The dental management of a mouth cancer patient

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Key points

- Promotes the role of all members of the dental team in the management of patients with mouth cancer.
- Reviews current evidence and practice for dentists in relation to the provision of dental care for mouth cancer patients.
- Explores new techniques and strategies available to aid in the oral healthcare of patients with mouth cancer.

Dentists and dental care professionals have a key role to play in the journey of the mouth cancer patient. Involved in the prevention, diagnosis and delivery of oral healthcare before, during and following mouth cancer treatment, dental professionals are essential to the delivery of patient care. This article will explore and consider the priorities of dental pre-assessment and the subsequent delivery of oral healthcare in the context of the different oncology treatment strategies utilised and in end-of-life care. The significant side effects of radiotherapy will be reviewed and clinical dental considerations presented using the existing evidence base and available guidelines. Ensuring mouth cancer does not result in dental disease is an important role for all members of the dental community.

Introduction

Mouth cancer and its treatment have life changing effects on each and every individual diagnosed with the condition. The impact of the disease and its subsequent management is not only felt by the individual but also their family, relatives and people near to them. Each dental team member has a vital role to play in the patient journey from diagnosis to the delivery of oral healthcare for those who are currently receiving or have received oncology treatment. Despite the considerable progress made in the management of neoplasia of the oral cavity, including reconstruction and rehabilitation, impairment and disability will continue to prevail as the side effects of treatment interventions significantly impact upon quality of life.[1] Dental team members can positively affect quality of life.

Historically, education and training in both the undergraduate and postgraduate realms have focused on developing the skills of the dental professional in the prevention and detection of mouth cancer.[2] While of seminal importance the prominence of these domains has often overshadowed the important role of the dental team in the management of patients with head and neck cancer prior, during and post treatment.

Although not considered a member of the core multi-disciplinary team, dentists and dental care professionals are an important element in the nexus of healthcare delivery for this patient group. If patients are to be truly placed at the centre of care during their mouth cancer journey we all must play our role and be valued by each other.

The dentist's role in the journey of the mouth cancer patient

The dental practitioner and dental team members may interface with the mouth cancer patient at various different stages during their journey from diagnosis to survivorship or end of life care. The intensity of the role dental professionals will play varies depending on the stage the patient is currently at in their cancer treatment (Fig. 1).

The collaborative approach of the dental team is essential to maximise patient care, and

Fig. 1 The mouth cancer patient journey and the dentists involvement with the MDT

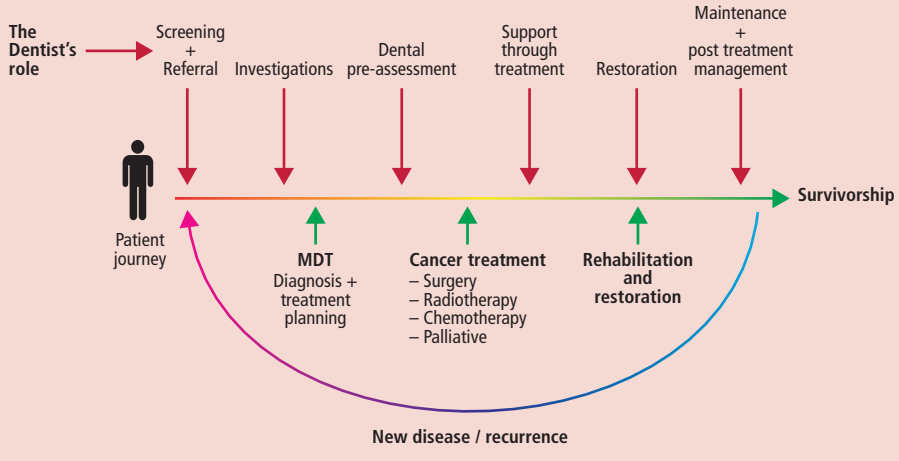

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Table 1 Overview of the roles of dental team members during the oral oncology journey

Stage of head and neck oncology care	Restorative consultant	Special care dentist	General dental practitioner	Dental therapist and/or hygienist
Pre-treatment	Undertakes dental assessment prior to oncology treatment	Undertakes necessary dental treatment in liaison with the restorative consultant prior to beginning oncology treatment	Undertakes necessary dental treatment as prescribed by restorative consultant prior to beginning oncology treatment	Undertakes necessary dental treatment as prescribed by restorative consultant prior to beginning oncology treatment
	Develops and prescribes treatment plan to be shared with dental team members			Role in maximising oral hygiene and periodontal condition prior to treatment
Peri-treatment		Management of patient during treatment in liaison with oncology team Including acute issues:	Supportive care as required	Supportive care as required
		Infection		
		Mucositis		
		Oral pain and discomfort		
Post-treatment	Undertakes oral rehabilitation in liaison with OMFS team.	End of life care	Examination, risk assessment and maintenance care including:	Delivery of maintenance care
	Including the use of complex maxillofacial prosthodontics and implants	Examination, risk assessment and maintenance care in cases of increased complexity including:	Operative Dentistry including:	Prevention including:
		Prevention	Prevention	Oral hygiene instruction
		Restorations	Restorations	Dietary advice
		Endodontics	Endodontics	Fluoride Delivery
		Periodontal treatment	Periodontal treatment	Hygiene phase therapy and restorations as appropriate
		Removal of teeth in sites at risk of ORN in liaison with OMFS/ oral surgery		

to foster efficiency and effectiveness to ensure treatment is delivered by the best person at the most appropriate time. An overview of the different roles of the dental team members is presented in Table 1.

Each dental team member has a valuable set of skills which augment each other and ensure quality care is delivered to each individual patient.

Screening and referral

Effective history taking to elucidate risk factors, signs and symptoms together with thorough clinical assessment of the head and neck region are the cornerstones of oral cancer detection. However, the holistic oral healthcare physician must also be sensitive to presenting systemic signs and symptoms of cancer including unexplained weight loss, dysphagia and lethargy. The various presentations of mouth cancer and the subsequent necessary actions have previously been described in this review series. The late presentation of cancer results in more advanced disease and poorer survival rates.[3] This underlines the need for timely and appropriate referral which should be undertaken in accordance with published guidelines. In Scotland, *The Scottish Cancer Referral Guidelines*[4] clearly describe justifications for urgent referral (Table 2). The NICE guideline 'Suspected Cancer: Recognition and Referral' provide recommendations for healthcare professionals to refer a patient with suspected cancer. While only officially for use in England, the guideline is also employed in other parts of The United Kingdom (Table 2).[5]

The MDT and the dental team

Following referral, appropriate investigation will be undertaken by local units including biopsy and imaging such as CT and PET scans. A subsequent diagnosis and staging using the TNM classification will be provided. With the diagnosis of oral cancer confirmed each patient case is presented at a multidisciplinary team (MDT) meeting attended by surgeons, oncologists, pathologists, radiologists, clinical nurse specialists and the restorative consultant. The oncological treatment options proposed are discussed on an individual basis by team members. A subsequent decision relating to the best treatment option for the patient is made by consensus. During this meeting it will also be decided whether the individual is required to see a dentist before the commencement of oncology treatment. The consultant in restorative dentistry should assess any individual who will require oral rehabilitation following surgery or those who will undergo radiotherapy, with or without adjuvant chemotherapy, to the head and neck region.[6] However, oncology management may not always have a curative intent with palliation and best supportive care provided. Any individual with an end of life diagnosis must not be left forgotten as we deliver equity in our standards of care. Every effort should be made to ensure they are fully supported in having a mouth which is pain free and comfortable as they come to the end of their life.

Dental assessment prior to oral oncology treatment

The restorative dentistry and oral rehabilitation: united kingdom national multidisciplinary guidelines have been produced by Butterworth *et al.* on the dental management of the head and neck cancer patient.[6] In addition to this The Royal College of Surgeons of England and British Society for Disability and Oral Health have produced valuable guidance for the general management of oncology patients

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entitled *The oral management of oncology patients requiring radiotherapy, chemotherapy and/or bone marrow transplantation*.[7] Both guidelines present the aims of dental assessment before oncology treatment (Table 3).

Dental assessment before head and neck oncology treatment should include a full history with appropriate consideration of dental, medical, social and environmental factors in addition to the proposed oncology management plan. Clinical assessment entails thorough examination of the appropriate extra and intra oral sites including the hard and soft tissues of the mouth. Adjuvant diagnostic measures should be used to identify oral disease including caries, periodontal disease and apical pathology. Special investigations should be undertaken where indicated, such as sensibility testing, to evaluate the vitality of teeth of concern. There is an important role for the use of radiographic imaging in pre-assessment for both dentate and edentulous individuals. Imaging may include an orthopantomogram (OPT) to provide an overview of the oral and maxillofacial structures. This may be supplemented by periapical or bitewing radiographs where appropriate.

Dental treatment prior to oncology care

The mouth of each patient undergoing head and neck cancer therapy must be in a state of dental health before oncology care. Teeth with existing infection should be removed by the dentist before head and neck cancer treatment. However, if the patient is to receive primary surgery, liaison with the oncology surgeon can facilitate removal during a planned procedure. Where the individual is to undergo radiotherapy, consideration should also be given to the removal of teeth of poor long-term prognosis which are situated in the field of radiation. Teeth compromised by extensive caries and those deemed unrestorable or non-vital should also be removed. While endodontic procedures form part of the dentist's clinical armoury, within the oncology context both the risk of failure and the limited time available contraindicates its use. The supporting tooth structures should also be evaluated fully as periodontally compromised teeth should be considered for removal in addition to non-functional and unopposed teeth. It should be stressed, however, that where possible key teeth should be saved within reason to maximise restorative options in the immediate and long-term post treatment period. Carious teeth which are deemed restorable should be stabilised where possible before surgery.

The timing of dental extractions in relation to oncology treatment remains controversial with a recent systematic review highlighting the dubiety of the available evidence and significant heterogeneity in study design.[8] Existing UK guidelines continue to support the removal of foci of infection before oncology treatment.[6,7] Dental extractions should be performed no less than 10 days to 2 weeks before beginning any combination of chemo-radiotherapy treatment in order to allow for sufficient healing. However, this decision should only be taken having reviewed the sockets.

Sharp teeth and prostheses with rough edges should be smoothed and adjusted in an effort to minimise traumatic injury or further exacerbate pain or mucositis during treatment. It is also recommended that any soft tissue infections including oral or pharyngeal candidosis should be treated before beginning oncology management.

Where appropriate, it is valuable to take impressions which can be used for the creation of fluoride trays or soft splints and may be also used by a restorative consultant to inform subsequent rehabilitative management.

Dental treatment will be prescribed by the restorative consultant. However, necessary treatment may be delivered by dental team members in primary or secondary care. There

Table 2 Scottish and NICE referral guidelines for suspected oral cancer

Scottish Cancer Referral Guidelines: Head and Neck Cancer	NICE Guidelines Suspected Cancer Recognition and Referral:
Reasons for urgent cancer referral:	Reasons for suspected cancer referral:
Persistent unexplained head and neck lumps >3 weeks	Unexplained ulceration in the oral cavity lasting for more than 3 weeks
Ulceration or unexplained swelling of the oral mucosa persisting for >3 weeks	A persistent and unexplained lump in the neck
All red or mixed red and white patches of the oral mucosa persisting for >3 weeks	Reasons for urgent cancer referral:
Persistent hoarseness lasting for >3 weeks (request a chest X-ray at the same time)	A lump on the lip or in the oral cavity A red or red and white patch in the oral cavity consistent
Dysphagia or odynophagia (pain on swallowing) lasting for >3 weeks	with erythroplakia or erythroleukoplakia
Persistent pain in the throat lasting for >3 weeks.	Reasons for suspected cancer referral recognised by a dentist:
	A lump on the lip or in the oral cavity consistent with oral cancer or
	A red or red and white patch in the oral cavity consistent with erythroplakia or erythroleukoplakia

Table 3 Aims of dental pre-assessment in oral oncology

1. Avoid unscheduled interruptions to oncology treatment due to dental problems	1. Establish the risk of oral disease
2. Plan and undertake treatment to deliver prosthetics including implants or an obturator	2. Identify and plan for the removal of foci of infection
3. Plan for the extraction of teeth of doubtful prognosis or are at risk of dental disease in the future and are in an area where there would be risk of osteoradionecrosis.	3. Prepare the patient for the potential short and long term oral side effects of oncology treatment
4. Plan for the restoration of remaining teeth as required	4. Develop and implement an appropriate preventative plan to meet the increased challenge to the oral and dental structures following oncology treatment
5. Provide and implement preventive advice and treatment	
6. Assess for the risk of post-treatment access difficulties including trismus	

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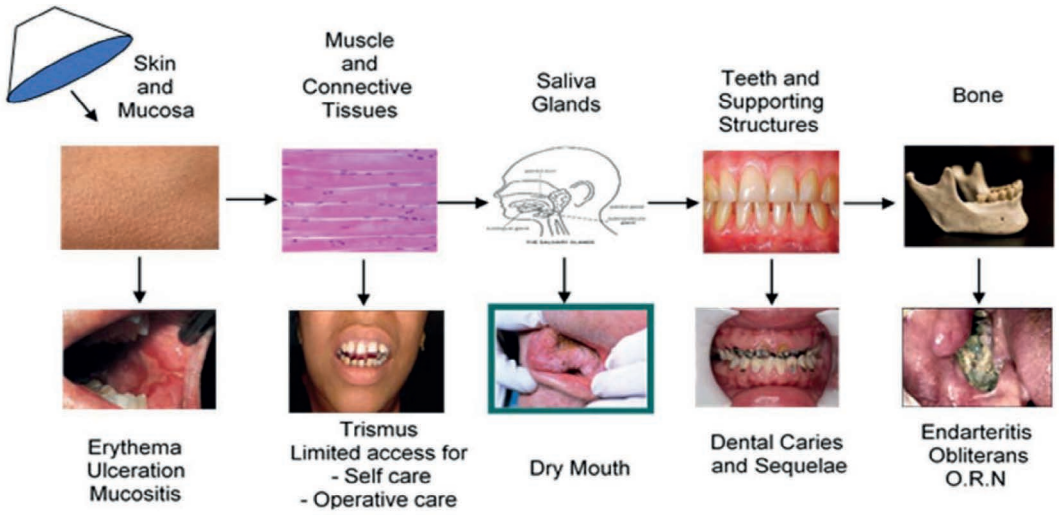

Fig. 2 The gross structures of the head and neck and the subsequent side effects of radiotherapy

are significant benefits of allowing patients to see a hygienist or therapist to promote oral health and deliver treatment where appropriate.

The side effects of head and neck cancer treatment

Survival rates for mouth cancer are continually improving, but the side effects of the disease and its treatment result in both impairment and disability. The treatment modalities available to the surgeon and oncologist come at a price and will affect how the dental practitioner plans their future management. The side effects of each treatment modality will now be considered with reference to the role of the different dental team members .

Surgery

The site of surgery and extension of disease, will determine the resultant defect which may or may not be surgically reconstructed depending on many factors. Following the resection of the tumour with or without neck dissection the oral and maxillofacial surgeon and restorative dentist will work together with highly skilled specialised lab technicians to plan and undertake the appropriate oral rehabilitation of the head and neck cancer patient.[9] However, the individual will still require support with an intensive dental maintenance care programme to prevent dental disease and facilitate the appropriate hygiene rituals to care for any prosthetic work delivered and the mouth as a whole. It is here the seminal role of dental care professionals must be emphasised. With highly developed skills across the breadth of their realm of practice, hygienists and therapists are well placed to provide periodontal therapies and maintenance care. Tailoring oral hygiene advice in addition to the use of fluoride and supportive therapy is essential to the maintenance of the residual natural dentition and any subsequent maxillofacial prosthodontics.

Chemotherapy

While surgical intervention remains the mainstay of mouth cancer treatment, chemotherapy may be used either with curative or palliative intent. Its use in combination with radiotherapy is prescribed by an oncologist to control disease which is locally advanced or receives a staging grade of III or IV. Adjuvant chemoradiation therapy provides the greatest chance of locoregional control and the prevention of relapse when compared to radiotherapy alone. Where metastatic disease to distant sites exists, multimodal therapeutic agents may be used to alleviate symptoms and enhance quality of life.

Haematological side effects of chemotherapy result in both myelosuppression and immunosuppression. Oral infections in an immunosuppressed individual have the potential to become significant, affecting both morbidity and mortality.

In general, cell counts begin to reduce within the first few days following the delivery of chemotherapy. This reduction will continue until around day 10–14 when cell counts will begin to rise again. White cells, particularly neutrophils, are significantly impacted by chemotherapy and where levels are abnormal no operative care should be provided without the involvement of the oncology team.

The impact of chemo toxic drugs on platelets, while less common and often less severe, may render a significant bleeding risk should operative dentistry be attempted. If a patient requires dental treatment during chemoradiotherapy it is of primary importance to check where they are in their cycle of treatment and their haematological status. No operative dentistry should be undertaken when platelets fall below 50×10^9/l. Appropriate communication should be undertaken with the oncologist to determine a potential treatment strategy. If acute dental infection or febrile neutropenia presents it is essential the patient is appropriately managed in liaison with the MDT and antibiotics are delivered as required.

Radiotherapy

Radiotherapy is used by oncology teams to destroy cancer cells by damaging cellular DNA. In head and neck cancer, this treatment modality is commonly used as an adjuvant to primary surgery. An external beam is used to target specific sites. The total dose of radiotherapy delivered is undertaken in daily fractions over the course of six weeks. However, it may also be employed before surgery as a neoadjuvant technique or in cases of advanced end stage cancer to manage symptoms.

Mucositis

To access the cancerous site, the radiotherapy beam will pass through a number of tissues in the human body (Fig. 2.). The first tissue it will encounter extra orally will be skin with erythema ensuing which may progress to ulceration.

The most superficial tissue in the mouth is the oral mucosa. Both radiotherapy and

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chemotherapy possess the potential to cause oral mucositis. An acute toxicity, mucositis may clinically present in its mildest form as erythema and soreness, through to erosions and ulceration. In its most severe form it will prevent individuals from eating. Mucositis is classified by the WHO mucositis scale (Table 4). Radiotherapy induced mucositis is a common side effect and may present within 2–3 weeks of commencing treatment but can persist for several months. Radiotherapy-induced mucositis is limited to mucosal sites directly or in proximity to the path of the radiotherapy beam. Chemotherapy-induced mucositis can affect the entire gastrointestinal tract. Oral health appears to affect mucositis both before and during the period of treatment. Radiotherapy delivered in the presence of poor oral hygiene, has a synergistically negative impact on the oral microbiome with a resultant increased release of lipopolysacchairds (LPS) from gram negative bacteria. The proinflammatory state together with the available portal of entry presented by ulceration affords for opportunistic infection in the immunosuppressed individual.[10] Establishing good oral hygiene routines with weekly nurse-led examination of the oral mucosa may positively affect both the severity and duration of mucositis experienced.

Prophylactic measures to prevent mucositis have been evaluated in a recently published systematic review with keratinocyte growth factor shown to reduce the risk of moderate to severe mucositis in those having radiotherapy with adjuvant chemotherapeutic agents cisplatin and 5FU.[11] Other measures have been put forward to aid in the prevention and management of mucositis including barrier agents, chlorhexidine, aloe vera, granulocyte colony stimulating factor (GCSF), pure natural honey and joint antibiotic/anti-fungal medications. However, the existing evidence in relation to each of these interventions continues to be minimal. At present, cryotherapy to manage head and neck cancer-associated mucositis is not recommended due to a theoretical risk of a decrease in the treatment efficiency due to thermal induced vasoconstriction.[10] However, this technique does have a beneficial role in the management of patients with solid tumours or those undergoing haematological stem cell transplant.

There is increasing interest in the role of low level laser light therapy (LLLT), now more commonly termed photobiomodulation (PBM), in the management of oral mucositis. Protocols are still in their infancy but the technique requires a light of a wavelength between 630–830 nm to be delivered daily to the mucosa during and following radiotherapy.[12] Much remains to be discovered about the mechanism through which PBM exerts its biological effects. Experimental data indicates a reduction in inflammation and the promotion of healing through increases in ATP production and the reduction of oxidative stress.[13] The beneficial clinical implications are evidenced by reduced levels of severe mucositis and reported pain.[14]

Table 4 WHO Mucositis Scale

Score	Definition
1	Soreness/erythema
2	Erythema/ulceration but patient is able to eat solid foods
3	Ulcers, requires a liquid diet
4	Food administration is not possible orally

Trismus

Having passed through the skin or oral mucosa, the radiotherapy beam will then pass through the muscles and connective tissues. Trauma to the cells within these tissues results in fibrosis. As the tissues lose their elasticity the ability of the mouth to open becomes increasingly impaired. Generally, reduced incisal opening of less than 35 mm is considered as trismus.[16] Should additional muscles in the head and neck be affected stricture will similarly ensue affecting the patient's ability to turn their head and neck.

Trismus is a significant barrier to the provision of oral self-care and for operative dentistry access. Where trismus exists and access for operative dentistry is indicated, consideration should be given to the use of a paediatric handpiece. Additionally, the operator and patient may find it advantageous and more comfortable to use a mouth prop. Numerous short appointments focusing on high quality are to be favoured over prolonged sessions where quality is compromised due to patient cooperation and discomfort.

The management of trismus is to date somewhat limited. Patients may be provided with active or passive exercises and may use a Therabite or, where that is unavailable, a series of wooden sticks placed together may be utilised to help improve mouth opening.

Dysphagia

The mouth cancer disease process and its management through surgical or radiotherapeutic interventions can result in an impairment in the ability to swallow. Dysphagia can result in difficulty eating, malnutrition, dehydration, aspiration and pneumonia.[17] Ideally, patients should be assessed by both nutritionists and speech and language therapists before oncological treatment and provided with appropriate exercises to minimise the potential impact of the primary treatment.

Acute toxicity from oncology treatment may result in the need for enteral feeding. For those undergoing radiotherapy and or chemotherapy both percutaneous endoscopic gastrostomy (PEG) and nasogastric (NG) methods are utilised, with the former being found to be significantly longer and ten times more expensive than NG feeding.[18] Loss of weight is experienced by individuals with head and neck cancer from their initial presentation and may persist beyond the cessation of therapy. Current guidelines[19] propose that an energy intake of 30 Kcal/kg/day is required but may need to be elevated, which is consistent with recently published work indicating 35 Kcal/kg/day are required to ensure the maintenance of weight.[20]

The increased nutritional needs of the mouth cancer patient may result in food fortification or, if required, oral nutritional support in the form of liquid supplementation. The prescription of frequent high protein and calorie supplements and meals, which if possible will be consumed orally, oppose the existing oral health guidance provided by dental professionals. However, weight management is an essential component of the mouth cancer care package. Collaborative working between dietician and oral healthcare team is essential to ensure diets are modified appropriately.

It is hoped that with time any dysphagia experienced will improve but it can be a chronic complication. Many dysphagic patients prefer to sit upright in the dental chair, further impairing access. The dental team should be encouraged to take frequent breaks where possible during treatment to allow the patient to swallow. The use of dental dam and high-volume aspiration to prevent aspiration are valuable clinical adjuncts.

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Table 5 The Challacombe Scale of Clinical Oral Dryness[24]

Score	Clinical sign	Severity	Suggested management
1	Mirror sticks to buccal mucosa	Mild Score between 1 – 3	Use of sugar-free chewing gum for 15 minutes, twice daily Ensure hydration
2	Mirror sticks to tongue		
3	Saliva frothy		
4	No Saliva pooling in floor of mouth	Moderate Score between 4-6	Sugar free chewing gum Simple sialagogues Saliva substitutes Topical Fluoride
5	Tongue shows generalised shortened papillae (mild depapillation)		
6	Altered gingival architecture		
7	Glassy appearance of oral mucosa, especially palate	Severe Score between 7– 10	Sugar free chewing gum Simple sialagogues Topical Fluoride May require specialist input
8	Tongue lobulated / fissured		
9	Cervical caries		
10	Debris on palate sticking to teeth		

Table 6 Saliva replacement and stimulation products

Saliva replacement	Saliva stimulation
Saliva Orthana Oral spray Lozenges	Pilocarpine
Biotène Oralbalance Gel	Chewing gum sugar free
BioXtra products	Diabetic sweets
Saliveze	
Oralieve Dry Mouth Relief	

Dry mouth

Dry mouth is a significant side effect of both radiotherapy and chemotherapy, although in the latter the toxicity experienced is temporary in nature. Xerostomia may begin as early as the first week of radiotherapy. The total volume of saliva secreted is reduced and the quality will become significantly more viscous and sticky in nature. Dryness continues to worsen until around one to three months post therapy with any salivary gland recovery maximising at around two years post treatment.[21] Although, Braam has shown there may continue to be improvement up to five years later.[22] Dry mouth has traditionally been classified as being present when the unstimulated whole salivary flow rate is <0.1 ml/min or the stimulated flow rate is of <0.5 ml/min. [23]

Clinically, dry mouth can be identified by several features which are described in the Challacombe Scale of Oral Dryness (Table 5) and include a lack of pooling of saliva in the floor of mouth, a lobulated or fissured tongue and a glass like appearance to the mucosa (Table 2).[24] However, xerostomia is a notoriously individual experience and despite normal salivary flow rates being recorded patients including those undergoing cancer treatment may still report xerostomia. Various questionnaires have been produced to aid in the diagnosis of xerostomia and maybe useful where doubt exists.[25] The protective properties of saliva are also affected by radiation therapy resulting in impaired defensive properties and the reduced capacity of the saliva to buffer pH changes in addition to an alteration in electrolytes.

An associated feature of dry mouth is dysgeusia. Patients often report an inability to taste certian foods and may add more sugar or salt to their meals to overcome this. The addition of large quantities of sugar to enable taste can significantly increase the risk of further oral disease.

The effect of radiotherapy on the salivary glands is both dose and field dependent. The ensuing hypofunction is a result of inflammation within the glands and degenerative changes within the parenchyma. Intensity-modulated radiotherapy (IMRT) has significantly reduced the impact of radiation therapy on the parotid glands reducing salivary gland hypofunction and improving the volume of saliva secreted and the quality of life experienced.[26]

A recently published Cochrane review drew attention to the ability, although of lower quality evidence, of amifostine to help prevent dry mouth and salivary gland dysfunction following radiotherapy, although the authors highlight the significantly high expense.[27] Interestingly, another research group has provided initial promising data using amifostine locally, avoiding the negative systemic side effects of the drug.[28] Despite the numerous other pharmacological interventions available there appears to be little available evidence present to support their use.[27]

Two therapeutic strategies have dominated the management of dry mouth to date. Saliva stimulation is used where residual function exists within the glands. Saliva replacement seeks to substitute saliva through artificial measures. Pharmacological methods of stimulating saliva include the use of pilocarpine, a cholinergic receptor agonist. Various topical saliva replacements have been produced but there is little evidence to suggest they are effective.[29] The most prominent strategies are listed in Table 6. However, it should be highlighted to the reader that there are products which are sold and prescribed that can cause damage to the mouth. Glandosane is the most notable product as it is acidic in nature. It is advisable to review the ingredients within any product before prescribing. Many flavoured products recently brought to the forum contain citrate, a weak organic acid, and are unbuffered by other components of the product.

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Prevention against oral disease

The institution of an appropriate individualised preventative regime is an essential element in the dental management of this patient group. The armamentarium available is presented in Table 7. Toothpaste with an increased fluoride content should be prescribed for those receiving radiotherapy and this should be a lifelong measure to reduce the risk of future dental caries. Some patients are unable to tolerate the high strength formulations currently available and are thus unable to gain the additional protective benefits. They report experiencing a burning sensation of the oral mucosa and sodium lauryl sulphate (SLS) is thought to be a precipitating factor. Although of a lower fluoride concentration, alternative toothpastes are available which do not contain SLS.

Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) has emerged as an adjunct to the preventative regime for caries in recent years. Tooth mousse contains CPP-ACP and is reported to positively affect remineralisation. Much of the available evidence has significant caveats to support its use[30] originating from laboratory-based studies. While positive clinical outcomes are evident these generally relate to orthodontic studies.[31] Also Tooth mousse cannot be prescribed and has a significant cost associated with it, this, together with the clear need for a more substantial and population appropriate evidence base,[32] indicates that further research must be conducted.

Table 7 Preventative measures for dental disease in head and neck cancer

Preventative measure	Comments
Sodium fluoride toothpaste 2,800 ppm F- 5,000 ppm F- **OraNurse toothpaste** 1,450 ppm F- **Biotène toothpaste** 1,450ppm F-	Used twice daily during toothbrushing Used in fluoride trays
Additional fluoride supplementation:	
Tooth mousse	Increase the free calcium available for uptake into teeth
Fluoride mouth rinses	There may well be a role for sodium fluoride mouth rinse.
	However, it should be alcohol free and used at alternative times of the day from increased fluoride toothpaste use.
Fluoride varnish	The use of fluoride varnish is not evidence based within this patient group.
22,600 ppm	However, it does provide and increase exposure to fluoride in this high-risk group
Chlorhexidine mouthwashes	The use of chlorhexidine mouthwashes is currently evident in some existing guidelines. However, its use may cause significant discomfort to the oral mucosa in individuals receiving radiotherapy of chemotherapy to the head and neck. Therefore, it should not be routinely prescribed. However, it may have a role in situations where no other method of obtaining oral hygiene is possible.

Dental caries

The caries experience of people with mouth cancer who have been treated with radiotherapy with or without chemotherapy is increased.[33] The pathological process of radiation-induced caries remains controversial. Impaired saliva secretion and the loss of its protective effects undoubtedly has an impact on caries. However, it may also be influenced by the direct effect of the radiotherapy beam on tooth structure. Laboratory studies have indicated that changes in both the microhardness and micromorphology of tooth structure may result from interaction with the radiotherapy beam.[34] This may further tip the balance of dysbiosis in favour of pathology. While radiation caries follows the same aetiopathogeneis as conventional caries,[33] the clinical pattern differs with cervical margins, incisal edges and cusp tips being affected.[35] While radiotherapy-induced changes to collagen within the mineralised portion of the tooth have not been demonstrated, pulpal collagen does appear to be affected,[36] although the significance of this is yet to be determined.

Osteoradionecrosis

The calculated decisions made during dental pre-assessment in relation to the prognosis of teeth, with due consideration to dental, medical, social and environmental factors, are ultimately well-informed guesses. Predicting the future of a dentition is a skill that even highly trained and experienced clinicians can misjudge. The hostile oral environment of the mouth cancer patient can result in dental disease regardless of every preventative measure being in place. Despite the efforts of prevention and operative intervention there may well come a point where no more can be done to save a tooth. These rigorous and intensive efforts are made in order to avoid extraction of teeth due to the risk of osteoradionecrosis (ORN).

ORN is a serious complication associated with the use of radiotherapy in the oncological management of mouth cancer. ORN can result in infection and can ultimately progress to pathological fracture of the jaw bones affected. Classifications of ORN have evolved over time but it is currently defined as exposed radiated bone that fails to heal without any evidence of persisting tumour.[37] The reported prevalence of ORN ranges from 0.4% to 56%.[37] While all-encompassing, the reporting of such large percentages is false as modern radiotherapy has changed significantly. More modest occurrences have recently been reported of 4.3% over ten years[38] and 8% over 30 years.[39] This significant change has resulted from the use of IMRT and may reduce again with the development of proton beam radiation therapy/intensity modulated proton therapy with its ability to further spare organs.[40] ORN is a more common occurrence in the posterior mandible due to a reduced blood supply. Additional risk factors include: poor dental health, tobacco and alcohol use,[38] extraction or operative surgery involving mucosa and bone in the site of radiotherapy and high dose radiation (>60 Gy). [41] Once again, there is little agreement as to the pathophysiology of ORN. Marx originally proposed a theory of hypoxia, hypocellularity and hypovascularity, which subsequently drove both the development of ORN classification systems and treatment protocols. However, this work has been challenged by Delanian *et al.* who have put forward the radiation-induced fibroatrophic theory.[42] The work of this eminent group has challenged and progressed the management of ORN, their PENTOLCO studies have shown

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Fig. 3 Dental pre-assessment radiograph

Fig. 4 Radiograph two years post oncology treatment

Fig. 5 Radiograph of Patient X 5 years following completion of chemo-radiotherapy

remarkable and successful results for established ORN which has not responded to other treatment strategies.[44] Evolving from their results, questions have been asked around the prophylactic use of pentoxifylline and vitamin E before the extraction of teeth in people at risk of ORN. Patel *et al.* have led the way with their initial study where only one individual in their sample developed ORN. The authors are open and honest in their reporting of the limitations of the presented case report however, their results highlight the promise of this treatment schedule.[44]

Every effort must be made to avoid tooth extraction in a patient who has received radiotherapy for head and neck cancer with reference to the risk of ORN. Irreversible pulpal pathology or apical pathology should be managed with endodontic therapy where possible. If the coronal tooth structure is compromised in these situations it is still pertinent to consider and evaluate the potential for endodontic therapy followed by coronectomy, thus avoiding tooth extraction. Both the field and dose of radiation should be determined when considering extraction to establish risk.

It is now imperative that, on the cusp of this paradigm shift, general dental practitioners begin to liaise with the oncology team looking after the patient to determine the risk of ORN and whether prophylaxis is required. Should multiple teeth require extraction then a staged approach should be taken. This reduces the size of the wound. Loose bony fragments or any bone that is likely to sequestrate from the socket should also be removed at the time of tooth extraction. Achieving primary closure should be evaluated on a case-by-case basis as the amount of trauma to the bone and tissues should be minimised as far as possible. Where doubt exists referral to oral and maxillofacial surgery, oral surgery or special care dentistry is appropriate as collaborative and shared approaches to care are to be encouraged where complexity increases.

End of life care

While mouth cancer is a treatable disease many people receive care with a palliative intent. It is important that the use of the term palliative is not associated with 'no treatment'. When a person is in the end stages of their life, their priorities are different and this should also be reflected in the oral healthcare strategies employed. End of life care should focus on maximising quality of life by appropriately managing pain, reacting to and managing symptoms, and allowing an individual to die with dignity and respect.[45] The oral cavity is an often-forgotten region in the context of cancer management but at the end of life allowing a person to have a pain-free, functional and comfortable mouth that they can use to communicate should never be underestimated. Oral health is generally poor during end of life care within the in-patient setting with almost 70% of individuals reporting mouth pain and almost 80% reporting a dry mouth.[46] Additionally, various pathologies may present in end of life care including viral and fungal infections.[47]

Promoting good oral hygiene goes some way to reducing the risk of infection and facilitating mouth comfort. Where the mouth is particularly sore and sensitive a silk tooth brush may be very much valued and appreciated by patients. Keeping the mucosa lubricated by ensuring appropriate hydration levels and using saliva substitutes may well be beneficial. Sharp and rough teeth which can be painful and act as a plaque retention factor can be smoothed or dressed by undertaking simple

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Fig. 6 Pre-operative photo

Fig. 7 Post-operative photo

restorative procedures. Treatment should always be considered in the context of the disease and prognosis. Complex dentistry is often not appropriate and delivering dentistry that meets the health needs of the individual appropriately is to be encouraged.

Here also lies a distinct role for the dental hygienist. Their well-honed skills are significantly valuable in supporting oral health and comfort.

The implications of oral oncology on oral health and quality of life

Case 1

Despite all the efforts taken to appropriately assess each person with mouth cancer on an individual basis, failure can result. The first case presented demonstrates the deterioration of a dentition over the course of eight years following treatment for mouth cancer. The patient was diagnosed with a squamous cell carcinoma, transforming from oral lichen planus of the right lateral border of the tongue. He remains free of cancer, but the effects of his treatment have impacted his oral health and quality of life.

The first radiograph shows the individual at his dental pre-assessment (Fig. 3). The patient has an unrestored dentition which clinically and radiographically appears sound. No periodontal pockets of >4 mm were found. The presence of the third molars was noted but clinically they were unerupted with no communication to the oral cavity. A decision was made in conjunction with the patient to leave these *in situ* with only two weeks remaining till the start of chemo-radiotherapy. This clinical picture is set in the background of a history of a low cariogenic diet and good oral hygiene where fluoride was routinely used. The patient was provided with increased fluoride toothpaste, fluoride trays and attended a hygienist before undergoing treatment. He was given all the appropriate advice and guidelines were adhered to.

In just two years, it is clear to see the significant deterioration in dental health status (Fig. 4). The clinical picture was consistent with the radiographic presentation as numerous teeth have been affected by caries. The posterior teeth have been temporised awaiting further treatment planning in this radiograph. The rate of bone loss is also significant in a period of only two years. A stabilisation phase of dental treatment was undertaken to save his dentition. A decision was made in liaison with oral and maxillofacial surgery to remove the symptomatic and unrestorable 27, 36 and 37 at this point in time.

The five-year time point represents further failure (Fig. 5). The first and second molar teeth have now been extracted in the left and right mandible. Furthermore, rapidly progressive caries is present despite all efforts to maintain the teeth. In the three years following, the patient was seen by both dentist and dental hygienist at between one monthly and three monthly intervals. Continual prevention and appropriate operative dentistry was undertaken, yet the individual's dentition continues to fail. The quality of the bone is remarkable in the mandible. This appearance represents osteoradionecrosis. The teeth were removed one by one to reduce the size of the wound for healing but no prophylaxis for ORN was given at the time. He subsequently required two episodes of surgical debridement to achieve mucosal coverage.

This case poignantly displays the significant effects of oncology treatment associated with mouth cancer. Profound xerostomia and trismus have acted as significant barriers to oral health. While not unique, it represents a failure and shows clearly why the role of each member of the dental team is essential.

For this single case of failure, it must be stressed that there are numerous individuals who, under the care of the MDT and dental team, have been rehabilitated with relative aesthetic and functional success.

Case 2

This case further demonstrates the importance of all the members of the dental team. A 65-year-old diagnosed with a T1N1 SCC of the right tonsil received surgery and chemoradiotherapy to manage his disease. His dental pre-assessment advocated removal of multiple teeth leaving him with just six anterior teeth in the maxilla and six anterior teeth in the mandible. Having spent a considerable period as a non-attender to dental services he presented with both radiation caries and non-carious tooth surface loss (Fig. 6). The gentleman had both trismus and dysphagia.

The gentleman did not wish to undergo rehabilitation with dental implants. Due to both his dysphagia and trismus, he received his dental treatment under the care of a special care dentistry service. With input from a dental

hygienist, dentist and lab technicians his dentition was stabilised, and he subsequently underwent an initial phase of restoration. Primary orthograde endodontics, composite restorations and removable prosthodontics were provided (Fig. 7). The enhanced preventative regime provided for him, in addition to both a simple and conservative approach to restoration, allowed this gentleman to live out the remainder of his life with no further operative dentistry required. He enjoyed improved self-confidence allowing him to once again communicate and socialise with his family and friends, making a significant impact upon his quality of life.

Conclusions

Each member of the dental team has an essential role to play in the care of the mouth cancer patient. Oral Oncology treatment modalities come with side effects which result in an increased risk of oral disease. Preventative regimes must be incorporated into the treatment strategies for patients, with the use of fluoride and the delivery of supportive maintenance care essential to success. Communication between team members is essential to facilitate appropriate and timely care before, during and following oral oncology treatment. The dental team must work in collaboration to ensure quality healthcare which promotes oral and systemic health for those with mouth cancer

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