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Hearing disability before and after radiotherapy for nasopharyngeal carcinoma

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Abstract

This paper evaluates post-irradiation hearing changes in patients with nasopharyngeal carcinoma (NPC) from a disability orientated approach, which takes into account binaural hearing. Newly diagnosed patients with NPC were studied before radiotherapy, and at four to 12 months (mean 9.2 months) after radiotherapy, provided they remained disease-free. Each patient was examined clinically and with pure tone audiograms. Tympanometry was used to confirm middle ear effusion. Averaged hearing thresholds over 0.5, 1 and 2 kHz were evaluated. If abnormal (>30 dB), the resultant hearing disability was illustrated by a modified Glasgow Plot. Twenty-three males and 10 females completed the study. Middle ear effusions resulted in 39.3 per cent (binaural in two patients) and 33.3 per cent (binaural in five patients) of patients having hearing disability pre- and post-irradiation respectively. No patient had hearing disability as a result of a sensorineural loss. It is recommended that future reporting of post-irradiation hearing changes in patients with NPC, as in middle ear surgery, be considered from a disability-orientated approach.

Key words: Otitis media with effusion; Nasopharyngeal neoplasms; Radiotherapy; Deafness

Introduction

Nasopharyngeal carcinoma (NPC) is a common disease among the Chinese. Localized disease usually responds well to radiotherapy (RT) but because both the ears and Eustachian tubes are included in the radiation field, otological complications in either ear are common following RT (Tami *et al.*, 1989). There have been earlier reports of hearing loss in individual ears in humans after RT (Borsanyi *et al.*, 1961; Morretti, 1976) but there are no reports on post-RT hearing disability, which takes into account binaural hearing. As pointed out by Browning *et al.* (1991), the degrees of hearing disability are different for monoaural and binaural loss of hearing. Hearing disability has been emphasized to be the preferred way of reporting hearing results following middle ear surgery (Toner and Smyth, 1993) as it gives an indication of whether there is any improvement of hearing handicap as a result of the surgery performed. There is no reason why hearing results following RT for NPC should not be reported in a similar way. It gives a picture of the effects of radiation on hearing in an individual patient rather than in an individual ear which is more useful both from the patient's hearing handicap point of view, the otolaryngologist's management point of view as well as from the radiotherapist's post-irradiation auditing point of view. The aim of this study is to evaluate post-irradiation hearing changes in patients with NPC from a disability-orientated approach.

Methods and materials

Only patients with newly diagnosed NPC and treated by radiotherapy alone were studied. They were evaluated before RT and at three–12 months (mean 6.5 months) after RT. Those found to have recurrence or persistence of disease following radiation were excluded from further study.

During each evaluation the ears were examined, air and bone conduction thresholds were measured by the Interacoustic AC5 pure tone audiometer in a sound proof room, with masking applied where necessary. Middle ear effusions (MEEs) suspected clinically or audiometrically were confirmed by tympanometry.

The mean air-conduction threshold over 0.5, 1 and 2 kHz was calculated for each audiogram and used for further evaluation. Hearing was considered abnormal if this calculated value was more than 30 dB (Smyth and Patterson, 1985; Browning *et al.*, 1991). A patient was deemed to have monoaural or binaural hearing disability if he/she had unilateral or

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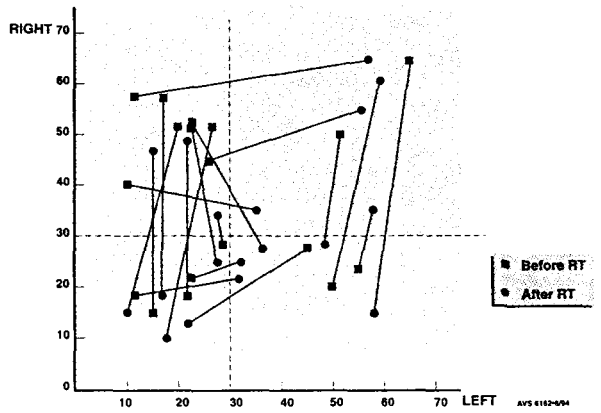

FIG. 1

Modified form of a Glasgow Plot showing hearing status of individual patients with hearing disability before and/or after radiotherapy.

bilateral abnormal hearing. The hearing disability of each patient, if present, was illustrated by a modified form of the 'Glasgow Plot' (Browning *et al.*, 1991) (Figure 1).

In the modified Glasgow Plot shown in Figure 1, the y-axis and x-axis represent the hearing levels (mean air-conduction thresholds over 0.5, 1 and 2 kHz) of the right and left ears respectively (in dBs). As shown, the Plot is divided into two square and two rectangular areas by the two broken lines at 30 dB of each axis. Individuals with hearing falling within the square areas of the Plots have either no hearing disability (left lower square) or binaural hearing disability (right upper square). The rectangular areas of the Plot represent monoaural hearing disability.

Radiotherapy technique

All patients were treated with megavoltage (6 or 10 MV) X-rays from linear accelerators. Immobilization was achieved with beam direction Cobex shells. The primary volume was treated using a three-field technique to cover the nasopharynx, adjacent parapharynx to the level of the inferior border of C2, the posterior part of the nasal cavity and maxillary antra. In the standard treatment, the brain stem was shielded throughout on the lateral fields. A total dose of 70 Gy in 35 daily factions was prescribed to the 100 per cent isodose to encompass this target volume. Where there was bulky parapharyngeal involvement, a further boost dose of 10 Gy in five daily fractions was delivered.

The neck was treated with a matched on field with midline spinal cord shielding. An opposing posterior field might be added if the antero-posterior separation of the neck at the level of the cricoid was greater than 15 cm. A dose of 60 Gy in 30 fractions was prescribed to the 90 per cent isodose to treat the neck electively. Sites of palpable nodes were boosted to an additional 10 to 14 Gy.

TABLE I

HEARING LEVELS IN EARS BEFORE AND AFTER RADIOTHERAPY (RT)

	Pre-RT	Post-RT
≤30 dB	51	50
>30 dB	15	16
Total	66	66

Results

Twenty-three males and 10 females with a mean age of 46.3 years (range 32 to 65 years) completed the study.

There were a total of 26 ears which had MEE before and/or after RT. Before RT, MEE was present in 15 ears (including bilateral ones in two patients) of which five resolved following RT. On the other hand, 11 ears with no prior MEE developed it after radiation, making a total of 21 ears with MEE post-RT (including bilateral ones in seven patients).

The resolution or formation of MEE after RT led to changes in air-bone gap ranging from 13 to 60 dB (mean 34.1 dB). Even in those 10 ears whose MEE persisted after RT, there can be marked conductive changes after RT, ranging from 6 to 40 dB (mean 13.5 dB).

In the remaining 40 ears with no MEE before nor after RT, the AB gap may become wider or narrower after RT but the degree of change is not marked (not more than 12 dB). The hearing thresholds of all these ears, however, were normal before RT and all remained within the normal limits after RT.

All patients with abnormal hearing had hearing loss secondary to MEE. There were no patients who had abnormal hearing as a result of sensorineural hearing loss, before or after RT. The number of ears with abnormal hearing before and after RT were 15 (22.7 per cent) and 16 (24.2 per cent) respectively (Table I). Two patients had bilateral abnormal hearing pre-RT and five patients had bilateral abnormal hearing post-RT. Hence, the number of patients having hearing disability pre-RT was 13 (39.3 per cent) of which two were binaural; and the number of patients with post-RT hearing disability was 11 (33.3 per cent) of which five were binaural (Table 2).

As shown in Figure 1, five patients with no hearing disability before RT developed monoaural disability and four patients with monoaural disability before RT progressed to have binaural disability after RT. Conversely, one patient with bilateral abnormal hearing before RT achieved unilateral normal hearing while five patients who had unilateral abnormal hearing managed to gain bilateral normal hearing after RT. It is interesting to note that there

TABLE II

HEARING DISABILITY IN PATIENTS BEFORE AND AFTER RADIOTHERAPY (RT)

	Pre-RT	Post-RT
Disability	13	11
No disability	20	22
Total	33	33

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were no patients with bilateral normal hearing before RT who progressed to have bilateral abnormal hearing post-RT nor vice versa.

Discussion

There have been a number of earlier reports on the existence of MEE in patients with NPC before and after RT (Lau *et al.*, 1992; Tang *et al.*, 1992). To date, there are few if any reports on the extent and degree of conductive hearing loss resulting from the MEE in these patients. It is important to evaluate this as hearing loss is the main symptom of MEE, and persistent MEE after RT is a very difficult problem to manage. Unlike the MEE in children, the procedure of myringotomy with insertion of a ventilation tube is not a good solution for the resultant hearing loss as the procedure often resulted in persistent otorrhea (Skinner and van Hasselt, 1991). Since myringotomy with ventilation tube insertion is not considered to be a viable treatment option for the resultant conductive deafness (Tang *et al.*, 1992), those with binaural disability are likely to require hearing aids to cope while those with monoaural disability may opt for hearing aids to achieve binaural hearing.

The present study shows a significant proportion of patients with NPC have some degree of hearing disability as a result of MEE both before and after RT. An ear with abnormal hearing from MEE may regain normal hearing after RT and conversely, an ear with normal hearing prior to RT may develop abnormal hearing after RT. This is shown by the data in Figure 1 and such data have the potential to aid the doctor predict the chances of these happening in individual patients (rather than individual ears) which would be very useful during the pre-irradiation counselling of the patient.

Post-irradiation sensorineural hearing loss due to cochlear damage had been shown in animal studies (Winther, 1970). In their review of earlier studies on post-irradiation hearing loss, Tami *et al.* (1989) found a paucity of such studies on humans and the few studies (most of which were retrospective) published were contradictory as to the incidence, time of onset, type and severity of hearing loss. In this prospective study on hearing loss after RT for NPC, there were no patients who suffered hearing disability (averaged over 0.5, 1 and 2 kHz) due to cochlear damage within one year after RT. However, post-irradiation cochlear damage manifesting only in the longer term cannot be excluded (Morretti, 1976).

Conclusion

A significant proportion of patients with NPC were found to have hearing disability as a result of middle ear effusion before and after radiotherapy: almost 40 per cent before radiotherapy and about one-third after irradiation. It is recommended that future reporting of post-irradiation hearing changes in patients with NPC should be considered from a disability approach as it is clinically more meaningful than when assessing hearing changes in individual ears.

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