Effect of ear exercises on hearing loss in patients with nasopharyngeal carcinoma after radiotherapy

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Abstract
The objective of the study is to explore the effect of an ear health exercise on hearing loss of patients with nasopharyngeal carcinoma receiving radiotherapy. One hundred and seventeen patients diagnosed with nasopharyngeal carcinoma from June 2018 to January 2020 were selected as research subjects randomly divided into three groups. Thirty-eight cases were in experimental group 1 and given an ear health exercise for 6 months, 38 cases were in experimental group 2 and given an ear health exercise for 12 months, and 41 cases in control group only received hearing health education. The hearing loss of three groups was compared before intervention and at 6 and 12 months after intervention. The value of the average audibility threshold of air conduction, the occurrence rate of abnormal acoustic immittance (ear), the rate of tympanic cavity effusion, and occur rate of secretory otitis media in two experimental groups were lower than control group among different time points. The above indicators of experimental group 2 were lower than those of group 1 ($p < .05$). The total effective rate of hearing improvement in experimental groups 1 and 2 was higher than that of control group after the intervention. Besides, the total effective rate in experimental group 2 was higher than that in group 1, and the difference was statistically significant ($p < .05$). There was no serious adverse reaction. An ear health exercise can reduce hearing loss of patients with nasopharyngeal carcinoma receiving radiotherapy. It can be used as daily rehabilitation measures to prevent or delay hearing loss for these patients.

Nasopharyngeal carcinoma is the most common malignant tumor of the head and neck, and radiotherapy is the first choice. With the rapid development of imaging and radiotherapy technology, the 5-year survival rate for nasopharyngeal cancer patients has risen from less than 20% in the 1950s to more than 75% today, and the patients with stages I and II can reach more than 90%.$^{2,3}$ With the extension of survival time, there is growing concern about the quality of life of patients with nasopharyngeal cancer. However, due to the special anatomical site of nasopharynx, hearing impairment can be caused before and after treatment, especially the incidence of secretory otitis media (SOM) is as high as 78.3%, which not only obstructs patients' social communication activities, but even develops into deafness.$^4$ According to the report,$^5$ hearing loss has become the second most common complication in nasopharyngeal cancer patients after treatment except dry mouth, seriously affecting patients' daily life. Therefore, it is urgent for medical staff to take feasible rehabilitation intervention measures for such patients to keep good hearing as far as possible and improve their quality of life. According to the theory of traditional Chinese medicine, the ear is the orificium of the heart and kidney, and is connected to the brain, especially the kidney, ear health massage can not only strengthen

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the heart and kidney, but also dredge the meridians, so that the ear qiao qi and blood filling, and then improve their hearing function or restore their hearing. Modern medicine believes that regular massage of the ear acupoints can promote ear blood circulation, relax the ear, relax the auditory nerve, with deafness and eyesight, physical fitness, disease prevention and treatment, and prolong life. At present, ear acupoint pressing has been widely reported in hearing health care, but most of the relevant measures are based on empirical exploration and lack of empirical studies to verify their effects. This study is based on ear disease physiology and traditional Chinese medicine theory, referring to the ear acupoint and eardrum massage techniques in various literature reports. Based on the physiology of ear diseases and the theory of traditional Chinese medicine, this study designed a set of ear exercises by referring to the massage techniques of ear acupoint and eardrum in various literature reports and through expert consultation, to observe the effects of ear exercises on hearing loss in patients with nasopharyngeal cancer after radiotherapy, so as to prevent or delay hearing loss in patients with nasopharyngeal cancer after radiotherapy.

1 | OBJECTS AND METHODS

1.1 | Research object

From June 2018 to January 2020, a total of 117 nasopharyngeal carcinoma patients (334 ears) were selected from radiotherapy department of grade A tumor hospital in Jiangsu Province as the research object. Inclusion criteria: (1) first pathologic diagnosis of nasopharyngeal carcinoma and radiotherapy; (2) age 75 years old or less; (3) Karnofsky score (KPS) ≥60 and expected survival time over 1 year; (4) primary school education or above, able to use WeChat. Exclusion criteria: (1) otitis media and perforation of tympanic membrane before radiotherapy, having a history of otitis media, ear diseases, trauma, autoimmune diseases affect hearing, and hearing disorders (mean auditory threshold of bone conduction >20 dB); (2) CT or magnetic resonance imaging indicating that the tumor had invaded the middle or inner ear; (3) taking medicine for ear disease at present. Elimination criteria: stopping or reducing workout time due to illness aggravation or other reasons. One hundred and seventeen patients who met the inclusion and exclusion criteria were numbered according to the order of admission time, and divided into trial group 1 (38 cases), trial group 2 (38 cases), and control group (41 cases) according to the random number table method. All subjects consented to participate in this study voluntarily.

1.2 | Research method

1.2.1 | Intervention method of experimental group

Setting up a study group
The research team consisted of two TCM physicians, one radiotherapy physician, one otorhinolaryngology physician, one radiotherapy nurse, and one graduate student. Among them, the nurse has more than 10 years of radiotherapy nursing experience for nasopharyngeal cancer patients, national grade 3 psychological consultant, and is a core member of the TCM nursing team in the hospital. She has a good command of common TCM nursing technical operation standards and auricular acupoint-related knowledge, and has good communication skills. In this research group, doctors of traditional Chinese medicine, radiotherapy department, and otorhinolaryngology department are mainly responsible for formulating and adjusting ear health exercise program; the nurse is mainly responsible for implementing intervention programs and collecting information; graduate students are mainly responsible for sorting, statistics, and analysis of data.

Developing intervention plans
This study was guided by TCM rehabilitation and recuperation after radiotherapy and chemotherapy for nasopharyngeal cancer, TCM prevention and recuperation of common otorhinolaryngological diseases, auricular point diagnosis thinking and clinical practice, and practical manual of TCM appropriate techniques and characteristic nursing, and through literature review, expert consultation, combined with the characteristics of nasopharyngeal cancer radiotherapy patients to develop ear exercises intervention program.

Hearing loss associated with radiotherapy in NPC patients is mainly related to radiation damage to middle ear mucosa, blood vessels, lymphatic endothelium and mucociliary drainage system in middle ear cavity, impeded lymphatic reflux, blocked secretion elimination, vascular dysfunction and cochlear nerve fibrosis, and other factors. As a reaction point and control point of systemic information, ear points can be reflected to the corresponding part of auricle through meridians when lesions occur in a certain viscera or part of the human body. Ear health exercises as a means of rehabilitation, it is through stimulating the ear acupoints or reaction points, dredge the ear meridians, promote the ear blood circulation, so as to delay the development of hearing impairment. The distribution of auricular points in the ear is like that of a fetus inverted in the womb, with the head down and the buttocks up, and the corresponding acupoints on the cheek are in the earlobe. Stimulating the auricle, tragus and earlobe of these local acupoints can effectively stimulate the nerves around the ear, enhance the capillary permeability of the inner ear, improve the microcirculation, promote the exchange between blood and labyrinth, conducive to the improvement of the pathological process in the ear. Tinggong is the acupoint of the small intestine channel of hand-taiyang, the meridian of the hand “but into the ear,” which has the effect of hearing and opening the body, reflecting the idea of “the meridians, attending and reaching.” The technique of massage eardrum and mingtian drum is based on the 12-section-brocade final of Nei Gong Tu Shuo. This method can activate the air in the ear canal and gradually restore the function of eardrum. Modern medical research has also confirmed that massage manipulation acts on the skin, which is beneficial to dilate capillaries, promote the circulation of blood and lymph, accelerate the excretion of metabolites, reduce the production of histamine and other chemical media in blood, thus effectively reducing the occurrence of adverse reactions.
After the development of the ear exercise intervention program, the radiotherapy department nurses shot it into a micro video, a total of eight sections.

Implementation of intervention programs
On the basis of the intervention method of control group, ear exercise intervention was carried out.

Section 1: cover auricle. After rubbing the palms hot, press the palms on both sides of the auricles until the ears can hear no outside sound and hum. Section 2: massage the eardrum. Place the palms of both hands on the ears on both sides, then press and release the palms gently and quickly. Section 3: stroke the auricle. Hold empty fist in both hands, push back and forth with thumb and index finger along the ear until the auricle is hyperemic and hot. Push and rub with thumb abdomen, while the index finger abdomen is placed in the opposite part of the thumb. Section 4: pull earlobe. With forefinger, thumb from the inside out to pull the tragus, earlobe, pulling force to do not feel pain is appropriate. Section 5: press the tragus. Press and relax the tragus with two index fingers continually, both left and right at the same time. Section 6: rub Tinggong. Tinggong is in front of the tragus, and it is a depression when opening the mouth. Use the pulp of the index finger to press and rub the Tinggong until it is hot.

Section 7: Ming Tian Gu. After rubbing the palms of both hands, press the ears tightly, put the index fingers of both hands on the middle fingers, gently tap the occipital bone of the posterior brain for 60 times, and tap the teeth up and down. After the knock, take five deep breaths. Section 8: tap auricle. Close the four fingers outside the thumb and gently tap the auricle at a rhythm of two times per second.

Exercise once a day, 3 cycles each time, 20 times per section, about 20 min to complete health exercises. The intervention lasted for 6 months in the first group and 12 months in the second group. During the intervention, it is advisable for the subjects to feel warm and relaxed in their ears. During hospitalization, the radiotherapy nurse supervised the patient’s daily practice in the classroom in the ward, and answered any doubts at any time. During the stay at home, the patient practiced at home by himself, and his family members assisted him to take photos and punch in the WeChat group after the daily completion.

Training and assessment
Before the beginning of the experiment, the subjects were trained in ear exercises for 2 weeks by radiotherapy nurses trained in ear exercises, and they were assessed on the last day, and the patients who passed the assessment could officially enter the experiment. At the same time, ear exercises video and graphic manual were distributed to enable patients to master the training methods.

Follow-up visit
Nurses followed up twice a week by phone or at home until the study was completed. Telephone follow-up is mainly to understand the recent health status of patients, the implementation of ear exercises and problems encountered, to give timely guidance to their doubts, and strengthen the motivation of patients. The main purpose of home follow-up is to guide the patients in ear exercises, correct their irregular movements, inquire and solve the problems encountered in the process of training, and further strengthen the patients’ compliance with practice.

1.2.2 Control group intervention method
The control group was given routine hearing health education by the responsible nurse during the hospital period, including basic knowledge of nasopharyngeal cancer treatment-related hearing impairment, prevention and treatment methods, hearing health knowledge, and so on. After discharge, the patient will be followed up by telephone once a month to inquire about the latest health status and solve any problems encountered.

1.2.3 Ethical principle
This study has been approved by the Ethics Committee of our hospital, and all subjects signed informed consent. To ensure fairness, after the study, the control group was taught the same ear exercises with the consent of the patients, and the ear exercises videos and manuals were distributed.

1.2.4 Quality control method
Study nurses were trained in intervention methods and data collection prior to the trial. During the trial, all three groups received the same routine treatment, nursing, and hearing health education after radiotherapy. In order to ensure the compliance of subjects to participate in the study, patients were provided with ear exercise videos and related graphic manuals for easy reference and recall. During the period of hospitalization, patients were provided with a place for exercise (classroom indicating ward), supervised and signed in by the research nurse, and patients with special conditions were treated with personalized treatment. During the stay at home, patients were required to take photos and punch in the WeChat group after completing exercises every day. The number of times of punching in was counted at 22:00 every Sunday, and the subjects who persisted were given material rewards. The longer they persisted, the more rewards they were given. In addition, during the stay at home, the researcher followed up the exercise schedule by telephone or on-site guidance at least twice a week, and kept listening to the opinions of the subjects or their family members during the intervention. Compliance is calculated based on the number of check-in and WeChat punch records of the subject. If the number is ≥90%, it is considered as good compliance; otherwise, it is considered as poor compliance. All cases with poor compliance were regarded as shedding cases. Organize research data regularly, check all information, and re-query and supplement if necessary to improve the accuracy of data.
1.2.5 | Evaluation indicators and data collection methods

Observe the radiation damage of middle ear. All patients received pure tone audiometry, acoustic conductance, and ear endoscopy before intervention and at 6 and 12 months after intervention. (1) Pure tone audiometry was conducted in the soundproof room according to gb7583-87 standard, and the mean values of 0.5, 1, 2, and 4 kHz air conduction auditory domain were collected; (2) acoustic conductance test was conducted in the sound isolation chamber, and the sound was detected at 226 Hz. Abnormal acoustic conductance (ear) cases were collected. The normal acoustic conductance is A-type diagram, and the peak pressure point is –50~50 daPa. Abnormal acoustic conductance includes: B-type, flat type; type C, negative pressure type, peak pressure point is located outside 100 and –100 daPa. Air leakage and liquid leakage occur. (3) The occurrence of tympanic effusion and middle ear canal inflammation was detected by ultra-high definition endoscopic camera system. The study nurse collected the results of air conduction threshold, acoustic immittance, and otoscopy of patients in the three groups at the above three time points.

1.2.6 | Evaluation criteria of curative effect

Efficacy criteria can be divided into curative effect, marked effect, effectiveness, and ineffectiveness.\(^{15}\) The specific criteria are as follows: (1) curative effect: after the intervention, the mean value of patients’ air conduction threshold was ≤25 dB, and/or acoustic conductance was still A-type diagram; (2) marked effect: the mean value of air conductance threshold increased by ≥15 dB and/or acoustic conductance changed from B-type or high-negative pressure C-type to A-type; (3) effectiveness: after intervention, the mean value of air conduction threshold increased by ≤5 dB, <15 dB, and/or acoustic conductance changed from B-type or high-negative pressure C-type to non-high-negative pressure C-type (represented by C); (4) ineffectiveness: after intervention, the mean value of air conductance threshold increased by <5 dB and/or acoustic conductance remained B-type or high-negative pressure C-type. Total effective rate = (curative effect + marked effect + effectiveness)/total number of cases × 100%.

1.2.7 | Statistical method

SPSS 24.0 was used to analyze the data. The measurement data of normal distribution were expressed as mean ± standard deviation, one-way ANOVA was used for comparison between multiple groups, and LSD-T test was used for pairwise comparison. The counting data were described by frequency and percentage. The comparison between groups was performed by \(\chi^2\) test, and Fisher’s exact probability method was used when \(\chi^2\) test conditions were not met. Repeated measurement data analysis, if the measurement data, repeated measurement analysis of variance. In the case of counting data, the generalized estimation equation is used for analysis. \(p < .05\) was considered as statistically significant difference.

2 | RESULT

2.1 | Comparison of general data of three groups

During the study, one patient in the trial group and one patient in the control group withdrew from the study due to hospital transfer. One patient in trial group two was withdrawn from the study due to acute pulmonary edema during treatment. A total of 114 patients completed the study. Comparison of general data among the three groups showed no statistically significant difference \((p > .05)\), indicating comparability, as shown in Table 1.

2.2 | Comparison of mean values of air conductance threshold before and after intervention among three groups

The results of this study showed that the mean value of air conductance threshold in the three groups after radiotherapy increased gradually with the passage of time, and the difference was statistically significant \((p < .01)\). At the end of the 6th and 12th month of intervention, the mean values of the two trial groups were lower than those of the control group \((p < .05)\), and at the end of the 12th month of intervention, the mean values of the trial group two were lower than those of trial group one \((p < .05)\), and the values of the two trial groups were significantly lower than those of the control group \((p < .05)\), as shown in Table 2.

2.3 | Comparison of the incidence of abnormal acoustic conductance (ear) and the results of ear endoscopy among the three groups

The results of this study showed that the incidence of abnormal acoustic conductance (ear), the rate of tympanic effusion, and the incidence of otitis media in test group 1 and test group 2 were lower than the control group, with statistical significance \((p < .05)\), and the above indexes in test group 2 were lower than that in test group 1 \((p < .05)\). Comparison of repeated measurement time: there were differences in the incidence of abnormal acoustic conductance (ear), tympanum effusion and otitis media at different time points \((p < .05)\), and the longer the intervention time, the lower the incidence of these indicators. See Tables 3-5.

2.4 | Comparison of hearing improvement effect among three groups

The results of this study showed that the comparison between groups: the total effective rate of hearing improvement in test group
and test group 2 was higher than that in control group, the difference was statistically significant ($p < .05$), and test group 2 was higher than that in test group 1 ($p < .05$); comparison of repeated measurement time: there were differences in the total effective rate of hearing improvement increased at different time points with the increase of intervention time ($p < .05$), as shown in Table 6.

### Table 1: Comparison of general data of three groups

| Items                              | Test group 1 (n = 37) | Test group 2 (n = 37) | Control group (n = 40) | Statistical quantity | p value |
|------------------------------------|-----------------------|-----------------------|------------------------|----------------------|---------|
| Gender cases (%)                   |                       |                       |                        | 0.276<sup>a</sup>   | .871    |
| Male                               | 28 (75.7)             | 26 (70.3)             | 29 (72.5)              |                      |         |
| Female                             | 9 (24.3)              | 11 (29.7)             | 11 (27.5)              |                      |         |
| Age (years, $\bar{x} \pm s$)      | 58.24 ± 5.71          | 60.13 ± 6.05          | 59.47 ± 6.36           | 0.224<sup>b</sup>   | .795    |
| Education cases (%)                |                       |                       |                        | 2.245<sup>a</sup>   | .697    |
| Primary school                     | 6 (16.2)              | 8 (21.6)              | 9 (22.5)               |                      |         |
| Junior high school                 | 10 (27.0)             | 12 (32.4)             | 15 (37.5)              |                      |         |
| High school/technical secondary school or above | 21 (56.8) | 17 (45.9) | 16 (40.0) |              |         |
| KPS score (score, $\bar{x} \pm s$) | 78.52 ± 6.21          | 79.16 ± 6.38          | 78.73 ± 5.98           | 0.173<sup>b</sup>   | .854    |
| Mean air conductance threshold of hearing (dB HL, $\bar{x} \pm s$) | 25.71 ± 6.39          | 25.47 ± 7.01          | 25.65 ± 6.83           | 1.041<sup>b</sup>   | .239    |

Abbreviation: KPS, Karnofsky score.
<sup>a</sup>$\chi^2$ value.
<sup>b</sup>F value.

### Table 2: Comparison of audiothreshold before and after intervention in three groups (dB HL, $\bar{x} \pm s$)

| Group               | Cases | Before radiotherapy | Six months after radiotherapy | Twelve months after radiotherapy | $F_{\text{interblock}}$ | $F_{\text{time}}$ | $F_{\text{interaction}}$ |
|---------------------|-------|--------------------|-----------------------------|---------------------------------|--------------------------|------------------|-------------------------|
| Control group       | 37    | 25.65 ± 6.83       | 54.36 ± 8.21                | 85.36 ± 9.72                    | 23.122<sup>*</sup>       | 356.953         | 18.727<sup>*</sup>       |
| Test group 1        | 37    | 25.71 ± 6.39       | 38.60 ± 7.23**              | 67.84 ± 8.57**,***              |                          |                  |                         |
| Test group 2        | 40    | 25.47 ± 7.01       | 38.94 ± 7.64**              | 52.75 ± 8.19**                  |                          |                  |                         |
| $F$ value           |       | 3.875              | 27.388                      | 45.856                          |                          |                  |                         |
| $p$ value           |       | .071               | <.001                       | <.001                           |                          |                  |                         |

<sup>*</sup>$p < .01$; **Comparison with control group, $p < .05$; ***Compared with test group 2, $p < .05$.

### Table 3: Comparison of the incidence of abnormal acoustic conductance (ear) in three groups before and after intervention [n (%)]

| Group               | Cases | Before radiotherapy | Six months after radiotherapy | Twelve months after radiotherapy | Wald $\chi^2_{\text{interaction}}$ | Wald $\chi^2_{\text{time}}$ |
|---------------------|-------|--------------------|-----------------------------|---------------------------------|------------------------------------|-----------------------------|
| Control group       | 37    | 0                  | 47 (63.51)                  | 67 (90.54)                       | 6.355<sup>*</sup>                  | 53.743**                    |
| Test group 1        | 37    | 0                  | 34 (45.95)                  | 50 (67.57)                       |                                    |                             |
| Test group 2        | 40    | 0                  | 36 (45.00)                  | 38 (47.50)                       |                                    |                             |

<sup>*</sup>$p = .012$; **$p = .000$.

### Table 4: Comparison of rate of tympanic effusion under otoscope in three groups before and after intervention [n (%)]

| Group               | Cases | Before radiotherapy | Six months after radiotherapy | Twelve months after radiotherapy | Wald $\chi^2_{\text{interaction}}$ | Wald $\chi^2_{\text{time}}$ |
|---------------------|-------|--------------------|-----------------------------|---------------------------------|------------------------------------|-----------------------------|
| Control group       | 37    | 0                  | 46 (62.16)                  | 61 (82.43)                       | 5.094<sup>*</sup>                  | 64.715**                    |
| Test group 1        | 37    | 0                  | 28 (37.84)                  | 42 (56.76)                       |                                    |                             |
| Test group 2        | 40    | 0                  | 27 (33.75)                  | 25 (31.25)                       |                                    |                             |

<sup>*</sup>$p = .000$.
Radiotherapy is the main treatment for nasopharyngeal carcinoma after radiotherapy, but there are also many complications, such as otorrhea, deafness, tympanic effusion, resulting in ROM.

Nasopharyngeal carcinoma is a common malignant tumor in otorhinolaryngology. When the tumor volume increases, it causes mechanical compression on the pharyngeal opening of the eustachian tube, and at the same time, the tumor can directly invade the middle ear and surrounding tissues. With the progress of the disease, the secretion of the middle ear increases continuously and the bacterial retention increases, resulting in infection. In addition, the allergic reaction induced by tumor cells can lead to eustachian tube obstruction and tympanic effusion, resulting in ROM. Radiotherapy is the main treatment for nasopharyngeal carcinoma, and in the process of radiotherapy, X-ray acting on the body cells, tissues, and other substances can lead to protein molecular chain fracture, loss of metabolic enzyme activity, cell structure damage. X-rays can also ionize water molecules in the body, leading to an increase in free radicals. Chronic inflammatory injury may occur in tissues and organs during radiotherapy, such as nerve palsy, radiation damage of middle ear mucosa, decreased local resistance, and increased bacterial infection. After radiotherapy, the mucosa of the eustachian tube is prone to edema and congestion, resulting in fibrosis and obstruction of nasopharyngeal lymphatic return, eustachian tube obstruction, and secretion discharge obstruction. X-rays can also cause vasculitis in tissues, reduce blood supply to the cochlea, and lead to degeneration of basal spiral ganglia due to ischemia and hypoxia, which directly or indirectly damage the middle ear and form radioactive secretory otitis media (RSOM), leading to hearing loss in patients.

At present, clinical studies on the treatment of RSOM have been widely carried out, mainly focusing on drug therapy and surgical treatment, but there are also many complications, such as otorrhea, infection, perforation, and so on, which greatly increased the suffering of patients. From the perspective of traditional Chinese medicine, the hearing loss of nasopharyngeal cancer patients after radiotherapy is mainly caused by the damage of ear meridians, obstruction of qi and blood, and occlusion of the ear body, so this study tries to apply the method of ear health exercises. In this study, the mean value of the audiowithres of the three groups after radiotherapy increased gradually with the passage of time, but the longer the intervention time, the lower the mean value of audithreshold of the air conduction (p < .05). The incidence of abnormal acoustic conductance (ear), tympanum effusion, and otitis media was lower than that of the control group (p < .05), and the incidence of these indicators showed a decreasing trend with the increase of intervention time, with statistical significance, indicating that NPC patients had varying degrees of hearing damage after radiotherapy. The hearing loss degree of the experimental group was lower than that of the control group after ear exercise intervention, indicating that ear exercise has a protective effect on the hearing loss of patients with nasopharyngeal carcinoma after radiotherapy, which is helpful to improve the hearing function of such patients. The ear health exercises designed in this study select Tinggong in the hand-sun Meridian to dredge the sun meridian, massage auricle, tragus and earlobe, and other local acupoints around the ear to dredge the ear meridian qi and blood, open the ear orifician, through beating Tiangu to dredge veins, stimulate internal qi. This is consistent with the analysis of why Wenquan et al. used acupuncture therapy to improve the curative effect of sensorineural deafness and tinnitus. Xu et al. also found in clinical practice that by improving the blood characteristics of the inner ear microcirculation, more blood components can pass through the narrowed and unable to expand the microvessels. Hearing rehabilitation measures to restore hair cell nutrition and metabolism can be used as a new method to improve hearing loss in patients with NPC radiotherapy and chemotherapy.

In this study, by increasing the intervention time of ear exercises, it

### Table 5 Comparison of incidence of otitis media in three groups before and after intervention [n (%)]

| Group          | Cases | Before radiotherapy | Six months after radiotherapy | Twelve months after radiotherapy | Wald \( \chi^2 \) interaction | Wald \( \chi^2 \) time |
|----------------|-------|---------------------|------------------------------|----------------------------------|------------------------------|------------------------|
| Control group  | 37    | 0                   | 45 (60.81)                   | 68 (91.89)                       | 6.763*                       | 58.053*                |
| Test group 1   | 37    | 0                   | 35 (47.30)                   | 52 (70.27)                       |                             |                        |
| Test group 2   | 40    | 0                   | 35 (43.75)                   | 36 (45.00)                       |                             |                        |

*p = .012; **p = .000.

### Table 6 Comparison of total effective rate of hearing improvement among three groups after intervention [n (%)]

| Group          | Cases | Before radiotherapy | Six months after radiotherapy | Twelve months after radiotherapy | Wald \( \chi^2 \) interaction | Wald \( \chi^2 \) time |
|----------------|-------|---------------------|------------------------------|----------------------------------|------------------------------|------------------------|
| Control group  | 37    | 0                   | 43 (58.10)                   | 18 (24.32)                       | 12.865*                      | 38.273**               |
| Test group 1   | 37    | 0                   | 58 (78.38)                   | 33 (44.59)                       |                             |                        |
| Test group 2   | 40    | 0                   | 56 (70.00)                   | 53 (66.25)                       |                             |                        |

*p = .002; **p = .000.

### 3 DISCUSSION

#### 3.1 Ear exercises can effectively reduce the degree of hearing loss in patients with nasopharyngeal carcinoma after radiotherapy

Nasopharyngeal carcinoma is a common malignant tumor in otorhinolaryngology. When the tumor volume increases, it causes mechanical compression on the pharyngeal opening of the eustachian tube, and at the same time, the tumor can directly invade the middle ear and surrounding tissues. With the progress of the disease, the secretion of the middle ear increases continuously and the bacterial retention increases, resulting in infection. In addition, the allergic reaction induced by tumor cells can lead to eustachian tube obstruction and tympanic effusion, resulting in ROM. Radiotherapy is the main treatment for nasopharyngeal carcinoma, and in the process of radiotherapy, X-ray acting on the body cells, tissues, and other substances can lead to protein molecular chain fracture, loss of metabolic enzyme activity, cell structure damage. X-rays can also ionize water molecules in the body, leading to an increase in free radicals. Chronic inflammatory injury may occur in tissues and organs during radiotherapy, such as nerve palsy, radiation damage of middle ear mucosa, decreased local resistance, and increased bacterial infection. After radiotherapy, the mucosa of the eustachian tube is prone to edema and congestion, resulting in fibrosis and obstruction of nasopharyngeal lymphatic return, eustachian tube obstruction, and secretion discharge obstruction. X-rays can also cause vasculitis in tissues, reduce blood supply to the cochlea, and lead to degeneration of basal spiral ganglia due to ischemia and hypoxia, which directly or indirectly damage the middle ear and form radioactive secretory otitis media (RSOM), leading to hearing loss in patients.

At present, clinical studies on the treatment of RSOM have been widely carried out, mainly focusing on drug therapy and surgical treatment, but there are also many complications, such as otorrhea, infection, perforation, and so on, which greatly increased the suffering of patients. From the perspective of traditional Chinese medicine, the hearing loss of nasopharyngeal cancer patients after radiotherapy is mainly caused by the damage of ear meridians, obstruction of qi and blood, and occlusion of the ear body, so this study tries to apply the method of ear health exercises. In this study, the mean value of the audiowithres of the three groups after radiotherapy increased gradually with the passage of time, but the longer the intervention time, the lower the mean value of audithreshold of the air conduction (p < .05). The incidence of abnormal acoustic conductance (ear), tympanum effusion, and otitis media was lower than that of the control group (p < .05), and the incidence of these indicators showed a decreasing trend with the increase of intervention time, with statistical significance, indicating that NPC patients had varying degrees of hearing damage after radiotherapy. The hearing loss degree of the experimental group was lower than that of the control group after ear exercise intervention, indicating that ear exercise has a protective effect on the hearing loss of patients with nasopharyngeal carcinoma after radiotherapy, which is helpful to improve the hearing function of such patients. The ear health exercises designed in this study select Tinggong in the hand-sun Meridian to dredge the sun meridian, massage auricle, tragus and earlobe, and other local acupoints around the ear to dredge the ear meridian qi and blood, open the ear orifician, through beating Tiangu to dredge veins, stimulate internal qi. This is consistent with the analysis of why Wenquan et al. used acupuncture therapy to improve the curative effect of sensorineural deafness and tinnitus. Xu et al. also found in clinical practice that by improving the blood characteristics of the inner ear microcirculation, more blood components can pass through the narrowed and unable to expand the microvessels. Hearing rehabilitation measures to restore hair cell nutrition and metabolism can be used as a new method to improve hearing loss in patients with NPC radiotherapy and chemotherapy.
was found that the degree of hearing loss of patients was reduced than that of patients in the same group. It was speculated that within a certain range, the longer the intervention time, the more beneficial it was to reduce the degree of hearing loss of patients. However, this study was limited to monitoring the hearing loss at 6 and 12 months after the intervention. As for the longer period of time, whether the patients have sustained reduction of hearing loss remains to be confirmed by further studies.

3.2 Increasing the time of ear exercises can effectively improve the effect of hearing

In this study, after receiving ear exercise intervention, the total effective rate of hearing improvement in test group 1 and test group 2 was higher than that in control group (p < .05), and after 12 months of intervention, the test group 2 was higher than the test group 1, the difference was statistically significant (p < .05), indicating that with the increase of intervention time, the total effective rate of patients’ hearing improvement increased. Therefore, on the premise of ensuring patient compliance, exercise time can be appropriately extended. The results of this study are similar to those of Liu Hui who implemented ear exercises intervention measures for the hearing loss elderly for 18 weeks. On the one hand, the ear exercise program designed in this study mainly massages the auricle repeatedly, and vibrates the eardrum with negative pressure, so that the vibration is transmitted to the inner ear, effectively stimulating the peripheral nerves of the ear, dredge ear meridians, improving the microcirculation of the ear, and reducing the symptoms of hearing loss. On the other hand, increasing the length of massage practice time for patients’ tension, anxiety, and other emotions can also play a certain role in relieving. However, as there are few longitudinal intervention studies related to auricular acupoint massage therapy reported at present, the specific duration of ear exercises is the most appropriate, which needs to be improved by longitudinal studies with larger samples and longer time in the future. However, there are still few longitudinal intervention studies related to ear acupoint massage therapy reported at present. As to how long is the most appropriate time for ear exercises, a larger sample and longer longitudinal study should be designed to improve it in the future.

4 SUMMARY

Ear massage is one of the most studied interventions for hearing loss at present, but it is rarely seen in the treatment of hearing loss in patients with nasopharyngeal carcinoma after radiotherapy. Ear massage can effectively prevent or slow down the hearing loss and improve the quality of life of patients with nasopharyngeal carcinoma radiotherapy for the first time. Besides, it has definite curative effect, simple operation, low price, and small side effects, and is easy for patients to accept and master, which is worthy of clinical promotion and application. This intervention has laid a foundation for more scientific application of hearing loss in NPC patients after radiotherapy and related prevention and rehabilitation methods. However, since the patients in this study were selected for the first diagnosis of nasopharyngeal cancer without otitis media, tympanic membrane perforation, or tumor invasion to the middle ear and other factors affecting hearing, whether this intervention method is suitable for those with hearing loss remains to be further explored.

AUTHOR CONTRIBUTIONS

Study design: Juan Lu, Hui Zhang, Linyun Shi, Dejing Xu. Literature review and manuscript drafting: Juan Lu, Hui Zhang. Data analysis: Hui Zhang, Jing Wen. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

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