Cerebral Radionecrosis in Patients with Nasopharyngeal Carcinoma

Ying-Che Hsu, Ling-Feng Wang, Ka-Wo Lee, Kuen-Yao Ho, Chih-Jen Huang,[1] and Wen-Rei Kuo
Departments of Otolaryngology and [1]Radiation Oncology, Kaohsiung Medical University
Chun-Ho Memorial Hospital, Kaohsiung Medical University, Kaohsiung, Taiwan.

This study involved seven patients with cerebral radionecrosis following radiation therapy for nasopharyngeal carcinoma (NPC). Their charts were reviewed and the relationship of extracranial malignancies to cerebral radionecrosis was investigated. The radiation dose ranged from 70 to 135 Gy, and the latency was from 6 to 39 months. Two of seven patients died of NPC-related complications during follow-up. The crude incidence of cerebral radionecrosis in patients with NPC was 0.93% in our series. Improvement of symptoms could be achieved by corticosteroid therapy, with or without surgery. In a review of the literature, there were 306 cases of cerebral radionecrosis in extracranial malignancies. The nasopharynx is the most common primary site in cerebral radionecrosis of extracranial malignancies, followed by the scalp and sinonasal tract. The 3-year overall survival rate in our series was 68.57%, as provided by the Kaplan-Meier product limited method. Cerebral radionecrosis in NPC patients should be differentiated from tumor recurrence, in order to apply the appropriate treatment.

Key Words: radionecrosis, nasopharyngeal carcinoma
(*Kaohsiung J Med Sci* 2005;21:452–9)

Radiation therapy is considered effective in nasopharyngeal carcinoma (NPC) and other head and neck malignancies. However, it is not without morbidity, and complications can develop as a result of damage to neighboring structures. The irradiation field of head and neck neoplasms may include brain tissue, which may result in brain radiation necrosis. Reported cases of cerebral radionecrosis are still rare in Taiwan. We present seven cases that were clinically diagnosed as cerebral radionecrosis among NPC patients in our institute. We also review cases of extracranial malignancies, diagnostic modalities and treatment from the literature.

Received: April 24, 2005 Accepted: August 11, 2005
Address correspondence and reprint requests to: Dr. Wen-Rei Kuo, Department of Otolaryngology, Kaohsiung Medical University, 100 Tzyou 1st Road, Kaohsiung 807, Taiwan.
E-mail: kart001.tw@yahoo.com.tw

Materials and Methods

From 1991 to 2001, 775 patients with newly diagnosed NPC received complete radiotherapy at Kaohsiung Medical University Hospital. By May 2004, seven patients had a clinical diagnosis of cerebral radionecrosis. Their charts were retrospectively reviewed. There were four male and three female patients. The mean age at diagnosis of cerebral radionecrosis was 52.7 years (range, 34–74 years).

Four of seven patients had received neoadjuvant or adjuvant chemotherapy with a cisplatin-based regimen (cisplatin, 5-fluorouracil, and leucovorin). None had concurrent chemoradiotherapy. One patient had diabetes mellitus. Five patients with documented recurrence had been re-irradiated. All patients were treated with 6 MV photons using the same technique of two lateral-opposed fields, supplemented by an anterior field. The radiation dose per course was 65–70 Gy, delivered in 2-Gy fractions

via the lateral portal once daily for 5 days per week, and 1.5-Gy (6 patients) or 1.8-Gy (1 patient) fractions 10 times via the anterior portal. The total radiation dose ranged from 70 to 135 Gy (mean, 111 Gy), and the mean latent period from the end of the last radiation to the diagnosis of cerebral radionecrosis was 26.3 months (range, 6–39 months).

Computed tomography (CT) or magnetic resonance imaging (MRI) of the brain was performed in all patients. The diagnosis of cerebral radionecrosis was confirmed by surgical intervention in two cases and clinically diagnosed based on CT or MRI in five cases. Five patients had a further MRI perfusion-diffusion weighted scan. One had a Tc99m-hexamethyl-propyleneamine oxime (HMPAO) single photon emission CT (SPECT) scan of the brain.

A search of the English-language literature was undertaken in PubMed (http://www.ncbi.nlm.nih.gov/).

Results

The incidence of cerebral radionecrosis in NPC in this series was 0.93% (7/755). Clinical symptoms and signs included epilepsy, change in consciousness, memory impairment, vertigo/dizziness, and headache (Table 1A and 1B). Epilepsy was the main presenting symptom for Patient 5, while Patient 4 only had vague symptoms and developed epilepsy 19 months after the diagnosis of cerebral radionecrosis by CT scan. Two patients (2 and 7) had consciousness change as the initial manifestation. Patient 3 had severe vertigo that made her normal daily activity impossible. Patients 1 and 6 complained of headache as their main symptom. Six of the seven patients had an associated optic neuropathy.

Cerebral radionecrosis was mainly in the temporal lobe of the brain. In five patients, diffusion-perfusion weighted MRI of the intracranial lesion showed a high signal in the diffusion-weighted image, and a low signal in the perfusion-weighted image. Patients 1 and 2 had initial surgical treatment with surgicopathologic documentation, while the other patients were treated conservatively. Patient 7 received betamethasone (0.75 mg/day), Patients 1, 3, 5, and 6 were given prednisolone (15 mg/day), and Patient 2 was treated with cortisone (25 mg/day).

Patient 1 formed a brain abscess 20 months after the diagnosis of cerebral radionecrosis and underwent craniotomy. Patient 3 developed intracranial hemorrhage 17 months after diagnosis and presented with epilepsy. The follow-up period lasted for a mean of 21.3 months (range, 4–36 months). Six patients had a favorable response to corticosteroids, with or without surgery, while one (Patient 4) was treated only with an anti-epileptic agent. Two patients eventually died of NPC-related complications during follow-up.

Table 1A. Patient data

Patient	Sex	Age at diagnosis of radionecrosis (Yr)	TNM	Tumor recurrence	Total dose (Gy)	C/T	Latency (Mo)	Lesion site
1	M	34	T4N0M0	Yes	135.0	2 course adj	18	Bil T
2	M	60	T4N1M0	Yes	131.5	6 course adj	14	LT R cerebral
3	F	58	T2N2M0	No	72.5	N	38	Bil T
4	M	45	T3N2M0	Yes	121.0	N	38	Bil T
5	M	50	T4N0M0	Yes	126.0	2 course neoadj	6	Bil T LF
6	F	52	T4N0M0	No	70.0	9 course adj	31	RT
7	F	74	T2N1M0	Yes	121.0	N	39	Bil T

C/T = chemotherapy; adj = adjuvant chemotherapy; Bil T = bilateral temporal; neoadj = neoadjuvant chemotherapy; LF = left frontal; RT = right temporal; TNM = tumor-node-metastasis staging.
Chemotherapy regimen: cisplatin-based.

Table 1B. Patient data

Patient	Clinical symptoms and signs of cerebral radionecrosis						Systemic disease	Treatment		Duration of follow-up after diagnosis of cerebral radionecrosis (Mo)	Clinical outcome
	Epilepsy	Consciousness change	Memory impairment	Vertigo/ dizziness	Headache	Associated optic neuropathy		Surgery	Corticosteroid therapy		
1	–	–	+	+	++*	+	–	Yes	Yes	25	Brain abscess formation 20 months later
2	–	+*	+	+	–	+	–	Yes	Yes	15	Death at 15 months follow–up
3	–	–	–	++*	+	+	DM	No	Yes	31	Bilateral intracranial hemorrhage 17 months later
4	+	–	–	+	+	+	–	No	No	26	Epilepsy developed 19 months after diagnosis by CT scan
5	+*	–	+	–	–	+	–	No	Yes	12	Improved
6	–	–	–	+	+*	+	–	No	Yes	36	Improved
7	–	+*	+	+	–	–	–	No	Yes	4	Death at 4 months follow–up

*Initial presenting symptom for diagnosis of cerebral radionecrosis; – = none; + = mild to moderate; ++ = severe; DM = diabetes mellitus; CT = computed tomography
Chemotherapy regimen: cisplatin-based.

Discussion

The incidence of NPC is higher in Southeast Asia than in the West. Radiation therapy is the main treatment modality, and the irradiation field inevitably covers the medial and inferior temporal lobes of the brain, owing to the close proximity to the skull base. In addition, the radiation dose is usually 65–70 Gy, which exceeds the tolerance of brain tissue.

Radionecrosis is a late complication of radiotherapy. The first case of extracranial neoplasm with cerebral radionecrosis was described by Fischer and Holfelder in 1930 [1]. In 1984, Glass et al reported nine cases of cerebral radionecrosis and reviewed another 65 cases in the literature [2]. Since then, another 232 patients have been reported, including our series (Table 2) [2–31], giving a total of 306 cases of cerebral radionecrosis in extracranial malignancy. The most common primary site of malignancy is the nasopharynx (mainly NPC), followed by the scalp and the sinonasal tract.

In our institute, cerebral radionecrosis was detected in seven cases, giving a crude incidence of 0.93%. The reported incidence of radionecrosis in NPC patients ranges from 0.40% to 18.60% with different radiation regimens [3,32,33]. Lee et al reported that 64 Gy at the conventional fraction of 2 Gy daily would lead to a 5% necrotic rate in 10 years [32]. Hence, the incidence of radionecrosis in NPC in our patients is thought to be underestimated. This may be because the fractional dose via the anterior portal was low (1.5 or 1.8 Gy) compared to the normal fractional dose (1.8–2.0 Gy). Other anatomic sites reported in the literature are summarized in Table 2.

Table 2. Primary malignancy site of cerebral radionecrosis in extracranial malignancy

Location	*n*
Nasopharynx	
In the literature [2–17]	220
This series	7
Total	227
Scalp [2,18–22]	32
Sinonasal tract [2,17,23–28]	23
Ear [2,17]	9
Oropharynx [2]	2
Lacrimal gland [2]	4
Submandibular gland [2]	1
Parotid gland [2,29,30]	5
Glomus jugulare tumor [2]	1
Orbit [2,31]	2
Total	306

The period between the last irradiation and the diagnosis of cerebral radionecrosis in our series ranged from 6 to 39 months (mean, 26.3 months). Latency has been reported at 1 month to 16 years after the end of irradiation [34], with approximately 80% occurring within 3 years after the last dose of radiotherapy [2]. The mechanism is thought to be endothelial cell damage, resulting in brain tissue ischemia in long-term follow-up [35,36].

The radiation dose in our series ranged from 70 to 135 Gy (mean, 111 Gy). The average dose was higher in our series because five of our seven cases had documented recurrent disease. A dose of 60 Gy delivered in 1.8–2-Gy fractions represents the upper limit of the "safe dose" to brain tissue [37]. To treat NPC, the radiation dose inevitably exceeds this limit. The irradiation field used to treat NPC and other malignancies of the sinonasal tract and scalp may include a part of the brain tissue. The ratio of brain tissue irradiated may be higher for scalp tumors than those in the nasopharynx, which makes the scalp the second most frequent tumor site associated with cerebral radionecrosis. The threshold for injury may be lowered by hypertension [38] or concomitant chemotherapy [39,40], although the effect of induction or adjuvant chemotherapy has not been reported. Old age or systemic illness may play a role in developing radionecrosis. Lee et al analyzed their irradiation regimen and concluded that the most significant factor was the fractional dose [32]. Prolonging the treatment time offered little protective effect [32], and yet, the overall treatment time had a significant impact [41]. The age at the time of radiotherapy also appeared to affect the volume of radionecrosis [42].

The clinical symptoms of cerebral radionecrosis are variable. It may manifest major symptoms, such as changes in consciousness and seizures, or minor complaints, such as dizziness, vertigo or memory impairment. In our series, consciousness change was detected in two cases, headache in two, epilepsy in one and vertigo in one. One patient had vague symptoms. If a patient has neurologic or psychiatric symptoms, an encephalopathy must be ruled out [4]. Patients with temporal lobe radionecrosis have significant impairments in memory, language, motor ability, and executive function, compared with those without radionecrosis [5]. Asymptomatic patients are sometimes found by follow-up imaging studies.

Distinguishing radionecrosis from tumor is a challenge in traditional imaging studies. The general characteristics of cerebral radionecrosis and tumors are summarized in Table 3. Differentiating radionecrosis from recurrent tumor is difficult with CT or MRI findings alone because of similar

Table 3. Diagnostic tools and general characteristics of recurrent nasopharyngeal carcinoma and cerebral radionecrosis

Diagnostic tool	Recurrent nasopharyngeal carcinoma	Cerebral radionecrosis	Note
Angiography		Avascular space-occupying lesion	
CT [4]	Low-density, post-contrast enhancement	Digitiform or round hypodense lesion Post-contrast enhancement	Reported detection rate: 50% Detection rate < MRI
PET-18 FDG	↑ uptake	↓ uptake	Expensive and limited availability
SPECT	↑ uptake	↓ uptake	No significant differences in sensitivity or specificity for FDG-PET and ^{201}Tl SPECT
MRI [6]	Low signal in T1W, high signal in T2W	Low signal in T1W, High signal in T2W	Poorly differentiated from tumor with only T1W, T2W
	Heterogeneous contrast enhancement	Heterogeneous contrast enhancement	Superior sensitivity to CT scan
		Irregular or cystic shape	Lesions best shown on T2W
MRI perfusion-weighted scan (rrCBV map)	High signal	Low signal	
MRI diffusion-weighted scan (ADC map) [7]	Low signal	High signal	
MR spectroscopy [44]	↑ NAA/Cr ratio	↑ Choline peak and ↓ NAA/Cr ratio	

CT = computed tomography; MRI = magnetic resonance imaging; PET-18 FDG = ^{18}F-fluorodeoxyglucose positron emission tomography; SPECT = single photon emission computed tomography; T1W = T1 weighted; T2W = T2 weighted; rrCBV = relative regional blood volume; ADC = apparent diffusion coefficient; NAA/Cr = N-acetylaspartate/choline ratio.

imaging characteristics. Scintigraphic studies, such as ^{18}F-fluorodeoxyglucose positron emission tomography or ^{201}Tl chloride SPECT, have been reported to sensitively distinguish recurrent tumor from radionecrosis [43]. Recent MRI techniques, such as perfusion- and diffusion-weighted scans or MR spectroscopy to detect the brain N-acetylaspartate/choline ratio, may also help distinguish the lesion [7,8,44]. However, pitfalls in scintigraphic imaging have also been reported [18,23,24].

The standard diagnosis of radiation necrosis is histologic verification, and two of our seven patients had initial surgical treatment. The pathologic features of radionecrosis were fibrinoid and coagulation necrosis of the brain tissue. Even though surgery is an invasive procedure, it should be undertaken if the diagnosis is unclear. The surgical exploration rate may be reduced and the diagnostic rate may be increased by combining imaging studies and clinical characteristics. The clinical diagnosis of cerebral radionecrosis without pathologic proof in NPC patients has been discussed [6], and one study reported direct biopsy under local anesthesia via a left temporal craniotomy by the neurosurgeon [30].

Treatment includes conservative management with corticosteroid or invasive procedures, such as craniotomy to clean necrotic tissue or brain lobectomy [9]. Six of our seven cases showed clinical improvement after corticosteroid therapy, with or without surgical treatment. The reported regimen is dexamethasone 4–16 mg/day for 4–6 weeks, which is gradually tapered off [3,10]. Tsui et al point out that a perfusion and diffusion mismatch might imply injured tissue, such as edema and potentially salvageable brain tissue, and this may be used to predict response to treatment [8]. Lee et al reported a mortality rate of 8% due to uncontrolled sepsis, with a 44% associated side-effect rate in corticosteroid treatment [3]. Hyperbaric oxygen therapy has also been reported [45].

Patient 3 developed a brain abscess 17 months after the diagnosis of cerebral radionecrosis. She underwent craniotomy and her symptoms improved, which stabilized her condition for the following 5 months of follow-up.

Cheng et al reported six cases complicated by brain abscess formation in 28 patients with temporal lobe radionecrosis following radiotherapy for NPC [46]. Cerebral radiation necrosis is a predisposing cause of brain abscess formation, as is the use of corticosteroids. Surgical excision is the recommended treatment.

Six of our patients had optic neuropathy, possibly because of the higher radiation dose due to tumor recurrence. One patient with a lower irradiation dose had diabetes mellitus (Patient 3), which may exacerbate the impairment of microcirculation caused by radiotherapy. The patient developed intracranial hemorrhage 17 months after the diagnosis of cerebral radionecrosis (55 months after the end of radiotherapy). Cheng et al reported five cases of acute hemorrhage in late radiation necrosis of the temporal lobe [47]. The interval between the onset of hemorrhage and cranial irradiation was long (mean, 7.8 years), and rupture of the thin-walled new blood vessel is the hypothesized hemorrhage mechanism.

Clinical improvement has been reported in the treatment of cerebral radionecrosis using anti-coagulation therapy with heparin and warfarin [48]. Anti-platelet treatment with pentoxyfyllin, aspirin, and ticlopidine has also been used, but the potential risk of bleeding from these agents must be considered [49].

The follow-up time after diagnosis of cerebral radionecrosis ranged from 4 to 36 months (mean, 21.3 months). Two of our seven patients died. The 3-year overall survival rate in our series was 68.57%, as provided by the Kaplan-Meier product limited method. Lee et al found a 5-year survival rate for cerebral radionecrosis in NPC of 59%, with or without treatment [33]. The weak points of our sampling were the relatively short follow-up time and the limited numbers of cases.

Conclusions

Patients with NPC comprise the majority of those with cerebral radionecrosis following treatment for extracranial malignancies. Differential diagnosis with tumor recurrence is needed. Since advances in the treatment of NPC have resulted in an accumulation of long-term survivors, cerebral radionecrosis may become a major clinical concern. Several studies have shown that a promising first-line treatment is with corticosteroids [3,4, 10,11]. The consequences of cerebral radionecrosis, which include brain abscess and acute hemorrhage, are also of chief concern.

References

1. Fischer AW, Holfelder H. Lokales Amyloid in Gehirn. Eine spatfolge von rontgenbestrahlungen. *Dtsch Z Chir* 1930;227: 475–83.
2. Glass JP, Hwang TL, Leavens ME, et al. Cerebral radiation necrosis following treatment of extracranial malignancies. *Cancer* 1984;54:1966–72.
3. Lee AW, Ng SH, Ho JH, et al. Clinical diagnosis of late temporal lobe necrosis following radiation therapy for nasopharyngeal carcinoma. *Cancer* 1988;61:1535–42.
4. Hu JQ, Guan YH, Zhao LZ, et al. Delayed radiation encephalopathy after radiotherapy for nasopharyngeal cancer: a CT study of 45 cases. *J Comput Assist Tomogr* 1991;15:181–7.
5. Cheung M, Chan AS, Law SC, et al. Cognitive function of patients with nasopharyngeal carcinoma with and without temporal lobe radionecrosis. *Arch Neurol* 2000;57:1347–52.
6. Lee AW, Cheng LO, Ng SH, et al. Magnetic resonance imaging in the clinical diagnosis of late temporal lobe necrosis following radiotherapy for nasopharyngeal carcinoma. *Clin Radiol* 1990; 42:24–31.
7. Tsui EY, Chan JH, Leung TW, et al. Radionecrosis of the temporal lobe: dynamic susceptibility contrast MRI. *Neuroradiology* 2000;42:149–52.
8. Tsui EY, Chan JH, Ramsey RG, et al. Late temporal lobe necrosis in patients with nasopharyngeal carcinoma: evaluation with combined multi-section diffusion weighted and perfusion weighted MR imaging. *Eur J Radiol* 2001;39: 133–8.
9. Lee AW, Ng SH, Tse VK, et al. Bilateral temporal lobectomy for necrosis induced by radiotherapy for nasopharyngeal carcinoma. *Acta Oncol* 1993;32:343–4.
10. Shaw PJ, Bates D. Conservative treatment of delayed cerebral radiation necrosis. *J Neurol Neurosurg Psychiatry* 1984;47: 1338–41.
11. Woo E, Lam K, Yu YL, et al. Cerebral radionecrosis: is surgery necessary? *J Neurol Neurosurg Psychiatry* 1987;50:1407–14.
12. Jen YM, Hsu WL, Chen CY, et al. Different risks of symptomatic brain necrosis in NPC patients treated with different altered fractionated radiotherapy techniques. *Int J Radiat Oncol Biol Phys* 2001;51:344–8.
13. Wong ET. Recurrent cystic radiation necrosis of the brain. *Oncol Rep* 1998;5:685–7.
14. Chong VE, Fan YF. Radiation-induced temporal lobe necrosis. *AJNR Am J Neuroradiol* 1997;18:784–5.
15. Julow J, Slowik F, Kelemen J, et al. Late post-irradiation necrosis of the brain. *Acta Neurochir (Wien)* 1979;46:135–50.
16. Bederson JB, Harsh GRt, Walker JA, et al. Radiation-induced bilateral cystic temporal lobe necrosis: reversal of memory deficit after fenestration and internal shunting: Case report. *J Neurosurg* 1990;72:503–5.
17. Dwyer J, Gilbert JJ, Heeneman H. Lethal delayed radiation necrosis of the brain as a complication of radiotherapy for cancer in the head and neck. *J Otolaryngol* 1985;14:301–4.
18. Matheja P, Rickert C, Weckesser M, et al. Scintigraphic pitfall: delayed radionecrosis. Case illustration. *J Neurosurg* 2000; 92:732.

19. Vallee B, Malhaire JP, Person H, et al. Delayed cerebral pseudo-tumoral radionecrosis following scalp-tumor irradiation. Case report and review of literature. *J Neurol* 1984;231:135–40.
20. Kerob D, Kolb F, Margulis A, et al. Delayed cerebral radionecrosis following radiation therapy of cutaneous squamous cell carcinomas of the head. *Ann Dermatol Venereol* 2002;129:41–5.
21. Hugon J, Vallat JM, Dumas M, et al. Cerebral radionecrosis after radiotherapy for frontal cutaneous epithelioma. *Nouv Presse Med* 1981;10:1072.
22. Ciaudo-Lacroix C, Lapresle J. Pseudo-tumoral form of delayed radionecrosis of the brain. *Ann Med Interne (Paris)* 1985;136: 137–41.
23. de Vries B, Taphoorn MJ, van Isselt JW, et al. Bilateral temporal lobe necrosis after radiotherapy: confounding SPECT results. *Neurology* 1998;51:1183–4.
24. Hsu YC, Ho KY, Kuo WR, et al. Cerebral radionecrosis with cystic degeneration following radiotherapy for nasal cavity squamous cell carcinoma: a case report. *Kaohsiung J Med Sci* 2004;20:308–12.
25. Baron SH. Brain radiation necrosis following treatment of an esthesioneuroblastoma (olfactory neurocytoma). *Laryngoscope* 1979;89:214–23.
26. Miyagami M, Maejima S, Satoh K, et al. Delayed radiation necrosis of the temporal lobe following radiation therapy of maxillary carcinoma. *No To Shinkei* 1989;41:623–30.
27. Jiang GL, Morrison WH, Garden AS, et al. Ethmoid sinus carcinomas: natural history and treatment results. *Radiother Oncol* 1998;49:21–7.
28. Tran TA, Fuller GN, Whitman GJ, et al. Radiologic-pathologic conferences of the University of Texas M.D. Anderson Cancer Center. Delayed cerebral radiation necrosis. *AJR Am J Roentgenol* 2003;180:70.
29. Iwai Y, Yamanaka K, Oda J, et al. Tracer accumulation in radiation necrosis of the brain after thallium-201 SPECT and [11C]methionine PET—case report. *Neurol Med Chir (Tokyo)* 2001;41:415–8.
30. Coghlan KM, Magennis P. Cerebral radionecrosis following the treatment of parotid tumors: a case report and review of the literature. *Int J Oral Maxillofac Surg* 1999;28:50–2.
31. Barcikowska M, Chodakowska M, Klimowicz I, et al. A case of radionecrosis mimicking metastatic tumor of the cerebral hemisphere. *Folia Neuropathol* 1995;33:55–7.
32. Lee AW, Foo W, Chappell R, et al. Effect of time, dose, and fractionation on temporal lobe necrosis following radiotherapy for nasopharyngeal carcinoma. *Int J Radiat Oncol Biol Phys* 1998;40:35–42.
33. Lee AW, Law SC, Ng SH, et al. Retrospective analysis of nasopharyngeal carcinoma treated during 1976–1985: late complications following megavoltage irradiation. *Br J Radiol* 1992;65:918–28.
34. Chandler A, Tucker FC, Herzberger EE. Late radiation necrosis of the brain. *Wis Med J* 1964;63:297–300.
35. Hopewell JW. The late vascular effects of radiation. *Br J Radiol* 1974;47:157–8.
36. Conomy JP, Kellermeyer RW. Delayed cerebrovascular consequences of therapeutic radiation. A clinicopathologic study of a stroke associated with radiation-related carotid arteriopathy. *Cancer* 1975;36:1702–8.
37. Keime-Guibert F, Napolitano M, Delattre JY. Neurological complications of radiotherapy and chemotherapy. *J Neurol* 1998;245:695–708.
38. Hopewell JW, Wright EA. The nature of latent cerebral irradiation damage and its modification by hypertension. *Br J Radiol* 1970;43:161–7.
39. Price RA, Jamieson PA. The central nervous system in childhood leukemia. II. Subacute leukoencephalopathy. *Cancer* 1975;35:306–18.
40. Byfield JE. Ionizing radiation and vincristine: possible neurotoxic synergism. *Radiol Clin Biol* 1972;41:129–38.
41. Lee AW, Kwong DL, Leung SF, et al. Factors affecting risk of symptomatic temporal lobe necrosis: significance of fractional dose and treatment time. *Int J Radiat Oncol Biol Phys* 2002;53: 75–85.
42. Cheung MC, Chan AS, Law SC, et al. Impact of radionecrosis on cognitive dysfunction in patients after radiotherapy for nasopharyngeal carcinoma. *Cancer* 2003;97:2019–26.
43. Kahn D, Follett KA, Bushnell DL, et al. Diagnosis of recurrent brain tumor: value of 201Tl SPECT vs ^{18}F-fluorodeoxyglucose PET. *AJR Am J Roentgenol* 1994;163:1459–65.
44. Chong VF, Rumpel H, Fan YF, et al. Temporal lobe changes following radiation therapy: imaging and proton MR spectroscopic findings. *Eur Radiol* 2001;11:317–24.
45. Leber KA, Eder HG, Kovac H, et al. Treatment of cerebral radionecrosis by hyperbaric oxygen therapy. *Stereotact Funct Neurosurg* 1998;70:229–36.
46. Cheng KM, Chan CM, Fu YT, et al. Brain abscess formation in radiation necrosis of the temporal lobe following radiation therapy for nasopharyngeal carcinoma. *Acta Neurochir (Wien)* 2000;142:435–40.
47. Cheng KM, Chan CM, Fu YT, et al. Acute hemorrhage in late radiation necrosis of the temporal lobe: report of five cases and review of the literature. *J Neurooncol* 2001;51:143–50.
48. Glantz MJ, Burger PC, Friedman AH, et al. Treatment of radiation-induced nervous system injury with heparin and warfarin. *Neurology* 1994;44:2020–7.
49. Giglio P, Gilbert MR. Cerebral radiation necrosis. *Neurologist* 2003;9:180–8.

鼻咽癌之腦部放射性壞死

許英哲　王凌峰　李家和　何坤瑤　黃志仁　郭文烈

高雄醫學大學附設中和紀念醫院 耳鼻喉科 放射治療科

本研究報告 **7** 名鼻咽癌病患接受放射線治療後產生放射線性壞死。我們重新審視病歷並探討其與顱外惡性腫瘤之腦部放射線壞死的相關性。放射劑量從 **70** 到 **135** 格雷，潛伏期自 **6** 個月到 **39** 個月。**2** 名病患在追蹤期死於鼻咽癌相關併發症。鼻咽癌之腦部放射性壞死的粗發生率在我們的報告是 **0.93%**。經由接受皮質類固醇治療有或沒有接受手術均獲得症狀的改善。回顧文獻，一共有 **306** 位顱外惡性腫瘤病患有放射線性壞死。鼻咽是最常見的原發腫瘤部位，接下來依序是頭皮以及鼻竇。**3** 年整體存活率經 **Kaplan-Meier** 法計算是 **68.57%**。鼻咽癌放射性壞死病患必須要和腫瘤複發作鑑別診斷，以給予適當的治療。

關鍵詞：放射線性壞死，鼻咽癌

（高雄醫誌 **2005;21:452–9**）

收文日期：**94** 年 **4** 月 **24** 日

接受刊載：**94** 年 **8** 月 **11** 日

通訊作者：郭文烈醫師

高雄醫學大學附設中和紀念醫院耳鼻喉科

高雄市自由一路 **100** 號