



Original Article

Effects of the professional oral care management program on patients with head and neck cancer after radiotherapy: A 12-month follow-up



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Abstract *Background/purpose:* Because oral health of patients with head & neck cancer is prone to disease after radiotherapy, effective and long-lasting oral care program is necessary. We aimed to evaluate the effects of the oral care management program, which lasted up to 12 months after radiotherapy for patients with head and neck cancer.

Materials and methods: Sixty-eight patients who visited a dental clinic prior to the initiation of radiotherapy were recruited and categorized into either a “healthy” or a “vulnerable” group. The vulnerable group was made of patients with dental caries or periodontal attachment loss. Professional oral hygiene care, including tooth brushing instructions, professional mechanical tooth cleaning, and fluoride varnish application, was conducted once every week for a month during radiotherapy and once every 3 months after radiotherapy. Oral health, including dental caries, plaques, gingival index, and periodontal attachment loss, was examined at baseline, 6 months, and 12 months after radiotherapy.

Results: ; Twenty-nine and 16 patients were followed up at 6 and 12 months after radiotherapy, respectively. Oral health indices, such as the number of decayed teeth, amount of plaque, and gingival index, did not significantly change in either group. However, the periodontal pocket depth significantly decreased in both groups at 6 months after baseline, and this decrease continued in the vulnerable group up to 12 months after baseline.

Conclusion: Periodic dental visits and professional oral hygiene care during and after

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radiotherapy were effective in maintaining oral health for over 12 months after radiotherapy in patients with head and neck cancer.

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Introduction

Head and neck cancers (HNCs) are malignancies involving various soft and hard tissues of the head and neck, including the oral cavity.¹ The incidence of HNC has increased annually in South Korea since 1998.² Compared with other types of cancer, the incidence of cancers of the tongue, salivary glands, and hypopharynx rapidly increased between 1999 and 2012 in South Korea.³ To treat locally-advanced HNC, chemotherapy-associated with radiotherapy is the major treatment option in most cases, which can cause various types of pain in patients.⁴ Acute pain in the oral cavity may be caused by inflammation of the skin and mucosae in the radiation field, which in turn may lead to poor oral hygiene and poor quality of life.^{5–7}

Also, radiation of the oral cavity has been reported to cause varying levels of decrease in saliva secretion. In particular, saliva secretion may decrease considerably when the parotid gland is in the radiation field.^{8,9} Hypo-salivation can result in poor oral health, because saliva has many protective functions, such as controlling the pH of plaques, maintaining the dental structure, and supporting the natural microbial flora.⁸ In addition, radiation can directly affect the mechanical structure of the dental surface, which may be one of the reasons why radiation-induced caries develop faster than general caries.¹⁰ These altered conditions may aggravate dental caries and periodontitis, which are the main reasons for dental extraction. Therefore, because of HNC, the importance of good oral hygiene is emphasized for patients receiving radiotherapy with or without chemotherapy.¹¹

According to the guidelines for oral management of patients with HNC, they should be informed of the oral complications and the necessity of dental management.¹² It was recommended that dental examinations be done more often, good oral hygiene be maintained rigorously, and daily topical fluoridation be continued not only during but also after radiotherapy. Highly-concentrated fluoridation could be achieved by daily self-administration of fluoride with a custom tray, fluoride mouthwashes, and the dentifrice containing 5000 ppm of fluoride. In addition, periodontitis should be treated promptly and thoroughly.¹³ To achieve these outcomes, regular monitoring by, and the support of a general dental practitioner; and the patient's full compliance with dental management are necessary.

However, these commitments could be difficult for patients to fully comply with.¹¹ For instance, low compliance to self-administration of fluoride by patients with HNC has been reported. In one study,¹⁴ only about 19% of 155 patients performed fluoride gel application for a year using a custom-made tray. We experienced a similar situation among patients with HNC at our hospital. One problem was

the absence of an efficient protocol that a general dental practitioner can easily implement to keep patients free from periodontal issues.

On the other hand, the fluoride varnish application had demonstrated its effectiveness in preventing dental caries^{15–17} and was reported to be effective in preventing caries in compliant irradiated head and neck cancer patients.¹⁸ However, there is not enough research on the effectiveness of the fluoride varnish instead of fluoride gel with customized tray in head and neck cancer patients and there is no long-term study about that.

Therefore, instead of fluoride gel application using a custom-made tray which is not efficient protocol due to low compliance of the patients and bad convenience of general dental practitioners, we assessed the fluoride varnish to prevent caries and attempted to establish a protocol that general dental practitioners can perform relatively easily to help patients with HNC maintain their oral health during and after radiotherapy.

Materials and methods

Subjects

This study received approval from the University's Institutional Review Board at the Kyungpook National University Hospital (KNUMC 2015-05-133-001), and is registered with the Clinical Research Information Service Registry (no. KCT0002807). This study was performed per the ethical standards laid down in the 1964 Declaration of Helsinki.

The participants were patients who had been diagnosed with HNC at the Department of Otolaryngology of the Kyungpook National University Medical Center, Daegu, Korea, and then referred to the Department of Dentistry for dental evaluation before the initiation of radiotherapy. Patients were eligible if they met the following criteria: (i) it was their first time of receiving head and neck radiotherapy; (ii) they were physically and mentally capable of having an oral examination and receiving oral health education; and (iii) they had at least four natural teeth.

Initially, 68 of the patients who visited the dental clinic prior to the initiation of radiotherapy met these criteria, agreed to the study, and were recruited. The objectives and methods of this study were explained to all participants, who provided informed consent. However, 39 participants dropped out for the following reasons: transferred to other hospitals (5 patients), worsened condition (13 patients), behavioral problems such as exhaustion (5 patients), withdrew their consents (6 patients), and lost to follow-up (10 patients). In the end, 29 patients participated in this study.

Methods

The oral examination was conducted by a single dentist before the start of radiotherapy and emergent dental treatments such as extraction of hopeless teeth were done if necessary. Also scaling and TBI were done once for all patients. In addition, we conducted follow-up oral examinations to assess the periodontal status at 6 and 12 months after the start of radiotherapy. All participants were categorized into either a "healthy" or a "vulnerable" group. The vulnerable group comprised patients with one or more decays, and/or a periodontal pocket depth of at least 4 mm, and the healthy group was made of patients who did not have any of the above. The participants received professional oral hygiene care, including education on tooth brushing, at every dental visit. This was performed every week for the first month of radiotherapy and every 3 months until 12 months after radiotherapy (Fig. 1).

Surveys

The dental hygienists explained to the participants how to complete the survey. The survey was performed to determine the smoking status, drinking status, mean number of times teeth were brushed daily, and subjective oral health assessment of the participants. Smoking and drinking status were classified as "none experienced," "did in the past, but

not now," and "currently doing." The mean number of times the teeth were brushed per day was classified based on brushing the teeth twice a day. The subjective oral health assessment results were classified as "healthy," "normal," or "not healthy."

Medical record investigation

Information on the types of cancer and the regimen of radiotherapy was provided through the medical records of the participants. Cancers were classified either as squamous cell carcinoma (SCC), adenoid cystic carcinoma, pleomorphic adenoma, or other, based on the histopathologic findings by biopsy. The frequency of radiotherapy was classified into two groups based on 33 sessions, and the dose was classified into two groups based on 66 Gy.

Oral examination

All participants seated in a dental chair and underwent oral examination by the same dentist. Dental decay or missing teeth were recorded. We also measured the plaque and gingival index of six teeth: the maxillary right first molar, central incisor, maxillary left first molar, mandibular left central incisor, left first molar, and mandibular right first molar. If these index teeth were absent, the adjacent teeth were examined. If the adjacent teeth were also absent, the

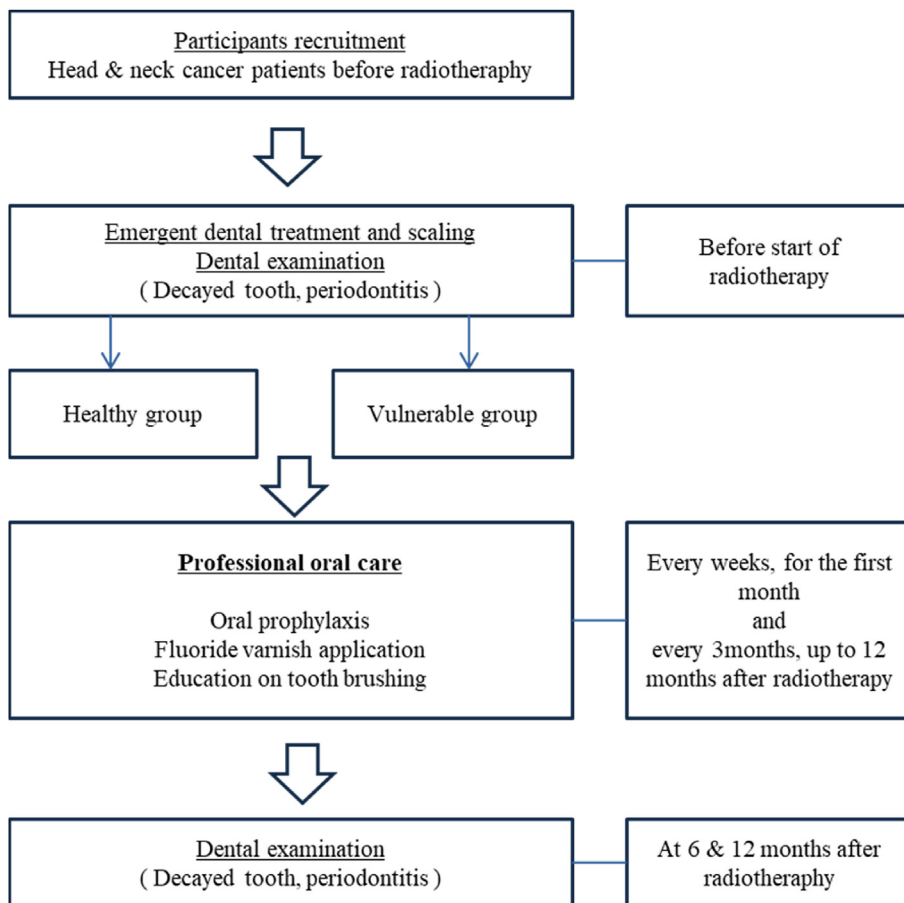


Figure 1 The flow chart of study.

corresponding area was excluded. Plaque and gingival indices were measured at mesiobuccal, midbuccal, and distobuccal surfaces of six index teeth using Loe and Silness' criteria.¹⁹ Of these three parts of the tooth surface, the highest value was recorded and used as the representative value for each tooth. Of the representative values of the index teeth, the highest value was used as the representative value for each participant.

We scored plaque and gingival indices using a 4-point scale with scores from 0 to 3. A higher score indicated increased plaque or poorer gingival health. A plaque index of 0 indicated no plaque. A plaque index of 1 indicated that the plaque that was invisible to the naked eye but was detectable using a disclosing solution or a probe had adhered to the tooth. A plaque index of 2 or 3 indicated that plaque was moderate or severe, respectively, in the gingival tissue and/or on the tooth surface, although it was invisible to the naked eye. A gingival index of 0 indicated no inflammation and healthy gingiva. A gingival index of 1 indicated mild inflammation, slight gingiva color change, and slight edema, but no bleeding on probing. A gingival index of 2 indicated that there was moderate inflammation, moderate glazing, redness, and bleeding on probing. A gingival index of 3 indicated that there was severe inflammation, marked redness, hypertrophy, ulceration, and a tendency for spontaneous bleeding.

The periodontal pocket depths were measured by a single examiner, who was a trained and experienced dentist and used the conventional periodontal probe with a constant pressure of about 20 Ncm. The index teeth were the same as those used for the plaque and gingival indices. The pocket depths were measured at six (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual, and distolingual) different pocket sites within a single tooth. Of these six sites, the highest value was recorded and used as the representative value for each tooth. Of the representative values of index teeth, the highest value was used as the representative value for each participant.

Professional oral hygiene care

A proficient dental hygienist performed oral prophylaxis to remove plaque, which included cleaning the teeth mechanically with a low-speed handpiece, a rubber cup, and fluoride-containing prophylaxis paste. However, we also included supragingival calculus removal if necessary. Next, fluoride varnish was applied to the entire surface of the teeth. We used MI Varnish™ (GC Corporation, Tokyo, Japan), which is a 5% sodium fluoride varnish. Then, a dental hygienist instructed the participants on the proper way to brush their teeth.

Statistical analysis

The statistical analysis was performed using the Statistical Package for the Social Sciences for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). The Chi-square test and Mann-Whitney U-test were performed to compare characteristics between groups before radiotherapy. Changes in oral hygiene and health at 6 and 12 months between the groups of participants were analyzed using the repeated

measures t-test or the one-way repeated measures analysis of variance test. $P < 0.05$ was considered statistically significant.

Results

General and medical characteristics of the study participants at baseline

A total of 29 patients with HNC participated in this study. They were categorized as either "healthy" or "vulnerable" according to the presence of dental caries and periodontal attachment loss. There was no significant difference in the general characteristics between the two groups (Table 1). Twenty-four patients had SCCs and five had other types of cancer. There were no significant differences in the distribution of variables related to cancer and treatment in each group (Table 2). However, according to the definition of each group, the vulnerable group had a significantly higher number of decayed teeth and significantly deeper periodontal pockets than the healthy group (Table 1).

Comparison of oral hygiene and health in the study population after 6 and 12 months

Although the number of decayed teeth increased, the difference was not statistically significant in either group. The plaque and gingival index increased in the healthy group and decreased in the vulnerable group, but these changes were not statistically significant. However, the periodontal pocket depth significantly decreased in both groups at 6 months after baseline (Table 3).

At 12 months after baseline, a total of 16 patients were followed. The number of decayed teeth increased in both groups, though this increase was not statistically significant in either of the groups. The plaque index decreased, though not significantly, in both groups. The gingival index decreased in the healthy group and increased in the vulnerable group, although these changes were not statistically significant in either of the groups. The periodontal pocket depth decreased in both groups. While this decrease was not statistically significant in the healthy group, it was significant in the vulnerable group (Table 4).

Discussion

Irradiation of the maxillofacial region of patients with HNC can cause irreversible damage to the surrounding tissues after radiotherapy. When the total radiation dose exceeds 30Gy, signs of xerostomia are already considered irreversible.^{20,21} Many patients with HNC who receive radiotherapy have long-term hyposalivation.^{22,23} All participants in this study had radiation doses exceeding 30Gy, and irreversible damage to the salivary glands was predicted. Therefore, even after the end of the radiotherapy, ongoing professional oral hygiene care is very important for these patients. According to our previous study, regular dental visits, and professional oral hygiene care during the first 8 weeks of radiotherapy were effective for maintaining oral health in patients with HNC.²⁴ In this study, we maintained

Table 1 General characteristics of the study population at baseline.

	N	Healthy group (n = 15)	Vulnerable group (n = 14)	P
		n (%)	n (%)	
Age (years)				
≤59	18 (62.1%)	9 (50.0%)	9 (50.0%)	1.00
≥60	11 (37.9%)	6 (54.5%)	5 (45.5%)	
Gender				
Male	21 (72.4%)	13 (61.9%)	8 (38.1%)	0.11
Female	8 (27.6%)	2 (25.0%)	6 (75.0%)	
General disease				
No	25 (86.2%)	13 (52.0%)	12 (48.0%)	1.00
Yes	4 (13.8%)	2 (50.0%)	2 (50.0%)	
Smoking				
Never	10 (34.5%)	3 (30.0%)	7 (70.0%)	0.13
Experienced	19 (65.5%)	12 (63.2%)	7 (36.8%)	
Drinking				
Never	9 (31.0%)	3 (33.3%)	6 (66.7%)	0.25
Experienced	20 (69.0%)	12 (60.0%)	8 (40.0%)	
Tooth brushing				
≤2	23 (79.3%)	10 (43.5%)	13 (56.5%)	0.17
>2	6 (20.7%)	5 (83.3%)	1 (16.7%)	
Number of residual tooth	29	25.33 (±4.70)	20.71 (±7.25)	0.02
Decayed tooth	29	0.00 (±0.00)	1.29 (±1.38)	0.001
Plaque index	29	0.67 (±1.04)	1.00 (±0.96)	0.29
Gingival index	29	1.27 (±0.96)	1.43 (±0.75)	0.77
Periodontal pocket depth	29	2.67 (±0.488)	3.86 (±1.231)	0.005

P-values were calculated using Chi-square test or Mann-Whitney U-test.

regular oral hygiene care, provided education both during and after radiotherapy, and evaluated the long-term effects for 12 months after radiotherapy.

In this study, there were no significant differences in cancer treatment such as radiotherapy with surgery; radiotherapy with chemotherapy; radiotherapy with chemotherapy and surgery among groups. Recently, concurrent chemoradiotherapy recognized as a standard treatment compared to radiation therapy alone in the treatment of head and neck cancer.⁴ In keeping with this situation, none had been treated with radiotherapy alone among the subjects recruited for this study.

Oral health indices, such as the number of decayed teeth and plaque/gingival index showed minor changes that were not significant in either group. However, the

periodontal pocket depth decreased significantly in both groups at 6 months, and this significant change was maintained in the vulnerable group until 12 months after baseline. When we examined the change in oral hygiene and health during the 12-month follow-up period in all patients, improvements in the plaque index, and reductions in the depth of the periodontal pocket were observed. This indicates that oral hygiene and periodontal status were maintained and improved.

Although patients with HNC receiving radiotherapy were advised to perform self-fluoride-gel application using the custom-made tray,¹² low compliance was reported.¹⁴ Furthermore, in some countries, high concentrations of fluoride are not commercially available to the general public, and it is difficult for patients to fully comply with these instructions. Therefore, in this study, we used fluoride varnish during and after radiotherapy, which could be performed relatively easily, and with better patient compliance. In addition, for periodontal care, there was no clear and practical protocol that a dental hygienist could implement. Therefore, considering patient conditions, we only administered prophylaxis to remove the supragingival plaque and calculus every 3 months after discharge, which kept both the healthy and vulnerable participants periodontally healthy up to 12 months after baseline. In contrast to a previous study, in which oral health was maintained only during and after radiotherapy,²⁵ we maintained oral care and observed its effects for a relatively long period, until after discharge. Our oral care program for patients with HNC, which was composed of active teeth prophylaxis, fluoride varnish application, and education on tooth brushing, can be easily performed by dental hygienists and is relatively easy to adapt for patients with HNC undergoing radiotherapy. Therefore, it can be performed at individual dentistry clinics, and enable long-term continuous maintenance of patients with HNC undergoing radiotherapy.

Oral mucositis is a common toxicity of high-dose chemotherapy and head and neck radiotherapy.^{26,27} It often causes pain and dysphagia, leading to weight loss and malnutrition.²⁸ In severe mucosa conditions, it caused discomfort and interfere the oral care procedure. So, in case of need, we implemented mouth gargles such as Tantum® (Sama Pharm, Seoul, Korea) to prevent and manage oral mucositis.

However, this study could not clearly indicate the effect of professional oral hygiene management because it was administered without controls for ethical reasons. Since best oral hygiene maintenance and continuous fluoridation are essential for HNC patients with radiotherapy, professional oral management involving fluoride varnish application were performed on all patients in this study. Therefore, this study was designed to classify all the participants into two groups, the vulnerable and healthy groups, based on their previous oral state, and to compare the effects of professional oral management containing fluoride varnish application in each group.

Moreover, there was a relatively small number of participants because of patients who were lost to follow-up, which is one of limitations of this study. Among various drop-out reasons, worsened general condition was the most frequent reason as above mentioned. So continuous

Table 2 Cancer-related characteristics of the study population at baseline.

	N	Healthy group (n = 15)		Vulnerable group (n = 14)		P
		n (%)	n (%)	n (%)	n (%)	
Cancer type						
SCC	24 (82.8%)	14 (58.3%)	10 (41.7%)			0.11
Others	5 (17.2%)	1 (20.0%)	4 (80.0%)			
Primary site of tumor						
Mouths	5 (17.2%)	3 (60.0%)	2 (40.0%)			0.45
Nasopharynx	4 (13.8%)	1 (25.0%)	3 (75.0%)			
Oropharynx	8 (27.6%)	6 (75.0%)	2 (25.0%)			
parotid	4 (13.8%)	2 (50.0%)	2 (50.0%)			
Others	8 (27.6%)	3 (37.5%)	5 (62.5%)			
TNM stage						
I	7 (24.1%)	5 (71.4%)	2 (28.6%)			0.56
II	7 (24.1%)	4 (57.1%)	3 (42.9%)			
III	8 (27.6%)	3 (37.5%)	5 (62.5%)			
IV	7 (24.1%)	3 (42.9%)	4 (57.1%)			
Radiotherapy frequency (sessions)						
≤33	11 (39.3%)	6 (54.5%)	5 (45.5%)			1.00
>33	17 (60.7%)	9 (52.9%)	8 (47.1%)			
Radiotherapy dose (Gy)						
≤66	11 (39.3%)	6 (54.5%)	5 (45.5%)			1.00
> 66	17 (60.7%)	9 (52.9%)	8 (47.1%)			
Treatment						
Radio + Chemo	15 (53.6%)	9 (60.0%)	6 (40.0%)			0.67
Radio + Sur	6 (21.4%)	3 (50.0%)	3 (50.0%)			
Radio + Chemo + Sur	6 (21.4%)	2 (33.3%)	4 (66.7%)			
Others	1 (3.6%)	1 (100.0%)	0 (0.0%)			

P-values were calculated using Chi-square test.

Radio, radiotherapy; Chem, Chemotherapy; Sur, surgery.

Table 3 Change in oral hygiene and health parameters in the study population after 6 months (n = 29).

	Baseline	Follow-up	t	P
	Mean ± SD	Mean ± SD		
Decayed tooth				
Healthy group (n = 15)	0.00 ± 0.00	0.07 ± 0.26	-1.000	0.33
Vulnerable group (n = 14)	1.29 ± 1.38	1.57 ± 2.14	-0.888	0.391
Plaque index				
Healthy group (n = 15)	0.66 ± 1.04	0.80 ± 1.26	-0.45	0.653
Vulnerable group (n = 14)	1.00 ± 0.96	0.92 ± 0.99	0.268	0.793
Gingival index				
Healthy group (n = 15)	1.26 ± 0.96	1.40 ± 0.91	-0.619	0.546
Vulnerable group (n = 14)	1.42 ± 0.75	1.35 ± 0.92	0.268	0.793
Periodontal pocket depth				
Healthy group (n = 15)	2.66 ± 0.48	2.13 ± 0.74	2.256	0.041
Vulnerable group (n = 14)	3.85 ± 1.23	2.92 ± 1.26	2.414	0.031

t and P-values were calculated using a repeated measures t-test.

Table 4 Change of oral hygiene and health in the study population after 12 months (n = 16).

	Baseline	Follow-up	t	P
	Mean ± SD	Mean ± SD		
Decayed tooth				
Healthy group (n = 8)	0.00 ± 0.000	0.13 ± 0.354	-1.000	0.351
Vulnerable group (n = 8)	0.88 ± 1.126	1.13 ± 1.356	-0.403	0.699
Plaque index				
Healthy group (n = 8)	0.50 ± 1.069	0.75 ± 0.707	-0.798	0.451
Vulnerable group (n = 8)	1.00 ± 1.069	0.50 ± 0.756	1.871	0.104
Gingival index				
Healthy group (n = 8)	1.25 ± 1.035	1.00 ± 1.069	0.424	0.685
Vulnerable group (n = 8)	1.25 ± 0.886	1.50 ± 0.926	-0.447	0.668
Periodontal pocket depth				
Healthy group (n = 8)	2.75 ± 0.463	2.38 ± 0.744	1.426	0.197
Vulnerable group (n = 8)	4.00 ± 0.926	2.63 ± 0.518	3.667	0.008

t and P-values were calculated using a repeated measures t-test.

motivation for oral care and systemic approach to those patients is needed, which enables large-scale studies with longer follow-up periods.

Notwithstanding, considering the importance of oral health in patients with HNC, it is meaningful that our study has reported rare results of the long-term effects of professional oral management involving fluoride varnish application, which is relatively simple to perform at a general dentistry clinic, easy for patients to comply with, and has presented a long-term dental care protocol.

Conclusionally, our study showed that regular dental visits and periodic professional oral hygiene care using fluoride varnish during and after radiotherapy were effective in maintaining oral health among patients with HNC. In both the healthy and vulnerable groups, oral health was maintained for over 12 months after radiotherapy.

Declaration of Competing Interest

The authors have no conflicts of interest relevant to this research.

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