ENDOSCOPIC NASOPHARYNGECTOMY WITH POTASSIUM-TITANYL-PHOSPHATE (KTP) LASER FOR EARLY LOCALLY RECURRENT NASOPHARYNGEAL CARCINOMA

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Abstract: *Background.* Although early recurrent nasopharyngeal carcinoma (NPC) can be treated with surgery alone, conventional nasopharyngectomy still results in serious complications. Endoscopic nasopharyngectomy has been introduced, but data on the treatment outcomes of this technique are lacking.

Methods. From March 2004 to December 2007, 28 patients with rT1 or rT2a NPC underwent potassium-titanyl-phosphate (KTP) laser nasopharyngectomy by endoscopic techniques with curative intent.

Results. Twenty-five patients underwent surgery alone. Only 3 patients received postoperative adjuvant therapy. The 2-year local disease-free and 2-year overall survival rates for the 12 patients with rT1 tumor and for the 16 patients with rT2a tumor were 100% and 41.7% ($p = .007$); and 90.9% and 38.5% ($p = .03$), respectively. Only 3 patients had obvious osteonecrosis at the nasopharynx, and 1 patient developed hypoglossal nerve dysfunction.

Conclusions. Endoscopic KTP laser nasopharyngectomy is a simple, safe, and successful procedure for treating rT1 NPC, though its benefits are less clear for rT2a. © 2009 Wiley Periodicals, Inc. *Head Neck* 31: 1309–1315, 2009

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Because nasopharyngeal carcinoma (NPC) is highly radiosensitive, the mainstay of treatment for NPC is radiotherapy.¹ However, NPC is hindered in the nasopharynx and has no obvious symptoms and signs at the early stage, so most patients with NPC present at the late stage, and local recurrences are not uncommon, with recurrence rates ranging between 9% and 40% after primary radiotherapy.^{1–4} Because local recurrent disease always leads to death without proper treatment, it is usually aggressively treated with either reirradiation or salvage surgery, even though no definitive consensus exists

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on the therapy of choice.^{1,3} Reirradiation for recurrent NPC with external beam radiation,^{5,6} brachytherapy,⁷ or stereotactic radiosurgery⁸ have been shown to prolong the 5-year survival for patients with NPC. However, radiation treatment is associated with a high rate of complications such as osteoradionecrosis, multiple cranial nerve dysfunction, brain necrosis, and skull base fibrosis, all of which can significantly impair the patient's quality of life or even lead to death.^{5,9} Although wide excision of nasopharyngeal tumors is difficult to perform because of the difficulties in approaching the nasopharynx, various types of open nasopharyngectomy, including transpalatal,¹⁰ maxillary swing,¹¹ facial translocation,¹² mid-facial degloving,¹³ transmandibular,¹⁴ and transinfratemporal fossa approaches,¹⁵ have been used for treating small recurrent NPCs to circumvent complications caused by reirradiation. However, the surgical techniques of these approaches remain difficult to perform, with higher surgical risks, and can still produce many severe complications such as palatal defects, trismus, facial scarring, osteonecrosis, osteomyelitis, and rupture of the internal carotid artery.^{10,13,16,17}

With the advent of endoscopic technologies and the recent introduction of endoscopic surgeries for treating diseases of the sinonasal tract, some surgeons have attempted to perform nasopharyngectomy with endoscopic techniques for small recurrent NPC.^{18,19} At the same time, we have also developed techniques for performing endoscopic nasopharyngectomy without facial incision or osteotomy and used the potassium-titanyl-phosphate (KTP) laser to remove early recurrent NPC tumors.²⁰ Although these previous papers have stated that endoscopic nasopharyngectomy is technically feasible for complete excision of early recurrent NPC at the nasopharynx, conclusive data on the survival benefits of the patients who underwent this procedure are still lacking.¹⁸⁻²⁰ In this article, we report the treatment outcomes of endoscopic nasopharyngectomy performed on a larger group of patients for a longer follow-up time. To date, this is the first and largest series examining the feasibility of this technique for treating early locally recurrent NPC.

PATIENTS AND METHODS

Between March 2004 and December 2007, 33 patients with NPC who had primary recur-

rence at the nasopharynx without distant metastasis after radiotherapy underwent endoscope-assisted KTP laser nasopharyngectomy. The time interval between previous radiation for NPC and nasopharyngectomy ranged from 3 to 182 months, with median of 22 months. Preoperatively, all recurrent tumors were pathologically diagnosed by local biopsy and the tumor extents were all evaluated with nasopharyngoscopy and MRI scan. The TNM status of the recurrent NPC was classified according to the 2002 criteria of the American Joint Committee on Cancer (AJCC).²¹ Of these 33 patients, 5 patients with a locally advanced tumor received palliative KTP laser nasopharyngectomy for relief of nasal obstruction. The other 28 patients with early recurrence (rT1 or rT2a) received KTP laser nasopharyngectomy with curative intent. They were followed up until March, 2008. Treatment outcomes and any surgical complications were subsequently evaluated.

All statistical analyses were performed using GraphPad prism 3.02 (GraphPad Software, San Diego, CA). Follow-up period was defined as the time elapsed since treatment completion. The rates of local disease-free survival and overall survival were calculated using the Kaplan-Meier product-limit method. Recurrence at the primary nasopharyngeal site was recorded as failure for local disease-free survival, and all deaths were recorded for in the calculation for overall survival. Significance levels among curves were determined using the log-rank test. Corresponding *p* values $\leq .05$ were interpreted as statistically significant.

Surgical Technique. The surgical procedures for KTP laser nasopharyngectomy were reported in detail in our previous article.²⁰ Briefly, patients were placed in the supine position and anesthetized by oral-endotracheal intubation. Cotton pledgets soaked with 1:100,000 dilution of epinephrine were placed in their nasal cavities for 10 minutes to achieve decongestion. With the aid of 0° or 30° angle endoscopes (Karl-Storz, Tuttlingen, Germany), the resection margin of the tumor in the nasopharynx was marked under direct endoscopic view. With the aid of curved forceps, which were inserted from the opposite nostril to provide traction force, tumors with 2-mm surgical resection margins were en-bloc resected by use of the KTP laser (8–10 W, continuous mode) (Figure 1). In some cases, the resection included the prevertebral muscles

FIGURE 1. The surgical specimen of KTP laser nasopharyngectomy for recurrent T1 nasopharyngeal carcinoma. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

dependent on the tumor extent as shown by MRI. A hollow angulated probe to either the right or left with the KTP laser flexible guide fiber in it was also used to facilitate dissection of the tumor from the lateral wall of the nasopharynx and from the cartilage of the eustachian tube. Multiple tissue samples could be obtained from the inferior, lateral, superior and central deep surgical margins of the nasopharynx for margin control after tumor removal. Neither the soft and hard palates nor the nasal cavities were disturbed. After laser excision, the wound was healed with secondary intent, without any kind of reconstruction for the mucosal defect of the nasopharynx. Homeostasis was achieved by electrocoagulation via insulated suction cautery if necessary. No nasal packing was necessary. All patients could resume oral feeding 8 hours after general anesthesia and were discharged the day after surgery. Oral antibiotics were prescribed for 6 weeks postoperatively. The patients were instructed in nasal cleansing with normal saline irrigation. The patients were regularly followed up at the outpatient clinic.

RESULTS

Clinical data for the 28 patients are shown in Table 1. There were 21 men and 7 women. Their ages ranged from 31 years to 70 years, with a median age of 51 years. In accord with the AJCC classification on NPC in 2002, 12 tumors were classified as rT1N0, 14 tumors as rT2aN0, and 2 tumors as rT2aN1. Regarding the tumor location, all of the 12 rT1 tumors were located mainly in the central roof of the nasopharynx

without gross involvement of the eustachian tube. But 12 of the 16 rT2a tumors grossly involved the Rosenmuller fossa and eustachian tube. Twenty-six patients received KTP laser nasopharyngectomy alone, and the other 2 patients with clinically positive neck disease received concomitant KTP laser nasopharyngectomy plus modified radical neck dissection. The operation time for KTP laser nasopharyngectomy ranged from 30 to 180 minutes, with a median duration of 90 minutes. After operation, 25 patients underwent surgery without adjuvant therapy because of either negative section margins or absence of cancer cells in the specimen obtained by laser nasopharyngectomy. Only 2 patients received postoperative radiotherapy and 1 patient received postoperative chemotherapy due to positive section margins. After treatment, most of the patients had no serious complications, except for mild to moderate headache. This was relieved by oral analgesics and antibiotics and resolved several weeks later. Three patients had obvious osteonecrosis in the nasopharynx, which led to cervical spine abscess in 1 patient and massive bleeding from the nasopharynx in another patient. Furthermore, 1 more patient suffered from hypoglossal nerve palsy due to osteitis around the hypoglossal canal. During the post-treatment follow-up period, 6 patients had local recurrence alone in the fourth, fifth, sixth, eighth, and twelfth months, 3 patients had distant metastasis alone in the second, fifth, and sixth months, and one patient had local recurrence and distant metastasis in the second and eighth months after treatment. Among these 10 patients who were not disease-free after treatment, 2 patients underwent another session of KTP laser nasopharyngectomy and achieved complete remission again, 1 patient received another session of KTP laser nasopharyngectomy and postoperative concurrent chemoradiation, and 5 patients received palliative chemotherapy. The remaining 2 patients received supportive care only. Of these 10 patients, 6 died of disease in the follow-up period of 6 to 32 months, with a median follow-up period of 13 months. Four patients are alive to date, including 2 patients without disease for 13 and 48 months and 2 patients with distant metastasis for 7 and 11 months after treatment. Among the other 18 patients without clinically positive disease after treatment, 15 patients are alive and well, but 3 patients died of cachexia, osteonecrosis, and bleeding within

Table 1. Clinical characteristics of 28 patients with recurrent nasopharyngeal carcinoma undergoing KTP laser nasopharyngectomy.

No.	Sex/ age	Time interval, mo	Stage of recurrence	Cancer in operation specimen	Post- operative treatment	Complication	Local disease	Distant metastasis	Outcome	Follow-up, mo
1	F/45	11	T2aN0	+	—	—	+, 6 mo, Chemo	—	D	32
2	F/33	5	T2aN0	+	—	—	+, 5 mo, Re-KTP	—	A/W	48
3	M/67	11	T2aN0	+	—	—	+, 4 mo	—	D	6
4	M/47	26	T1N0	—	—	—	—	—	A/W	42
5	M/44	77	T1N0	+	RT	—	—	—	A/W	37
6	M/70	182	T1N0	+	—	—	—	—	DOD	6
7	F/53	24	T1N0	—	—	—	—	—	A/W	36
8	M/54	53	T2aN0	+	—	ON, cervical spine abscess	—	—	D	12
9	M/46	12	T2aN1	+	—	—	+, 6 mo, Re- KTP, CCRT	—	D	14
10	M/49	13	T2aN1	+	—	—	+, 2 mo, Chemo	+, 8 mo	D	12
11	F/49	22	T1N0	—	—	XII palsy	—	—	A/W	29
12	M/68	32	T2aN0	+	—	—	—	+, 5 mo, chemo	D	8
13	M/50	48	T2aN0	+	CCRT	ON	—	—	A/W	20
14	F/52	5	T2aN0	+	—	—	+, 8 mo	—	D	18
15	F/54	14	T1N0	+	—	—	—	—	A/W	18
16	M/62	108	T2aN0	+	—	—	—	—	A/W	17
17	M/58	78	T1N0	+	Chemo	—	—	—	A/W	16
18	F/53	37	T2aN0	+	—	—	+, 12 mo, Re- KTP	—	A/W	13
19	M/45	8	T1N0	+	—	—	—	+, 6 mo, chemo	A/D	11
20	M/54	24	T1N0	—	—	—	—	—	A/W	11
21	M/41	5	T2aN0	+	—	—	—	—	A/W	11
22	M/60	17	T2aN0	+	—	ON, bleeding	—	—	D	3
23	M/38	5	T1N0	+	—	—	—	+, 2 mo, chemo	A/D	7
24	M/31	24	T2aN0	+	—	—	—	—	A/W	7
25	M/47	6	T2aN0	+	—	—	—	—	A/W	6
26	M/62	3	T1N0	+	—	—	—	—	A/W	6
27	M/42	22	T1N0	—	—	—	—	—	A/W	5
28	M/54	44	T2aN0	+	—	—	—	—	A/W	3

Abbreviations: D, death of disease; Re-KTP, repeated KTP nasopharyngectomy; A/W, alive and well; RT, radiotherapy; DOD, dead of other disease; CCRT, concurrent chemoradiotherapy; ON, osteonecrosis; A/D, alive with disease; chemo, chemotherapy.

12 months. Overall, 9 patients died, 17 patients are alive with no evidence of disease and 2 patients are alive with disease. The 2-year disease-free survival rate of these 28 patients was 57.6%, and the 2-year overall survival rate was 59.4% (Figure 2). With regard to T classification of the tumor on the treatment outcomes after KTP laser nasopharyngectomy, none of the 12 patients with rT1 tumor had locoregional recurrence, but 2 of these patients developed distant metastasis. Only 1 patient died of other disease during the post-treatment follow-up. Seven of the 16 patients with rT2a tumor had local recurrence and 2 patients had distant metastasis. Eight of these patients died of disease. Thus, the 2-year local disease-free survival rates of the 12 patients with rT1 tumor and 16 patients with rT2a tumor were 100% and 41.7%, respectively ($p = .007$) (Figure 3A). In addition, the 2-year overall survival rates for patients with rT1

and rT2a tumors were 90.9 and 38.5%, respectively ($p = .03$) (Figure 3B).

FIGURE 2. Disease-free survival and overall-survival curves for 28 patients with locally recurrent nasopharyngeal carcinoma receiving KTP laser nasopharyngectomy. (The 2-year disease-free survival and overall survival rates: 57.6% and 59.4%).

FIGURE 3. (A) Local disease-free survival curves between rT1 and rT2a diseases. (The 2-year local disease-free survival rates: 100% vs 41.7%, $p = .007$) (B) Overall survival curves between rT1 and rT2a disease. (The 2-year overall survival rates: 90.9% vs 38.5%, $p = .03$.)

DISCUSSION

Because reirradiation for treating recurrent NPC results in severe late radiation complications, surgical excision without further radiation is an alternative choice when the recurrent tumor is resectable.^{1,10,12–15,17} Because the nasopharynx is located in the center of the head and has many vital neurovascular structures surrounding it, which limit the surgical extent, only small, early recurrent tumors confined to the nasopharynx without extension into the skull bone, parapharyngeal or intracranial spaces can be removed by surgery even with external open wide-field approaches. Although these external surgical approaches can successfully treat early recurrent NPC and avoid complications associated with reirradiation, they still cause other severe surgery-related complications.^{1,12–17} In recent years, minimally invasive endoscopic or microscopic nasopharyngectomy for recurrent NPC has been preliminarily reported in 3 English-language articles.^{18,19,22} Yoshizaki et al¹⁸ described the endoscopic nasopharyngectomy technique for 4 patients with

recurrent T2 NPC. Under endoscopic view, they used high-frequency diathermy or curved-blade harmonic scalpel to remove the recurrent tumor through the nasal cavity. In their experiences, large portions of the posterior bony nasal septum needed to be removed for surgical exposure. Although the authors reported that all of the recurrent tumors were completely removed, no data on either the disease status or the overall survival rate were provided. Roh and Park²² also reported the technique of nasopharyngectomy for 3 patients with recurrent T1 NPC through a trans-septal approach with elevation of the mucoperichondrial flap of the nasal septum under microscopic view. They used the CO2 laser technique to remove the recurrent tumor. In their series, all 3 recurrent tumors were successfully resected, and none recurred during the follow-up period of 12 to 28 months. Chen et al¹⁹ also reported their preliminary experience with endoscopic nasopharyngectomy for 5 patients with recurrent T1 or T2a tumors using either diode laser or Harmonic scalpel. Similar to the case with Yoshizaki's technique, they also disturbed the nasal septum and inferior turbinates to create enough working space during the operation. In their series, 2 patients were alive and disease-free for more than 5 years. However, 2 patients had local recurrence and another patient died of skull base osteoradionecrosis and bleeding. Although these 3 articles all advocated that this minimally invasive nasopharyngectomy with the assistance of the endoscopy or microscopy can successfully treat early locally recurrent NPC, the case numbers they described were too small to make a definitive conclusion about the feasibility and survival benefit of minimally invasive nasopharyngectomy.

In our previous article, we developed a simpler and less destructive method of nasopharyngectomy.²⁰ Our technique also involved an endoscopic approach through the nasal cavity without incisions of the facial skin or oral cavity mucosa, but we did not remove the nasal septum, turbinates, or soft palate for wide exposure or easy manipulation of the surgical instruments. This is the reason why postoperative nasal packing is not necessary in our work, which is different from other articles.^{18,19,22} More importantly, perturbation of the soft tissue or bone that had received radiotherapy may result in poor wound healing and osteonecrosis, which would be detrimental to treatment outcomes. Therefore, the less destructive the

surgical procedures, the less complications the patients will have. In fact, different angle endoscopes can be used to expose the whole nasopharynx without removing the posterior nasal septum. Besides, KTP laser can be transmitted through a very slim and flexible fiber and also has different angle laser probes so that we can remove the nasopharyngeal tumor easily without removing the nasal septum and turbinates. This is our main motivation in using the KTP laser for endoscopic nasopharyngectomy. Similar to the other 3 articles,^{18,19,22} our previous article reported our technique in detail for only 8 patients without survival data. In this article, we provided the treatment outcomes of endoscopic nasopharyngectomy with KTP laser in 28 patients with recurrent T1 or T2a NPC.

From the survival analysis of these 28 patients, the 3-year disease-free and overall survival rates were around 50%, which appeared to be worse than those treated with other techniques for early recurrent NPC.^{1,3,5,6,10,23} However, from our treatment experience of patients with 12 rT1 tumors, none of these patients had local recurrence during the follow-up period of 5 to 42 months after treatment, which was equal to or better than the treatment results with open nasopharyngectomy or reirradiation.^{1,3,6,10,21} Despite the fact that 2 patients with rT1 tumor later developed distant metastasis, endoscopic KTP laser nasopharyngectomy may be a good choice for treatment of recurrent T1 NPC, especially in cases in which the tumor is located in the central roof of the nasopharynx. To further confirm our results regarding the benefits of this technique in treating recurrent T1 tumors, we will enroll more patients and follow them for a longer time. However, endoscopic KTP laser nasopharyngectomy may not be suitable for treating recurrent T2a NPC, as 7 rT2a tumors had local recurrence during the follow-up of 2 to 20 months, with the 2-year local disease-free and overall survival rates of around 40% in this series. Possible explanations for this finding may be that rT2a tumors are bigger with almost involvement of the Rossemuller fossa or the cartilage of the auditory tube and endoscopic nasopharyngectomy cannot dissect far laterally from the Rossemuller fossa to yield enough section margins. Thus, for recurrent T2a NPC, it may be necessary to modify the technique by introducing other new assistant instruments to dissect the lateral margins

with the endoscope to improve efficacy and safety.

From our experiences, the procedures for this technique are simpler, have lower surgical risks, and have shorter operative time than other types of nasopharyngectomies.¹¹⁻¹⁵ Compared with other treatment modalities, the complication rate for this technique during the follow-up was relatively low, even though 3 patients received a second operation for local recurrence again. Repeated open nasopharyngectomy with osteotomy will result in high rates of facial skeletal necrosis and other morbidities. Additionally, because local wound infection may result in or worsen osteoradionecrosis, prolonged oral antibiotics and frequent nasal cleansing are advised for postoperative care. In this series, most nasopharyngeal wounds were healed. Only 3 patients had poor wound healing with osteonecrosis in the nasopharynx, and 1 patient had osteitis around the hypoglossal canal with some functional deficit.

CONCLUSIONS

Endoscopic nasopharyngectomy with KTP laser is a simple, safe, and successful procedure for treatment of recurrent T1 NPC with few complications. For recurrent T2a NPC, the benefit of this procedure is less clear, and further modifications may be needed for treating recurrent T2a NPC population.

REFERENCES

1. Wei WI, Sham JS. Nasopharyngeal carcinoma. *Lancet* 2005;365:2041-2054.
2. Chen WZ, Zhou DL, Luo KS. Long-term observation after radiotherapy for nasopharyngeal carcinoma (NPC). *Int J Radiat Oncol Biol Phys* 1989;16:311-314.
3. Yu KH, Leung SF, Tung SY, et al. Survival outcome of patients with nasopharyngeal carcinoma with first local failure: a study by the Hong Kong Nasopharyngeal Carcinoma Study Group. *Head Neck* 2005;27:397-405.
4. Hsu MM, Tu SM. Nasopharyngeal carcinoma in Taiwan. Clinical manifestations and results of therapy. *Cancer* 1983;52:362-368.
5. Teo PM, Kwan WH, Chan AT, Lee WY, King WW, Mok CO. How successful is high-dose (> or = 60 Gy) reirradiation using mainly external beams in salvaging local failures of nasopharyngeal carcinoma? *Int J Radiat Oncol Biol Phys* 1998;40:897-913.
6. Lu TX, Mai WY, The BS, et al. Initial experience using intensity-modulated radiotherapy for recurrent nasopharyngeal carcinoma. *Int J Radiat Oncol Biol Phys* 2004;58:682-687.
7. Vikram B, Hilaris B. Transnasal permanent interstitial implantation for carcinoma of the nasopharynx. *Int J Radiat Oncol Biol Phys* 1984;10:153-155.

8. Chua DT, Sham JS, Kwong PW, Hung KN, Leung LH. Linear accelerator-based stereotactic radiosurgery for limited, locally persistent, and recurrent nasopharyngeal carcinoma: efficacy and complications. *Int J Radiat Oncol Biol Phys* 2003;56:177–183.
9. Lee HT, Brown J, Fee WE Jr. Baroreflex dysfunction after nasopharyngectomy and bilateral carotid isolation. *Arch Otolaryngol Head Neck Surg* 1997;123:434–437.
10. Fee WE Jr, Moir MS, Choi EC, et al. Nasopharyngectomy for recurrent nasopharyngeal cancer: a 2- to 17-year follow-up. *Arch Otolaryngol Head Neck Surg* 2002;128:280–284.
11. Wei WI, Lam KH, Sham JS. New approach to the nasopharynx: the maxillary swing approach. *Head Neck* 1991;13:200–207.
12. Chang KP, Hao SP, Tsang NM, Ueng SH. Salvage surgery for locally recurrent nasopharyngeal carcinoma—a 10-year experience. *Otolaryngol Head Neck Surg* 2004;131:497–502.
13. To EW, Teo PM, Ku PK, Pang PC. Nasopharyngectomy for recurrent nasopharyngeal carcinoma: an innovative transnasal approach through a mid-face deglove incision with stereotactic navigation guidance. *Br J Oral Maxillofac Surg* 2001;39:55–62.
14. Morton RP, Liavaag PG, McLean M, Freeman JL. Transcervico-mandibulo-palatal approach for surgical salvage of recurrent nasopharyngeal cancer. *Head Neck* 1996;18:352–358.
15. Fisch U. The infratemporal fossa approach for nasopharyngeal tumors. *Laryngoscope* 1983;93:36–44.
16. Ng RW, Wei WI. Quality of life of patients with recurrent nasopharyngeal carcinoma treated with nasopharyngectomy using the maxillary swing approach. *Arch Otolaryngol Head Neck Surg* 2006;132:309–316.
17. Wei WI, Ho CM, Yuen PW, Fung CF, Sham JS, Lam KH. Maxillary swing approach for resection of tumors in and around the nasopharynx. *Arch Otolaryngol Head Neck Surg* 1995;121:638–642.
18. Yoshizaki T, Wakisaka N, Muroso S, Shimizu Y, Furukawa M. Endoscopic nasopharyngectomy for patients with recurrent nasopharyngeal carcinoma at the primary site. *Laryngoscope* 2005;115:1517–1519.
19. Chen MK, Lai JC, Chang CC, Liu MT. Minimally invasive endoscopic nasopharyngectomy in the treatment of recurrent T1–2a nasopharyngeal carcinoma. *Laryngoscope* 2007;117:894–896.
20. Tan CT, Hsiao SH, Hwang JH, Ko JY, Hsu MM. Potassium-titanyl-phosphate laser nasopharyngectomy with nasopharyngoscopic guidance for recurrent nasopharyngeal carcinoma. *J Formos Med Assoc* 2005;104:960–963.
21. American Joint Committee on Cancer. Pharynx. In: Greene FL, editor. *AJCC cancer staging manual*, 6th ed. New York: Springer; 2002. pp 193–200.
22. Roh JL, Park CI. Transseptal laser resection of recurrent carcinoma confined to the nasopharynx. *Laryngoscope* 2006;116:839–841.
23. Hao SP, Tsang NM, Chang KP, Hsu YS, Chen CK, Fang KH. Nasopharyngectomy for recurrent nasopharyngeal carcinoma: a review of 53 patients and prognostic factors. *Acta Otolaryngol* 2008;128:473–481.