TABLE 2

*University of Pittsburgh staging system for SCC of the temporal bone**

Status	Characteristics
T1	tumor limited to EAC w/o osseous erosion or evidence of soft-tissue extension
T2	tumor w/ limited EAC osseous erosion (not full thickness) or radiographic findings consistent w/ limited (<0.5 cm) soft-tissue involvement
T3	tumor eroding osseous EAC (full thickness) w/ limited (0.5 cm) soft-tissue involvement, or tumor involving ME &/or mastoid
T4	tumor eroding cochlea, petrous apex, medial wall of ME, carotid canal, jugular foramen, or dura mater, or w/ extensive (0.5 cm) soft-tissue involvement; patients presenting w/ facial paralysis
N	lymph node involvement (N1) as poor prognostic sign, placing patient in an advanced stage (that is, T1, N1 [Stage III], & T2, -3, or -4, N1 [Stage IV]); if lymph node not involved (N0), staging does not change
M	if metastasis present (M1), clinical stage is modified to Stage IV, which is considered a very poor prognostic sign; if metastasis not present (M0), staging determined by T & N status

* Clinical stage (TNM stage) is based on tumor (T) status and modified according to lymph node (N) and metastasis (M) status.

durally and resected along with the tumor mass. For tumors extending anteriorly to the temporomandibular joint that involved the medial and lateral pterygoid muscles, orbitozygomatic osteotomy was performed to provide a more anterior view (3 cases). Through this route, bone drilling was extended anteriorly along the carotid canal to the inferior orbital fissure by dividing the mandibular branch of the trigeminal nerve, and the pterygoid muscles were detached or cut close to the lateral pterygoid plate. This procedure allowed complete exposure of the petrous ICA to the extracranial space, while leaving the lateral tumor mass untouched. These procedures are schematically drawn in Fig. 1, and an illustrative intraoperative view after tumor resection is shown in Fig. 2 (Case 15).

Total TBR. In tumors extending to the petrous apex, total TBR was performed in 3 cases. Following exposure of the middle cranial fossa, the tumor around the carotid canal was first removed in a piecemeal fashion, and then standard subtotal TBR was performed. After resection of the main tumor mass, the remaining tumor and bone in the apex were removed.

Adjuvant Therapy

For patients who had been treated with radiotherapy, additional doses of radiation were administered postoperatively when possible. In the initial cases, preoperative radiotherapy of up to 40 Gy was administered in selected patients. Seven patients were treated with perioperative chemotherapy (Table 1).

Prognostic Factors and Statistical Analysis

To analyze factors that might influence local tumor control and survival, the pathologically verified surgical margin; preoperative imaging extensions to the petrous apex, infratemporal fossa, and jugular foramen; and dural extensions were evaluated by performing a Kaplan–Meier analysis followed by univariate analysis with the log-rank test (Dr SPSS II software, SPSS, Inc.). Statistical significance was set at a probability value < 0.05.

Results

Tumor Grading and Pathological Margin

Figure 3 depicts the tumor locations including extensions, according to a pathologically verified surgical margin. Although relatively small tumors were included in this study (such as in Cases 8 and 11), most of the lesions extended upward to elevate the dura or anteriorly into the infratemporal soft tissue. As a result, all tumors except 1 (Case 8, T3) were graded as T4 (Table 1).

Given that large tumors extended to the petrous apex in Cases 2, 4, and 6, total TBR was performed while preserving the petrous ICA, inevitably leading to a positive surgical margin (Fig. 3A). The patient in Case 1 harbored a large intracranial mass, which was resected in a piecemeal fashion. In Cases 5 and 7, the tumors were relatively small but involved the temporomandibular joint and pterygoid muscles; these anteriorly extending tumors were removed from the anterolateral direction in a piecemeal fashion.

After this initial experience, which resulted in poor patient survival, we introduced the orbitozygomatic osteotomy technique and achieved a negative surgical margin in Cases 15, 16, and 17. As shown in Fig. 3B, tumors in these cases were much larger than those in Cases 5 and 7. For tumors encroaching on the jugular foramen, the extradural posterior transjugular approach was combined with the standard temporal bone resection in 3 cases (Cases 9, 13, and 15). In another patient (Case 15), the tumor had invaded the lateral wall of the jugular bulb and sigmoid sinus, which was removed by the intradural route by directly opening the jugular bulb after a posterior transjugular approach. In 3 of these 4 cases, a negative surgical margin was successfully achieved; in the patient in Case 13, a small hard tumor mass attached to the fibrous band of the jugular vein was also removed.

Local Tumor Control and DSS

All patients, except 1 (Case 10), were followed up until death or the end of the study. During the follow-up period, local tumor recurrence was observed in 5 patients within the first 1.2 years (Fig. 4A); all of these patients died within 2 years of treatment. No local tumor recurrence was seen 2 years after surgery. The overall RFS rate was 67.5% at 5 years posttreatment.

One patient (Case 8) died following distant metastasis 6 months after surgery, despite having a negative surgical margin and good local tumor control. Another patient (Case 3) died of unrelated causes (pneumonia) without evi-

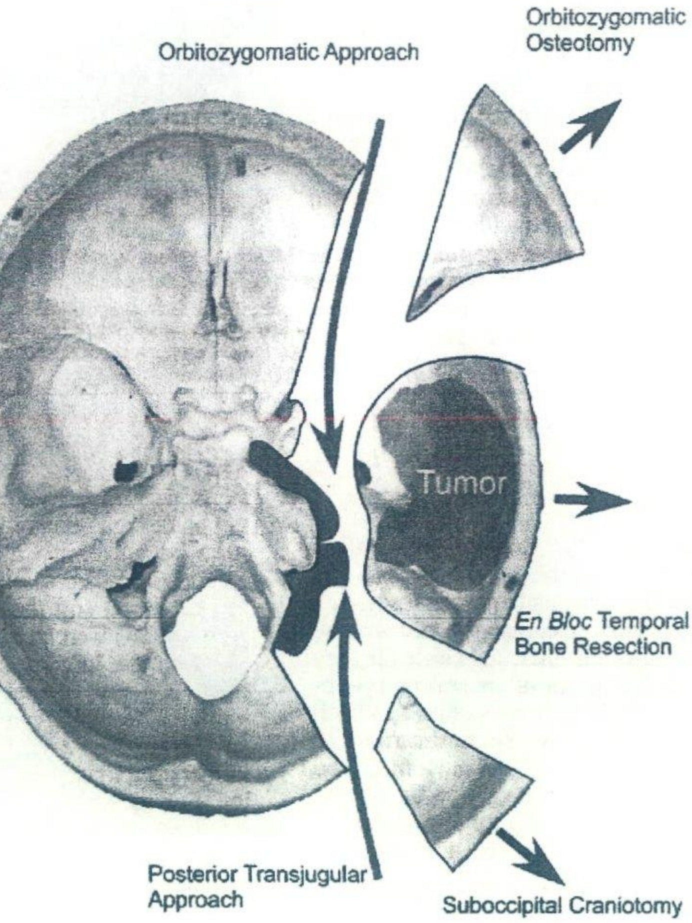


FIG. 1. Drawing illustrating the extent of subtotal TBR for tumors with infratemporal fossa and jugular foramen extension. En bloc resection of the lateral temporal bone can be achieved with a combined orbitozygomatic osteotomy and posterior transjugular approach, which provide anterior and posterior routes to the carotid canal and jugular foramen, respectively. *Red* indicates the carotid artery, and *blue* indicates the sigmoid sinus and jugular bulb.

dence of recurrence 5.4 years after surgery. Thus, the 5-year DSS rate was 60.1% (Fig. 4B). No patient who survived > 2 years showed evidence of disease, with the exception of the patient in Case 5 who had relatively stable multiple lung metastases of adenoid cystic carcinoma.

Prognostic Factors

The most important local prognostic factors for temporal bone malignancy are the size and extension of the tumor, which have been graded by several authors.[1,10,13,32,34] According to the University of Pittsburgh tumor grading system, all of the lesions in the present study were graded T4 (most advanced), except 1 (Case 8); therefore, we did not include tumor grading as a potential prognostic factor.

Instead, we evaluated the effects of a pathologically verified surgical margin; tumor extension to the petrous apex, infratemporal fossa, and jugular foramen; and dural involvement on RFS and DSS (Table 3). Both types of survival were significantly affected by surgical margin and petrous apex extension. None of the patients with a negative surgical margin (10 patients) had a local recurrence, and all of them had a 5-year RFS rate of 100%; those with a positive surgical margin (7 patients) had a local recurrence within 1.2 years posttreatment and a 5-year RFS rate of 29% ($p = 0.003$; Fig. 4A). Similarly, the 5-year DSS rates in patients with negative and positive surgical margins were 89 and 29%, respectively ($p = 0.03$; Fig. 4B).

All patients with petrous apex extensions (3 patients) who had undergone total TBR had a local recurrence within 1.2 years postsurgery and died within 2 years of surgery; those without petrous apex extensions had RFS and DSS rates of 84 and 75%, respectively, 5 years after treatment ($p = 0.004$ and $p = 0.006$, respectively). The 3 other factors evaluated had no significant effect on RFS and DSS, although jugular foramen extensions were marginally significant in DSS (Table 3).

Surgical Complications

The surgical complications are shown in Table 1. Cranial nerves VII and VIII were sacrificed during surgery in all but 1 patient (Case 1), which resulted in facial palsy and deafness. The mandibular branch of the CN V (V3) was also sacrificed in 5 patients. In the patient in Case 14, lower CNs were resected because of apparent tumor invasion with resultant postoperative dysphagia. No other new neurological deficits were noted postoperatively. Severe infections developed in 2 of the initial 8 cases. In the patient in Case 1, the infection may have arisen from the dead space that remained after the tumor invading the brain had been resected. In the patient in Case 6, a large tumor eroding the skin had been infected preoperatively due to tumor necrosis, which resulted in severe meningitis and encephalitis. Both patients were successfully treated with antibiotic therapy. In the final 9 cases, the most severe complication was brainstem edema, which was caused by resection of the jugular bulb but subsided within 2 weeks. This patient suffered no permanent brainstem symptoms. The overall and major surgical complication rates, unrelated to a planned sacrifice of CNs, were 29 and 18%, respectively. None of the patients died of surgical complications.

Discussion

Primary malignancies involving the lateral skull base originate from sites such as the EAC, middle ear, and petrous bone or extend from the parotid gland. The rarity, histological heterogeneity, and anatomical complexity of these lesions make direct comparisons difficult, although they have been made easier by the proposal of several preoperative staging systems.[1,10,21,28,32–34] Recent studies in which these classifications have been used are summarized in Table 4, as are the treatment modalities and outcomes. The University of Pittsburgh grading system proposed by Arriaga et al.[1] and Hirsch[13] is most frequently applied to the various malignancies and was used in the present study (Table 2).

As expected, the prognosis of small or early-grade tumors was excellent, with long-term survival rates of usually > 70%, regardless of the grading system (Table 4). However, the outcome in patients with advanced tumors was poor, with survival rates ranging from 0–50%. Focusing solely on University of Pittsburgh grading studies, the 5-year survival rates for T4 or Stage 4 tumors were 16–41%.[24,26,29,35,38] Therefore, the overall 5-year survival rate of 60% in patients with advanced tumors in the present study compares favorably.

Most treatments for these malignancies are a type of TBR. The extent of resection must be tailored to the location and extension of the tumor, which is basically classified into 4 types (for a review, see Willging and Pensak[37]). Canal or sleeve resection via cortical mastoidectomy is used for lesions confined to the cartilaginous portion of the EAC and can be extended to include the total osseous canal lateral to the stapes (lateral or partial TBR). Subtotal TBR is indicated for tumors extending into the mastoid or middle ear (T3 tumors) or much larger and more extensive lesions (T4). The principle of this en bloc procedure was first described by Parsons and Lewis.[27] For tumors extending to the petrous apex, total TBR is often indicated, and resection of the apex is inevitably piecemeal.

En bloc resection has been used for extensive tumors in the majority of recently reported studies (Table 4), with subtotal TBR documented in < 12 cases in these studies, except in those by Goodwin and Jesse[10] and Moffat et al.[24] Moreover, because of difficulties with en bloc resection, some lesion parts have been resected in a piecemeal fashion, as described by Moody et al.[25] and McGrew et al.[22] Accordingly, most outcomes following en bloc resection of Grade T4 tumors remain poor and are comparable to outcomes in other studies of piecemeal gross-total resection.[4,16,39] Despite these difficulties, en bloc resection with a tumor-free margin is reportedly a major prognostic indicator of excellent long-term survival ranging from 75–100% at 5 years posttreatment.[2,10,25,26,29,38] Compare this rate with that in patients with a positive surgical margin, who usually die within 2 years posttreatment. Thus, the most critical issue for improving long-term outcome in patients with Grade T4 tumors appears to be enhancing en bloc resectability.

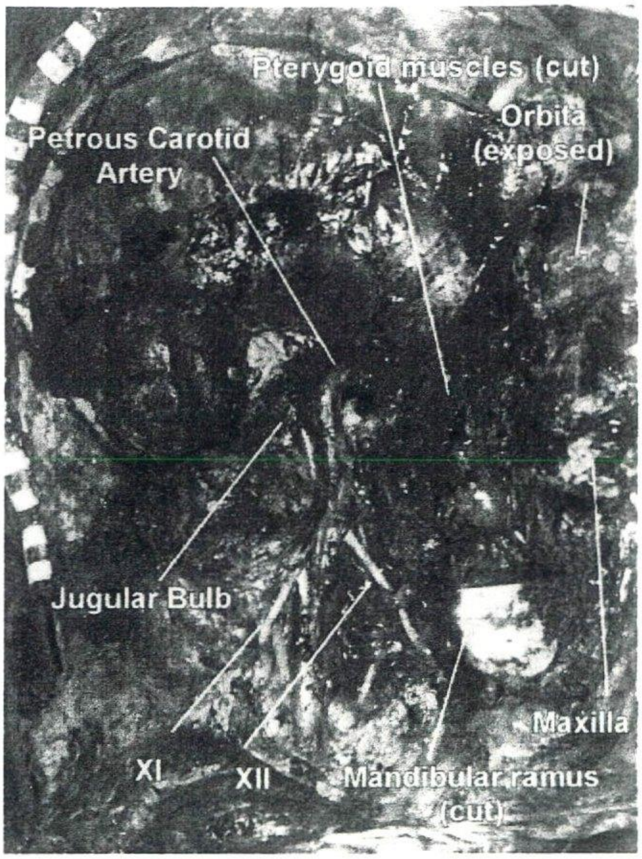


FIG. 2. Case 15. Photograph obtained after en bloc subtotal TBR via the orbitozygomatic and posterior transjugular approaches, showing complete removal with a tumor-free margin. The maxilla, orbit, jugular bulb, and ICA were all exposed after removal of the lesion. XI = accessory nerve; XII = hypoglossal nerve.

Our initial experience with extensive tumors (Grade T4) was similar in that en bloc resection with a tumor-free margin was technically difficult and led to poor patient survival. To overcome this trend, we introduced 2 methods. The first method was orbitozygomatic osteotomy, which allowed wider access to intracranial skull base lesions while minimizing brain retraction.[7,12] This technique, which was later modified and renamed the "orbitozygomatic infratemporal fossa approach,"[12,18] also provided a wider view of the infratemporal fossa,[14] particularly from the anterior direction. Performing an anterior or infratemporal tumor resection reportedly has been associated with a poor

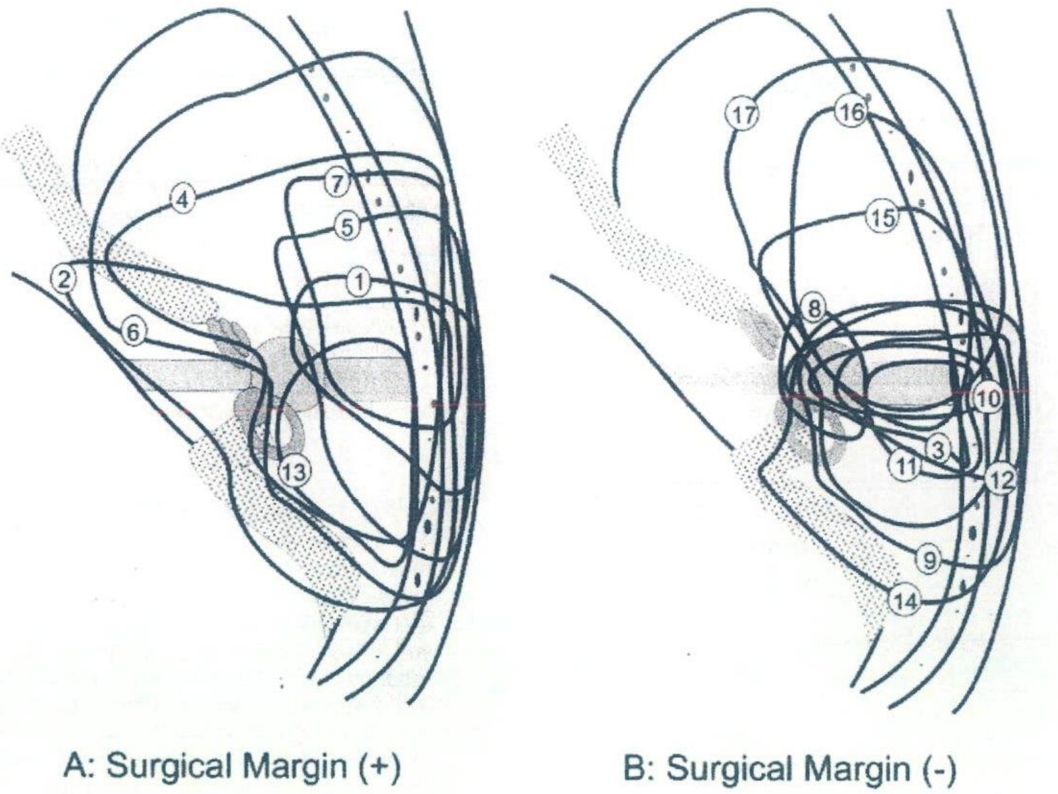


FIG. 3. Schematics revealing tumor locations and extensions in the temporal bone according to case number. A: Tumors in which a positive surgical margin was verified pathologically. B: Tumors with a negative surgical margin.

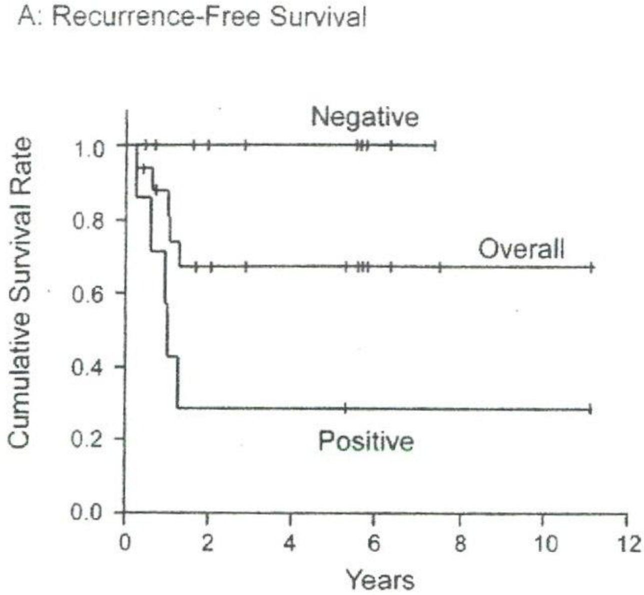
prognosis.[21] By using this technique in the present study, we achieved en bloc resection of tumors extending into the infratemporal fossa with a negative surgical margin, and these lesions were larger than those in previous cases.

The second method was the direct posterior approach to the jugular foramen without entering the mastoid process. A popular technique in the field of otolaryngology is the infralabyrinthine approach through a partial mastoidectomy,[17] which leads to tumor exposure or transection of large Grade T4 tumors extending to the jugular foramen. In the neurosurgical literature, however, the posterior approach as an extension of a suboccipital craniotomy without mastoidectomy, which provides an advantage in lateral base malignancies, has been described by Hakuba et al.,[11] Sasaki and Takakura,[31] George et al.,[8] and Kawahara et al.[15] We therefore used this approach in 4 cases in the latter half of the series and achieved a negative surgical margin in 3 of these cases. The introduction of these techniques markedly improved the probability of successful en bloc resection and survival (Table 1 and Fig. 3B). Recurrence-free survival and DSS rates 5 years after treatment in patients with a negative surgical margin were excellent (100 and 89%, respectively, vs 29% with a positive margin). Because of the high rate of negative surgical margins, the overall DSS rate 5 years after treatment improved to 60% among our series, which exceeded the rate in many previous studies (Table 4).

Another factor associated with poor patient survival is dural invasion. In the present study, preoperative MR imaging suggested dural invasion in 8 cases. Although overt brain invasion was apparent in 1 of these cases, the tumors in the other 7 did not invade intradurally and were completely resected with a wide safety margin. Thus, dural involvement on preoperative imaging studies did not affect long-term tumor control and survival.

Lesion extension to the petrous apex is usually resected piecemeal in total TBR, and the performance of this technique is usually associated with a worse 5-year survival rate than subtotal TBR,[25] which was estimated to be 0% in a systematic review by Prasad and Janecka.[30] It is also related to the issue of ICA sacrifice, and in this regard, Brisman et al.[5] have recommended ICA sacrifice and revascularization for extensive tumors. In their study, however, only 1 patient with adenoid cystic carcinoma out of 7 who had undergone carotid sacrifice and revascularization survived > 2 years without tumor recurrence, for a major complication rate of 71%. This outcome is similar to that in the present study, in which all 3 patients with petrous apex extension who had undergone total TBR with ICA preservation died within 2 years of surgery. Based on these results, we believe that curative resection for these tumors is rarely possible and that ICA sacrifice does not improve the survival rate but rather increases the likelihood of complications.

Given the relatively high risks of en bloc surgery, piecemeal resection combined with radiotherapy has been recommended by Kinney and Wood[16] and Birzgalis et al.,[4] for a survival rate of 37–45% (Table 4). Authors of these early



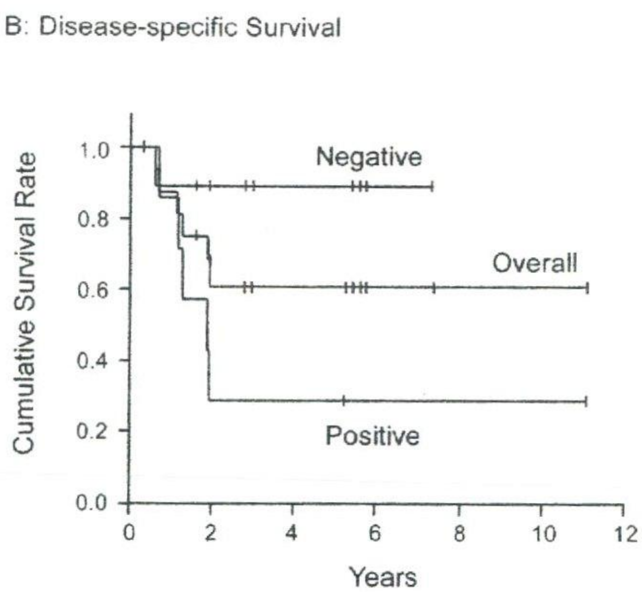


FIG. 4. Kaplan–Meier curves for RFS (A) and DSS (B). Negative = negative surgical margin; Positive = positive surgical margin.

TABLE 3
Factors predictive of RFS and DSS in 17 patients with skull base malignancy

Parameter	No. of Patients	p Value	
		RFS	DSS
surgical margin		0.003*	0.031*
positive	7		
negative	10		
tumor extension to			
petrous apex	3	0.004*	0.006*
infratemporal fossa	6	0.102	0.199
jugular foramen	6	0.179	0.048*
dura mater	8	0.099	0.278

* Statistically significant on univariate analysis with log-rank test.

studies used different classification systems, and therefore, the results cannot be compared with those in other reports. Although radiotherapy is usually combined with surgery in the treatment of such tumors, a recent study in which the University of Pittsburgh classification scheme was used revealed the limitations of conventional radiotherapy for advanced tumors, with a disappointing 5-year survival rate of 20% for Grade T4 tumors.[39]

In contrast, new technologies, such as 3D conformal radiotherapy, IMRT, and charged-particle therapy, can now be applied in the treatment of various head and neck malignancies.[3] In the context of charged-particle therapy, the 5-year overall local control and survival rates have been 60 and 33%, respectively, for carbon-ion therapy[23] and 74 and 44%, respectively, for proton beam therapy.[36] Even better results have been reported following IMRT for nasopharyngeal carcinoma, in which the 3- to 4-year local control and overall survival rates have been estimated as 82–98% and 77–88%, respectively, although the follow-up period remains short.[6,19] Based on these preliminary data, we predict that more patients will be treated using new radiotherapy alone or in combination with surgery.

However, these data should be analyzed with caution. Squamous cell carcinoma, which is the most common histological subtype, is the least responsive to charged-particle therapy (with a 5-year local control rate of 34%) and patient survival is poor,[23] indicating that the presence of some viable tumor cells can contribute to distant metastasis.[23,36] In addition, the good IMRT results for nasopharyngeal carcinoma might not be applicable to temporal bone malignancies, as the dosage must be limited to avoid possible side effects to adjacent brain. Therefore, we still recommend radical en bloc TBR aiming for a negative surgical margin, which has the potential to produce a 5-year survival rate of > 75%.[2,10,25,26,29,38]

Conclusions

Despite progress in skull base techniques in head and neck surgery and neurosurgery, the long-term prognosis of large lateral skull base malignancies remains poor. This poor prognosis is mostly related to the probability of en bloc tumor resection. While working as a multidisciplinary team, we have combined surgical techniques commonly used in the neurosurgical field (namely orbitozygomatic infratemporal fossa and posterior transjugular approaches) and improved the resectability of lesions and long-term survival of our patients. More active participation of neurosurgeons could further improve the probability of successful en bloc resection of these tumors. Lesions involving the brain and those extending to the petrous apex with ICA involvement still carry the worst prognosis. We believe that radical TBR is not curative in such cases and therefore should rarely be indicated. In such cases, new radiotherapies (such as IMRT or charged-particle therapy) could be used alone or in combination with less invasive palliative surgery.

TABLE 4

Literature summary of studies on TBR for malignant tumors

Authors & Year	No. of Cases	Tumor Classification (no. of cases)	Type of Surgery (no. of cases)	Resection Policy	Survival Rate	Prognostic Factor
Goodwin & Jesse, 1980	136	Group 1: cartilaginous EAC (76), Group 2: osseous EAC (22), Group 3: medial to ME (38)	subtotal TBR (25) for Group 3, other treatment (111) for Groups 1, 2, and 3	en bloc	all at FU of 5 yrs, Group 1: 57%, Group 2: 45%, Group 3: 29%	surgical margin
Kinney & Wood, 1987	30	Group 1: limited to EAC (12), Group 2: limited extension beyond EAC (7), Group 3: extension outside EAC (11)	piecemeal resection (29), radical TBR (1)	piecemeal	all at average FU of 2.5 yrs, Group 1: 91%, Group 2: 72%, Group 3: 45%	NA
Go et al., 1991	16	NA	partial TBR (4), total TBR (12)	en bloc	for malignant tumors, FU of 5 yrs, 56%	NA
Spector, 1991	34	EAC (7), superficial invasion (3), deep invasion (10), beyond TB (14)	canal resection (7), partial TBR (3), subtotal TBR (10), ITF (14)	en bloc	all at average FU of 36.6 mos, EAC + superficial invasion: 100%, deep invasion: 70%, beyond TB: 65%	
Birzgalis et al., 1992	66	early presentation (10), late presentation (39), not classified (17)	radical XRT (53), palliative XRT (7), not treated (6)	piecemeal	all at FU of 5 yrs, early presentation: 80%, late presentation: 26%, all treated: 32%, radical XRT: 37%, palliative XRT: 0%	tumor stage
Austin et al., 1994	22	UP grading: T1 (8), T2 (4), T3 (6), T4 (4)	canal resection (7), partial TBR (7), subtotal TBR (4), total TBR (2), other treatment (2)	en bloc	all at FU of 3 yrs, T1–T2: 75%, T3: 50%, T4: 50%, en bloc resection + XRT (6 patients): 100%	en bloc resection, adjuvant XRT
Pensak et al., 1996	46	Grade I: single tumor ≤1 cm (3), Grade II: single tumor >1 cm (14), Grade III: transannular extension (6), Grade IV: mastoid or petrous invasion (5), Grade V: extratemporal extension (10), Grade VI: neck adenopathy, distant, ITF (8)	canal resection (1), lat TBR (16), modified lat TBR (13), total TBR (9), other treatment (7)	en bloc	rate w/ no evidence of tumor, all at FU of 5 yrs, Grade I–II: 82%, Grade III: 67%, Grade IV: 40%, Grade V: 75%, Grade VI: 0%	NA†
Testa et al., 1997	79	UP grading: T1 (8), T2 (26), T3 (27), T4 (16), unknown (2)	canal resection (37), partial TBR (15), subtotal TBR (6), total TBR (1), other treatment (20)	NA	all at FU of 5 yrs, Stage 1–2: 77–100%, Stage 3: 45%, Stage 4: 16%, XRT only: 29%, subtotal + total TBR: 43%	tumor type, clinical stage, surgery, bone erosion
Manolidis et al., 1998	30	Group 1: epithelial tumors (30): Stage 1: confined to EAC (15); Stage 2: TMJ, parotid, ITF (5); Stage 3: ME, mastoid, facial nerve (4); Stage 4: dura, JB, SS, ICA, petrous apex (6)	lat TBR (22), total TBR (6), other (2)	NA	all at average FU of 54 mos, Stage 1: 80%, Stage 2: 80%, Stage 3: 25%, Stage 4: 0%	pain, facial paralysis, ITF extension
Pfreundner et al., 1999	27	UP grading: T1 (7), T2 (2), T3 (6), T4 (12)	local resection (10), partial TBR (14), subtotal TBR (1), other treatment (2)	NA	all at FU of 5 yrs, T1–2: 86%, T3: 50%, T4: 41%, negative margin: 100%, positive margin: 66%	dural/cerebral invasion, surgical margin
Zhang et al., 1999	33	UP grading: T1 (2), T2 (1), T3 (19), T4 (11)	gross resection (22), XRT only (11)	piecemeal	FU of 3 yrs, Stage 1–2: 100%; all at FU of 5 yrs, Stage 3: 69%, Stage 4: 20%, total: 29%, XRT alone: 28.7%	NA
Moody et al., 2000	32	UP grading: T1 (7), T2 (5), T3 (6), T4 (14)	modified lat TBR (3), lat TBR (18), subtotal TBR (6), total TBR (5)	medial margin: piecemeal	all at FU of 2 yrs, T1: 100%, T2: 80%, T3: 50%, T4: 7%, subtotal TBR: 33%, total TBR: 0%, negative margin: 75%, positive margin: 32%	surgical margin, dural invasion
McGrew et al., 2002	95	NA	lat TBR (NA), subtotal TBR (NA), total TBR (NA)	en bloc usually	at average FU of 50 mos, entire group: 63–74% (subtotal TBR excluded)	NA
Yeung et al., 2002	59	UP grading: T1–T4, no. NA	canal resection (20), lat TBR (30), subtotal TBR (9)	en bloc	all at FU of 5 yrs, Stage 1: 90%, Stage 2: 45%, Stage 3: 40%, Stage 4: 19%, negative margin: 80%, positive margin: 30%, subtotal TBR: 22%	surgical margin, histological features
Moffat et al., 2005	39	UP grading: T1 (0), T2 (2), T3 (6), T4 (31)	lat TBR (4), extended TBR (33), other treatment (2)	en bloc	at average FU of 7.6 yrs, T2: 100%, T3: 50%, T4: 38%; at FU of 2 yrs, overall: 39%	lymph node–positive, poor differentiation, brain involvement, salvage surgery
Nakagawa et al., 2006	25	UP grading: T1 (1), T2 (3), T3 (5), T4 (16)	lat TBR (7), subtotal TBR (5), conservative treatment (13)	en bloc	at FU of 3 yrs, T1–2: 100%; all at FU of 5 yrs, T3: 80%, T4: 35%, T4 w/ surgery: 75%, T4 w/o surgery: 16%	surgery, surgical margin, N status

* ITF = infratemporal fossa; NA = not available; SS = sigmoid sinus; TMJ = temporomandibular joint; UP = University of Pittsburgh.
† Authors listed contraindications instead, which were invasion of the cavernous sinus, ICA, ITF, and paraspinal musculature.

References

1. Arriaga M, Curtin H, Takahashi H, Hirsch BE, Kamerer DB: Staging proposal for external auditory meatus carcinoma based on preoperative clinical examination and computed tomography findings. **Ann Otol Rhinol Laryngol 99:**714–721, 1990
2. Austin JR, Stewart KL, Fawzi N: Squamous cell carcinoma of the external auditory canal. Therapeutic prognosis based on a proposed staging system. **Arch Otolaryngol Head Neck Surg 120:** 1228–1232, 1994
3. Bangalore M, Matthews S, Suntharalingam M: Recent advances in radiation therapy for head and neck cancer. **ORL J Otorhinolaryngol Relat Spec 69:**1–12, 2007
4. Birzgalis AR, Keith AO, Farrington WT: Radiotherapy in the treatment of middle ear and mastoid carcinoma. **Clin Otolaryngol Allied Sci 17:**113–116, 1992
5. Brisman MH, Sen C, Catalano P: Results of surgery for head and neck tumors that involve the carotid artery at the skull base. **J Neurosurg 86:**787–792, 1997
6. Eisbruch A, Marsh LH, Dawson LA, Bradford CR, Teknos TN, Chepeha DB, et al: Recurrences near base of skull after IMRT for head-and-neck cancer: implications for target delineation in high neck and for parotid gland sparing. **Int J Radiat Oncol Biol Phys 59:**28–42, 2004
7. Fujitsu K, Kuwabara T: Zygomatic approach for lesions in the interpeduncular cistern. **J Neurosurg 62:**340–343, 1985
8. George B, Lot G, Tran Ba Huy P: The juxtacondylar approach to the jugular foramen (without petrous bone drilling). **Surg Neurol 44:**279–284, 1995
9. Go KG, Annyas AA, Vermey A, Robinson PH, Belopavlovic M, Mehta DM: Evaluation of results of temporal bone resection. **Acta Neurochir (Wien) 110:**110–115, 1991
10. Goodwin WJ, Jesse RH: Malignant neoplasms of the external auditory canal and temporal bone. **Arch Otolaryngol 106:**675–679, 1980
11. Hakuba A, Hashi K, Fujitani K, Ikuno H, Nakamura T, Inoue Y: Jugular foramen neurinomas. **Surg Neurol 11:**83–94, 1979
12. Hakuba A, Liu S, Nishimura S: The orbitozygomatic infratemporal approach: a new surgical technique. **Surg Neurol 26:**271–276, 1986
13. Hirsch BE: Staging system revision. **Arch Otolaryngol Head Neck Surg 128:**93–94, 2002
14. Honeybul S, Neil-Dwyer G, Lees PD, Evans BT, Lang DA: The orbitozygomatic infratemporal fossa approach: a quantitative anatomical study. **Acta Neurochir (Wien) 138:**255–264, 1996
15. Kawahara N, Sasaki T, Nibu K, Sugasawa M, Ichimura K, Nakatsuka T, et al: Dumbbell type jugular foramen meningioma extending both into the posterior cranial fossa and into the parapharyngeal space: report of 2 cases with vascular reconstruction. **Acta Neurochir (Wien) 140:**323–330, 1998
16. Kinney SE, Wood BG: Malignancies of the external ear canal and temporal bone: surgical techniques and results. **Laryngoscope 97:**158–164, 1987
17. Lambert PR, Johns ME, Winn RH: Infralabyrinthine approach to skull-base lesions. **Otolaryngol Head Neck Surg 93:**250–258, 1985
18. Lee JP, Tsai MS, Chen YR: Orbitozygomatic infratemporal approach to lateral skull base tumors. **Acta Neurol Scand 87:**403–409, 1993
19. Lee N, Xia P, Quivey JM, Sultanem K, Poon I, Akazawa C, et al: Intensity-modulated radiotherapy in the treatment of nasopharyngeal carcinoma: an update of the UCSF experience. **Int J Radiat Oncol Biol Phys 53:**12–22, 2002
20. Lewis JS: Temporal bone resection. Review of 100 cases. **Arch Otolaryngol 101:**23–25, 1975
21. Manolidis S, Pappas D Jr, Von Doersten P, Jackson CG, Glasscock ME 3rd: Temporal bone and lateral skull base malignancy: experience and results with 81 patients. **Am J Otol 19:**S1–S15, 1998
22. McGrew BM, Jackson CG, Redtfeldt RA: Lateral skull base malignancies. **Neurosurg Focus 12(5):**E8, 2002
23. Mizoe JE, Tsujii H, Kamada T, Matsuoka Y, Tsuji H, Osaka Y, et al: Dose escalation study of carbon ion radiotherapy for locally advanced head-and-neck cancer. **Int J Radiat Oncol Biol Phys 60:**358–364, 2004
24. Moffat DA, Wagstaff SA, Hardy DG: The outcome of radical surgery and postoperative radiotherapy for squamous carcinoma of the temporal bone. **Laryngoscope 115:**341–347, 2005
25. Moody SA, Hirsch BE, Myers EN: Squamous cell carcinoma of the external auditory canal: an evaluation of a staging system. **Am J Otol 21:**582–588, 2000
26. Nakagawa T, Kumamoto Y, Natori Y, Shiratsuchi H, Toh S, Kakazu Y, et al: Squamous cell carcinoma of the external auditory canal and middle ear: an operation combined with preoperative chemoradiotherapy and a free surgical margin. **Otol Neurotol 27:** 242–249, 2006
27. Parsons H, Lewis JS: Subtotal resection of the temporal bone for cancer of the ear. **Cancer 7:**995–1001, 1954
28. Pensak ML, Gleich LL, Gluckman JL, Shumrick KA: Temporal bone carcinoma: contemporary perspectives in the skull base surgical era. **Laryngoscope 106:**1234–1237, 1996
29. Pfreundner L, Schwager K, Willner J, Baier K, Bratengeier K, Brunner FX, et al: Carcinoma of the external auditory canal and middle ear. **Int J Radiat Oncol Biol Phys 44:**777–788, 1999
30. Prasad S, Janecka IP: Efficacy of surgical treatments for squamous cell carcinoma of the temporal bone: a literature review. **Otolaryngol Head Neck Surg 110:**270–280, 1994
31. Sasaki T, Takakura K: Twelve cases of jugular foramen neurinoma. **Skull Base Surg 1:**152–160, 1991
32. Shih L, Crabtree JA: Carcinoma of the external auditory canal: an update. **Laryngoscope 100:**1215–1218, 1990
33. Spector JG: Management of temporal bone carcinomas: a therapeutic analysis of two groups of patients and long-term followup. **Otolaryngol Head Neck Surg 104:**58–66, 1991
34. Stell PM, McCormick MS: Carcinoma of the external auditory meatus and middle ear. Prognostic factors and a suggested staging system. **J Laryngol Otol 99:**847–850, 1985
35. Testa JR, Fukuda Y, Kowalski LP: Prognostic factors in carcinoma of the external auditory canal. **Arch Otolaryngol Head Neck Surg 123:**720–724, 1997
36. Tokuuye K, Akine Y, Kagei K, Hata M, Hashimoto T, Mizumoto T, et al: Proton therapy for head and neck malignancies at Tsukuba. **Strahlenther Onkol 180:**96–101, 2004
37. Willging JP, Pensak ML: Temporal bone resection. **Ear Nose Throat J 70:**612–617, 1991
38. Yeung P, Bridger A, Smee R, Baldwin M, Bridger GP: Malignancies of the external auditory canal and temporal bone: a review. **ANZ J Surg 72:**114–120, 2002
39. Zhang B, Tu G, Xu G, Tang P, Hu Y: Squamous cell carcinoma of temporal bone: reported on 33 patients. **Head Neck 21:**461–466, 1999

Manuscript submitted March 5, 2007.
Accepted July 11, 2007.

Address correspondence to: Nobutaka Kawahara, M.D., Ph.D., Department of Neurosurgery, Graduate School of Medicine, University of Tokyo 7-3-1, Hongo, Bunkyo-ku, Tokyo 113-8655, Japan. email: kawahara-tky@umin.ac.jp.

Jpn J Clin Oncol 2008;38(3)167–171
doi:10.1093/jjco/hym177

Original Articles

Planned Simultaneous Cervical Skin Reconstruction for Salvage Total Pharyngolaryngectomy

Kenta Watanabe[1], Takahiro Asakage[1], Kazunari Nakao[1], Yasuhiro Ebihara[1], Yoshinori Fujishiro[1], Mutsumi Okazaki[2], Hirotaka Asato[2] and Masashi Sugasawa[1]

[1]Department of Otolaryngology, University of Tokyo, Tokyo and [2]Department of Plastic and Reconstructive Surgery, University of Tokyo, Tokyo, Japan

Received October 1, 2007; accepted December 17, 2007; published online February 12, 2008

Background: Salvage surgery after definitive radiotherapy with or without chemotherapy is still controversial, especially in cases of hypopharyngeal cancer because of the poor prognosis and surgical complications. Irradiation of the skin results in loss of flexibility of the skin and impairment of the normal healing processes, thereby increasing the risk of wound infections, which could be potentially life-threatening. In an attempt to diminish the risk of major complications, we performed planned cervical skin replacement with salvage total pharyngolaryngectomy (TPL).
Methods: From 2005 to 2006, six patients underwent salvage TPL and cervical reconstruction with a deltopectoral flap at our hospital. The cervical skin replacement was determined pre-operatively and not according to the intraoperative status.
Results: There were no major post-operative complications. Both the prolongation of the operation time and of the duration of hospitalization were within acceptable limits.
Conclusion: Planned cervical skin reconstruction appears to be an appropriate and acceptable procedure with salvage pharyngolaryngectomy to avoid major complications.

Key words: hypopharyngeal cancer – reconstruction – chemoradiotherapy – salvage surgery – complication

INTRODUCTION

Remarkable improvements have been achieved in the treatment of head and neck squamous cell carcinoma (HNSCC) in recent years, owing to the advances in the radio- and chemoradiotherapeutic techniques employed. In the case of hypopharyngeal cancer, concurrent chemoradiotherapy has been shown to yield good complete response rates (1) and radiation combined with induction chemotherapy has been reported to be equivalent in therapeutic effect to surgery-based therapy which causes loss of voice (2,3). As organ preservation is very important for patients, more and more patients have begun to prefer radiation-based treatments. Unfortunately, in cases with locoregional control failure, surgical intervention is often considered as a salvage measure. However, the rationale of salvage surgery for locally recurrent hypopharyngeal cancer is still controversial in view of the high incidence of post-operative complications and the poor prognosis (4). Irradiation may cause radiodermatitis and fibrosis, with the resultant scarring producing loss of flexibility of the cervical skin and subcutaneous soft tissues, which poses surgical difficulties during subsequent salvage surgery. In addition to the intraoperative difficulties, the risk of post-operative complications, some of which can be life-threatening, e.g. carotid artery rupture, is also significantly increased (4–6). Wound healing is delayed and the normal processes of healing are impaired, which increase the risk of dehiscence and the chances of bacterial infection (7). Therefore, we were prompted to attempt replacement of the irradiated cervical skin with non-irradiated skin during salvage surgery. In this study, we report the usefulness of

For reprints and all correspondence: Kenta Watanabe, Department of Otolaryngology, Faculty of Medicine, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8655, Japan. E-mail: Quentaw@aol.com

Table 1. Patient characteristics

Patient	Age	Sex	Primary disease[a]	Primary treatment	Time to salvage	rTNM
1	63	Male	HPC(PS) T2N0M0	HART 72Gy	5 months	rT2N0M0
2	62	Male	HPC(PC) T1N2bM0	cCRT 70Gy	9 months	rT2N0M0
3	54	Male	CeEso TxN2bM0	cCRT 60Gy	2 months	rT3N2bM0
4	63	Male	HPC(PS) T3N2bM0	RT 70Gy with ICT	1 y 1 month	rT2N0M0
5	60	Male	HPC(PS) T3N0M0	cCRT 70Gy	2 y 6 months	rT3N0M0
6	64	Male	HPC(PS) T2N0M0	HART 72Gy with ICT	1 y 4 months	rT2N0M0

The TNM classification of cervical esophageal cancer was applied as that of hypopharyngeal cancer. HPC, hypopharyngeal cancer; CeEso, cervical esophageal cancer; PS, pyriform sinus; PC, post-cricoid; HART, hybrid accelerated radiotherapy; cCRT, concurrent chemoradiotherapy; RT, radiotherapy; ICT, induction chemotherapy; rTNM, TNM stage at recurrence.
[a]TNM (UICC 2002).

'preoperatively planned' cervical skin reconstruction with a deltopectoral (DP) flap in cases undergoing salvage total pharyngolaryngectomy (TPL) after intensive radiotherapy or concurrent chemoradiotherapy, for the prevention of major post-operative complications.

PATIENTS AND METHODS

From February 2005 to December 2006, a total of six Japanese patients underwent salvage TPL and planned cervical reconstruction with a DP flap at the University of Tokyo Hospital, Tokyo, Japan. All patients were males, with a mean age of 61 years (range 54–64 years). Of the six patients, five had hypopharyngeal cancer and one had cervical esophageal cancer. Pathologically, the primary lesion was squamous cell carcinoma in all the cases. The patients had previously received radiation therapy or concurrent chemoradiotherapy, as described in Table 1, however, local recurrence necessitated salvage surgery. The chemotherapeutic regimen for concurrent chemoradiotherapy was intravenous cisplatin, pirarubicin hydrochloride and fluorouracil, administered either singly or in combination. The mean interval from the primary therapy to the salvage surgery for local recurrence was 12.5 months (range 2–30 months). The TNM stages at recurrence (rTNM) are also shown in Table 1.

All patients gave informed consent for the surgical procedure after obtaining a thorough understanding of the risks of the salvage surgery. TPL with pharyngeal tube reconstruction using a free jejunal flap was performed for locally recurrent disease in all cases, and neck dissection was also undertaken where possible. Simultaneous cervical skin reconstruction with a DP flap, after sacrificing the irradiated anterior cervical skin, was performed with epidermization of the donor site of the flap with a graft from the femoral area (Fig. 1). Prophylactic antibiotics (cefotiam hydrochloride or cefazolin sodium) were given to all patients for 4–6 post-operative days. This procedure was determined pre-operatively in all the cases of this series according to the

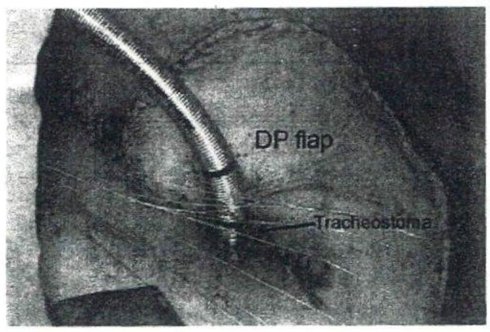


Figure 1. Intraoperative view of the procedure. Irradiated anterior cervical skin is sacrificed and replaced with a flexible deltopectoral (DP) flap.

comprehensive physical condition of the irradiated cervical skin, i.e. its flexibility, color and the thickness of the subcutaneous fat tissue. The peri- and post-operative courses of all the cases were evaluated retrospectively to determine the incidence of complications and the prognoses. The severity of the complications was classified according to the scheme proposed by Weber et al (8).

RESULTS

The surgical procedure was as mentioned above, and a schema is shown in Table 2. Bilateral level II–IV neck dissection was also performed in the majority of the cases. Neck dissection was omitted in one case due to the strong inflammatory adhesions that had developed following the development of a cervical abscess, and unilateral dissection was performed in another case due to previous neck dissection on the opposite side. The mean operation time was 12 h 13 min (range 10 h 15 min–14 h 3 min). The mean intraoperative hemorrhage volume was 398 ml (range 250—500 ml). Two cases required intraoperative blood transfusion. The mean time to oral intake after the operation was 12.5 days (range 10–15 days). The mean duration of hospitalization after operation was 28 days (range 22–40 days).

Table 2. Surgical data and prognosis

Patient	Surgical procedure	Operation time	Hemorrhage (ml)	Blood transfusion	Prognosis
1	TPL + FJT + DP	12 h	445	−	DOD after 12 months
2	TPL + bil.ND + FJT + DP	13 h 5 min	500	−	NED after 31 months
3	TPL + bil.ND + FJT + DP	14 h 3 min	510	+	DOC after 7 months
4	TPL + bil.ND + FJT + DP	12 h 25 min	250	+	DOD after 6 months
5	TPL + bil ND + FJT + DP	11 h 30 min	280	−	NED after 15 months
6	TPL + lt.ND + FJT + DP	10 h 15 min	400	−	NED after 14 months

TPL, total pharyngolaryngectomy; FJT, free jejunal transfer; DP, skin reconstruction with a deltopectoral flap; ND, neck dissection; DOD, died of the disease; NED, no evidence of disease; DOC = died of other cause.

None of the cases developed any major acute post-operative local complications, such as flap necrosis, salivary fistula formation and life-threatening major vessel crisis, or systemic complications. Therefore, during hospitalization, no further surgical procedures were necessitated in any of the cases and there were no surgery-related mortalities. In two cases, wound infection (peri-tracheostoma infection) occurred as an acute minor post-operative complication, which was treated by intravenous antibiotic administration. In two cases, stenosis of the tracheostoma was observed because of the coverage of the stoma by the sagging DP flap; this was treated by tube insertion or pulling up of the sagging skin with a tape after hospitalization (Fig. 2). During the follow-up period, two of the six patients died of the disease: one died due to recurrence in the parapharyngeal space and skin metastasis 6 months after the surgery, and another due to recurrence in the supraclavicular region 12 months after the surgery (Table 2). One patient died of other causes 7 months after the surgery, although he had lung metastasis at that time. The remaining three patients are alive at the time of writing, without evidence of disease recurrence (follow-up period range 14–31 months).

DISCUSSION

Intensive radiotherapy and concurrent chemoradiotherapy are becoming increasingly preferred strategies for the treatment of HNSCC. Previous studies have reported better survival rates with altered fractionated radiotherapy, including hyperfractionated and accelerated radiotherapy, than with conventional radiotherapy (9,10). Also, concurrent chemoradiation methods are now commonly chosen for advanced-stage head and neck cancers based on the equivalent or superior survival, locoregional control and organ preservation rates (1,11). Soo et al. (12) reported that there was no significant difference in the survival rate between advanced HNSCC patients treated by surgery and those treated by concurrent chemoradiotherapy. Recently, hyperfractionated or accelerated hyperfractionated concurrent chemoradiotherapy has also been evaluated for very advanced HNSCC (13,14). In cases of hypopharyngeal cancer, radiotherapy combined with induction chemotherapy has been reported to yield equivalent outcomes to surgery combined with post-operative radiation (2,3). As organ preservation, especially laryngeal preservation, may be expected to improve the quality of life, the aforementioned treatments have come to be increasingly preferred as compared to conventional surgery combined with post-operative radiation in patients with HNSCC (15).

On the other hand, in those cases with failure of organ preservation therapy, surgical procedures often need to be considered for salvage. The usefulness of salvage surgery is still controversial and such a surgery is regarded as a 'high stake' surgery, because of the poor prognosis, high risk of complications and also even the low cost–benefit ratio of the treatment (4–6,16). The disease-specific 5-year survival rate

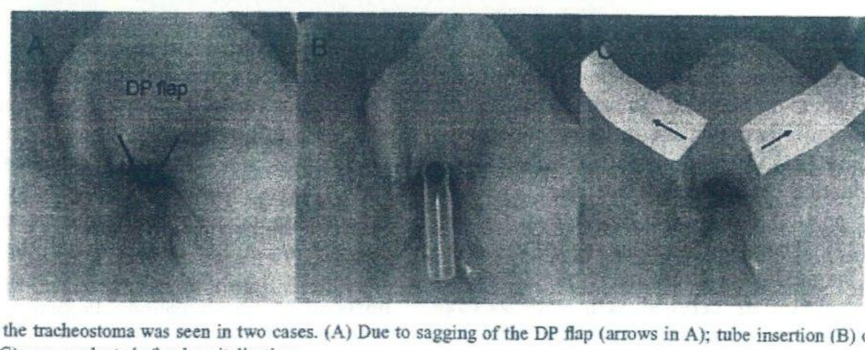


Figure 2. Stenosis of the tracheostoma was seen in two cases. (A) Due to sagging of the DP flap (arrows in A); tube insertion (B) or pulling up of the flap with a tape (arrows in C) was conducted after hospitalization.

of salvage surgery has been reported to be only 20%, especially in cases of hypopharyngeal cancer, and it has, therefore, been suggested that in these cases, salvage surgery should be performed only in very carefully selected cases (4). Not only minor complications, but also major ones, such as fistula formation and flap necrosis, are often reported in cases undergoing salvage surgery, which can sometimes directly lead to life-threatening carotid artery rupture (4–6). Although Proctor et al. (17) reported that patients treated by chemoradiation did not seem to be any significantly increased risk of acute post-salvage surgery complications, they did not include cases undergoing free tissue transfer in their study series. Meticulous attention should be paid to the operative procedure during salvage TPL, because the carotid arteries of both sides are exposed during the surgery. We, however, believe that salvage surgery should not be unduly restricted, except in unresectable cases and high-risk surgical cases because of poor general conditions, as better survival would be expected in cases with a favorable TNM stage at recurrence and a negative tumor resection margin (18); furthermore, even if the prognosis is poor, successful surgery without any major complications might still prolong the patients' time spent at home.

From January 2003 to 2005, we treated eight cases of salvage TPL with free jejunal transfer at our hospital, in none of which we performed skin reconstruction. We encountered major post-operative complications in four out of the eight cases, including one case of anastomotic leak that necessitated a second operation and three cases of carotid rupture. Therefore, the incidence rate of major complications was as high as 50%. Retrospective analysis of these cases has revealed that in the cases with the carotid rupture, the complication had developed consequent to wound infection caused by skin flap necrosis or seroma caused by poor vascularization and loss of flexibility of the irradiated skin, even in the absence of salivary fistula formation or jejunal flap necrosis. Irradiation damages the skin and subcutaneous tissue in terms of impairing wound healing (7). Impairment of fibroblast function by irradiation effects atrophy, contraction and fibrosis, leading to impaired wound healing (7), and surgeons often encounter surgical difficulties while operating on the irradiated tissue (6). It is recommended that all possible dead spaces be filled and that wounds be drained well and closed without tension to avoid the formation of seromas or hematomas which could cause wound infection (7,19). The effect of irradiation on wound healing is clearly dependent on the radiation dose (20) and organ damage occurs more frequently in patients undergoing concurrent chemoradiotherapy than in those undergoing radiotherapy alone (21). It has also been reported that surgery after induction chemotherapy was associated with a higher risk of post-operative complications in patients with HNSCC (22). Therefore, in this report, we have suggested a new surgical procedure, namely 'preoperatively planned' reconstruction of cervical skin with salvage TPL after radio- or chemoradiotherapy using non-irradiated, flexible and well-vascularized DP flaps. We have performed this procedure in cases needing salvage TPL at our hospital since February 2005, and have noted that the complication rate is indeed lower than that in the cases in which skin reconstruction is not undertaken after radio- or chemoradiotherapy. Reconstruction with flexible skin allows easy drainage and wound healing, reducing the risk of infections following the formation of seromas or hematomas. While there are some reports which suggest a high complication rate with the use of DP flaps and sacrifice of donor site, such as conspicuous scar deformity in the upper chest region (23), the DP flap remains a major useful candidate for neck reconstruction, especially as a salvage option (24), and indeed, we did not encounter any major complications in our series. The vascularization of the DP flaps, which we used only for covering the anterior neck region in this series, was maintained well, when the several perforators of the internal thoracic artery were preserved appropriately. Although superselective or selective neck dissection in salvage surgery and no elective neck dissection in recurrent N0 cases have been advocated (25,26), we suppose that replacement of cervical skin makes performance of neck dissection combined with TPL safer and also improves locoregional control. Although we have not yet determined definite criteria for this procedure, we think that it is especially valid for cases treated by concurrent chemoradiotherapy or altered fractioned radiotherapy, because the cervical skin in these cases seems calloused and poorly vascularized. During the same period, we encountered only two cases of salvage TPL without skin reconstruction which resulted in just a minor anastomotic leak and in no post-operative trouble, respectively, but they were cases of failure of conventional radiotherapy alone.

In this series, the operation time, time to oral intake and the duration of hospitalization all tended to be longer than those after TPL with a free jejunal flap reconstruction performed as first-line treatment at our hospital, although the data were not strictly comparable. The prolongation of the operation time was attributed to the surgical difficulties encountered during the manipulations in the irradiated area and the extra time required for elevation of the DP flap and epidermization at the donor site. Furthermore, the prolongation of hospitalization was attributed to the extreme caution required in monitoring the wound condition and hesitation against early start of oral intake post-operatively because of anxiety about salivary fistula formation, which was reported to occur in about 20% of cases undergoing salvage surgery in a previous study (5), and the long time required for epithelialization at the donor site of the DP flap and the skin grafting. We do not believe that these are too problematic, and also from the medical economics point of view, this procedure might prove to be more cost-beneficial than managing potential major complications following surgery which might necessitate other expensive medical interventions. As minor complications, we encountered stenosis of the tracheostoma in two cases, which did not deteriorate the quality of life of the patients. In this report, although we have presented only a small number of trial cases, the results suggest that the survival prognosis might be as poor as that reported previously (4), because half of the cases died within the very short follow-up period. On the other hand, all of the patients could be discharged from the hospital without major complications and could spend their last days at home without any medical intervention, with a good locoregional control rate. Recently, Fung et al. (27) reported a new surgical technique to avoid major wound complications, involving the use of a free vascularized flap placed at the pharyngeal closure at the time of salvage laryngectomy after chemoradiotherapy. They report that the technique 'converts' major wound complications into minor ones. Although we also do, of course, believe that salvage TPL is not a very safe surgical procedure and that the indications should be considered very carefully after obtaining informed consent, the procedure described in this report, even though the number of cases in which it was tried was small, could reduce the risk of major complications as suggested by Fung et al (27), and appears to be acceptable. A greater number of cases should be accumulated and followed up for complications to validate the usefulness of this preventative procedure for salvage surgery, to establish definite criteria for the procedure and to develop even safer surgical techniques.

Conflict of interest statement

None declared.

References

1. Lavertu P, Adelstein DJ, Saxton JP, Secic M, Eliachar I, Strome M, et al. Aggressive concurrent chemoradiotherapy for squamous cell head and neck cancer: an 8-year single-institution experience. *Arch Otolaryngol Head Neck Surg* 1999;125:142–8.
2. Lefebvre JL, Chevalier D, Luboinski B, Kirkpatrick A, Collette L, Sahmoud T. Larynx preservation in pyriform sinus cancer: preliminary results of a European Organization for Research and Treatment of Cancer phase trial. *J Natl Cancer Inst* 1996;88:890–9.
3. Zelefsky MJ, Kraus DH, Pfister DG, Raben A, Shah JP, Strong EW, et al. Combined chemotherapy and radiotherapy versus surgery and postoperative radiotherapy for advanced hypopharyngeal cancer. *Head Neck* 1996;18:405–11.
4. Stoeckli SJ, Pawlik AB, Lipp M, Huber A, Schmid S. Salvage surgery after failure of nonsurgical therapy for carcinoma of the larynx and pharynx. *Arch Otolaryngol Head Neck Surg* 2000;126:1473–7.
5. Agra IM, Carvalho AL, Pontes E, Campos OD, Ulbrich FS, Magrin J, et al. Postoperative complications after en bloc salvage surgery for head and neck cancer. *Arch Otolaryngol Head Neck Surg* 2003;129:1317–21.
6. Temam S, Pape E, Janot F, Wibault P, Julieron M, Lusinchi A, et al. Salvage surgery after failure of very accelerated radiotherapy in advanced head-and-neck squamous cell carcinoma. *Int J Radiat Oncol Biol Phys* 2005;62:1078–83.
7. Tibbs MK. Wound healing following radiation therapy: a review. *Radiother Oncol* 1997;42:99–106.
8. Weber RS, Berkey BA, Forastiere A, Cooper J, Maor M, Goepfert H, et al. Outcome of salvage total laryngectomy following organ preservation therapy. *Arch Otolaryngol Head Neck Surg* 2003;129:44–9.
9. Horiot JC, Bontemps P, van den Bogaert W, Fur RL, van den Weinjgaert D, Bolla M, et al. Accelerated fractionation (AF) compared to conventional fractionation (CF) improves loco-regional control in the radiotherapy of advanced head and neck cancers: results of the EORTC 22851 randomized trial. *Radiother Oncol* 1997;44:111–21.
10. Bourhis J, Overgaard J, Audry H, Ang KK, Saunders M, Bernier J, et al. Hyperfractionated or accelerated radiotherapy in head and neck cancer: a meta-analysis. *Lancet* 2006;368:843–54.
11. Adelstein DJ, Lavertu P, Saxton JP, Secic M, Wood BG, Wanamaker JR, et al. Mature results of a phase III randomized trial comparing concurrent chemoradiotherapy with radiation therapy alone in patients with stage III and IV squamous cell carcinoma of the head and neck. *Cancer* 2000;88:876–83.
12. Soo KC, Tan EH, Wee J, Lim D, Tai BC, Khoo ML, et al. Surgery and adjuvant radiotherapy vs concurrent chemoradiotherapy in stage III/IV nonmetastatic squamous cell head and neck cancer: a randomised comparison. *Br J Cancer* 2005;93:279–86.
13. Brizel DM, Albers ME, Fisher SR, Scher RL, Richtsmeier WJ, Hars V, et al. Hyperfractionated irradiation with or without concurrent chemotherapy for locally advanced head and neck cancer. *N Engl J Med* 1998;338:1798–804.
14. Allen AM, Elshaikh M, Worden FP, Bradford CR, Teknos TN, Chepeha DB, et al. Acceleration of hyperfractionated chemoradiation regimen for advanced head and neck cancer. *Head Neck* 2007;29:137–42.
15. Nguyen NP, Sallah S, Karlsson U, Antoine JE. Combined chemotherapy and radiation therapy for head and neck malignancies: quality of life issues. *Cancer* 2002;94:1131–41.
16. Goodwin WJ, Jr. Salvage surgery for patients with recurrent squamous cell carcinoma of the upper aerodigestive tract: when do the ends justify the means? *Laryngoscope* 2000;110(Suppl 93):1–18.
17. Proctor E, Robbins KT, Vieira F, Hanchett BA, Sommes G. Postoperative complications after chemoradiation for advanced head and neck cancer. *Head Neck* 2004;26:272–7.
18. Davidson J, Keane T, Brown D, Freeman J, Gullane P, Irish J, et al. Surgical salvage after radiotherapy for advanced laryngopharyngeal carcinoma. *Arch Otolaryngol Head Neck Surg* 1997;123:420–4.
19. Drake DB, Oishi SN. Wound healing considerations in chemotherapy and radiation therapy. *Clin Plast Surg* 1995;22:31–7.
20. Gorodetsky R, Mou X, Fisher DR, Taylor JM, Withers HR. Radiation effect in mouse skin: dose fractionation and wound healing. *Int J Radiat Oncol Biol Phys* 1990;18:1077–81.
21. Denis F, Garaud P, Bardet E, Alfonsi M, Sire C, German T, et al. Late toxicity results of the GORTEC 94-01 randomized trial comparing radiotherapy with concomitant radiochemotherapy for advanced-stage oropharynx carcinoma: comparison of LENT/SOMA, RTOG/EORTC, and NCI-CTC scoring systems. *Int J Radiat Oncol Biol Phys* 2003;55:93–8.
22. Corey JP, Caldarelli DD, Hutchinson JC, Jr, Holinger LD, Taylor SG IV, Showel JL, et al. Surgical complications in patients with head and neck cancer receiving chemotherapy. *Arch Otolaryngol Head Neck Surg* 1986;112:437–9.
23. Gilas T, Sako K, Razack MS, Bakamjian VY, Shedd DP, Calamel PM. Major head and neck reconstruction using the deltopectoral flap: a 20 year experience. *Am J Surg* 1986;152:430–4.
24. Andrew BT, McCulloch TM, Funk GF, Graham SM, Hoffman HT. Deltopectoral flap revisited in the microvascular era: a single-institution 10-year experience. *Ann Otol Rhinol Laryngol* 2006;115:35–40.
25. Robbins KT, Doweck I, Samant S, Vieira F. Effectiveness of superselective and selective neck dissection for advanced nodal metastases after chemoradiation. *Arch Otolaryngol Head Neck Surg* 2005;131:965–9.
26. Temam S, Koka V, Mamelle G, Julieron M, Carmantrant R, Marandas P, et al. Treatment of the N0 neck during salvage surgery after radiotherapy of head and neck squamous cell carcinoma. *Head Neck* 2005;27:653–8.
27. Fung K, Teknos TN, Vandenberg CD, Lyden TH, Bradford CR, Hogikyan ND, et al. Prevention of wound complications following salvage laryngectomy using free vascularized tissue. *Head Neck* 2007;29:425–30.

One-Segment Double Vascular Pedicled Free Jejunum Transfer for the Reconstruction of Pharyngoesophageal Defects

Mutsumi Okazaki, M.D.,[1] Hirotaka Asato, M.D.,[2] Masayuki Okochi, M.D.,[3] and Hirotaka Suga, M.D.[4]

ABSTRACT

The reported success rates of free jejunal transfer are over 95%, but in cases of postoperative vascular thrombosis, the salvage of jejunal flap is often difficult because of poor ischemic tolerance of the jejunum. To reduce the incidence of jejunal necrosis due to vascular thrombosis to nearly zero, we employed one-segment double vascular pedicled free jejunal transfer. Different from conventional double pedicled free jejunal transfer (transfer of the two jejunal segments by anastomosing two pairs of jejunal root vessels), the arcade vessels are used as an additional feeder after the routine anastomosis of jejunal root vessels in our method. Between December 2004 and January 2006, 20 patients with laryngeal, pharyngeal, or cervical esophageal cancer underwent free jejunal transfer using this method. In all patients, the jejunal flap survived completely without any complication associated with vascular anastomosis or blood circulation of the flap. The disadvantage of this procedure is the approximately 1-hour prolonged operative time. Although we have experienced only 20 cases and not obtained statistically significant validity of this method compared with conventional one, we believe that the concept of our method is one of the help for safer pharyngoesophageal reconstruction, especially in patients with higher risk of vascular thrombosis.

KEYWORDS: One-segment double vascular pedicled free jejunal transfer, pharyngoesophageal reconstruction, vascular thrombosis

Free jejunal transfer is now the most standard and reliable procedure of pharyngoesophageal reconstruction following cancer ablation because of its low complication rate and lower donor site morbidity. The reported overall success rates are high (95 to 97%)[1–5]; however, vascular thrombosis is inevitable in some cases. When vascular thrombosis develops postoperatively, the salvage of jejunal flap with thrombectomy and revascularization is difficult because of poor ischemic tolerance of the jejunal flap.[6,7] Consequently, reharvest and retransfer of the jejunum is often required in these cases. To reduce the incidence of vascular thrombosis and jejunal necrosis to nearly zero, the double vascular-feeding free jejunal transfer by anastomosing two pairs

[1]Department of Plastic and Reconstructive Surgery, Kyorin University, Tokyo, [2]Department of Plastic and Reconstructive Surgery, Dokkyo University School of Medicine, Tochigi, [3]Department of Plastic and Reconstructive Surgery, Fukushima Medical University, Fukushima, [4]Department of Plastic and Reconstructive Surgery, Graduate School of Medicine, University of Tokyo, Tokyo, Japan.

Address for correspondence and reprint requests: Mutsumi Okazaki, M.D., Department of Plastic and Reconstructive Surgery, Kyorin University, 6-20-2 Shinkawa, Mitaka-City, Tokyo, Japan, 181-8611.

J Reconstr Microsurg 2007;23:213–218.
DOI 10.1055/s-2007-981503. ISSN 0743-684X.

of artery and vein is a conceivable option. Total esophagoplasty using a double vascular pedicled free jejunum has been reported.[8,9] These reports describe the free transfer of two jejunal segments by anastomosing two pairs of jejunal root vessels to two pairs of recipient vessels. However, the application of these maneuvers for the routine pharyngoesophageal reconstruction is over-indicated because two jejunal segments nourished by two root vessels are sacrificed. We report our method of double vascular pedicled free jejunum transfer using one-segment jejunum for the reconstruction of the pharyngoesophageal defects. In this method, the arcade vessels are anastomosed to the recipient vessels in addition to the routine anastomosis of jejunal root vessels.

MATERIALS AND METHODS

Operative Procedure

We describe our methods of a one-segment double vascular pedicled free jejunal transfer. A segment of the jejunum is harvested with the second or third jejunal artery and vein. In addition to these root vessels, the arcade artery and vein are also prepared for vascular anastomosis (Fig. 1A). In the patients who undergo the pharyngo-laryngo-esophagectomy (PLE), the jejunum is transferred as a tube (Fig. 1B). The pharyngojejunal and jejunoesophageal anastomosis is performed in the end-to-end fashion using a hand-sewn technique.[10] On the other hand, the jejunum is transferred as a patch following the partial hypopharyngectomy (PH). The jejunum is trimmed to adjust its size to the pharyngoesophageal defect (Fig. 1B). Care is taken that the root pedicle alone or arcade pedicle alone can independently supply the jejunal flap. As for the recipient arteries, the branches of the carotid system or subclavian system are used (if possible, one flap artery is anastomosed to the branch of one system and another flap artery is anastomosed to the branch of another system). For the recipient veins, the jejunal root vein is preferably anastomosed to the internal jugular vein (IJV) in an end-to-side fashion. If possible, the jejunal arcade vein is anastomosed to a vein other than the internal jugular system, such as the external jugular vein (EJV). If impossible, the arcade vein is also anastomosed to the internal jugular system. When the diametric discrepancy is marked between the arcade vein and EJV, end-to-end anastomosis is performed using the branch-patch method.[11] After surgery, the patency of the vessels is checked using Doppler ultrasonography more than three times a day for a week.[10] A video-fluorographic study of the reconstructed esophagus is performed on the tenth postoperative day, and a liquid diet is then initiated.

Patients

Between December 2004 and January 2006, 20 patients with laryngeal, pharyngeal, or cervical esophageal cancer

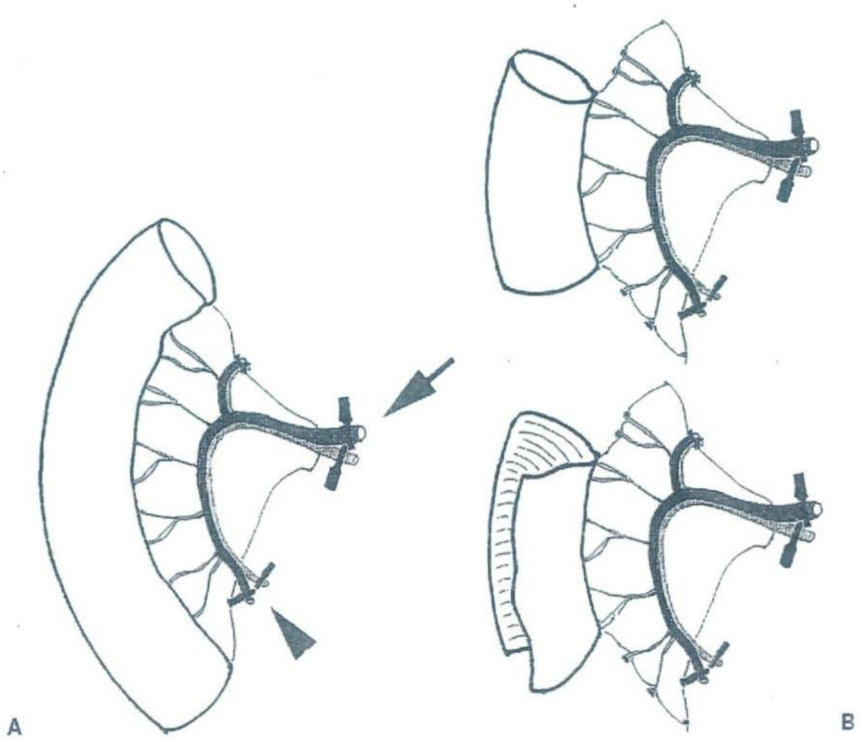


Figure 1 Schematics of the operative procedure. (A) Harvested jejunal segment. Root vessels (arrow) and arcade vessels (arrowhead). (B) Trimmed jejunal segment. Tubular jejunal flap (up) and patch jejunal flap (down). Jejunal flap is arranged so that the root pedicle alone or arcade pedicle alone independently can supply the jejunal flap.

underwent free jejunal transfer following PLE or PH using the operative procedure described at the University of Tokyo Hospital. There were 19 men and one woman ranging in age from 48 to 77 years, with an average of 61 years. Seventeen patients presented with hypopharyngeal, two with cervical esophageal, and one with laryngeal cancer. Five patients had recurrent cancer after therapeutic irradiation. Four patients had one or more major complications preoperatively, such diabetes mellitus (DM), liver cirrhosis (LC), arteriosclerosis obliterans, or atrial fibrillation. The jejunum was transferred as a tube after PLE in 15 patients and as a patch after PH in five patients. The deltopectoral flaps were additionally used to cover the front neck in three patients. The average follow-up was 11 months.

RESULTS

The jejunal flap survived completely in all 20 patients. No complications associated with vascular anastomosis or blood circulation of the flap occurred. The recipient vessels used for the vascular anastomosis are shown in Table 1. The jejunal root artery was anastomosed to the superior thyroid artery (STA) most commonly (15/20 patients) while the jejunal arcade artery was anastomosed to the transverse cervical artery (TCA) (13/20 patients) and ascending cervical artery (ACA) (6/20 patients). In 19 of 20 patients, two jejunal arteries were anastomosed to the external carotid and subclavian systems independently, except one whose flap arteries were anastomosed to the TCA and ACA (both of them are the branch of subclavian system). For the venous anastomosis, both the jejunal root and arcade vein were anastomosed to the IJV in 10 of 20 patients whereas the jejunal root and arcade veins were anastomosed to the IJV and EJV, respectively, in 7 of 20 patients. In 8 of 20 patients, two flap veins were anastomosed to the internal and external jugular system independently.

In two patients (one PLE patient and one PH patient), minor leakage was found on video-fluorography performed 10 days after the operation. However, the leakage was closed spontaneously with conservative treatment. In one patient with DM and LC, voluminous woozy bleeding continued postoperatively (400 to 1500 mL/d) probably because of impaired coagulation system due to LC, which was difficult to control. Despite the use of four suction tube drains, a large hematoma developed postoperatively, which pressed pharyngojejunal anastomosis and caused the rupture of pharyngoesophageal anastomosis. As reexploration revealed complete survival of the jejunal flap, pharyngostomy was placed, preserving the jejunal flap 12 days postoperatively. This patient could not undergo further reconstruction because of poor general condition and died of hepatic insufficiency 6 months after the operation. Although one patient had temporary mild ileus 4 weeks after the operation, 19 patients (except one) were able to resume a normal diet without dysphagia due to jejunal redundancy or jejunoesophageal constriction.

Table 1 Recipient Vessels

Artery (Root/Arcade)	n	Vein (Root/Arcade)	n
STA/TCA	10	IJV/IJV	10
TCA/STA	1	IJV/EJV	7
STA/ACA	5	CFV/IJV	1
*ECA/TCA	3	EJV/EJV	1
TCA/ACA	1	EJV/ITV	1
	20		20

*ECA, end to side anastomosis; CFV, common facial vein.

Case Report

A 48-year-old woman underwent PLE for cervical esophageal cancer (Fig. 2A). The defect was reconstructed with free jejunal transfer. Following the pharyngojejuno and jejunoesophageal anastomosis, the root jejunal artery and vein were anastomosed to the right STA and IJV, respectively. Next, the arcade jejunal artery and vein were anastomosed to the ACA and EJV, respectively (Fig. 2B, C). In this patient, the arcade artery was the smallest of all 20 patients. The postoperative course was uneventful, and the patient commenced oral intake of food 10 days after the operation.

DISCUSSION

The reported overall success rates of the free jejunal transfer are high (95 to 97%).[1–5] In free jejunal transfer, the jejunal graft should be revascularized within 3 hours,[7] because ischemic tolerance of jejunal flaps is poor.[6,7] Failure causes irreversible damage to the jejunal flap. If vascular thrombosis develops postoperatively, the salvage of the jejunal flap with thrombectomy and revascularization is difficult because of poor ischemic tolerance. Therefore, once vascular thrombosis occurs, the reharvest and retransfer of the jejunum is often inevitable, which might worsen the general condition. Moreover, the jejunal retransfer is occasionally impossible due to poor general and/or regional condition. Thus, safe achievement of pharyngoesophageal reconstruction with an initial jejunal transfer is important. The double vascular pedicled free jejunal transfer would be helpful for this safe reconstruction.

Total esophagoplasty using a double vascular pedicled free jejunum has been reported.[8,9] These articles describe the free transfer of two jejunal segments by anastomosing two pairs of jejunal root vessels to two pairs of recipient vessels. In fact, besides 20 cases presented in this article, we transferred short jejunum

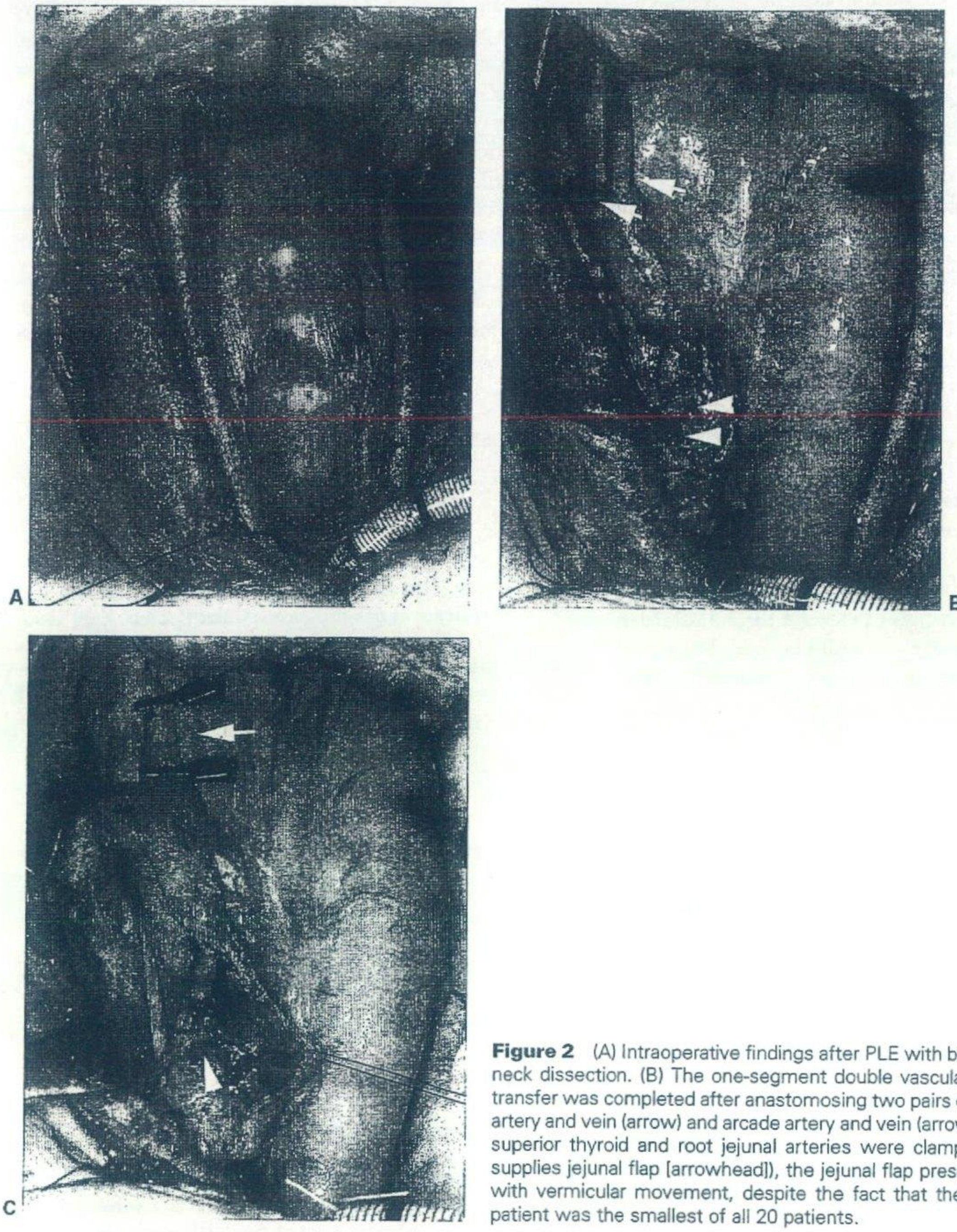


Figure 2 (A) Intraoperative findings after PLE with bilateral modified radical neck dissection. (B) The one-segment double vascular pedicled free jejunal transfer was completed after anastomosing two pairs of jejunal vessels. Root artery and vein (arrow) and arcade artery and vein (arrowhead). (C) Even when superior thyroid and root jejunal arteries were clamped (arrow) (only ACA supplies jejunal flap [arrowhead]), the jejunal flap presented acceptable color with vermicular movement, despite the fact that the arcade artery of this patient was the smallest of all 20 patients.

by anastomosing two pairs of root vessels in two cases with very high risk (trimming two jejunal segments to adjust its size to the defect, taking care that each root pedicle alone can independently supply the jejunal flap).[12] However, the sacrifice of two jejunal segments nourished by two root vessels is too invasive for common pharyngoesophageal reconstruction following routine PLE or PH. Our one-segment double vascular pedicled free jejunal transfer is reasonable in this sense.

The jejunal arcade arteries are generally small in diameter (1 to 2 mm), compared with jejunal root arteries (2 to 4 mm). In our series, when the arcade artery was comparatively large in diameter, it was anastomosed to STA or TCA, but when not so large, it was anastomosed to the ACA. A question may arise as to whether this small artery really can feed the jejunal flap. In the patient presented in the case reports, the arcade artery was the smallest of all 20 patients and was anastomosed to the ACA. Although the arcade artery was small, the jejunal flap presented acceptable color with vermicular movement fed only through the ACA-arcade artery. It is probable that the transferred jejunum needs less blood supply than the jejunum does as in its original state because the transferred jejunum does not have a role as a digestive tract (i.e., secretion, digestion, absorption, vermicular movement). Ideally, two jejunal arteries of a jejunal flap were anastomosed to the external carotid and subclavian systems independently, which was achieved in 19 of 20 patients in our series.

As for the venous anastomosis, IJV has been preferentially used as a recipient in head and neck reconstruction.[13,14] It would be better if two jejunal veins of a flap were independently anastomosed to the internal and external jugular systems because recent reports have revealed the high incidence (7 to 21%) of IJV occlusion after functional neck dissection.[15–17] In our series, however, this was achieved in only 8 of 20 patients. The chief reason was that the proximal stump of EJV was not preserved long enough for the anastomosis. The arcade veins are large in diameter compared with the arcade artery, but when the diametric discrepancy between arcade vein and EJV is marked, it can be overcome using the branch-patch method.[11]

Thus, our method seems to be well indicated for the patients with risk factors of vascular thrombosis such as DM, collagen disease, arrhythmia, and history of previous operation and preoperative radiation and is a helpful for the safer pharyngoesophageal reconstruction. Nowadays, we choose among the procedure of three types (common procedure with a pair of vascular anastomosis for patients with low risk, one with two pairs of root vessel anastomosis for patients with high risk, and one with two pairs [one root and one arcade] of anastomosis for patients with intermediate risk), depending upon the risk of vascular thrombosis. Furthermore, this method seems meaningful in a place for microsurgical education. In our institute, a resident makes his debut as a microsurgeon to perform the free flap transfer after they have succeeded in more than 50 free flap transfers in rats and experienced several successful replantations of finger amputations in humans. No matter how acceptable his technique is, it is the first case for the resident, while it is an "only case" for a patient. The staff surgeons should be responsible for their results, and thus, the staff surgeon adds the anastomosis of the arcade vessels after the residents perform the routine anastomosis of root vessels.

A disadvantage of this procedure is the long operative time. It took about an additional hour to anastomose the arcade artery and vein to the recipient vessels. Although an hour's prolonged operating time causes few problems in most patients, the indication of this methods should be determined after due consideration. In our patient who had LC and DM and sustained a rupture of the pharyngojejunal anastomosis due to large hematoma, the pharyngo-laryngo-esophagectomy itself might be contraindicated. In this patient, it might be probable that despite the formation of large hematoma, the jejunal flap survived completely owing to two pair of vascular anastomosis. Although we have only experienced 20 cases and did not obtain statistical significance of validity, we believe our concept of the one-segment double vascular pedicled free jejunal transfer contributes to the safer pharyngoesophageal reconstruction, especially in patients with higher risk of vascular thrombosis.

ACKNOWLEDGMENT

Presented at the 29th Annual Meeting of the Japan Society of Head and Neck Cancer in Tokyo, Japan, June 16–17, 2005.

REFERENCES

1. Carlson GW, Schusterman MA, Guillamondegui OM. Total reconstruction of the hypopharynx and cervical esophagus: a 20-year experience. Ann Plast Surg 1992;29:408–412
2. Kroll SS, Schusterman MA, Reece G-P, et al. Choice of flap and incidence of free flap success. Plast Reconstr Surg 1996;98:459–463
3. Nakatsuka T, Harii K, Asato H, et al. Comparative evaluation in pharyngo-oesophageal reconstruction: radial forearm flap compared with jejunal flap: a 10-year experience. Scand J Plast Reconstr Surg Hand Surg 1998;32:307–310
4. Nakatsuka T, Harii K, Asato H, et al. Analytic review of 2372 free flap transfers for head and neck reconstruction following cancer resection. J Reconstr Microsurg 2003;19:363–368
5. Sarukawa S, Sakuraba M, Kimata Y, et al. Standardization of free jejunum transfer after total pharyngolaryngoesophagectomy. Laryngoscope 2006;116:976–981
6. Olding M, Jeng JC. Ischemic tolerance of canine jejunal flaps. Plast Reconstr Surg 1994;94:167–173
7. Hikida S, Takeuchi M, Hata H, et al. Free jejunal graft autotransplantation should be revascularized within 3 hours. Transplant Proc 1998;30:3446–3448
8. Germain MA, Hartl DM, Boutin P, et al. Total esophagoplasty using a doubly vascularized free jejunal transplant: a last resort in two patients. Plast Reconstr Surg 2003;111:801–804
9. Takushima A, Momosawa A, Asato H, et al. Double vascular pedicled free jejunum transfer for total esophageal reconstruction. J Reconstr Microsurg 2005;21:5–10
10. Okazaki M, Asato H, Sarukawa S, et al. A revised method for pharyngeal reconstruction using free jejunal transfer. Ann Plast Surg 2005;55:643–647
11. Saad S, Tanaka K, Inomata Y, et al. Portal vein reconstruction in pediatric liver transplantation from living donors. Ann Surg 1998;227:275–281
12. Okazaki M, Asato H, Okochi M, et al. Double-pedicled free jejunal transfer for the high-risk cases [in Japanese]. J Jpn Soci Reconstr Microsurg 2007;20:85–91
13. Yamamoto Y, Nohira K, Kuwahara H, et al. Superiority of end-to-side anastomosis with the internal jugular vein: the experience of 80 cases in head and neck microsurgical reconstruction. Br J Plast Surg 1999;52:88–91

14. Ueda K, Harii K, Nakatsuka T, et al. Comparison of end-to-end and end-to-side venous anastomosis in free-tissue transfer following resection of head and neck tumors. Microsurgery 1996;17:146–149
15. Cotter CS, Stringer SP, Landau S, et al. Patency of the internal jugular vein following modified radical neck dissection. Laryngoscope 1994;104:841–845
16. Wax MK, Quraishi H, Rodman S, et al. Internal jugular vein patency in patients undergoing microvascular reconstruction. Laryngoscope 1997;107:1245–1248
17. Kubo T, Haramoto U, Yano K, et al. Internal jugular vein occlusion in head and neck microsurgical reconstruction. Ann Plast Surg 2002;49:490–494

Free Jejunal Transfer for Patients With a History of Esophagectomy and Gastric Pull-Up

Hirotaka Suga, MD, Mutsumi Okazaki, MD, Shunji Sarukawa, MD, Akihiko Takushima, MD, and Hirotaka Asato, MD

Abstract: Some patients who undergo pharyngolaryngoesophagectomy with free jejunal transfer reconstruction have a history of esophagectomy and gastric pull-up. We retrospectively reviewed a series of 12 patients to examine the characteristic problems in free jejunal transfer for patients with a history of esophagectomy and gastric pull-up. There was no postoperative thrombosis. No anastomotic leakage or fistula was found. Five of 12 patients presented postoperatively with dysphagia. Two of the 5 patients showed stricture at the distal anastomosis. Three of the 5 patients showed no stricture. However, their reconstructed tracts were tortuous around the distal anastomosis, which could be a cause of dysphagia. Even in patients with a history of esophagectomy and gastric pull-up, free jejunal transfer can be performed safely, although the functional outcome of swallowing is not always satisfactory.

Key Words: free jejunal transfer, history of esophagectomy, dysphagia

(*Ann Plast Surg* 2007;58: 182–185)

It is well known that patients with cancer of the head and neck have a high incidence of multiple primary cancers.[1,2] Some patients who undergo pharyngolaryngoesophagectomy with free jejunal transfer reconstruction have a history of esophagectomy and gastric pull-up. We hypothesized that not only tumor resection but also reconstruction would be difficult in such patients. In this study, we examined the characteristic problems in free jejunal transfer for patients with a history of esophagectomy and gastric pull-up.

PATIENTS AND METHODS

From 1995 through 2004, 112 patients underwent pharyngolaryngoesophagectomy with free jejunal transfer reconstruction at the University of Tokyo Hospital. Of these patients, 12 had a history of esophagectomy and gastric pull-up (Table 1). All of the 12 patients were males. The average age was 67 years (range, 45 to 82 years). The average interval between esophagectomy and free jejunal transfer was 7.5 years (range, 2 to 16 years). Nine of the 12 patients had received radiation therapy preoperatively. We retrospectively reviewed this series of 12 patients, focusing on the postoperative complications and functional results. The average follow-up was 12 months (range, 2 to 25 months).

RESULTS

In all 12 patients with a history of esophagectomy and gastric pull-up, a free jejunal graft could be harvested in the usual manner.

For recipient arteries, the superior thyroid artery was used in an end-to-end fashion in 6 patients and the transverse cervical artery in 6 patients. For recipient veins, the internal jugular vein was used in an end-to-side fashion in all 12 patients. There was no postoperative thrombosis, and free jejunal transfer was successful in all 12 patients.

The pharyngojejunal anastomosis (proximal anastomosis) was performed in an end-to-end fashion in all 12 patients. The distal jejunal stump was anastomosed to the esophageal stump in 6 patients because part of the cervical esophagus was left after pharyngolaryngoesophagectomy (Fig. 1). In the other 6 patients, no esophagus was left, and the distal jejunal stump was anastomosed to the gastric tube, which had been pulled up in a previous surgery (Fig. 2). No anastomotic leakage or fistula was found postoperatively, although 2 patients developed minor wound infection.

Five of the 12 patients presented postoperatively with dysphagia. Video fluorography in 2 patients (1 patient had a jejunal graft anastomosed to the esophageal stump, 1 patient to the gastric tube) showed stricture at the distal anastomosis (Fig. 3). Three patients (2 patients had a jejunal graft anastomosed to the esophageal stump, 1 patient to the gastric tube) showed no stricture. However, their reconstructed tracts were tortuous around the distal anastomosis, which could be a cause of dysphagia (Fig. 4).

No perioperative death occurred in this study. During the follow-up period, 7 of the 12 patients died of their tumors.

In the other 100 patients without a history of esophagectomy and gastric pull-up, 3 patients had postoperative thrombosis, 6 patients presented with anastomotic leakage or fistula, and 15 patients suffered from dysphagia postoperatively.

Received April 26, 2006, and accepted for publication, after revision, May 28, 2006.
From the Department of Plastic and Reconstructive Surgery, Graduate School of Medicine, University of Tokyo, Tokyo, Japan.
Reprints: Hirotaka Suga, MD, Department of Plastic and Reconstructive Surgery, Graduate School of Medicine, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8655, Japan. E-mail: sugah-tky@umin.ac.jp.

ISSN: 0148-7043/07/5802-0182
DOI: 10.1097/01.sap.0000235432.09523.eb

TABLE 1. Patient Data

Patient	Age/Sex	Interval, Year	Preoperative Radiation	Distal Anastomosis	Postoperative Thrombosis	Leakage or Fistula	Dysphagia	Follow-Up, Months
1	60/M	2	(−)	G	(−)	(−)	(+) a	9
2	80/M	6	(−)	E	(−)	(−)	(−)	9
3	74/M	16	60 Gy	G	(−)	(−)	(−)	2
4	82/M	10	86 Gy	G	(−)	(−)	(+) b	25
5	63/M	6	60 Gy	G	(−)	(−)	(−)	8
6	76/M	5	(−)	G	(−)	(−)	(−)	11
7	72/M	5	70 Gy	E	(−)	(−)	(+) b	6
8	67/M	12	60 Gy	G	(−)	(−)	(−)	14
9	45/M	2	50 Gy	E	(−)	(−)	(−)	8
10	65/M	12	Dose untraced	E	(−)	(−)	(+) a	24
11	55/M	2	72 Gy	E	(−)	(−)	(−)	14
12	61/M	12	Dose untraced	E	(−)	(−)	(+) b	11

a, stricture; b, tortuous tract; E, esophageal stump; G, gastric tube.

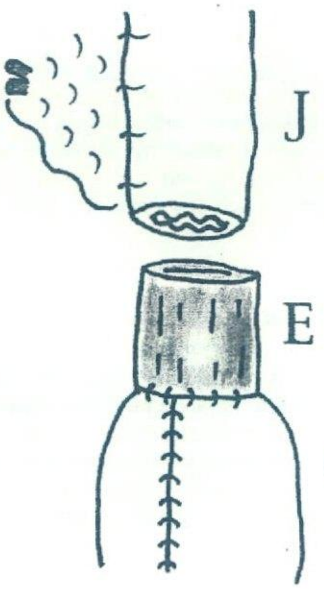


FIGURE 1. The distal jejunal stump is anastomosed to the esophageal stump. J, jejunal graft; E, esophagus; G, gastric tube.

FIGURE 2. The distal jejunal stump is anastomosed directly to the gastric tube. J, jujunal graft; G, gastric tube.

DISCUSSION

Free jejunal transfer has become a standard and reliable procedure for pharyngoesophageal reconstruction. Some previous reports have indicated that this procedure is highly successful, with few postoperative complications.[3–6] At our institution, too, more than 100 free jejunal transfers have been performed during the past 10 years, most of which have been successful.

Patients with cancer of the head and neck have a high incidence of multiple primary cancers. In terms of another primary cancer in the same patient with cancer of the head and neck, esophageal cancer is the most common.[1,2] Gastric pull-up is a well-accepted procedure for esophageal reconstruction, although colon interposition or jejunal pull-up is used in cases where the stomach is unavailable.[7,8] Against this background, we sometimes perform free jejunal transfer for patients with a history of esophagectomy and gastric pull-up. This tendency is apparently increasing because of the advancing age of patients and improvements in the diagnosis and treatment of malignant tumors.[1,2]

Despite a history of esophagectomy and gastric pull-up, microvascular anastomosis was successful in all patients. Okazaki et al[9] have reported a high rate of arterial thrombosis (3 of 13 patients) in patients who have undergone free jejunal transfer as a salvage surgery after failed esophageal reconstruction. Nakatsuka et al[10] have also described that the flap survival rate in secondary reconstruction is significantly lower than that in immediate reconstruction. In the patients in