REVISTA CIÊNCIAS e ODONTOLOGIA

EFFECTIVENESS OF INTRAORAL STENTS FOR TISSUE PROTECTION DURING HEAD AND NECK RADIOTHERAPY: INTEGRATIVE LITERATURE REVIEW

AVALIAÇÃO DA EFICÁCIA DOS STENTS INTRAORAIS PARA PROTEÇÃO DOS TECIDOS DURANTE A RADIOTERAPIA DE CABEÇA E PESCOÇO: REVISÃO INTEGRATIVA DA LITERATURA

Sandiele Duarte Dias[1], **Camila Yasmin Craveiro Sacramento**[1], **Charles William Cavalcante de Oliveira**[1], **Fernanda Cantão Souza da Costa**[1], **Thais Gomes Mateus Araujo**[1], **Erick Nelo Pedreira**[2].

1 Aluna(o) do Curso de Odontologia – UNIVERSIDADE FEDERAL DO PARÁ - BRASIL
2 Professor, Doutor em Patologia Bucal do Curso de Odontologia – UNIVERSIDADE FEDERAL DO PARÁ - BRASIL

Resumo

Objetivo: A radioterapia (RT) de cabeça e pescoço pode provocar diversos efeitos adversos que prejudicam as funções orais e contribuem para a perda de apetite e peso. Esta revisão integrativa da literatura visa sintetizar evidências sobre a eficácia dos stents intraorais (IOS) na proteção de tecidos moles adjacentes em pacientes submetidos à RT de cabeça e pescoço, bem como na redução de outras complicações associadas**. Métodos:** Foram incluídos estudos com pacientes com câncer de cabeça e pescoço (P) que utilizaram (I) ou não (C) IOS durante a RT, para avaliar sua eficácia na proteção dos tecidos bucais e na atenuação de efeitos adversos (O). Realizou-se uma busca nas bases PubMed, Scopus, ScienceDirect, Web of Science e Wiley, selecionando 2.103 artigos publicados entre 2014 e 2024, com os descritores "intraoral stents" OR "stent intraoral" OR "position stent" AND "protect oral tissues" AND "radiotherapy." **Resultados**: Os 12 estudos incluídos nesta revisão indicaram que o uso do IOS minimiza os efeitos adversos induzidos pela RT de cabeça e pescoço, reduzindo a dose e o volume de radiação nos tecidos adjacentes, sem comprometer a dose na área alvo**. Conclusão:** O IOS é eficaz na proteção dos tecidos moles adjacentes da cavidade oral, atenuando a exposição à radiação e, assim, reduzindo os efeitos adversos e a toxicidade em pacientes submetidos à radioterapia prolongada de cabeça e pescoço.

Palavras-chaves: Neoplasia de cabeça e pescoço; Radioterapia; stent intraoral; Efeitos Adversos.

Abstract

Objective: Head and neck radiotherapy (RT) can cause several adverse effects that impair oral functions and contribute to appetite and weight loss. This integrative literature review aims to synthesize evidence on the effectiveness of intraoral stents (IOS) in protecting adjacent soft tissues in patients undergoing head and neck RT, as well as in reducing associated complications**. Methods:** Studies were included that involved head and neck cancer patients (P) who used (I) or did not use (C) IOS during RT, to assess its effectiveness in protecting oral tissues and mitigating adverse effects (O). A search was conducted in the PubMed, Scopus, ScienceDirect, Web of Science, and Wiley databases, selecting 2,103 articles published between 2014 and 2024, using the descriptors "intraoral stents" OR "stent intraoral" OR "position stent" AND "protect oral tissues" AND "radiotherapy." **Results:** The 12 studies included in this review indicated that the use of IOS minimizes RT-induced adverse effects in head and neck regions by reducing the dose and volume of radiation to adjacent tissues without compromising the dose to the target area**. Conclusion:** IOS is effective in protecting adjacent soft tissues in the oral cavity by attenuating radiation exposure, thus reducing adverse effects and toxicity in patients undergoing prolonged head and neck RT.

Keywords: Head and neck cancer; Radiotherapy; Intraoral stent; Adverse effects.

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Contato: Sandiele.dias@altamira.ufpa.br

Introduction

The GLOBOCAN 2020 revealed that head and neck is the seventh most worldwide prevalent cancer and represents 900,000 and 400,000 annual new diagnoses and deaths, respectively.[1] Head and neck cancer can affect the oral cavity, nasal cavity, paranasal sinuses, oropharynx, hypopharynx, and larynx. Radiotherapy (RT) is a widely used treatment that can be combined with surgery and/or chemotherapy. [2,3]

Although effective, RT can result in several adverse effects (such as xerostomia, oral mucositis (OM), candidiasis, osteoradionecrosis, taste changes, trismus, radiation-induced caries, odontogenesis issues, bone growth disorders, and dermatitis), which can be exacerbated by inter- and intrafraction movement of structures within and surrounding the oral cavity that may unintentional irradiate healthy tissues.[4] These complications may significantly impair eating, swallowing, and speaking, and lead to appetite and weight loss. Severe cases can require parental nutrition and RT discontinuation which directly affects patient's prognosis. In addition to systematic oral care management, intraoral stents (IOS), also known as mouth-pieces or bite-blocks, have been

increasingly used during head and neck RT to immobilize oral structures, displace adjacent tissue away from the radiation beam, and thus minimize adverse effects.[5,6]

Therefore, this integrative literature review aimed to summarize relevant evidence on the effectiveness of IOS in protecting adjacent soft tissues in patients submitted to head and neck RT, as well as reducing complications such as OM, xerostomia, trismus, and other toxicities.

Methods

The evidence-based PICO strategy was used to determine the research question: *Are IOS effective in protecting oral tissues during RT?* Thus, studies on head and neck cancer patients (P) that used (I) or not (C) IOS during RT were selected to observe its effectiveness on oral tissue protection and attenuation of adverse effects (O). English-, Spanish-, and –Portuguese-written articles were searched the PubMed, Scopus, ScienceDirect, Web of Science, and Wiley databases by using the descriptors “intraoral stents” OR “stent intraoral” OR “position stent” AND “protect oral tissues” AND “radiotherapy”, as well as the following search strategy: intraoral stents OR stents intraoral OR position stent AND radiotherapy. The records were imported to a reference manager (Rayyan) to exclude duplicates and simplify screening, reading, and inclusion. Inclusion and exclusion criteria are described in Table 1.

Table 1: Inclusion and exclusion criteria.

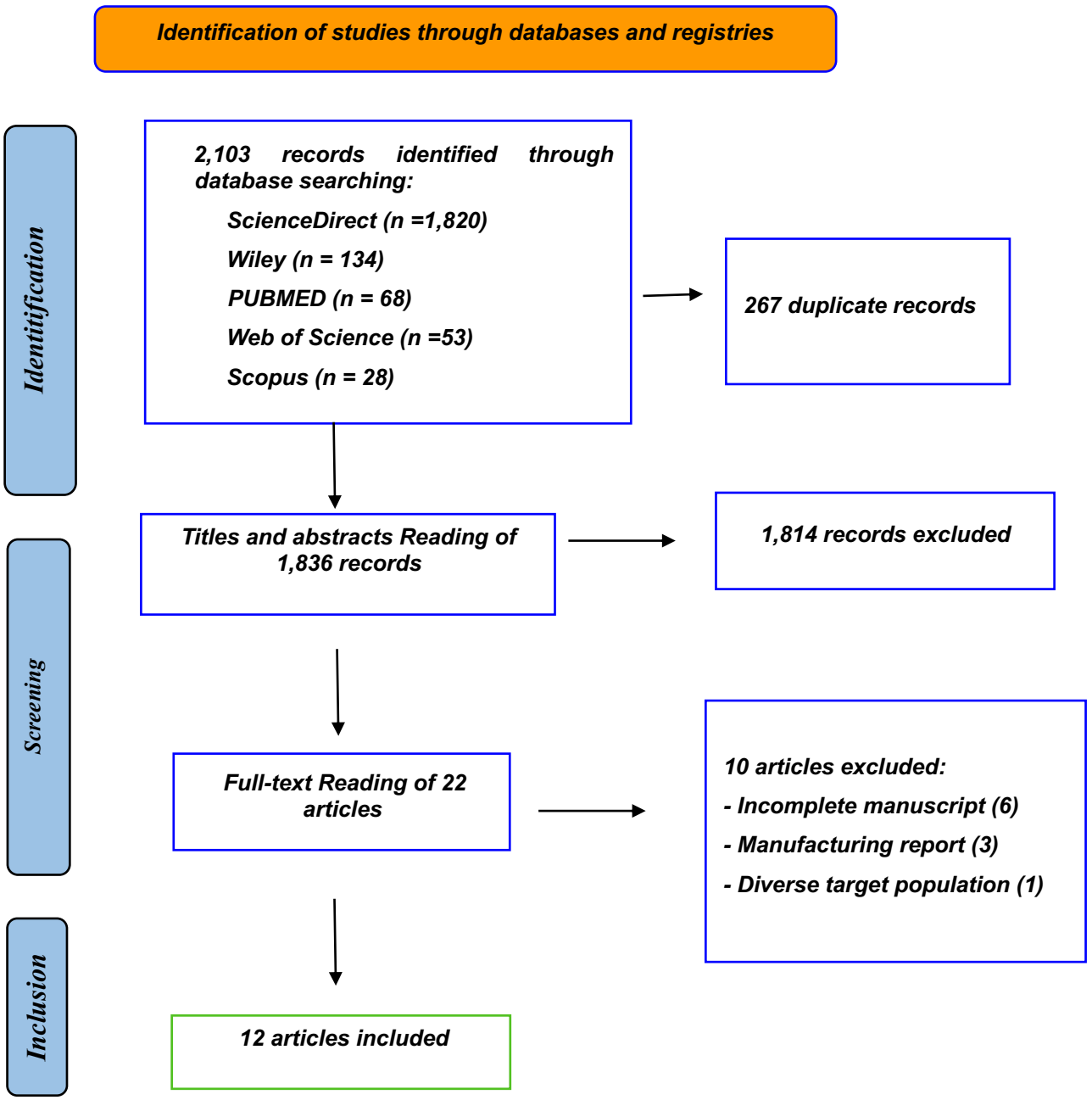
Selection criteria	Inclusion criteria	Exclusion criteria
Target population	Cancer patients submitted to head and neck RT.	Diverse target population.
Intervention	Use of IOS to protect adjacent tissue away from the radiation beam.	Other interventions used to attenuate adverse effects of head and neck RT.
Type	Original research, randomized clinical trial, pilot study, prospective observational study, and retrospective study.	Book chapter, literature review, in vitro study, animal in vivo study, and poster summary
Publication date	Between 2014 and 2024.	Before 2014.

Source: Authors (2024)

Results

A total of 2,103 records were identified in ScienceDirect (1,820), Wiley (134), PubMed (68), Web of Science (53), and Scopus (28) (Flowchart 1). Two hundred sixty-seven duplicate records were excluded. After reading titles and abstracts, 1,814 records did not meet the inclusion criteria, and 22 articles were selected for full-text review. Subsequently, 10 articles were excluded due to incomplete manuscripts (6), exclusive focus on IOS manufacturing (3), and diverse target populations (1). Details on the 12 articles included in this review are shown in Table 2.

Flowchart 1- Flowchart of studies attributed in the integrative literature review.



Source: PRISMA, 2020 (Adapted and translated)

Table 2. Articles included in this integrative literature review.

Author	Title	Type	Objective	Conclusion
Mall et al. (2016)	Effectiveness of positioning stents in radiation-induced xerostomia in patients with tongue carcinoma: A randomize d controlled trial	Randomized clinical trial	To perform an objective and subjective evaluation of the efficacy of positioning IOS in radiation-induced xerostomia in patients with tongue carcinoma.	The use of a positioning IOS minimized radiation-induced xerostomia and its symptoms.
Rocha et al. (2017)	Intraoral stents in preventing adverse radiotherape utic effects in lip cancer patients	Original research	To fabricate and evaluate the efficacy of customized IOS to minimize the potential side effects of radiation on oral tissues in patients with early stages of lip cancer.	IOS was shown to be promising in reducing the RT adverse effects. A multidisciplinary approach during oncological therapy is important.
Feng et al. (2019)	Construction and clinical evaluation of a new customized bite block used in radiotherapy of head and neck cancer	Original research	To build a novel customized bite block through a simple fabrication process using widely used materials in dental clinical practice, and evaluate its effect on dosimetric and clinical features in head and neck cancer RT.	The customized bite block showed promising results in decreasing the radiation dose to organs at risk during intensity-modulated RT (nasal cavity, paranasal sinuses, and oromaxillofacial) and may minimize potential radiation-induced complications.
Inoue et al. (2020)	Are intraoral stents effective for reducing the severity of oral mucositis during radiotherapy for maxillary and nasal cavity cancer?	Retrospective cohort	To compare the incidence and severity of OM and the parameters of the dose-volume histogram for adjacent tissues between patients using and not using an IOS during maxillary and nasal cavity cancer RT.	The use of a mouth-opening IOS decreased the unnecessary radiation to adjacent tissues, the grade of OM (in tongue, oral floor, mandibular gingiva), and opioid usage.

Stieb et al. (2020)	The impact of tongue-deviating and tongue-depressing oral stents on long-term radiation-associated symptoms in oropharyngeal cancer survivors	Prospective observational	To evaluate whether the use of IOS during intensity-modulated RT for oropharyngeal cancer is associated with long-term patient-reported symptoms.	Disease-site-specific select use of IOS was associated with reduced long-term patient-reported symptoms.
Hou et al. (2021)	Benefits of intraoral stents for sparing normal tissue in radiotherapy of nasopharyngeal carcinoma: a radiobiological model-based quantitative analysis	Original research	To determine the value of customized IOS for adjacent tissue protection in nasopharyngeal carcinoma RT using quantitative analysis of the radiobiological model.	IOS showed promising value in protecting adjacent tissue during nasopharyngeal carcinoma RT without affecting target dose coverage or tumor control.
Nakazawa et al. (2022)	Consideration of mouth opening when using positioning stents during radiotherapy for tongue cancer: a retrospective study	Retrospective	To address the range of mouth opening required to minimize the development of palatal OM while using a positioning IOS during tongue cancer RT.	The results may be useful for deriving the relationship between the amount of palatal irradiation attenuated by the positioning IOS and the range of mouth opening required.
Yang et al. (2023)	Wearing individualized 3D printed oral stent to protect normal tissues in patients with nasopharyngeal carcinoma during radiotherapy	Original research	To demonstrate a novel 3D-printed customized IOS during nasopharyngeal carcinoma RT and carry out a comparative analysis combining with a clinical case.	The preliminary results are encouraging since the IOS reduced the radiation dose to oral tissues and organs with little impact on the dose distribution of the target volume. The reduction of dose to organs at risk suggests the reduction of oral adverse reactions and improvement of patient's compliance and quality of life.

Carneiro et al. (2023)	Assessment of mouth opening before and after head and neck radiotherapy in patients with intraoral stents	Prospective observational	To evaluate the evolution of mouth opening before and after head and neck cancer RT in patients using IOS.	IOS can reduce radiation doses in adjacent areas and prevent the acute and late toxicities associated with cancer therapy.
Villani et al. (2023)	Protocol determinatio n for OSL in vivo measure ments of absorbed dose in the oral mucosa in oral cancer patients: A pilot study	Pilot	To report in vivo optically stimulated luminescence dosimetry protocol to investigate the dose distribution in the oral mucosa in patients with oral cancer using customized IOS.	IOS can decrease radiation doses in the oral mucosa and the understanding of dose distribution may help to minimize radiation-induced damage and establish dose restrictions.
Ma et al. (2023)	The application of 3D-printed oral stents in intensity-modulated radiotherapy for oropharyn geal cancer and their dosimetric effect on organs at risk	Original research	To investigate the accuracy of 3D-printed IOS in intensity-modulated RT for oropharyngeal cancer and their dosimetric effects on adjacent tissues.	IOS can significantly reduce the exposure dose of the upper cheek and hard palate and decrease the occurrence of adverse events such as OM, albeit it cannot affect the positioning error.
Kawakami et al. (2024)	Effectiveness of intraoral stents in reducing oral adverse events during radiot herapy for maxillary or nasal cavity malignant tumors	Retrospective	To examine the factors associated with the occurrence of OM and dysgeusia and the prevention efficacy of IOS.	The use of an IOS during maxilla or nasal cavity RT is recommended since it reduces the severity of OM by reducing irradiation to the tongue.

Source: Authors (2024)

Discussion

The use of IOS can minimize the side effects induced by head and neck RT (such as xerostomia, OM, hyposalivation, taste changes, and osteoradionecrosis) since it reduces both radiation dose and volume on adjacent tissues without affecting target dose coverage.[16] Although IOS can be manufactured or 3D-printed from different materials (such as polymethyl-

methacrylate resin, glass, lead, tungsten, titanium, and wood's metal or Cerrobend alloy), it is expected that the device presents an optimal adaptation and minimum movement during RT.[19, 21]

After evaluating the accuracy of 3D-printed IOS used during intensity-modulated RT for oropharyngeal cancer and their dosimetric effects on adjacent tissues, Ma et al.[16] reported a significant reduction in the exposure dose of the upper cheek and hard palate as well as a reduced occurrence of adverse effects.

Hou et al.[12] observed significant reductions in the mean radiation dose metrics of the oral cavity (11.6%), mandible (12.2%), left (15.4%) and right (8.7%) parotid glands after IOS use. Moreover, the probability of OM and xerostomia was significantly reduced (2.52% and 10.11%, respectively) in patients using IOS.

Mall et al.[18] objectively and subjectively evaluated the efficacy of positioning IOS in radiation-induced xerostomia in patients with squamous cell carcinoma in the tongue. IOS effectively controlled xerostomia and directly improved patients' quality of life.

After investigating the correlation between IOS use during head and neck RT and the reduction of trismus (grades 0 to 4), Carneiro et al.[11] highlighted the need for longitudinal studies to validate the effectiveness of these devices in preventing trismus. Nevertheless, the authors observed a significant reduction in OM after IOS use.

Nakazawa et al.13 observed a moderate correlation between the degree of mouth opening (y) and the attenuation of the irradiation dose to the palate (x), represented by the regression equation y=0.21x+19y = 0.21x + 19y=0.21x+19. Since the attenuation required to prevent OM is known, this regression equation can be useful for patients who cannot use IOS due to limitations in mouth opening.

Inoue et al.[9] observed that using IOS to maintain the mouth opening of head and neck cancer patients during RT decreased the unnecessary radiation to adjacent tissues and prevented OM in the tongue, oral floor, and gingiva. Moreover, IOS use prevented severe OM and decreased opioid usage during RT.

Stieb et al.[17] reported that patients using a tongue-depressing IOS during bilateral neck RT IOS significantly reduced moderate/severe dysphagia and mouth/throat sores, which can improve food ingestion and swallowing. Thus, the strategic use of IOS during RT for oropharyngeal cancer may minimize long-term radiation-associated symptoms and improve patient's quality of life.

In comparison to historical data without IOS use, Yang et al.[10] observed a mild degree of oral adverse reactions in nasopharyngeal carcinoma patients who used IOS during RT since the device keeps the tongue (particularly the tip) away from the target area. Thus, the radiation dose and severity of taste dysfunction are reduced.

Kawakami et al.[14] evaluated the efficacy of IOS during head and neck RT to prevent the factors associated with OM occurrence and dysgeusia. The authors reported that the device can reduce the incidence of severe OM and dysgeusia and figures as a promising alternative to improve the management of oral adverse effects.

In summary, the studies included in this integrative literature review underscore the effectiveness of using IOS to mitigate adverse effects of head and neck RT, such as xerostomia, OM, hyposalivation, taste changes, and osteoradionecrosis. By reducing both the radiation dose and exposure volume to adjacent tissues without impacting target dose coverage, IOS serves as a valuable tool in managing treatment-related toxicity. Additionally, the research emphasizes the importance of ongoing and multidisciplinary approaches to optimize care and enhance the quality of life for cancer patients undergoing RT. These findings support the incorporation of IOS in RT protocols as a promising strategy to improve patient outcomes and mitigate long-term complications.

Conclusion

The evidence gathered in this study demonstrates that the use of intraoral stents is an effective strategy for protecting soft tissues in the oral cavity during head and neck radiotherapy. These devices not only reduce the radiation dose received by healthy tissues but also minimize the incidence and severity of complications such as mucositis, xerostomia, and trismus, thereby significantly improving patients' quality of life. Given the observed effectiveness, the inclusion of intraoral stents in radiotherapy protocols for oncology patients represents a beneficial practice aligned with the goal of reducing long-term toxicity. Furthermore, it highlights the importance of a multiprofessional and interdisciplinary approach, essential for fully meeting the needs of these patients and optimizing resources.

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