The Journal of Laryngology and Otology
September 1999, Vol. **113,** pp. 815–817

Post-irradiation sudden deafness

YI-HO YOUNG, M.D., PEI-JEN LOU, M.D.

Abstract
As in radiation-induced cancer, post-irradiation sudden deafness (PISD) is defined as sudden onset deafness in patients post-irradiation. Fifteen nasopharyngeal carcinoma (NPC) patients with PISD were enrolled in this study. The mean interval from the completion of irradiation to the occurrence of PISD was 12 years. Seven had total deafness, seven had profound hearing loss, and one had moderate hearing loss. Nine out of 15 (60 per cent) patients experienced hearing recovery within three months after treatment. In conclusion, PISD is a late complication in NPC patients post-irradiation. The causative mechanism is theorized as vascular insufficiency.

Key words: Deafness, sudden; Nasopharyngeal neoplasms; Radiation effects

Introduction

By using cobalt 60 and/or the linear plus split course technique, the five-year overall survival of nasopharyngeal carcinoma (NPC) patients has improved to 70.6 per cent in our hospital (Huang *et al.*, 1985). The usual dose delivered to the primary tumour is 69 to 80 Gy. With these high radiation doses, complications are not uncommon, especially in the ear, such as effusion, otorrhoea, and hearing loss of either gradual or sudden onset. In our previous reports (Young and Hsieh, 1992; Hsu *et al.*, 1995; Young *et al.*, 1995; Young *et al.*, 1997; Young and Sheen, 1998), we studied the mechanism of effusion, otorrhoea, and progressive hearing loss in NPC patients post-irradiation. However, the cause of sudden onset deafness in NPC patients post-irradiation, that is termed 'post-irradiation sudden deafness (PISD)', remains unclear, and we, therefore, carried out the present study.

Patients and methods

Irradiated NPC patients with sudden onset deafness were admitted to the ward of the Department of Otolaryngology, National Taiwan University Hospital. Routine tests on admission consisted of physical examination of the ears, nose and throat, haematological and blood chemistry examination, serological tests for viral antibody titres, radiological study, and electrocardiography. All patients received a battery of audiological and neurotological tests including pure tone audiometry, tympanometry, acoustic reflex test, reflex decay test, vestibular function test, posturography, and electronystagmography (ENG) including the caloric test as well as examination of eye movements. All procedures were performed with the consent of the patient.

After completing the above tests, instead of 'shot gun therapy' (Wilkins *et al.*, 1987), patients were treated only with Dextran 40, 1000 ml daily for seven days and discharged. During hospitalization, the hearing condition in all patients was examined daily by pure tone audiometry. After discharge, all patients were regularly followed up at our clinic every two weeks for three months to evaluate whether there was an improvement in hearing or not.

Results

From 1991 to 1996, there were 1494 fresh cases of NPC who received radiotherapy. During this period, a total of 183 patients with idiopathic sudden deafness were encountered in our department. Among them, 15 (eight per cent) were irradiated NPC patients and admitted to our hospital. Eight were male and seven were female. The right ear was affected in seven, and the left ear in eight. Ages ranged from 21 to 57 years, with a mean age of 42 years at the time of diagnosis of NPC. Age at the occurrence of PISD ranged from 27 to 66 years, with a mean age of 54 years. Therefore, the interval from the completion of irradiation to the occurrence of PISD ranged from four to 23 years, with a mean interval of 12 years. Radiation dosage for these patients was 70 to 80 Gy, with a mean dosage of 72 Gy.

All patients had sensorineural hearing loss of the affected ear: seven had total deafness, one had moderate hearing loss and seven had profound hearing loss (Figure 1). For the caloric test, five

From the Department of Otolaryngology, National Taiwan University, Taipei, Taiwan.
Accepted for publication: 17 May 1999.

ears (36 per cent) had canal palsy. Magnetic resonance imaging (MRI) performed in a 31-year-old female NPC patient with PISD, showed radiation necrosis in the bilateral temporal lobes, more prominent in the right side (Figure 2).

The outcome of PISD is evaluated based on the criteria described in the literature (Nomura, 1988). 'Cured' indicates patients in whom all the thresholds of 250, 500, 1000, 2000, and 4000 Hz recover to within 20 dB, or in whom hearing loss decreases to the same threshold level as in the contralateral ear, if the auditory function of the intact ear is stable. 'Marked recovery' indicates patients in whom the average hearing gain of the five frequencies is more than 30 dB. 'Slight recovery' indicates averaging hearing gain is 10–30 dB, whereas 'Unchanged' means that it is less than 10 dB (Nomura, 1988). Based on these criteria, five patients were cured, three had marked recovery, one had slight recovery, and six remained unchanged, three months after treatment (Figure 3). Therefore, the recovery rate was nine out of 15 (60 per cent).

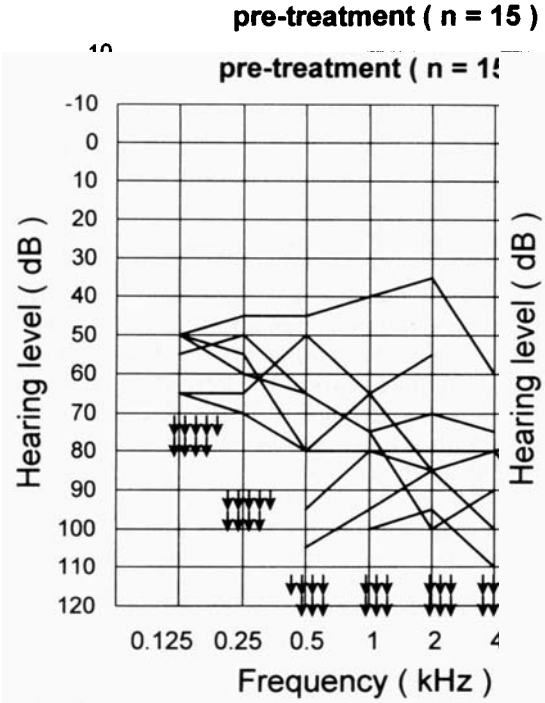
FIG. 2

Magnetic resonance imaging scan of a 31-year-old woman with nasopharyngeal carcinoma, five years post-irradiation. Radiation necrosis (arrowheads) in bilateral temporal lobes was noted.

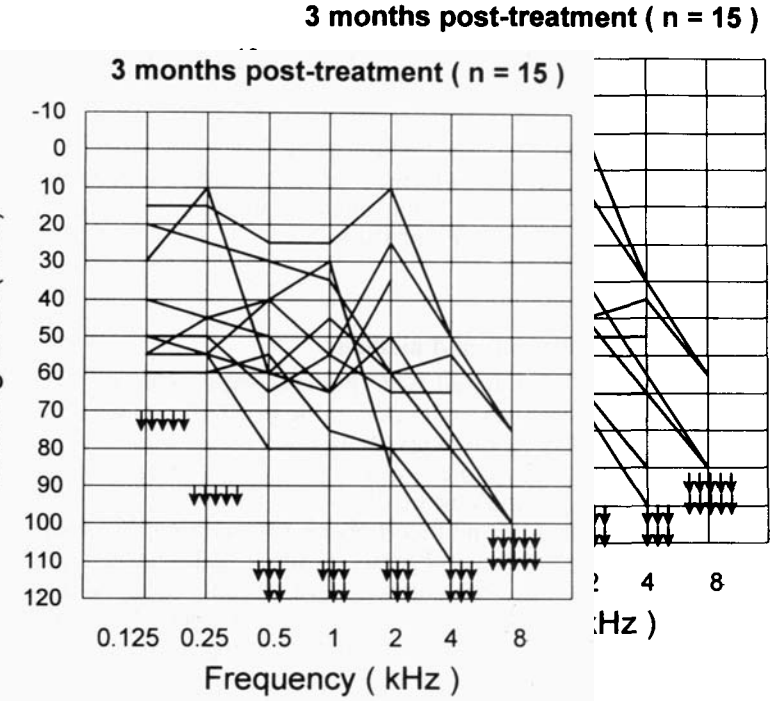
Discussion

Through the development of radioimaging diagnostic techniques and the improvement in radiotherapy, an increase in the survival rate of NPC patients has ensued (Huang *et al.*, 1985). However, increasing numbers of patients develop ear symptoms such as effusion, otorrhoea, and hearing loss of either gradual or sudden onset after radiotherapy. From previous reports, development of otitis media with effusion (OME) in NPC patients post-irradiation is due to both tubal obstruction and inflammatory reactions caused by high radiation doses (Young and Hsieh, 1992; Young *et al.*, 1997).

Insertion of a ventilation tube in NPC patients with OME may aggravate OME and result in chronic otorrhoea (Young and Sheen, 1998). Meanwhile, if otic drops are used to combat ear infection, ototoxicity may superimpose, resulting in progressive hearing loss (Young *et al.*, 1995). However, up to the present time, there has been no discussion about the mechanism of sudden onset deafness in NPC patients after irradiation. As in radiation-induced cancer (Steeves and Bataini, 1981), post-irradiation



Hearing level for air conduction of 15 affected ears, pre-treatment (arrow = scale out).



Hearing level for air conduction of 15 affected ears, three months post-treatment (arrow = scale out).

https://doi.org/10.1017/S0022215100145281 Published online by Cambridge University Press

TABLE I
DIFFERENTIAL DIAGNOSIS BETWEEN POST-IRRADIATION SUDDEN DEAFNESS AND IDIOPATHIC SUDDEN DEAFNESS

	Post-irradiation sudden deafness	Idiopathic sudden deafness
Previous irradiation	+	−
Aetiology	Vascular insufficiency	Variable
Patterns of audiogram	Total deafness or profound hearing loss	Variable

sudden deafness is characterized as sudden onset deafness in patients having radiation exposure to the temporal bone previously. From 1991 to 1996, there were 1494 fresh cases (300 cases per year) of NPC who received radiotherapy. During this period 15 irradiated NPC patients had idiopathic sudden deafness. As the 10-year survival rate is 40 per cent in our hospital (Young *et al.*, 1997), the expected prevalence of sudden deafness for the NPC survival population is 2.5 per cent.

In this study population, the mean radiation dosage was 72 Gy, and mean interval from the completion of irradiation to the occurrence of PISD was 12 years. This indicates that PISD in NPC patients seems to be a late complication of irradiation and is unrelated to the dosage of irradiation, since 72 Gy is not very high and in those who received two courses of irradiation (80 Gy and 50 Gy, respectively), the incidence of PISD did not increase.

Two important mechanisms play a role in radiation-induced pathologic tissue changes. Direct cellular injury, an early complication, results from radiation. The stria vascularis and the organ of Corti appear to be most susceptible to irradiation (Gamble *et al.*, 1968). An indirect effect, a late complication, is due to obliterative endarteritis (Guida *et al.*, 1990). As Dextran 40 acts as a plasma expander, that can increase vascular perfusion, and decrease both blood viscosity and red blood cell sludging (Redleaf *et al.*, 1995), it is given to all patients to make a therapeutic diagnosis and evaluate its effect. Vascular insufficiency is possibly the most important cause of PISD in NPC patients, since MRI reveals radiation necrosis (Figure 2). The latter is considered to be due to endothelial injury leading to the thickening of vascular wall.

In cases of idiopathic sudden deafness, a scale-out audiogram or profound hearing loss was considered to be a poor prognostic factor. Yet, in this study, cure occurred in five patients, marked recovery in three patients, and slight recovery in one patient, with a total recovery rate of 60 per cent. This result is very encouraging in that in NPC patients with PISD, recovery of hearing is possible.

PISD seems to differ from idiopathic sudden deafness in three ways (Table I). Firstly, PISD is precipitated by previous irradiation, the latency is around 12 years post-irradiation. Secondly, the patterns of the audiograms in idiopathic sudden deafness are variable, whereas profound hearing loss or total deafness is frequently encountered in PISD. Thirdly, PISD is probably due to vascular insufficiency, whereas the other causes of sudden deafness vary.

In conclusion, PISD is a late complication of irradiation in NPC patients, occurring 12 years post-irradiation. There is no correlation between the occurrence of PISD and radiation dosage. By treatment with Dextran 40, the recovery rate of PISD in NPC patients was 60 per cent in this series.

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Address for correspondence:
Yi-Ho Young, M.D.,
Department of Otolaryngology,
National Taiwan University Hospital,
1 Chang-te St.,
Taipei,
Taiwan.

Fax: (886)-2-23410905
e-mail: youngyh@ha.mc.ntu.edu.tw