

Multidisciplinary Team Role in Cochlear Implantation after Radiotherapy and Chemotherapy in Nasopharyngeal Carcinoma Patients

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Abstract

Objectives: To explore the role of multidisciplinary team (MDT) in perioperative safety and feasibility evaluation and postoperative effect prediction of cochlear implantation (CI) in patients with bilateral profound sensorineural hearing loss (SNHL) after radiotherapy and chemotherapy for nasopharyngeal carcinoma (NPC). **Methods:** From 2017 to 2022, 11 patients with bilateral profound SNHL after radiotherapy and chemotherapy for NPC received CI in our department. MDT formulated diagnosis and treatment plan for all patients during their perioperative period. The MDT participants were from the following departments: otorhinolaryngology, radiology, radiotherapy, neurology, psychiatry, anesthesiology, and audiology and speech rehabilitation. Several hearing examinations were tested during the follow-up to dynamically observe the effectiveness of the hearing and speech rehabilitation in the patients. **Results:** Based on the MDT conclusion and decision, five patients underwent routine CI, two patients underwent simultaneously extended radical mastoidectomy and CI, and four patients underwent simultaneously subtotal petrosectomy, external auditory canal elimination, mastoid cavity obliteration by fat graft or musculoperiosteal flaps and CI. The pure tone average of all 11 patients was 39.5 ± 5.0 dB and the average speech discrimination score was $95.0 \pm 9.7\%$ postoperatively. One patient underwent a second surgery for the cochlear electrode prolapsed postoperatively. **Conclusion:** To some extent, CI is risky for patients after chemoradiotherapy for NPC. However, the MDT approach can reduce the risk fast, predict the auditory effect after implantation early, as well as predict and prevent the occurrence of postoperative complications. Therefore, MDT exerts a positive effect on the outcome of the relatively safe and feasible application of CI in these patients. **Keywords:** Multidisciplinary team, nasopharyngeal carcinoma, cochlear implantation.

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Key points:

1. Hearing loss is a major adverse effect of the treatment of an NPC patient and cochlear implantation is an effective method for the recovery of the hearing of patients suffering from severe to profound hearing loss.
2. This is the first study applying multidisciplinary team method to face the long-term complications after chemoradiotherapy for NPC patients, including limitation of the mouth opening, caused by temporomandibular joint dysfunction, osteoradionecrosis of the temporal bone, chronic otitis media and radioactive encephalopathy.
3. Our study showed that MDT has an important role in the whole process of diagnosis and treatment, which can rapidly reduce the perioperative risk, effectively predict the postoperative auditory effect, and prevent the occurrence of postoperative complications.
4. Based on the results of the MDT discussion, surgeons employed different operative approaches depending on the patient's situation, including the extent of ORNTB and the intactness of tympanic membrane.
5. Our study showed that the application of CI in patients who underwent chemoradiotherapy for NPC is relatively safe and feasible.

INTRODUCTION

Nasopharyngeal carcinoma (NPC) is a malignant epithelial tumor that originates from the nasopharynx, which is highly prevalent in East and Southeast Asia, especially in South China.¹Intensity-modulated radiotherapy (IMRT) alone or in combination with chemotherapy is recommended for the treatment of NPC.²In the course of treatments, the hearing apparatus, including the tympanic membrane, eustachian tube, and cochlea are damaged by radiation and the adjuvant chemotherapy drugs. Hearing loss was reported was a major adverse effect of the treatment of an NPC patient.³ Hearing loss seriously and negatively affects patients' daily communication and quality of life, further leading to a decline in patients' cognitive function. In contrast to the insufficient compensation effect of hearing aids (HA), cochlear implantation (CI) is an effective method for the recovery of the hearing of patients suffering from severe to profound SNHL.^{4,5}

However, long-term complications after chemoradiotherapy, including limitation of the mouth opening, caused by temporomandibular joint dysfunction, neck fibrosis, osteoradionecrosis of the temporal bone (ORNTB), chronic otitis media, eustachian tube dysfunction, radioactive encephalopathy (REP), and radioactive paranasal sinusitis affect perioperative safety and surgical feasibility.^{6,7} Although previous evidence has shown that CI can significantly improve the hearing of patients with severe or profound SNHL after chemoradiotherapy for NPC, the perioperative safety and feasibility, as well as surgical effect of CI remain key issues.⁸ Therefore, we propose the introduction of the multidisciplinary team (MDT) discussion approach of the above issues.

MDT is a clinical treatment mode in which experts from different specialties form relatively fixed expert groups that regularly schedule discussion concerning the diagnosis and treatment for a certain organ or system disease. Currently, MDT is widely implemented in the field of malignant tumor therapy.⁹ In our department, MDT is often used in the comprehensive treatment of head and neck tumors. Experts from various departments jointly evaluate and plan interventions of specific patients. Hence, optimal treatment plans are assigned to patients according to the particular clinical needs.

In this study, we applied MDT to the whole process, including the perioperative and postoperative period. Our study showed that the role of MDT in CI after chemoradiotherapy of NPC patients is of considerable significance.

MATERIALS AND METHODS

In this study, we reviewed the data of 11 patients with bilateral profound SNHL after radiotherapy and chemotherapy for NPC who underwent CI in our department “Blinded for review” from 2017 to 2022.

Evaluation of the perioperative safety and feasibility through MDT

Currently, our hospital “Blinded for review” has established MDT, whose core is the Department of Otorhinolaryngology, combined with the Departments of Radiology, Radiotherapy, Neurology, Psychiatry, Anesthesiology.

Radiotherapists, radiologists, and otorhinolaryngologists evaluated the tumor control situation to exclude tumor residue, local recurrence, and distant metastasis

According to the Chinese Society of Clinical Oncology (CSCO) clinical guidelines for the diagnosis and treatment of NPC, nasopharyngoscopy and nasopharyngeal and neck magnetic resonance imaging (MRI) scan were employed to assess the local lesions. Besides, chest computed tomography (CT) scan, abdominal ultrasound or upper abdominal CT, whole-body bone scan, and detection of Epstein-Barr virus (EBV) DNA copy number in peripheral blood were used to exclude distant post-treatment metastases. When necessary, PET-CT examination should be considered.²

Radiologists and otorhinolaryngologists assessed the severity of ORNTB and otitis media

ORNTB was characterized as either localized or diffuse based on Ramsden classification: 1) localized type: mostly limited to the external auditory canal (EAC) without invading the mastoid bone of the middle ear; 2) diffuse type: predominantly diffuse necrosis of the temporal bone with a high risk of involvement of adjacent structures, in particular the brain, labyrinth, and the facial nerve and to a lesser extent the temporomandibular joint and the parotid gland.¹⁰⁻¹³ Based on the Ramsden classification, the surgeons and the radiologists planned the application of three different surgical methods by assessing the intactness of the tympanic membrane (TM) and the thickness and integrity of the cortical bone of the posterior and upper wall of the EAC through the temporal bone CT thin-layer scan on the horizontal section from the facial recess to the base turn of cochlea.

Radiologists diagnosed radiation encephalopathy (REP) and assessed the severity of REP; neurologists and psychologists evaluated patients’ cognitive function and psychological status.

Focal cerebral radiation necrosis, which is a type of REP, can occur after incidental irradiation of the brain during NPC treatment.¹⁴ The diagnosis of REP is based mainly on NPC radiotherapy history, imaging examinations, clinical symptoms, and cognitive functions. However, the clinical presentation of focal radiation necrosis is a subacute space-occupying lesion, which is nonspecific. Therefore, imaging examinations, such as standard MRI scans, are the main diagnostic methods for REP (Fig. 1).¹⁵ The radiologists diagnosed REP and assessed the severity of REP by MRI. Meanwhile, neurologists and psychologists assisted in judging whether epilepsy and cognitive dysfunction caused by REP were contraindications.

Anesthesiologists should evaluate patients’ perioperative situation and the risk of anesthesia.

One of the most common complications after radiotherapy for NPC is limitation of the mouth opening, which increases the difficulty of endotracheal intubation and thus increases the risk of anesthesia. The anesthesiologists used the modified Mallampati scores to divide the patients into four classes. Nasotracheal intubation should be considered in grades III and IV patients, whereas orotracheal intubation was applied in grade I and II patients.¹⁶

Otorhinolaryngologists and audiologists evaluated the patients' remaining hearing and speech abilities and predicted the postoperative results.

All patients underwent preoperative audiological examination evaluation for cochlear implant candidacy. Intraoperative audiologists routinely performed neural response telemetry (NRT). Postoperative routine reexamination of temporal bone CT was conducted to confirm the electrode's position in order to exclude the possibility of electrode fracture, partial electrode implantation or implantation failure.

Evaluation of postoperative effects through MDT

These postoperative patients were followed up by the hearing and speech rehabilitation team. During the follow-up, professional audiologists assessed the cochlear implanters' postoperative hearing and speech function recovery by Category of Auditory Performance (CAP), Speech Intelligibility Rating (SIR), pure tone average (PTA) and speech discrimination score (SDS). If MDT team noticed the occurrence of postoperative complications, such as infection, electrode array extrusion, facial paralysis, and device failure, they would immediately inform the attending surgeons and provide relevant treatment.

Statistical analysis

SPSS software (Version 20.0; SPSS, IBM Corp., Armonk, NY, USA) was used to analyze the data in this study, a paired T-test was used to assess the preoperative and postoperative data results. $P < .05$ was considered to indicate a statistically significant difference.

RESULTS

In this study, a total number of 11 patients (4 males and 7 females) aged from 36 to 69 years, with bilateral severe or profound SNHL after chemoradiotherapy for NPC, who underwent CI, were enrolled. All patients had suffered from hearing loss after standard chemoradiotherapy prior to CI. All patients were regularly followed up postoperatively, with a follow-up duration ranging from 6 to 60 months, with an average of 29 months (Table 1).

MDT discussion results

All patients participated in a perioperative MDT discussion for the evaluation of the safety and feasibility of surgery, preliminarily prediction of the postoperative effects, and prevention of the occurrence of postoperative complications. The following results were obtained: 1) All primary lesions were completely controlled after comprehensive treatment without signs of residues, recurrence, or metastasis; 2) All patients were classified into three different classes. Five patients of grade (a), whose ORNTB were localized by an intact TM and continuous cortical bone of the posterior and superior walls of the EAC, were accepted for routine CI (Fig. 2a). Two patients of grade (b) with diffuse ORNTB and an intact TM and a continuous cortical bone of the posterior and superior walls of the EAC were subjected to simultaneous extended radical mastoidectomy and CI (Fig. 2b). The other four patients of grade (c) simultaneously underwent subtotal petrosectomy (STP), external auditory canal elimination, mastoid cavity obliteration by fat graft or musculoepiosteal flaps and CI because of their diffuse ORNTB with perforate TM and defects in the posterior and upper walls of the EAC (Fig. 2c); 3) Radiologists diagnosed five patients who had different levels of REP depending on standard MRI and CT. Neurologists and psychiatrists found that four of them had no abnormal neurological symptoms or clinical signs due to REP. It is worth noting that a patient had been diagnosed with REP on the bilateral temporal lobe after epileptic seizures in 2012 and underwent partial radiation lesion resection of the right temporal lobe. Because the epilepsy was well controlled and the patient did not occur any seizure over a year, MDT team did not regard REP as a surgical contraindication. But REP was predicted to pro-

bably affect postoperative hearing recovery; 4) According to modified Mallampati scores, anesthesiologists classified four patients into grade IV, characterized by difficult airway passage, thus nasotracheal intubation under fiberoptic bronchoscopy was considered, combined with preparation of emergency measures such as tracheotomy before anesthesia.

Operative approach

Based on the results of the MDT discussion, surgeons employed different operative approaches depending on the patient's situation. However, the surgeon planned to perform the grade (c) surgery method in one of the patients. However, this patient could not accept the symptom of aural fullness, and thus grade (b) surgery method was adopted. The other patients agreed with the results of the MDT discussion and accepted the surgical methods. The intraoperative time fluctuated 3.2 $\pm$ 1.0 hours. Intraoperative neural response telemetry (NRT) showed that the surgery of all cochlear implant was performed successfully. Smooth anesthesia and operation without complications were achieved in all patients (Table 2).

Postoperative hearing and speech performance

During the follow-up visits, audiological examinations were performed to observe the dynamics of all patients' postoperative hearing and speech recovery. The encouraging audiological outcomes revealed that CI had positive effect on hearing rehabilitation.

All 11 patients were diagnosed with profound bilateral SNHL before surgery. The average hearing threshold was more than 80 dB, with mean SDS scores with hearing aids of less than 70%. The mean PTA and SDS scores obtained at the last follow-up examination were 39.5 $\pm$ 5.0 dB and 95.0 $\pm$ 9.7% (mean $\pm$ standard deviation), respectively.

The mean CAP and SIR scores obtained before CI and at the last follow-up examination were 1.8 $\pm$ 1.0 versus 5.9 $\pm$ 0.8 and 1.5 $\pm$ 0.5 versus 4.1 $\pm$ 0.7, respectively, which were significantly better than the preoperative ones (paired Wilcoxon signed-rank test, $P = 0.000 < .05$) (Table 3).

Incidence of postoperative complications

None of the 11 patients had serious postoperative complications in the short term. However, 2 patients had otitis externa mycotica, which was detected during the follow-up examinations; their condition was relieved by the application of anti-fungal topical ointment. The patient who refused surgeon's advice was noted to have an exposed electrode in the right external auditory canal 12 months postoperatively (Fig. 3a), and the intracochlear electrode array was completely migrated 28 months postoperatively (Fig. 3b). Therefore, the patient accepted and underwent STP, external auditory canal elimination, mastoid cavity obliteration by fat graft, and cochlear reimplantation during the second operation (Fig. 3c).

DISCUSSION

Hearing impairment remains the most common complication in long-term survivors after comprehensive treatment for NPC. Currently, CI is the only method implemented for the rehabilitation severe to profound SNHL in cases of insufficient compensation effect of the HA. However, various postradiotherapy complications increase the difficulties of surgery, and have negative effect on postoperative recovery. Therefore, the evaluation performed only by otorhinolaryngologists of the condition of such patients was not sufficient, and thus MDT was used to make the diagnosis and provide the treatment plan for each of the patients included in the present study.

According to the CSCO clinical guidelines for NPC, post-treatment follow-up of NPC is very important. In this study, the relevant examinations were strictly completed following the guidelines, and MDT evaluated the situation of tumor control jointly by specialists from different departments. The results showed that NPC in all 11 patients was controlled completely.

Huang et al.¹⁷ divided the postirradiated NPC patients into three categories: mild, moderate and severe. Different from our study, they recommended that patients of severe category underwent subtotal temporal

bone resection (STBR), external auditory canal elimination, CI simultaneously or by stage because they suffered recurrent suppurative otitis media and mastoiditis, combined with the external moist EAC with defect of skin and bear dead bones, and serious or severe radiation osteomyelitis by CT/MRI. The results showed that CI for postirradiated ears of NPC is safe and feasible following specific surgical methods aiming to three categories.

In this study, we classified ORNTB into localized type and diffuse type referring to Ramsden classification.¹¹ On the basis of Ramsden classification, our center's experience demonstrated the importance of the thickness and integrity of the cortical bone of the posterior and superior wall of the EAC. This was due to the fact that the intact EAC can protect the cochlear electrode array, preventing the occurrence of infection and electrode exposure. Thus, we recommended that the patients of grade (c) underwent STP, external auditory canal elimination, mastoid cavity obliteration by fat graft or musculo-periosteal flaps and CI simultaneously. Prasad et al.¹⁸ reported that STP is indicated in osteoradionecrosis while STBR is usually used on the temporal bone malignancies. In the present study we initially excluded the residues, recurrence, or metastasis of the primary lesion based on perioperative MDT discussion. Therefore, STP was selected to eliminate potential infection, reduce the risk of postoperative complications and achieve rapid postoperative recovery. It is worth noticing that the aforementioned cochlear implant was dysfunctional because of the total detached electrode from the round window. Considering the history of radiotherapy for NPC and diffuse ORNTB, conservative management would have exposed the patient to a high risk of infection. Therefore, the patient underwent a second surgery, as mentioned earlier. Chua et al.¹⁹ performed conservative treatment with close clinical surveillance as a reasonable option faced with electrode array extrusion post-CI in a post-irradiated patient. In contrast, we suggest a positive surgical treatment in case of electrode extrusion. Besides, MDT precisely predicted the risk of electrode exposure in this patient, reflecting the potential of MDT to reduce the incidence of medical errors.

Several studies have revealed marked improvements in the hearing of cochlear implant recipients who had previously received radiotherapy for head and neck cancers. In this regard, Soh et al.²⁰, Chang et al.²¹, and Low et al.²² established that there were no obvious differences in the effectiveness of CI in post-irradiated NPC patients with hearing impairment as compared with non-NPC patients with profound SNHL. However, whether REP, which is regarded as a severe post-irradiation complication, affects postoperative hearing outcome remains unclear. Besides, there are no clear guidelines for the diagnosis and treatment of REP. In our study, it was shown that the postoperative hearing and speech rehabilitation effects of all 11 patients were significantly better than those before surgery, regardless of the presence or absence of REP.

CONCLUSION

Our study showed that the application of CI in patients who underwent chemoradiotherapy for NPC is relatively safe and feasible. The long-term complications reported here, including mastoiditis, ORNTB, and REP, are not absolute surgical contraindications. MDT has an important role in the whole process of diagnosis and treatment, which can rapidly reduce the perioperative risk, effectively predict the postoperative auditory effect, and prevent the occurrence of postoperative complications.

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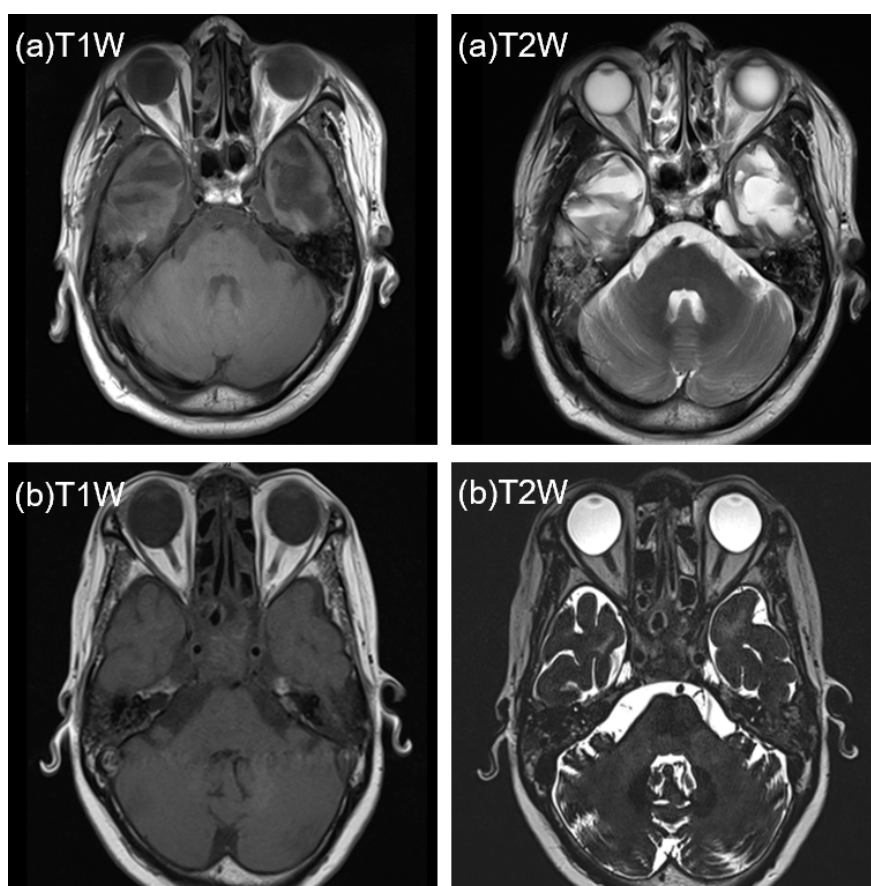
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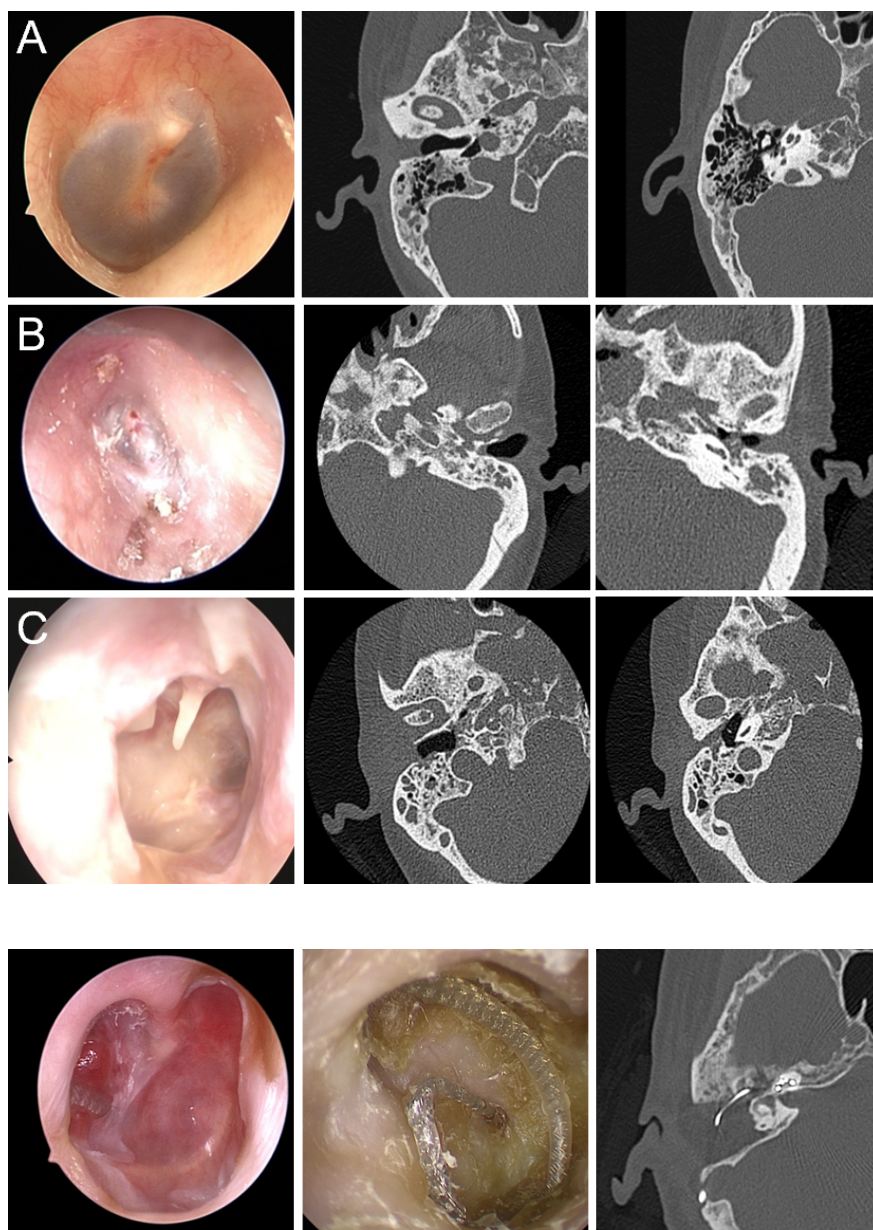
Figure Legends

Figure 1. MRI scan of cases with or without REP. Imaging of (a) showed typical REP in bilateral temporal lobes. Imaging of (b) showed no obvious sign of REP. MRI = magnetic resonance imaging; REP = radioactive encephalopathy.

Figure 2. Endoscopic imaging and CT scan of preoperative situation. Imaging of (a) showed intact TM and the posterior and upper wall of EAC, and localized ORNTB. Imaging of (b) showed intact TM and the posterior and upper wall of EAC, and diffuse ORNTB. Imaging of (c) showed perforated TM and the defects on the posterior and upper wall of EAC, and diffuse ORNTB. CT = computed tomography; TM = tympanic membrane; EAC = external auditory canal; ORNTB = osteoradionecrosis of the temporal bone.

Figure 3. Endoscopic imaging of electrode exposure and CT scan of postoperative situation. Imaging of (a) showed an exposed electrode in the right posterior wall of the external auditory canal 12 months after surgery. Imaging of (b) showed that the intracochlear electrode array was completely migrated 28 months after surgery. Imaging of (c) showed the right electrode's position in cochlea with the protection of abdominal fat graft.





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