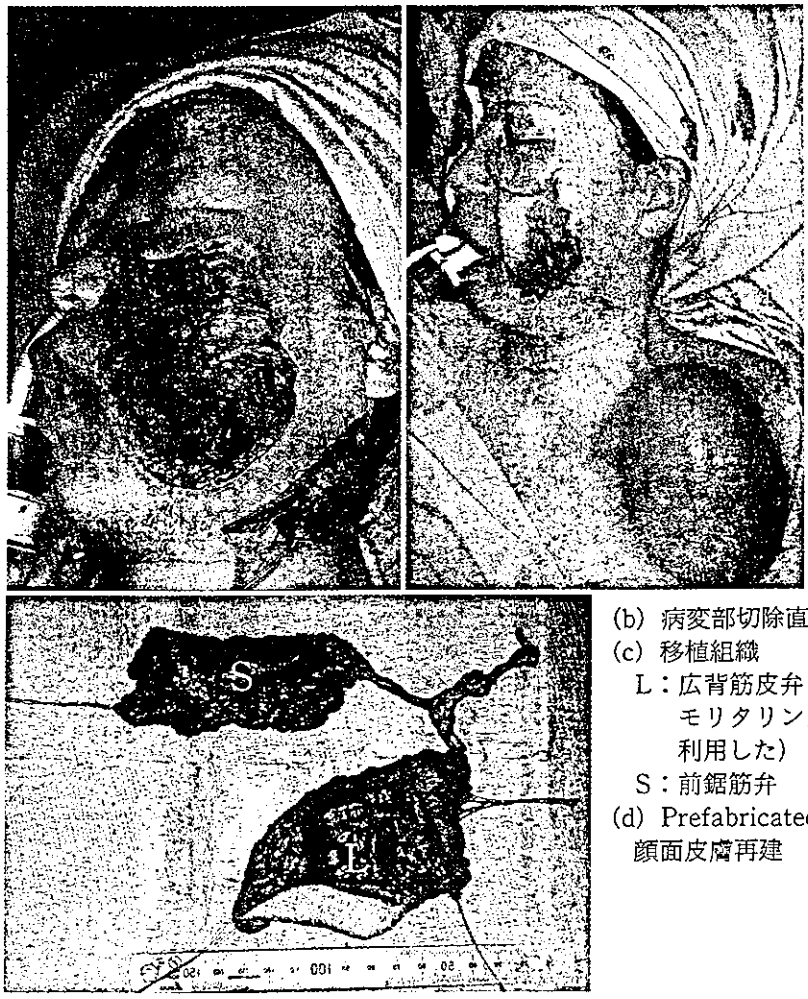
II 症　例

【症例1】 54歳，男

右上顎癌に対し，他院耳鼻咽喉科において拡大上顎全摘術および計95 Gyの放射線療法が行われ，その後に生じた顔面変形を主訴に当科を紹介された。右側頭部に鼻腔・口腔との交通性のある潰瘍形成，および高度の顔面変形を認め（図2-a)，これに対して肩甲下動静脈系の遊離複合組織移植による再建を行った。鼻腔・口蓋粘膜は肩甲皮弁により，上顎の死腔充塡を広背筋弁により，眼窩下縁の骨性再建を肩甲骨により行った（図2-b～d)。瘢痕拘縮解除後に生じた右側頭部から頬部の皮膚欠損に関しては，一時的には広背筋皮弁により被覆した。同時に，挙上しておいた前鋸筋膜弁をvascular carrierとして鎖骨上部皮下に誘導し，これをもってprefabricated flapを作成した（図2-e)。鎖骨上部に皮下ポケットを作成し，500 ccのtissue expanderを挿入するとともに前鋸筋膜弁を同ポケット内に誘導し，辺縁を3-0ナイロンで真皮に固定した。

遊離複合組織移植により顔面形態は改善したものの，広背筋皮弁による再建顔面皮膚は色調・質感ともに整容面での問題を残している（図2-f)。これに対して初回手術2カ月後に鎖骨上部に作成したprefabricated flapで

(a) 初診時所見　　(e) 術後 8 カ月の状態
口角の挙上も可能である。



b | d
c

(b) 病変部切除直後の状態
(c) 移植組織
L：広背筋皮弁（皮島部分はモリタリング皮弁として利用した）
S：前鋸筋弁
(d) Prefabricated flap による顔面皮膚再建

図 3　症例 2：34 歳，女，右顔面巨大 AVM

顔面皮膚のresurfaceを行った（図2-g）。術直後の皮弁色調はやや暗赤色を呈しうっ血状態を示したが，翌日には改善し皮弁は完全に生着した。広背筋皮弁による顔面皮膚に比較して，鎖骨上部のprefabricated flapは色調・質感ともに顔面皮膚により合致したものであり整容的改善が得られた（図2-h）。皮弁辺縁の瘢痕切除等を予定していたが，不慮の事故により3カ月後死亡した。

【症例2】 34歳，女

左頬部から下顎にかけての巨大動静脈奇形の症例である（図3-a）。主要な栄養血管である顔面動脈と顎動脈に対して塞栓術を行った後，病変部の外科的切除を行った（図3-b）。顔面表情筋とともに頬部の病変部分を完全切除した後，広背筋弁による表情筋の動的再建とprefabricated flapによる頬部の皮膚再建を行うこととした（図3-c）。採取した9×5 cmの広背筋弁は，胸背神経を顔面神経頬筋枝の断端に神経縫合し，耳下腺被膜と鼻唇溝部真皮に固定した。この広背筋弁は筋膜上に脂肪組織とモニタリング皮弁としての皮島を有しており，頬部の皮膚欠損に対する一時的な閉鎖は，病変部の皮膚を薄層に剝離し分層皮膚として利用することにより行った。一方，胸背動静脈の前鋸筋枝とそれに連なる前鋸筋弁（10×5 cm）を鎖骨上部皮下へ誘導し，510 ccのtissue expanderを挿入した。2カ月の伸展期間の後，prefabricated flapによる整容的顔面皮膚再建を行った（図3-d）。

皮弁は完全生着し，術後2年を経過し整容的にも満足のゆく結果が得られている（図3-e）。

III 考　察

広義のprefabricated flapとは，移植前に皮弁採取部に対して人為的操作を加えることにより，再建目的に見合った移植組織に変換させておく皮弁と定義することができる。通常のaxial pattern flap（軸走型皮弁）においては，移動の際に必要な血管茎，移植時に含ませることのできる組織，移植し得る皮弁の形態・大きさなどがある程度規定されることになる。これは，既存の血行形態に依存する形で皮弁を挙上することによる制限であるが，prefabricated flapは移植前操作後に生じる血管新生により新たな血行形態を兼ね備えた皮弁を作成することができる点で多くの可能性を秘めている。

元来の「prefabrication」の意味を考えれば，単なるdelay操作やtissue expansionもprefabricationの一環と考えることができる。しかし，近年の文献においてはPribazら[5]が述べているように，「prefabricated flap」は，vascular carrierを導入し一定期間経過した後，新たな血管茎により挙上する皮弁に限定し，その他の移植前操作によるprefabricationとは区別する意見が多い[5]。一方で，vascular carrierの導入とは異なり，元来の移植組織には含まれなかった組織（骨，軟骨，粘膜，皮膚など）を移動前に移植しておき，目的に見合った形態や機能を兼ね備えた移植組織に変換させる操作もprefabricated flapとして報告する文献[2)12)]も散見される。どこまでをprefabricated flapとして認めるかに関しては，学会等での統一した見解が望まれるところである。

Prefabricated flapにexpanderを併用することは，特に比較的大きな皮弁を必要とした場合に非常に有用である[4]。Expanderによる被膜形成はvascular carrierに新たな血管網が付加され，prefabricated flapの血行改善に極めて大きな効果を与えると考えられる[10]。一方で，expanderの過伸展により移行した血管茎が閉塞することが危惧されるが，段階的なexpansionであれば伸展血管

は問題なく良好な開存を示すことが動物実験により確認されている[13]。提示した症例においても，頚部皮下トンネル内の前鋸筋枝のみならず，鎖骨上部の伸展部分においても前鋸筋弁内の動脈の拍動をドップラー聴診器において良好に聴取することができた。

Expanderを併用したprefabricated flapにおいて，術直後の皮弁うっ血はよく知られている。われわれの方法においては広頚筋下に挿入した前鋸筋枝を広頚筋やシリコンシート周囲の被膜とともに挙上しているが，これらの組織を介した静脈還流により多少なりとも静脈還流が付加され，術翌日には皮弁の色調は平常化していた。

多くの再建対象を有し三次元的に複雑な形態が求められる広範囲の中顔面組織欠損において，複数の組織を同時に再建材料として利用でき，かつ十分な長さの血管茎を得ることができる遊離複合組織移植の採取部は限られている[4)9)13)]。しかも，組織欠損が顔面皮膚にまで及んだ場合，それらの移植組織が必ずしも顔面皮膚に適した再建材料を含んでいるとは限らない。このように既存の血行形態による組織移植では制限が加わるような場合，prefabricated flapの有用性が高まると考えられる。そもそも複雑な中顔面再建に適した遊離複合組織移植術はvascular carrierとなり得る組織を多く含んでおり，再建材料の欠点を補うためのprefabricationは理にかなった有用な術式であると考えられた。

まとめ

中顔面の再建において利用される遊離複合組織は，既存の血行形態のままでは顔面皮膚の再建に適した再建材料を得ることが困難である。これに対して，整容的観点から移植組織の一部をvascular carrierとして利用するprefabricated flapが有用であると考えられた。

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ABSTRACT

Reconstruction of The Sole Using a Median Plantar Flap and a Reversed Median Plantar Flap Usefulness and Problems

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The advantage of the median plantar flap (MPF) and the reverse median plantar flap (RMPF) is that they can provide durable tissue capable of withstanding continuous weight bearing. However, the use of these flaps can cause certain problems that should be given careful consideration, as follows :

1) Blood circulation in the non-weight-bearing area and the foot must be evaluated before using these flaps.

2) A limited flap size that is insufficient for coverage of the entire sole.

3) Treatment of the vascular anatomy and pedicles is problematic due to variations in and the condition of the branches of the median plantar artery.

4) Treatment of the plantar aponeurosis must be judged on a case-by-case basis.

5) Treatment of the digital branch of the median plantar nerve to the great toe is not clear.

6) Lack of consensus over the necessity of a sensory flap for reconstruction of the sole.

7) Donor site morbidity, including pain, hypesthesia, concavity and pigmentation, and normal site morbidity.

8) Venous drainage that is not always reliable when the RMPF is elevated

In this paper the authors discussed the problems associated with the MPF and the RMPF. We think that it is important to understand the problems involved and completely eliminate flap necrosis when using these flaps.

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Versatile lotus petal flap for vulvoperineal reconstruction after gynecological ablative surgery☆

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Abstract

Objective. The objective of the present work was to assess the efficacy and complications of the use of the lotus petal flap in the vulvoperineal reconstruction among female patients treated for vulvar malignancies.

Methods. Between December 2000 and April 2003, five patients underwent vulvoperineal reconstructions with the fasciocutaneous skin flaps elevated from gluteal folds immediately after vulvoperineal ablative surgeries at National Cancer Center Hospital, Tokyo, Japan.

Results. The mean surface area of vulvoperineal tissue defects was 157.9 cm^2 (64.0–195.0 cm^2), which could be filled completely by bilateral lotus petal flaps. The mean length of follow-up was 18 months (7–32 months). All flaps successfully survived without fatal necrosis. In postoperative follow-up, all patients had no complaint of pain and no abnormal sensation at the site of flap or at the donor site, and the lotus petal flap caused no severe damage to excretion, mobility of the hip, or the sensation in the vulvoperineal area. The gluteal fold could make the donor-site scar stand out in all patients.

Conclusion. The lotus petal flap is thought to be one of the most ideal reconstructive procedures for vulvoperineal region from various viewpoints of oncology, function, wound healing, and cosmetic surgery.

Keywords: Lotus petal flap; Gluteal fold; Fasciocutaneous skin flap; Vulvoperineal reconstruction

Introduction

In general, most surgical therapies are being pointed to more conservative and reductive procedures today. Gynecologic oncologists also should pursue less-aggressive surgical methods for early vulvar cancers to preserve function and appearance of the affected area as completely as possible. On the other hand, radical operations for advanced vulvar cancers must be performed to remove malignant lesion completely if possible. The patients are psychologically, as well as physically, damaged by bulky defect in the vulvoperineal area [1,2]. Therefore, adequate morphofunctional reconstruction must be recognized an integral procedure for vulvar cancer treatment.

In the past, the vulvoperineal area was misthought to heal poorly because of a deficiency of blood supply, although in reality, this region has a rich blood supply [3,4]. On that account, various bulky flaps such as myocutaneous and fasciocutaneous skin flaps, nourished by vascular pedicle mainly from the thigh, were frequently used in the late 1970s and early 1980s. The most frequently used myocutaneous flap after gynecological ablative surgery has been the gracilis myocutaneous flap [5]. Some fasciocutaneous flaps, such as the gluteal thigh flap [6] and the superomedial thigh

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flap [7], were devised to preserve muscles and make the reconstructive flaps much thinner. But these flaps were incomplete, especially because of instability of blood supply and conspicuous donor-site scars. In 1996, Yii and Niranjan [4] primarily reported a vulvar reconstructive method with gluteal-fold skin nourished by the internal pudendal artery. They called this flap a lotus petal flap from its appearance and versatility. However, the lotus petal flap has not yet come into wide use by gynecologic oncologists. We used the lotus petal flap in the vulvoperineal reconstruction for five patients treated for gynecologic malignancies between December 2000 and November 2002 to investigate its efficacy and complications.

Patients and methods

Patients

Between December 2000 and April 2003, five patients underwent vulvoperineal reconstructions with the fasciocutaneous skin flaps elevated from gluteal folds immediately after vulvoperineal ablative surgeries at the National Cancer Center Hospital, Tokyo, Japan. Their mean age at the time of the operation was 64 years (56–72 years). Patient 1 had undergone modified vulvectomy with combined complete resection of perianal skin outside the anal verge preserving the sphincter ani externus. Patients 2, 3, and 4 had undergone en bloc radical vulvectomy with bilateral groin dissection. Patients 3 and 4 had undergone combined resection of the distal 2.0-cm section of the urethra preserving urethral sphincter function. Patient 5 had undergone wide local excision with combined partial resection of perianal skin outside the anal verge. No patient had radiotherapy before vulvoperineal reconstruction (Table 1).

Surgical resection and reconstruction were performed in a team approach. The ablative surgery was done by gynecologic oncologists, and the reconstruction was done by plastic surgeons.

Preoperative care

All the patients ate nothing by mouth more than 2 days before each operation day in the hospital, and they drink only water. They were nourished with total parenteral nutrition by means of subclavian vein catheter. Intestinal preparation preceding operation was performed with cathartics and glycerin enema for thorough mechanical cleansing of the intestine.

Flap elevation

All patients were placed in the lithotomy position. At the time of vulvoperineal procedure, the patient's legs could be elevated higher to get a better surgical view.

A fasciocutaneous skin flap nourished by pudendal vessels was designed in the shape of lotus petal (lozenge) at either side. Both flaps had gluteal fold as the median axis. The flaps were incised circumferentially and elevated with the underlying sheath from the fascia of the gluteus maximus muscle. The pivot point was set in the medial apex of the flap in the triangle formed by the ischial tuberosity, anus, and urethral meatus at either side. There were indispensable vascular pedicles supporting the flaps under the pivot points at both sides. The redundant fatty tissue around the vascular pedicle was removed as much as possible for preventing pedicle torsion. The diameter of both pedicles became approximately 3–4 cm.

The rotation of the flaps was carried out symmetrically with much caution. Direction of rotation of the elevated flap was classified into two types (Fig. 1). If the defect involved the skin around the anus, the flap was rotated to shift the distal side of the flap toward the bottom of the defect (type I). If the defect mainly involved the skin ablated in vulvectomy, the flap was pivoted to shift the distal side of the flap toward the top of the defect (type II). The flaps were medially transposed into the bilateral defects.

In patient 1, the defect involved the skin around the anus, and type I flap was introduced to the defect (Fig. 2). The

Table 1
Summary of the present cases

Patient	Age	Diagnosis	Gynecologic surgery	Defect size (cm)	Flap type	Flap size (cm)	Total operation time	Postoperative complication
1	65	REC of EPD, vulva	MV	13.0 × 13.0	I, bilateral	L: 4.0 × 15.0 R: 6.0 × 15.0	4 h 10 min	None
2	72	EPD with AC, vulva	RV	13.0 × 15.0	II, bilateral	L: 6.0 × 15.0 R: 5.0 × 14.0	5 h 50 min	None
3	56	MM, vulva	RV	12.0 × 15.0	II, bilateral	L: 6.0 × 15.0 R: 6.0 × 15.0	6 h 00 min	None
4	64	SCC, vulva	RV	11.0 × 16.5	II, bilateral	L: 5.5 × 15.0 R: 5.0 × 15.0	5 h 20 min	Epidermal necrosis of one flap
5	62	SCC, vulva	WLE	8.0 × 8.0	II, bilateral	L: 5.0 × 12.0 R: 5.0 × 14.0	5 h 33 min	None

REC: recurrence; EPD: extramammary Paget's disease; AC: adenocarcinoma; MM: malignant melanoma; SCC: squamous cell carcinoma; MV: modified vulvectomy; RV: radical vulvectomy; WLE: wide local excision; L: left; R: right.

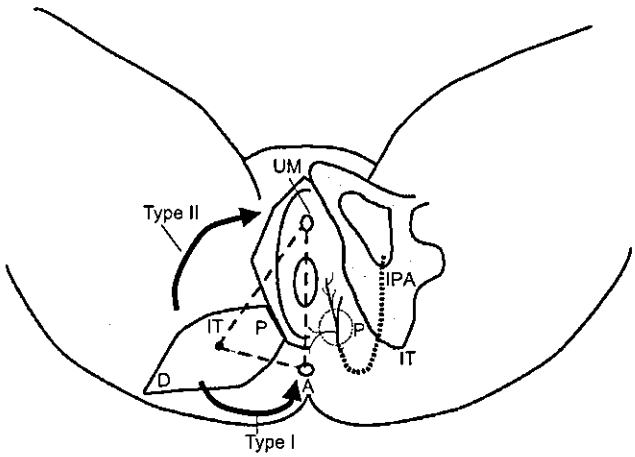

Fig. 1. Schematic design of the lotus petal flaps [12]. Direction of rotation of the elevated flap is classified into two types. Type I: the defect involves the skin around the anus. Type II: the skin defect after vulvectomy. UM: urethral meatus, IT: ischial tuberosity, A: anus, D: distal side of the flap, P: pivot point, IPA: internal pudental artery.

flaps were trimmed to adjust the shape of tissue defect, and especially at the anus they were cut out in a small circle shape to fit the anal verge. In patients 2–5, type II flap was applied to the defect (Fig. 3). In patient 5, the partially resected anus was reconstructed with transposition of the remaining right-sided labium minora.

After assurance of hemostasis, suction tubes were placed beneath skin flaps. The donor sites at the gluteal folds were closed primarily. Two flaps were sutured together to reconstruct the commissura labiorum anterior and commissura labiorum posterior. The vaginal and anal mucosa was sutured to the corium of the flaps. The other parts of the flaps were secured to adjacent skin.

Postoperative care

The patients were forced to bed rest for 7 days postoperatively. Especially, they were not to sit or close the legs tightly. They received total parenteral nutrition instead of oral intake to protect the reconstructive areas from

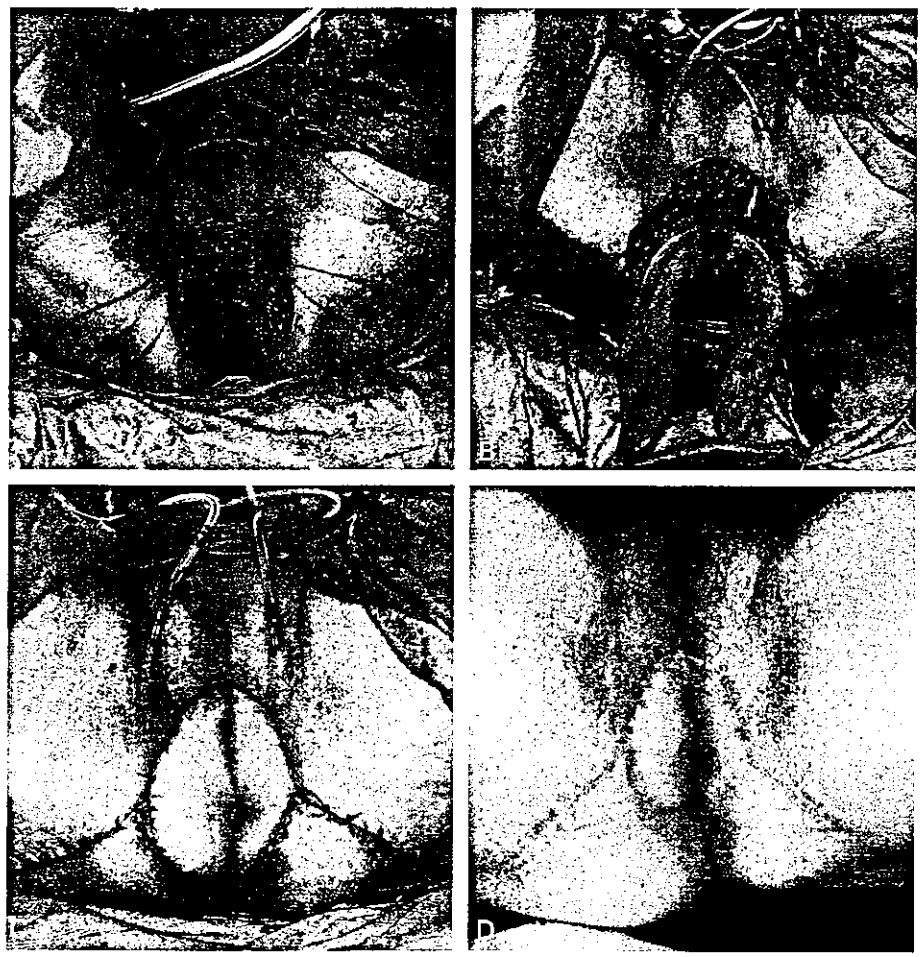

Fig. 2. Patient 1. (A) Bilateral lotus petal flaps are designed to fit defect following modified vulvectomy. Left: 4 × 15 cm, right: 6 × 15 cm. (B) Bilateral lotus petal flaps are developed. Donor sites are primary closed. Suction tubes are placed beneath flaps. (C) Appearance at the end of surgery. (D) Appearance 8 months postoperatively.

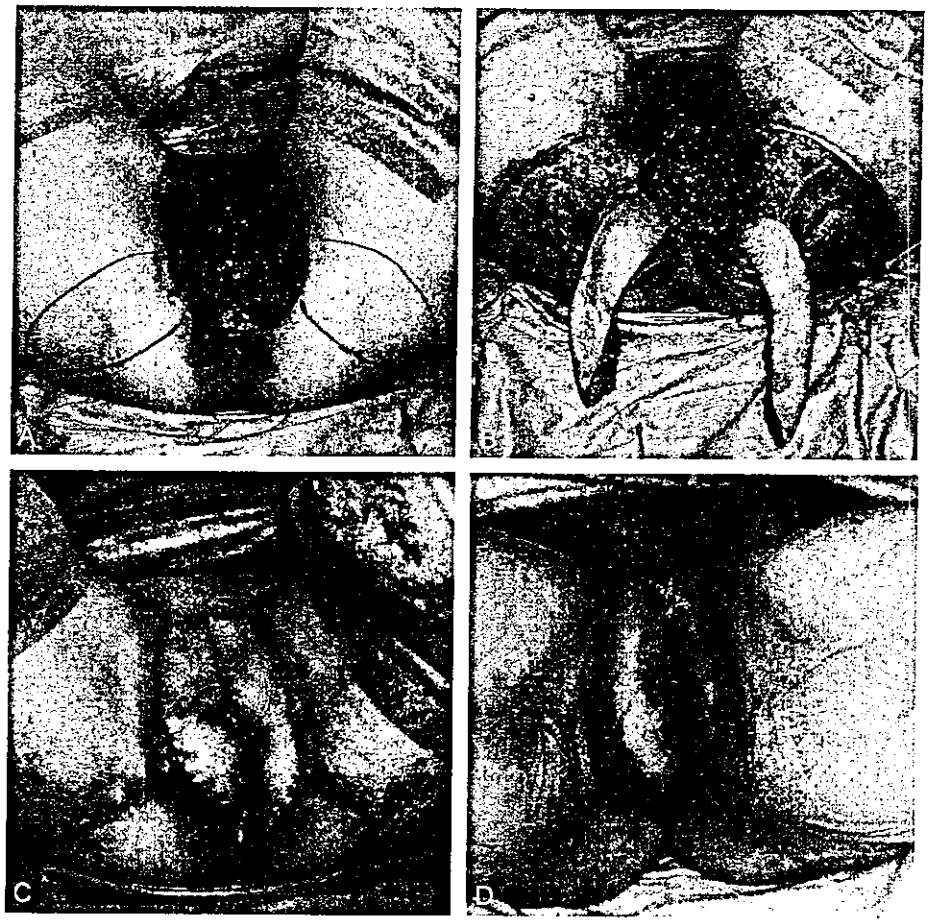

Fig. 3. Patient 2. (A) Design of bilateral lotus petal flaps following radical vulvectomy. Left: 6 × 15 cm, right: 5 × 14 cm. (B) Bilateral lotus petal flaps are developed. The gluteus maximus muscles can be seen. (C) Appearance at the end of surgery. (D) Appearance 2 months postoperatively.

excrement and promote wound healing for 7 days postoperatively.

Results

The mean surface area of vulvoperineal tissue defects was 157.9 cm^2 (64.0–195.0 cm^2). The mean length of follow-up was 18 months (7–32 months). The present cases were summarized in Table 1.

In all patients, the flaps survived well without fatal necrosis. Patient 1 felt discontented with mild fecal incontinence, somewhat narrow stool, and discomfort of the donor sites because of mild skin contracture around both the vagina and anus 1 month later. But 6 months later, most problems faded. In patient 2, the left flap was somewhat edematous for several days, but then recovered. In patient 3, mild wound infection was seen at a donor site on postoperative day 7, but it was cured by drainage of a small amount of pus. In patient 4, mild wound infection and epidermal necrosis were seen at the margin of one flap, but it was improved with conservative therapies. Patient 5 has no trouble besides narrow stool.

In all cases, both good external appearance and function were successfully achieved. No secondary remodeling was needed. Two of three patients underwent postoperative adjuvant therapy and all the patients are being oncologically followed-up.

Discussion

In the late 1970s and early 1980s, various types of myocutaneous and fasciocutaneous skin flaps have been described for use in the vulvoperineal area. Each flap has a vascular pedicle that acts as the pivot point of the flap. The arc of the flap is dependent on its length and pedicle, and determines whether the flap reaches the defect. The disadvantages of these flaps include conspicuous donor-site scars, mismatch of skin color, instability of blood flow, deformity, bulkiness, softness, limited mobility, and duration of completing procedure. Morbid donor sites often require secondary procedures for remodeling. Because the unstable blood flow of flaps is due to relatively long distance between the vascular pedicle and the perineum, most flaps do not survive vascular spasm by torsion and tension at the vascular pedicle.

Recently, the perineal blood flow from the internal pudendal artery has been recognized for perineal reconstruction, and several flaps have been devised. These include the pudendal thigh flap [8] and the vulvoperineal fasciocutaneous flap [9]. But these are not adequate flaps for vulvar cancer operation because the donor sites of these flaps are too close to the excision outline. The fasciocutaneous skin flaps raised from gluteal folds was first reported in 1996. This present flap is also called the lotus petal flap because of its shape [4], infragluteal skin flap for the donor site [10], and gluteal-fold flap for anatomy [11,12].

In our experiences, the lotus petal flap is one of the most ideal methods for vulvoperineal reconstruction after vulvectomy. This present method has seven major advantages compared to other reconstructive methods. First, the lotus petal flap is very easy to elevate. Second, the lotus petal flap is quite stable in respect to blood flow. A rich blood supply is commonly essential for mobilization and survival of skin island-flaps. The lotus petal flap is vascularized by several perforators of the superficial perineal artery, which is a branch of the internal pudendal artery. The vascular pedicle of the lotus petal flap can be practically designed in the triangle formed by the ischial tuberosity, anus, and urethral meatus. Furthermore, the perineum is an area of rich blood supply with multiple arterial anastomoses [13]. Therefore, the lotus petal flap conclusively differs from other conventional reconstructive procedures in respect to vascularity.

Third, the lotus petal flap can preserve innervations of the vulvoperineal area. The posterior cutaneous nerve of the thigh and the pudendal nerve innervate the gluteal-fold area. The perineal branch of the pudendal nerve runs parallel to perforators of the perineal artery. Because the lotus petal flap includes these vessels, the nerve endings are also preserved [14]. Actually, all five patients recovered the sense of pressure and touch in early postoperative stages.

Fourth, the lotus petal flap is suitable to replace as the convex labium because of its moderate volume. Trimming or thinning the redundant tissue is necessary for preventing the pedicle from torsion, as well as for fitting the flap. The gluteal-fold flap is supplied by direct cutaneous vessel according to the classification of blood inflow of thin flap suggested by Kimura and Satoh [15], and so it is not actually difficult to trim and thin the redundant tissue near the pedicle.

Fifth, the gluteal fold is also an ideal donor site in oncological aspect because it is appropriately distant from

Table 2
Summary of previously reported cases and sources about vulvoperineal reconstruction with fasciocutaneous skin flaps elevated from gluteal folds

Case	Age	Diagnosis	Gynecologic surgery	Flap	Complication	Paper
1	64	VIN	WLE	Hemilateral	None	Yii NW, Niranjan NS.
2	61	SCC, vulva	RV	Bilateral	None	Br J Plast Surg
3	67	SCC, vulva	RV	Bilateral	None	1996;49:547–54 [4].
4	74	SCC, vulva	RV	Bilateral	None	
5	76	SCC, vulva	RV	Bilateral	None	
6	57	Malignancy, vulva	RV	Bilateral	None	Knol AC, Hage JJ., Plast Reconstr Surg., 1997;99:1954–9 [10].
7		VIN	RV	Bilateral	None	Moschella F, Cordova, A.
8		VIN	RV	Bilateral	None	Plast Reconstr Surg 2000;
9		SCC, vulva	RV	Bilateral	None	105:1649–57 [14].
10		SCC, vulva	RV	Bilateral	None	
11		SCC, vulva	RV	Bilateral	None	
12		SCC, vulva	RV	Bilateral	None	
13	82	AC, vulva	RV	Bilateral	Wound breakdown (donor site)	Hashimoto I, et al., Plast Reconstr Surg, 2001; 108:
14	19	Malignant rhabdoid tumor, vulva	WLE	Hemilateral	None	1998–2005 [11].
15	76	Eccrine porocarcinoma, vulva	WLE	Hemilateral	None	
16	61	SCC, vulva	RV	Bilateral	None	
17	78	SCC, vulva	RV	Bilateral	None	
18	71	SCC, vulva	WLE	Hemilateral	None	
19	81	EPD, anus and buttock	WLE	Hemilateral	None	
20	65	REC of EPD, vulva	MV	Bilateral	None	Our study
21	72	EPD with AC, vulva	RV	Bilateral	None	
22	56	Malignant melanoma	RV	Bilateral	None	
23	64	SCC, vulva	RV	Bilateral	Epidermal necrosis of one flap	
24	62	SCC, vulva	WLE	Bilateral	None	

VIN: vulvar intraepithelial neoplasia; SCC: squamous cell carcinoma; AC: adenocarcinoma; REC: recurrence; EPD: extramammary Paget's disease; WLE: wide local excision; RV: radical vulvectomy; MV: modified vulvectomy.

the vulva. It is only natural that the malignant lesion must not involve the donor site.

Sixth, the gluteal fold can hide residual donor-site scars anatomically. When the patient wears undergarments, the donor site almost cannot be seen. The present reconstruction can also satisfy a consciousness of beauty.

Seventh, versatility of the lotus petal flap is worthy of remark. Whether the vulvar operation is bilateral vulvectomy or hemivulvectomy, the lotus petal flap can be used for perineal reconstruction to reproduce the labium [4,10,13,14]. We presented a new application of lotus petal flap to perianal reconstruction as modified lotus petal flaps. In patient 1, the flaps were pivoted counter to the past described lotus petal flaps. The lotus petal flap is considered a potential method for various types of perineal reconstruction.

However, the lotus petal flap has a few minor drawbacks. There is a lack of hair adnexa in the skin because of transposition from the gluteal fold. It may be inadequate for reconstruction of vulvar defects, but it is adequate for intravaginal defects. In some papers, the present flap frequently makes the patients uncomfortable on sitting transiently during wound healing [14]. But this discomfort is apt to fade gradually in our experiences.

In conclusion, we believe that the lotus petal flap is one of the most ideal methods for perineal reconstruction from the viewpoints of oncology, function, wound healing, and cosmetic surgery. Skilled gynecologists must be able to complete the vulvar ablative surgeries and vulvoperineal reconstructions by themselves because of its facility. Only four reports (19 cases) are now available on the reconstruction with the fasciocutaneous skin flaps elevated from gluteal folds immediately after vulvoperineal ablative surgeries for gynecologic malignancies. We wish to add our patients to the reported cases mentioned above, and improve the method of vulvoperineal reconstruction (Table 2). Nonetheless, further studies with the use of the lotus petal flap are still needed to determine its advantages and disadvantages compared to other flaps in reconstruction after vulvar cancer operation.

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Importance of Additional Microvascular Anastomosis in Esophageal Reconstruction after Salvage Esophagectomy

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Esophageal reconstruction after salvage esophagectomy in patients who have undergone curative-intent chemoradiotherapy for esophageal cancer is associated with a significant risk of perioperative morbidity and mortality. In particular, anastomotic leakage can cause severe and potentially fatal complications, including mediastinitis and pneumonia. The authors performed esophageal reconstruction with a pedicled right colon graft after salvage esophagectomy in eight patients. To decrease the rate of anastomotic leakage, the authors performed an additional microvascular anastomosis at the distal end of the graft. The distal stumps of the ileocolic artery and vein were anastomosed to the cervical vessels. After surgery, aspiration pneumonia and localized wound infection were observed in two patients each, but slight anastomotic leakage was observed in only one patient. Postoperative swallowing function was satisfactory in all patients. Although the incidence of anastomotic leakage is reportedly high, the authors observed anastomotic leakage in only one of eight patients. The authors believe that additional microvascular anastomosis helps prevent anastomotic leakage, especially in patients who have undergone salvage esophagectomy after curative chemoradiotherapy. (*Plast. Reconstr. Surg.* 113: 1934, 2004.)

Historically, surgery has been the treatment of choice for esophageal cancer. However, curative chemoradiotherapy is being performed with increasing frequency. When disease recurs locally or complications such as esophageal fistula develop after definitive chemoradiotherapy, salvage esophagectomy followed by esophageal reconstruction is the only treatment option, but it is associated with a significant risk of perioperative morbidity and mortality in these patients. In particular, anastomotic leakage occurs frequently[1,2] and can cause severe and potentially fatal complications, including mediastinitis and pneumonia. In an attempt to decrease postoperative morbidity, we performed reconstruction with a pedicled right colon graft that had not been irradiated. Furthermore, we performed additional microvascular anastomosis at the distal end of the pedicled colon graft to prevent disturbance of the arterial supply and venous drainage. We evaluated outcomes in eight patients who underwent esophageal reconstruction after salvage esophagectomy.

Patients and Methods

Salvage esophagectomy after curative-intent chemoradiotherapy for esophageal cancer was performed in eight patients at our hospital from January of 1998 through December of 2001 (Table I). According to the classification of the Japanese Society for Esophageal Disease,[3] one cancer was in the upper third of the thoracic esophagus, three cancers were in the middle third, and four cancers were in the lower third. All patients received radical chemoradiotherapy according to the following regimen: fluorouracil, 400 mg/m^2 over 24 hours administered intravenously on days 1 to 5 and 8 to 12; cisplatin, 40 mg/m^2 over 2 hours administered intravenously on days 1 and 8; and concurrent radiation therapy, 2 Gy/day on days 1 to 5, 8 to 12, and 15 to 19. This regimen was repeated in

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TABLE I
Patient Data

Patient	Age (yr), Sex	TNM*	Localization†	Chemotherapy	Radiation (Gy)
1	50 M	T3N1M0	Middle	FP × 3	60
2	60 F	T4NxMx	Middle	FP (uncertain)	60
3	68 F	T3N0M0	Lower	FP × 4	60
4	46 M	T4N1M0	Upper	FP × 4	50
5	62 M	T3N1M0	Lower	FP × 4	90
6	54 M	T3N1M0	Lower	FP × 4	60
7	54 M	T3N0M0	Middle	FP × 4	60
8	59 M	T2N0M0	Lower	FP × 4	60

TNM, tumor, node, metastasis; FP, chemotherapy with 5-fluorouracil and cisplatin.
* TNM classification: UICC (1997).
† Middle, middle third of thoracic esophagus; Lower, lower third of thoracic esophagus; Upper, upper third of thoracic esophagus.

5 weeks and was followed by a second regimen—fluorouracil, 800 mg/m^2 over 24 hours administered intravenously on days 1 to 5; and cisplatin, 80 mg/m^2 over 2 hours administered intravenously, on day 1—which was repeated in 4 weeks. The average radiation dose delivered to the esophagus was 62.5 Gy (range, 50.0 to 90.0 Gy). After curative-intent chemoradiotherapy, residual tumor was observed in three patients, the primary tumor recurred locally in three patients, and esophagobronchial fistula developed in three patients.

In patients with local recurrence, one-stage esophagectomy and reconstruction was performed with a two-team approach. After subtotal esophagectomy, a pedicled graft consisting of the right hemicolon and the distal end of the ileum was harvested. The colonic end of the right hemicolon was anastomosed to the stomach, and the colon graft was placed subcutaneously at the anterior chest wall. Anastomosis was then performed between the cervical esophagus and the ileal end of the graft. Finally, additional microvascular anastomosis was performed for the distal stumps of the ileocolic artery and vein to prevent disturbance of the arterial supply and venous drainage.

In patients with severe mediastinitis caused by esophageal fistula, two-stage esophagectomy and reconstruction was performed. In the first stage, subtotal esophagectomy was performed and mediastinitis was treated with drainage and antibiotics. In the second stage, esophageal reconstruction was performed with a pedicled right hemicolon graft and additional vascular anastomosis. Outcomes after salvage esophagectomy and reconstruction were evaluated on the basis of the length of mechanical ventilator dependence, length of stay in the intensive care unit, the rate of anastomotic leakage, and postoperative swallowing function.

RESULTS

One-stage esophagectomy and reconstruction was performed in four patients with local recurrence. Two-stage esophagectomy and reconstruction was performed in four patients with severe mediastinal infection 18 to 58 days after initial surgery. The peripheral stump of the ileocolic artery was anastomosed to the transverse cervical artery in all eight patients, and the ileocolic vein was anastomosed to the internal jugular vein in six patients and to the external jugular vein in two patients (Table II).

Postoperative complications included aspiration pneumonia in two patients, local infection in two patients, and anastomotic leakage in one patient (patient 6). In patient 6, a small leakage hole at the anastomosis between the pedicled colon graft and the cervical esophagus was treated conservatively. The length of dependence on mechanical ventilation after esophageal reconstruction ranged from 0 to 7 days (mean, 2.1 days), and stays in the intensive care unit ranged from 1 to 13 days (mean, 4.6 days). Oral feeding began 7 to 35 days after surgery, and all patients except one could tolerate a nonsoft diet (Table III).

TABLE II
Perioperative Status of the Patients

Patient	Preoperative Status	Esophagectomy and Reconstruction	Vascular Anastomosis	
			Artery	Vein
1	Residual tumor	One-stage	TCA	IJV
2	Esophageal injury	Two-staged	TCA	IJV
3	Local recurrence	One-stage	TCA	IJV
4	Esophageal fistula	Two-staged	TCA	EJV
5	Local recurrence	One-stage	TCA	IJV
6	Residual tumor/fistula	Two-staged	TCA	IJV
7	Residual tumor/fistula	Two-staged	TCA	EJV
8	Local recurrence	One-stage	TCA	IJV

TCA, transverse cervical artery; IJV, internal jugular vein; EJV, external jugular vein.

CASE REPORT

Patient 6 was a 54-year-old man with esophageal cancer at the lower third of the thoracic esophagus treated with curative-intent chemoradiotherapy (Fig. 1). The total dose of irradiation was 60 Gy, and the radiation field extended from the top of the cervical esophagus to the level of the celiac artery (Fig. 2). Five months after initial chemoradiotherapy, an esophageal fistula was found, and salvage esophagectomy was performed emergently. At the first operation, subtotal esophagectomy and mediastinal drainage were performed. Esophageal reconstruction was performed 18 days after this initial operation. The pedicled right colon graft was elevated through an anterosternal route and anastomosed to the cervical esophagus. The distal end of the ileocolic artery was anastomosed to the transverse cervical artery, and the vein was anastomosed to the internal jugular vein (Fig. 3). Because radiographic examination 7 days after esophageal reconstruction showed no anastomotic leakage (Fig. 4), the patient was allowed to start oral feeding. However, 2 days later, slight leakage was observed at the cervical anastomosis (Fig. 5). The leakage was treated conservatively, and 28 days later the patient was able to resume oral feeding.

DISCUSSION

Treatment strategies for esophageal cancer are now changing because of poor outcomes and poor quality of life after surgery. Some oncologists advocate definitive chemoradiotherapy as the initial treatment for esophageal cancer. Although long-term survival is possible with chemoradiotherapy, locoregional recurrence and complications, such as esophageal fistula, are major problems. Indeed, locoregional recurrence is reported in 40 to 60 percent of patients after initial chemoradiotherapy.[4,5] Salvage esophagectomy followed by esophageal reconstruction is the only treatment option for such patients and is expected to be performed with increasing frequency. However, this type of surgery is compromised by postirradiation sequelae and is associated

TABLE III
Postoperative Status of the Patients

Patient	Postoperative Complication	Ventilator Dependent (days)	ICU Stay (days)	Beginning of Oral Feeding (postoperative day)	Diet
1	Local abscess	None	3	7	Normal
2	Pneumonia	1	2	12	Normal
3	Local abscess	2	3	19	Normal
4	Pneumonia	7	13	34	Normal
5	None	3	7	10	Normal
6	Minor leakage	1	1	28	Soft
7	None	1	4	7	Normal
8	None	1	4	20	Normal

ICU, intensive care unit.

FIG. 1. A 54-year-old man with esophageal cancer at the lower third of the thoracic esophagus was treated with curative chemoradiotherapy.

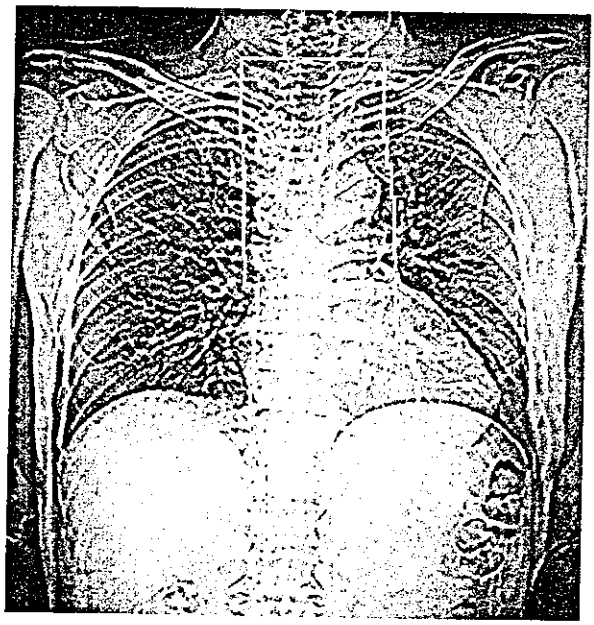

FIG. 2. *White lines* indicate the field of irradiation. The cervical esophagus and the upper body of the stomach were included.

FIG. 3. Anastomosis between the pedicled colon and cervical esophagus (**arrow*). Stump of ileocolic artery and vein was anastomosed with the transverse cervical artery and internal jugular vein (***arrow*).

with a significant risk of perioperative morbidity and mortality. In particular, anastomotic leakage is a potentially fatal complication that must be avoided. In addition, a less invasive, less complex, and safer method must be established for esophageal reconstruction, because of the patient's poor general condition and nutritional status after initial chemoradiotherapy.

As Swisher et al.[1] mentioned, salvage esophagectomy may improve patient survival; however, we do not have sufficient survival benefit data at present. Therefore, overall prognosis is not a significant factor in patient selection at this time. We intended to cure the patients with recurrent disease or a complication. Our approach is not palliative and we choose the candidate very carefully. Our patient selection was as follows. When disease recurred locally or complications developed after chemoradiotherapy, the patient was initially referred to a thoracic surgeon. The thoracic surgeon determined whether the tumor was operable. If this was the case, we provided enough information about the salvage esophagectomy to the patients. The final decision to proceed was made by the patient.

The use of the stomach as a conduit for esophageal replacement through the posterior

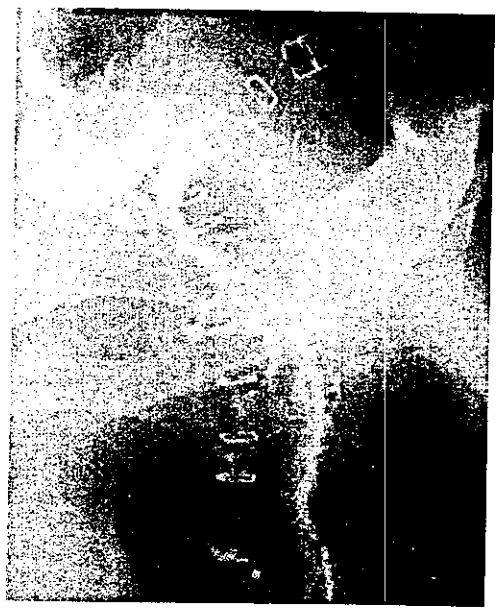

FIG. 4. Postoperative esophagography was performed at 7 days after esophageal reconstruction. No anastomotic leakage was observed.

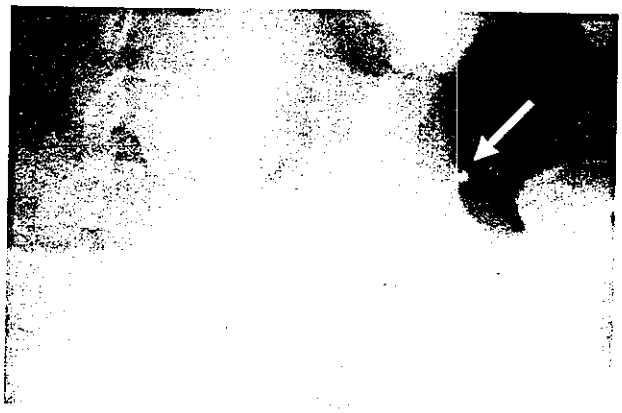

FIG. 5. Anastomotic leakage at the cervical anastomosis was observed 2 days after beginning of oral feeding. *Arrow* indicates small fistula, which was treated conservatively and closed 28 days later.

mediastinal route is less invasive and less complex and is also an ideal food pathway. However, the stomach cannot be used for esophageal reconstruction in patients who have undergone gastrectomy or have cancers of the stomach. Furthermore, a previously irradiated stomach is unsuitable for esophageal reconstruction. In such patients, a pedicled colon or jejunal graft should be used. However, an important consideration in the use of pedicled jejunal grafts is redundancy of intestinal segments, which can impair the passage of food.[6]

Redundancy of a jejunum graft is caused by radial arrangement of its vascular arcade, and we cannot avoid it. Though controversial, usage of colon provides an adequate length as a substitute of the esophagus. In contrast, pedicled colon grafts have several advantages. As previously mentioned, a pedicled colon graft can be used even in patients with gastric cancer. Furthermore, use of a pedicled colon graft avoids manipulation of an irradiated stomach. At our hospital, the radiation field for esophageal cancer often extends from the cervical esophagus to the proximal stomach. To avoid anastomosis between an irradiated cervical esophagus and an irradiated stomach, we use a pedicled colon graft for esophageal reconstruction after salvage esophagectomy.

DeMeester et al.[7] have reported four cases of intraoperative graft ischemia and three cases of postoperative graft necrosis in 92 patients who had undergone esophageal reconstruction with pedicled colon interposition but without microvascular anastomosis. Swisher et al.[1] report anastomotic leakage in five of 13 patients (39 percent) after salvage esophagectomy and colonic reconstruction. Meunier et al.[2] have reported anastomotic leakage in two of six patients (33 percent) after salvage esophagectomy and esophageal reconstruction with a gastric tube. Although anastomotic leakage is frequently reported, only a single case of slight anastomotic leakage, which healed with conservative treatment, occurred in our eight patients.

Previous authors have emphasized the importance of adequate arterial supply and venous drainage in pedicled colon grafts. Disturbance of a graft's blood flow can lead to fatal complications, especially in the patients who have undergone salvage esophagectomy after curative chemoradiotherapy. Therefore, we believe that microsurgical arterial and venous anastomoses should be used in esophageal reconstruction after salvage esophagectomy. The technique of microvascular anastomosis in reconstruction following esophagectomy was first described by Longmire,[8] and recently Nagawa et al.[9] reported on nine cases of additional arterial anastomosis. However, these authors have not mentioned the importance of additional microvascular anastomosis in esophageal reconstruction following salvage esophagectomy.

Another consideration in our method is the postoperative course of our patients. Average length of dependence on mechanical ventilation and stay in the intensive care unit after esophageal reconstruction is shorter than that of a previous report.[1] Furthermore, all the patients achieved satisfactory swallowing function postoperatively, except one patient with an anastomotic leak. This indicates that scar formation attributable to minor leakage can cause a disturbance of swallowing function.

A significant disadvantage of our method is its complexity. The surgical procedure involves three intestinal anastomoses and extensive subcutaneous undermining of the anterior chest. However, the pedicled colon is the organ of first choice for esophageal replacement when the stomach has been resected or irradiated. Furthermore, the subcutaneous route is safe and reliable. We believe our method is appropriate for esophageal reconstruction after salvage esophagectomy. We also believe that additional arterial and venous anastomoses are important for successful reconstruction.

Conclusions

Esophageal reconstruction with a pedicled colon graft was performed after salvage esophagectomy in patients with relapse or complications after having undergone curative-intent chemoradiotherapy for esophageal cancer. Arterial supercharge and venous superdrainage were performed to avoid anastomotic leakage caused by disturbance of blood flow in the pedicled colon graft. Minimal anastomotic leakage was observed. We conclude that additional microvascular anastomosis is important for esophageal reconstruction after salvage esophagectomy.

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