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Case Report

Personalization of supportive orofacial care in the context of high-technology head and neck radiotherapy: A case report

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ABSTRACT

This case report describes the dental support provided to a patient undergoing radiotherapy for a malignant lip neoplasm, emphasizing the importance of tailoring orofacial care to specific patient needs. A 38-year-old male diagnosed with squamous cell carcinoma of the lip,presenting with anatomical and functional post-surgical sequelae,received dental care before, during, and after high-precision radiotherapy. Prophylactic and curative dental management was individualized, including a personalized intraoral device and photobiomodulation therapy. The patient achieved a favorable clinical outcome, maintaining oral hygiene and solid food intake throughout the treatment, with toxicities limited to grade 2 oral mucositis and grade 1 xerostomia. At the 9-month follow-up, there were no signs of tumor recurrence, xerostomia, or dysgeusia. Furthermore, the patient demonstrated improved mouth opening and no signs of radiation-induced caries. Within the limitations inherent to a case report, these findings suggest a potential role for personalized orofacial care in minimizing orofacial complications in the context of high-technology head and neck radiotherapy. Future studies with a higher level of evidence, such as randomized controlled clinical trials and systematic reviews are necessary to advance knowledge in this field.

Keywords: Lip cancer; Radiation injuries; Dental care; Personalized intraoral device; Photobiomodulation therapy.

Statement of Clinical Significance

This case report illustrates that the integration of personalized and continuous orofacial care into high-technology head and neck radiotherapy workflows may represent a supportive strategy to mitigate treatment-related toxicities and support treatment continuity.

INTRODUCTION

Treatment of patients with malignant neoplasm in the head and neck (HN) region may involve surgery, radiotherapy (RT), and chemotherapy (CT). Generally, these therapeutic modalities may compromise the oral cavity through structural and functional alterations resulting from surgical interventions, as well as through cytotoxic effects related to RT and CT, leading to short-, long-, or permanent sequelae with a substantial impact on patients' quality of life (QoL).[1,2] Therefore, to prevent and treat these morbidities, a multidisciplinary and multiprofessional team, including oncological dentistry, must be involved in patient care.[3-5] Dental support, which must occur before, during, and after anticancer therapy, is important for controlling foci of infection, as well as for preventing and reducing inflammatory and/or infectious complications.[2,6,7] Such care includes, for example, the creation of personalized intraoral devices (PIDs), the prevention and management of acute and late oral complications, and the maintenance of oral health.[2,8] It is estimated that between 90% and 100% of patients undergoing HN RT whose irradiation fields include oral tissues will develop some degree of orofacial complication.[1] Although technological advances in RT have made it possible to administer high doses of radiation to the target volume, it is still complex to protect and reduce doses to surrounding normal tissues, especially in cases with locally advanced tumors.[9] Additionally, as RT techniques in HN become more sophisticated and precise, there is a need for better control, stabilization, and positioning of oral anatomical structures to prevent them from moving or entering the treatment fields due to the consequent emergence of toxicities.[9,10] In these clinical scenarios, it is important to use personalized preventive measures that take into account, for example, the complex anatomical and

functional configuration of orofacial tissues and to assist in preventing adverse effects and optimizing the administration of high-technology RT.

CASE REPORT

This case report was prepared in accordance with the CARE (CAse REport) guidelines (https://www.equator-network.org/reporting-guidelines/care/) and informed consent was obtained from the patient prior to submission.

A 38-year-old male patient, leukoderma, car mechanic, who was diagnosed with malignant neoplasm of the lower lip (squamous cell carcinoma, grade 2 – pT1N0M0; Stage I) and recommended for adjuvant RT, was referred by the radiation oncology team to the oncology dentistry team for appropriate oral care. His medical history revealed a recurrence of the lip malignancy after 13 months, for which he underwent a repeat surgical resection. The patient reported no comorbidities and no history of allergies. He had a history of long-term sun exposure, smoked from 17 to 27 years of age, and consumed alcohol socially. On physical examination, he was flushed, eupneic, and hydrated, scoring 1 on the Eastern Cooperative Oncology Group (ECOG) Performance Status Scale (https://training.seer.cancer.gov/followup/dataset/ecog-performance-status.html). His locoregional evaluation did not identify cervical lymph node enlargement but showed surgical scars near the nasal and lip region on the left (Figure 1A).

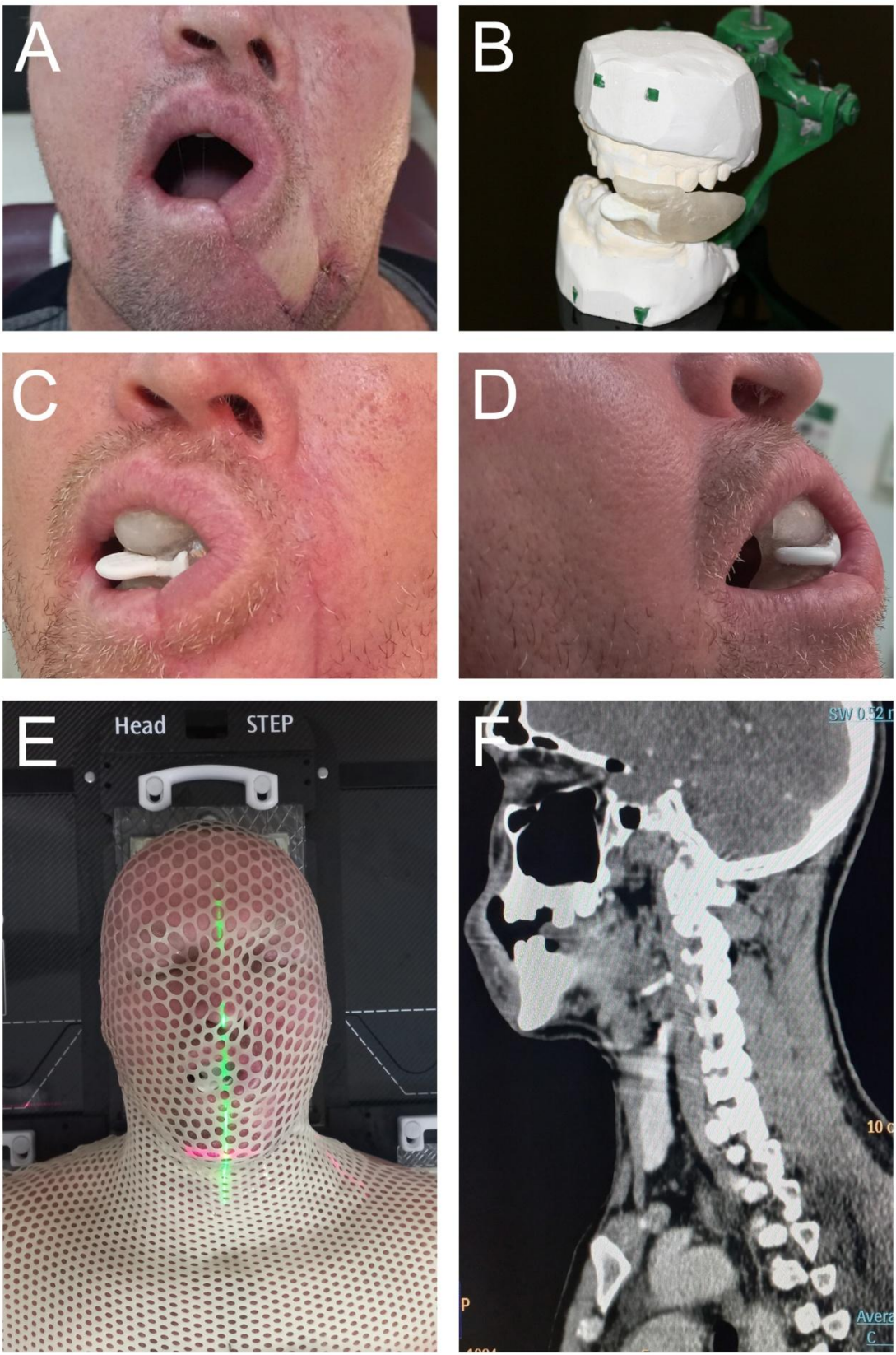

Fig. 1. (A): Pre-RT extraoral examination. Facial asymmetry, microstomia, and scars extending from the perinasal region and the median portion of the lower lip to the lower

third of the face on the left are highlighted. (B): PID mounted on a semi-adjustable articulator. (C and D): lateral aspect of the face, with the PID positioned on the left and right, respectively. (E): Immobilization of the HN region by means of the thermoplastic mask and use of the PID. (F): Sagittal section of the planning CT. Observe the interocclusal distance and the lip and cheek separation promoted by the PID.

The examination of the oral structures was difficult due to the presence of microstomia and trismus (interincisal distance of approximately 1.5 cm). Residual molar roots and pigmentation on the tooth surfaces caused by cigarette smoke were visible. The radiographic evaluation demonstrated the presence of residual roots.

The RT procedures consisted of three-dimensional planning on an Elekta Monaco® calculation platform and treatment using volumetric-modulated arc therapy (VMAT), a modality of intensity-modulated radiotherapy (IMRT) techniques with daily localization performed with image-guided radiotherapy (IGRT). Doses of 54 Gy and 60 Gy were prescribed to the elective cervical drainage regions and the tumor site (both on the left), respectively, in 30 fractions, administered using an Elekta Synergy Full® linear accelerator (Elekta, Sweden).

The patient's dental management was based on recommendations from the Multinational Association for Supportive Care in Cancer (MASCC) (https://mascc.org) and the International Society of Oral Oncology (ISOO), in addition to the individualization of pre-, during, and post-RT orofacial care, as described below.

1. Pre-RT orofacial care

The following pre-RT orofacial care was implemented:

I. Discussion of the case with the radiation oncology team;

II. Pre-RT oral care, through coronal scaling, dental prophylaxis, and extraction of residual roots;

III. Creation of a PID for mouth opening, mandibular immobilization, and labial separation of the teeth, taking into account the individual demands of the patient (Figures 1B, 1C, 1D, 1E, and 1F), following the methodology used by Kaanders et al.;[11]

IV. Outlining of the target volume and, to reduce radiation exposure, contouring of the teeth, mandible, oral cavity, lips, and salivary glands (Figures 2A and 2B;

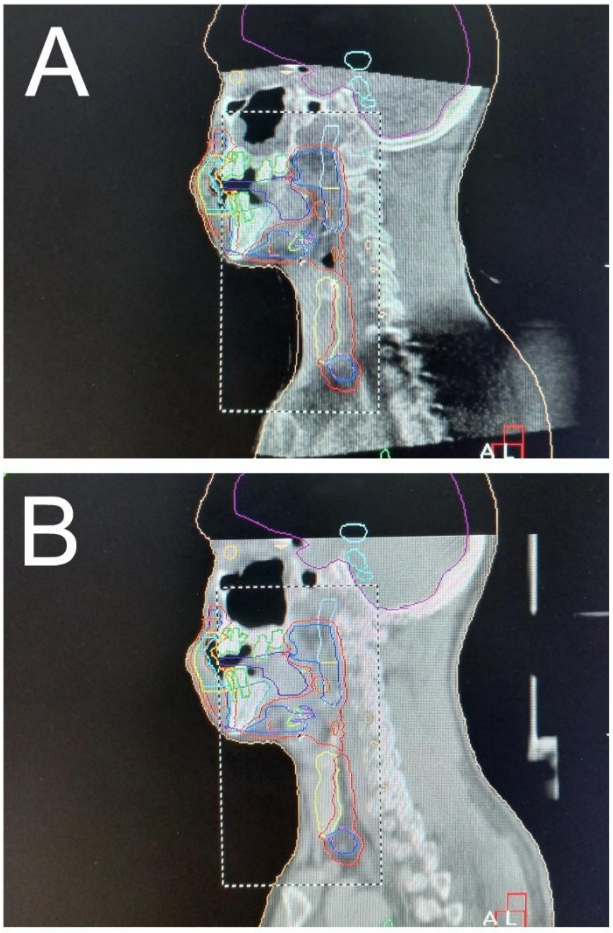

Fig. 2. (A): Sagittal section of the CBCT of the IGRT performed in the 30th fraction of the RT. Note the maintenance of the lip displacement and oral opening promoted by the

PID, in addition to the positioning of the target regions and protected tissues (including the teeth) according to the reference CT (B). (B): Sagittal section of the IMRT/VMAT planning CT with the contour of the areas to be irradiated and protected.

mean doses described in Table 1).

Table 1. Doses attributed to anatomical structures at risk of adverse effects

Structure/organ	*Mean dose (Gy)**
Lips	56,2
Teeth	42,5
Mandible	36,5
Oral cavity	38,2
Right parotid gland	2,6
Left parotid gland	47,9
Right submandibular gland	6
Left submandibular gland	59,2

*Gy = Gray

The lip outlining was guided by the protocol proposed by Brouwer et al.;[12]

V. Guidance on the importance of maintaining oral hygiene, as well as the risk of oral complications induced by RT and the importance of adherence to preventive care;

VI. Prescription of 3 mg benzydamine hydrochloride (1 lozenge every 8 hours), mouthwash with bicarbonate water (10 ml every 8 hours), and frequent oral hydration to be initiated and maintained from the first fraction of RT;

VII. Planning of PBMT using laser therapy and LED (light emitting diodes) therapy. Considering the proximity of the regions to be irradiated (labial region and lymphatic drainage chains) to the oral and cutaneous structures, there was a high risk of the

emergence of oral mucositis (OM) and acute radiodermatitis (AR). Prior to the use of phototherapy, the points in the oral mucosa and skin to be photoirradiated were defined prophylactically, considering the RT fields.

2. Orofacial care during RT

2.1 Prophylaxis of oral mucositis and radiodermatitis through PBMT

For AR prophylaxis, a LED cluster (Linealux Rosso®, Mauá, São Paulo, Brazil) measuring 10 x 12 cm (120 cm^2), with 660 nm and 36 LEDs (5 mW average each), was used (Figure 3).

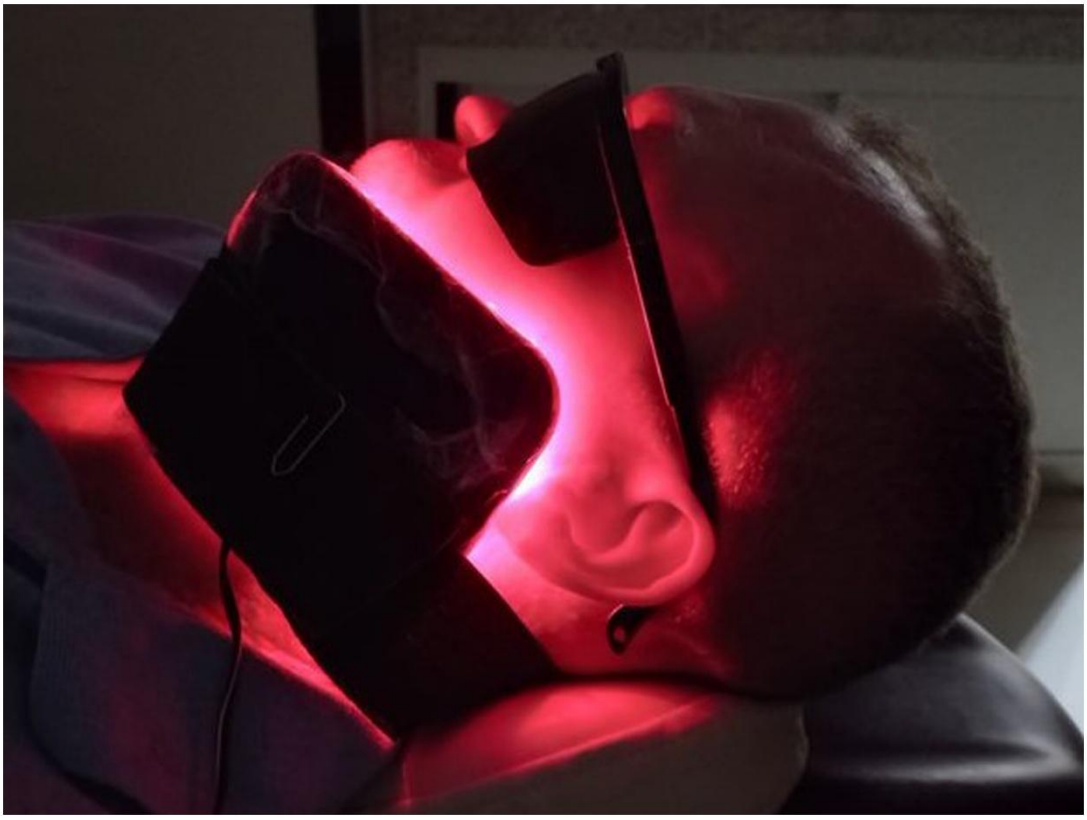

Fig. 3. PBMT using LED therapy. LED cluster positioned, in contact, on the mandibular body and submandibular region on the left.

Applications were performed in contact for 600 seconds, delivering 3 J/LED (total energy of 108 J). This protocol resulted in an energy fluence of 0.9 J/cm², photon fluence of 1.71 p.J/cm², and 0.38 Einstein. For OM prophylaxis, PBMT was performed using a diode laser (Therapy XT®, DMC, São Carlos, SP, Brazil) in the red spectrum (660 nm), operating at 100 mW with a 0.028 cm² spot size (irradiance of 3.57 W/cm²). Applications were punctual, in contact, with 1.0 cm spacing, delivering 0.5 J/point over 5 seconds. This protocol resulted in an energy fluence of 17.85 J/cm², photon fluence of 33.915 p.J/cm², and 7.53 Einstein. The irradiated sites comprised the labial mucosa (one point at each commissure and two at each vermilion border); the lingual dorsum (four points on each side) and its apex (one point); the ventrolateral aspect of the tongue (two points

bilaterally); the mandibular vestibule fundus (two anterior points and two on each side); the floor of the mouth (two points bilaterally); and the anterior buccal mucosa (two points bilaterally). A total of 33 points were irradiated per session, resulting in a total energy delivery of 16.5 J. Due to limited mouth opening, applications to the posterior buccal mucosa were performed extraorally at two points in contact with the corresponding region, using a dose of 1 J/point (i.e., 10 sec/point). The PBMT was started on the day of the first fraction of the VMAT and performed daily throughout the course of the RT.

2.2 Grading of oral mucositis, xerostomia, and radiodermatitis

To evaluate and grade OM, xerostomia, and AR, the scales recommended by the World Health Organization (WHO)[13] and by the Radiation Therapy Oncology Group (RTOG)[14,15] were used.

2.3 Clinical outcomes

In the 6th fraction (6/30) of VMAT (with a dose of 12 Gy), the patient presented grade 1 xerostomia. When the dose reached 18 Gy (9th fraction), grade 1 AR was observed in the middle third of the face and in the left cervical region. Grade 2 mucositis appeared in the 10th fraction (20 Gy) in the anterior vestibule of the maxilla, which was associated with discomfort. In the 13th fraction, there were erythema and shallow ulcers (grade 2 OM) in the labial and buccal mucosa on the left, in addition to the anterior fornix of the maxilla. The lesions extended to the labial commissure in the 16th fraction of RT. In the following day, there was no longer discomfort associated with the lesions. In the 25th fraction (50 Gy), healing of OM was noted, except for the presence of remaining lesions in the left retrocommissural region. In the last RT fraction (30th) with a total dose of 60 Gy, there

was recurrence of OM (grade 2) in the labial mucosa, and AR remained mild (grade 1) (Figures 4A, 4B, and 4C).

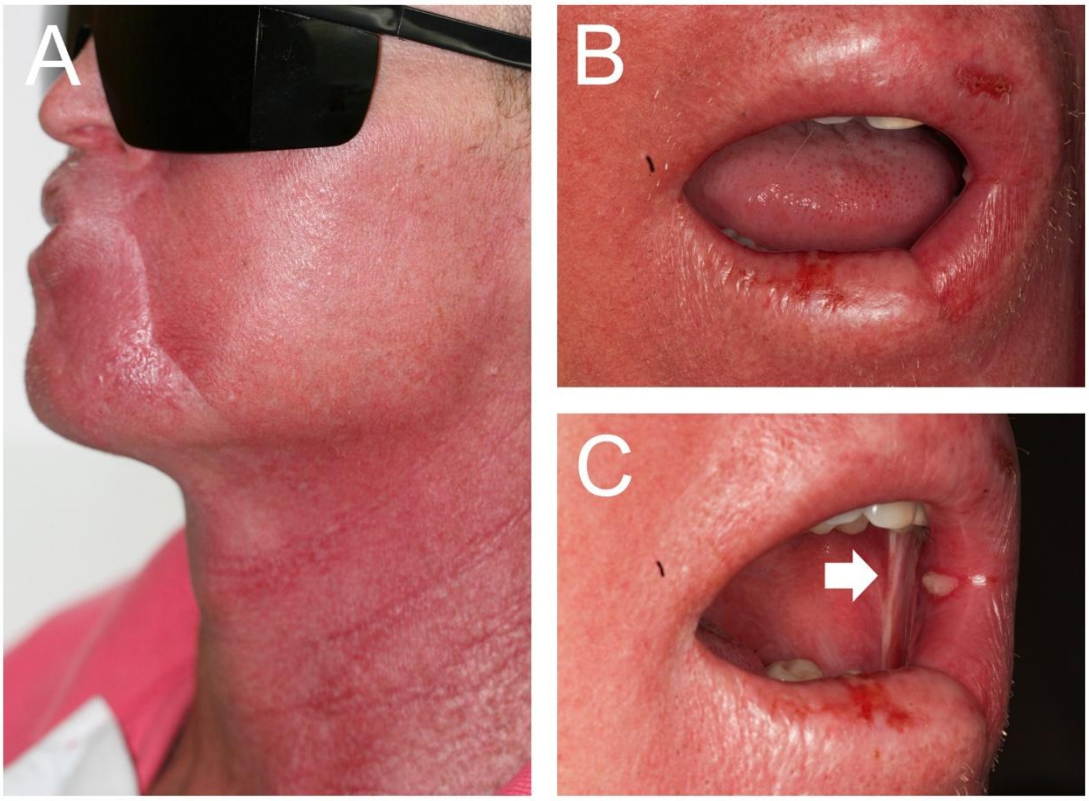

Fig. 4. Clinical aspect of mucocutaneous lesions in the 30th fraction (with total doses of 54 Gy and 60 Gy in cervical drainage regions and at the tumor site, respectively). (A): Cervicofacial erythema on the left, characterizing grade 1 AR (RTOG). (B and C): Presence of shallow ulcers with an erythematous base present in the lower and upper labial mucosa and semimucosa, in addition to the left labial commissure, characterizing grade 2 mucositis (WHO). Note the absence of mucositis in the lingual apex and in the left jugal region. The arrow indicates an area of post-surgical fibrosis.

The curative approach to OM was performed by means of PBMT with an increase in the dose, per point, to 1J in the affected intraoral regions and with the use of a dexpanthenol-based ointment for lip use. Additionally, a cream of 0.125 mg fludroxycortide,

moisturizing cream, and a vial with injectable suspension of 5 mg/ml betamethasone dipropionate + 2 mg/ml betamethasone disodium phosphate was used to control AR. At the end of VMAT, we observed that the patient was able to maintain oral hygiene and intake of solid foods during. Toxicity ranged from mild (grade 1 for both xerostomia and AR) to moderate (OM grade 2). Hypogeusia occurred but was most evident in the 25th fraction of RT. The PID, which was easily placed by the patient himself, was able to adequately immobilize the mandible and position the lips and cheek region as observed by cone-beam computed tomography (CBCT) of IGRT (Figure 2A). There was no need to interrupt RT.

3. Oral care after RT

PBMT was continued until the 12th day after RT, when complete healing of OM occurred. To help prevent radiation-induced caries, 1% fluoride gel in a neutral base was prescribed,[16] in addition to guidance related to a cariogenic diet and oral hygiene. The patient continued to undergo periodic monitoring. After 9 months of discharge from RT, there were no signs of recurrence of the malignant neoplasm, the patient did not report xerostomia or changes in taste perception, there was an increase in mouth opening (interincisal distance = 3 cm), and there were no signs of radiation-induced caries (Figure 5).

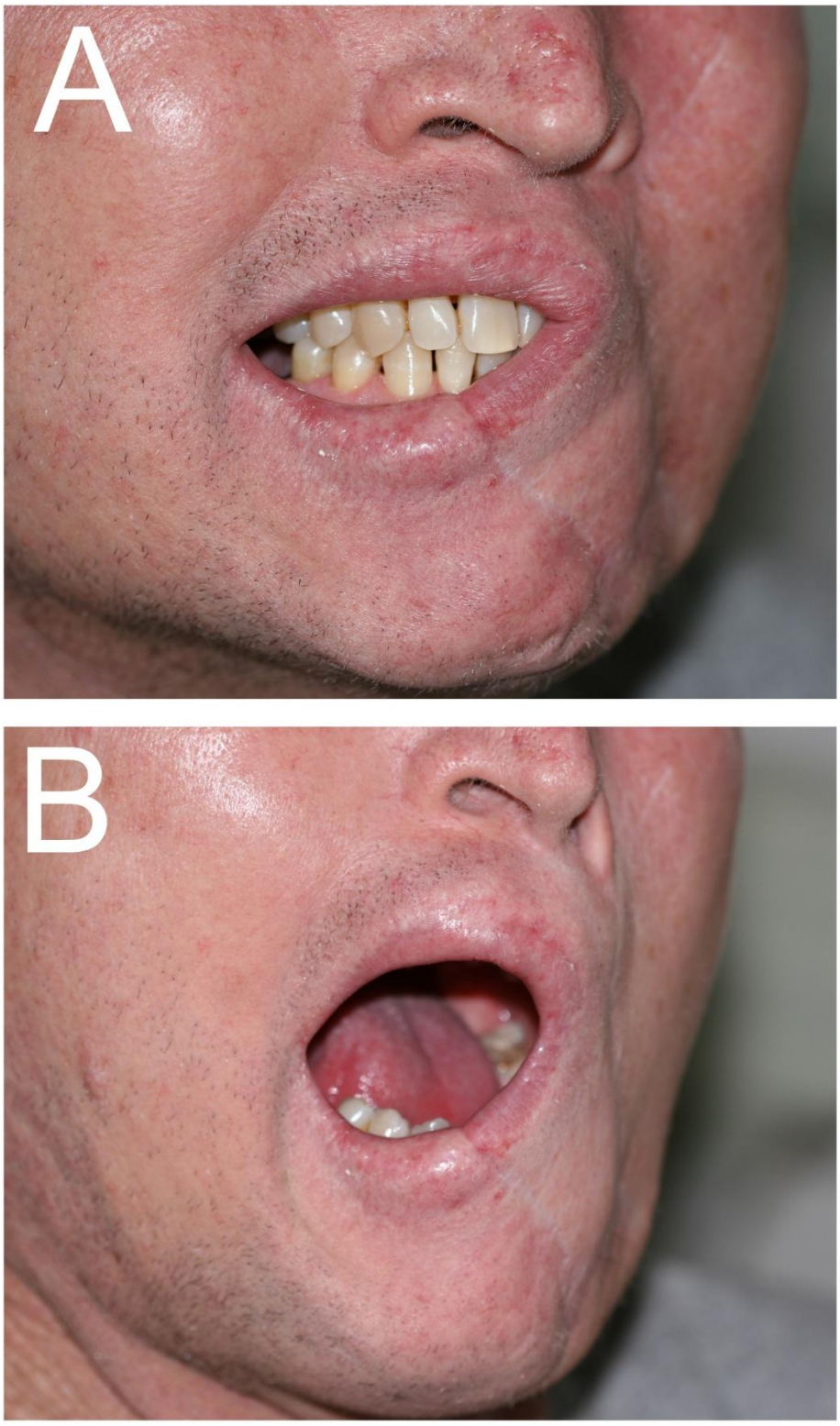

Fig. 5. Extraoral (A) and intraoral (B) clinical aspect 9 months after RT. Note the absence of signs of recurring malignant neoplasia in the cutaneous and labial region, the absence of signs of carious lesions, and the increased mouth opening.

DISCUSSION

Working together with the oncology team, dentists with expertise in oncology play crucial roles in the prevention and management of oral complications induced by RT. Oral health programs for patients undergoing HN cancer treatment improve oral health and QoL, control adverse oral effects, reduce RT interruptions, and improve the quality of oncology care.[17,18] However, we believe that prophylactic measures need to consider the risk of toxicities and be adjusted to the anatomical and functional particularities of the patient. Despite advancements in personalized oncology, the ability to identify patients susceptible to severe treatment-related toxicities and to provide tailored supportive care remains limited. This is particularly evident regarding mucositis, for which assessment protocols for the early identification of high-risk individuals are still lacking.[19]

In this clinical context, the present case report describes the dental management of a patient undergoing RT for a malignant lip neoplasm, highlighting the relevance of personalized orofacial care. The contribution of this study lies in the synergistic approach between the fabrication of a PID and the planning and administration of high-technology RT in a setting of severe mouth-opening limitations. Furthermore, the integration of contouring oral regions at risk of actinic damage with PBMT guided by the irradiation fields enabled the delivery of curative RT doses with reduced associated toxicity.

For advanced techniques such as VMAT, the use of PIDs is vital for geometric stability, as high dose conformity demands maximum precision. Since the objective is to concentrate radiation on the target volume while sparing surrounding normal tissues,

efficient immobilization and positioning consistency are crucial. Without such control, anatomical movements can compromise the accuracy of dose delivery relative to the treatment plan, increasing the risk of toxicity.[20,21]

In the case reported, there was a need for adequate immobilization of the mandible to favor the delivery of the high dose of radiation to the target region, in addition to moving the teeth away from the area to be irradiated. A PID built specifically for this purpose was easy for the patient to install. The device helped to move the dental structures away and ensured mandibular immobilization, contributing to the optimization of radiation delivery to the target by VMAT. The positioning of the anatomical structures was periodically checked during the course of RT using IGRT (Figure 2A). This helped to ensure that the target volume and the regions to be spared remained as planned before RT (Figure 2B) guaranteeing the millimeter reproducibility required for the VMAT margins. In a recently published letter to the editor, our research group has emphasized the importance and future perspectives of using these devices in the era of high-technology HN RT.[22]

Although direct effects of radiation on dental tissues have been proposed, current evidence supports the predominance of the so-called "oral symptom cluster" in the pathogenesis of radiation caries. This cluster encompasses post-radiotherapy alterations such as hyposalivation, highly cariogenic diet, inadequate oral hygiene, oral microbiota dysbiosis, and reduced salivary pH and buffering capacity. The hypothesis of direct radiation-induced structural damage remains biologically plausible. Nevertheless, the available mechanistic evidence, marked by methodological heterogeneity, does not support it as an isolated or exclusively determinant mechanism in the pathogenesis of this

condition.[23]

Walker et al., observing that doses ≥ 60 Gy may be deleterious to the structure of enamel and dentin, suggested limiting the exposure of dental tissues to an average dose < 60 Gy, when clinically possible.[16] Therefore, in the present case, in addition to the organs usually considered and outlined in the planning, contouring of the teeth in the proximity of the target volume was also performed, which received a mean dose of 42.5 Gy.

OM and xerostomia are common complications associated with cancer therapies.[24] OM usually appears in the second week of RT (15 to 20 Gy) and is clinically characterized by the presence of erythema (in its initial phase) that can progress to the formation of ulcers.[8,24,25] These lesions are extremely painful, making speech, chewing, and swallowing difficult, and may prevent oral food intake.[7,8] In a cohort of 576 patients treated with IMRT, 360 (62%) developed severe OM, which was associated with enteral feeding, hospitalization, weight loss, and opioid use.[26] In the present case, the lesions appeared only in the regions where they were expected to occur (near the surgical bed). Although severe mucositis was expected to appear in these sites, the lesions reached moderate toxicity (grade 2), which persisted until discharge from VMAT; there was no severe pain to the point that opioids were necessary; the patient remained able to clean the oral cavity and ingest solid foods; and RT did not need to be suspended, which could affect the prognosis of the oncological disease.[7] The use of VMAT with careful delineation of structures at risk, prophylactic PBMT planning based on RT portals, use of the PID, adjunctive anti-inflammatory therapy, and ongoing dental follow-up may have acted together to prevent and control OM. In addition, rinsing with bicarbonate water may have been useful in improving the patient's oral comfort.[6]

Commonly, the RT treatment fields in HN encompass to some degree the major and/or minor salivary glands, due to the proximity of the salivary glandular tissues to the tumors and/or involved lymph nodes, which may result in glandular hypofunction and changes in salivary composition in the first week of RT.[27] This may increase the risk of, for example, infections, carious lesions, dysgeusia, and deterioration of nutritional status.[28] Considering these complications, when possible, RT modalities capable of sparing the major and minor salivary glands, such as IMRT, should be used to reduce the risk of salivary gland hypofunction and xerostomia.[28] In the present report, there was mild xerostomia (grade 1) at the beginning of the first week of RT. However, this symptom did not worsen and remained unchanged throughout the treatment. The use of IMRT/VMAT with dose restriction to the parotid and submandibular glands (especially the contralateral ones [Table 1]), as well as PBMT in regions of minor salivary glands[28] and the use of PID,[22] may have contributed to the reduction of toxicity in the salivary glands.

According to the most recent MASCC/ISOO guidelines for the management of OM, intraoral PBMT using laser is recommended for the prevention of OM in adult patients undergoing HN RT, alone or in combination with CT.[29] Although there is insufficient evidence to consolidate recommendations in all scenarios, randomized controlled trials (RCTs) demonstrate that PBMT mitigates complications such as hyposalivation, pain, and dysgeusia, in addition to OM itself.[30] PBMT reduces the consumption of analgesics and anti-inflammatory drugs, and promotes better QoL.[31] Additionally, it improves nutritional status and functional impairment, as well as reducing the incidence of RT interruptions.[32]

Regarding pharmacological interventions, although the MASCC/ISOO guidelines recommend benzydamine mouthwash for radiation doses <50 Gy,[29] 3 mg lozenges were used in this case to prioritize prolonged mucosal contact and patient adherence. The slow dissolution of this formulation potentially enhances local anti-inflammatory activity, although the most robust clinical evidence currently supports the mouthwash solution.

Furthermore, recent reviews highlight the efficacy of PIDs in mitigating OM, salivary disorders, and trismus, findings that align with the mild-to-moderate toxicities (Grades 1 and 2) observed in this report, despite the administration of curative doses (60 Gy).[33]

Approximately 95% of patients undergoing RT may develop some degree of radiodermatitis. AR usually appears between 2 and 4 weeks after the start of RT. AR grades 2 to 4 may be associated with severe pain and a decrease in QoL.[34,35] Severe cases may require temporary or permanent suspension of RT, which may affect the anticancer therapeutic response. As occurred in the process of preventing OM in this case, a mapping of the skin regions at risk for AR was performed for prophylaxis using PBMT. The use of IMRT/VMAT concomitantly with PBMT may have contributed to mild AR (grade 1), considering that more severe degrees of AR are observed in skin regions within or near the RT fields. Scientific literature data are still insufficient to provide clinical support guidelines for AR in HN cancer patients through PBMT.[36] A recent systematic review demonstrates that LED therapy attenuates AR in breast cancer patients when standardized protocols and rigorous methodologies are employed.[37] For the integration of LED therapy into clinical practice, future RCTs with standardized protocols and validated outcome measures are essential.[37] In this regard, the World Association for Photobiomodulation Therapy (WALT) has recommended dosimetric parameters to assist in clinical support

and research on PBMT for AR management.[36] The first RCT to evaluate the efficacy of PBMT in preventing AR in HN cancer patients using laser therapy (DERMISHEAD trial) demonstrated that PBMT is capable of reducing AR severity in patients undergoing IMRT/VMAT.[38] Preliminary cohort data showed promising results using LED therapy (650 nm, 21 mW/cm², and prophylactic and curative doses of 3 J/cm² and 6 J/cm², respectively) in the prevention and treatment of AR in HN cancer patients.[39] Encouraging clinical outcomes were observed by our research group when using PBMT for the treatment of cervical AR.[40]

Although pre-existing microstomia and trismus often pose significant hurdles to dental management, the strategy implemented here, encompassing device customization and extraoral PBMT, suggests that tailored therapeutic interventions facilitate the delivery of advanced radiotherapy in anatomically complex scenarios, ultimately reducing treatment toxicity.

It is worth highlighting an additional relevant point: the patient was proactive. The guidance on the importance of maintaining oral health may have contributed to adherence to oral care.

Although high-technology RT modalities allow better dose conformity and sparing of organs at risk, access to these technologies may not be universal, given their high cost and infrastructure limitations. Therefore, in resource-limited settings, the availability of advanced RT planning and delivery techniques may be restricted, reflecting broader inequalities in cancer care. In such contexts, adjunctive strategies, including PIDs and

structured dental follow-up, may play an even more relevant role in mitigating treatment-related toxicity.

CONCLUSION

In conclusion, this case report suggests that the combination of personalized and prophylactic approaches in the context of high-technology RT may have contributed to the prevention and reduction of toxicities secondary to RT, even though the satisfactory responses observed cannot be treated as evidence. Future studies with a higher level of evidence, such as randomized controlled clinical trials and systematic reviews are necessary to advance knowledge in this field.

CONSENT FOR PUBLICATION

Informed consent was obtained by authors from the patient before submission of the case reported.

AUTHORS' CONTRIBUTIONS

BAR: conceptualization, supervision, writing – original draft, writing – review & editing. AS: writing – original draft, writing – review & editing. MMST: writing – original draft, writing – review & editing. ASM: writing – original draft, writing – review & editing. CALJ: writing – original draft, writing – review & editing. MCRH: conceptualization, supervision, writing – original draft, writing – review & editing.

CONFLICT OF INTEREST STATEMENT

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Ethics approval:

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