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CASE REPORT

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Zirconia crowns as a treatment option in oncology pediatric patients undergoing frequent magnetic resonance imaging: a case presentation

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Abstract

Background: Stainless Steel Crowns (SSC) are considered the gold standard for restoration of severely carious teeth in children. However, there are cases where they are contraindicated. The aim of this case report is to present the dental treatment of an oncology pediatric patient, in which alternative materials, that do not interfere with the magnetic field during Magnetic Resonance Imaging (MRI), were used. **Case**: A 5-year-old boy was referred for dental treatment. The child had been diagnosed with abdominal cancer at the age of 4 years old, and had been treated with surgery, chemotherapy and concomitant radiotherapy. At the day of presentation, he was under maintenance therapy. Clinical examination revealed severe caries on all primary teeth, and fistula on the right maxillary first primary molar. Radiographic examination showed a radiolucency on the abscessed molar, and extensive caries close to the pulp on the lower first and second primary molars. Treatment plan involved restorations of carious teeth using composite resin restorations, vital pulp therapy in teeth with lesions involving the pulp and extractions of severely carious primary teeth. On severely carious teeth, zirconia crowns were used instead of SSC as the patient is undergoing regular MRIs to control for metastasis and metal restorations are contradicted. The patient has been attending the clinic for follow up visits without presenting any new carious lesions or complications. Sealants were placed on the 2-year follow-up visit to the first permanent molars that had erupted. **Conclusions**: Treating patients diagnosed with a malignancy is not contraindicated but appropriate planning and choice of materials that are compatible with MRI imaging is necessary. Composite resin restorations, zirconia crowns or computer-aided design and manufacturing (CAD/CAM) materials are indicated in cancer survivors.

Keywords

Pediatric patients; Composite restorations; Zirconia crowns; CAD/CAM; MRI

1. Introduction

Magnetic Resonance Imaging (MRI) is considered a valuable diagnostic tool in pediatric oncology as it provides information for primary cancer staging, therapeutic outcomes and follow-up care in cancer survivors [1]. In addition, MRI has no radiation exposure compared to other imaging techniques, requires less frequent imaging, and provides information related to soft tissue tumors [1].

Childhood cancer survivors are at risk of developing oral health problems directly associated to the disease and its treatment [2, 3]. Therefore, many presents with increased caries, diminished oral hygiene and dental developmental defects that further increase caries prevalence. These patients are also susceptible to reduced salivary flow and altered microflora, that due to their immunosuppression can increase their risk for oral and dental infections [3]. As a result, they are often in need of extensive restorative treatment using crowns.

Stainless Steel Crowns (SSC) are considered the gold standard for restoration of severely carious teeth in high caries risk children [4], they are also indicated in teeth with developmental defects, teeth that have undergone pulp therapy or when other restorative materials are likely to fail [5]. However, they are contraindicated in oncology patients and cancer survivors that need to undergo MRI frequently for oncology follow-ups as SSC are made of base metal. Base metals used in dentistry frequently interfere with the radio waves and distort the image due to the difference in magnetic susceptibility between the soft tissues and the metallic restorations [6]. Thus, oncologists and radiologists often request the removal of the metallic oral prostheses (such as orthodontic appliances, crowns, *etc.*) from the mouth prior to an MRI.

The aim of this paper is to present, through a case report, the dental management of a patient treated for an abdominal

malignancy, using dental materials that are compatible with frequent MRIs.

2. Case description

A 5-year-old Caucasian male with a history of abdominal cancer presented for dental treatment in a private clinic. After informed consent, including publication of his case in scientific journals, medical and dental history were reported followed by clinical examination.

The patient was diagnosed with stage IV abdominal neuroblastoma when he was 4 years old. He underwent pancreatectomy followed by chemotherapy, and radiation therapy. At the day of examination, he was under maintenance therapy, his blood levels were normal and was receiving insulin daily due to the pancreatectomy.

In regards to his dental history, the patient's mother reported that he was instructed to stop toothbrushing for a couple of months during his treatment and this was when she saw his teeth "getting rotten". At the time of the initial examination, the patient was brushing his teeth with fluoridated toothpaste once a day, had sugary snacks every other day, and did not experience any tooth pain.

Initial clinical examination showed primary dentition, with gingiva and soft tissues being within the normal limits. Regarding dental hard tissues, white spot lesions were detected on the buccal surface of all teeth, and cavitation of the maxillary and mandibular incisors, left canines and mesial surface of lower first primary molar was noted. In regards to occlusion, patient had mesial step and Class I canine occlusion, a 2 mm overjet, 5% overbite, and spacing on the anterior teeth. No radiographs were taken at the initial visit as the patient was uncooperative.

Based on his medical history, several factors related to systemic diseases were considered prior to treatment planning. Oncology patients are often in higher caries risk due to xerostomia, dental defects and limited oral hygiene practices at times of aplasia. Also, this case presents a child that had pancreatectomy which led to diabetes which is often associated with gingival and oral inflammation. Finally, as the patient received long lasting treatments and at a very young age, his cooperation was compromised and this was taken into consideration at treatment planning.

The treatment plan included a strict preventive protocol with toothbrushing twice every day with a fluoridated toothpaste (1450 ppm F) and with casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) fluoride toothpaste once per day, elimination of sugary foods and drinks twice per week. Regarding restorative care, the canines and the cavitated primary first molar were restored with composite resin. At this time, chair-side treatments were kept to a minimum, as the patient was uncooperative, and the parents did not want the child to undergo dental treatment using pharmacological management due to his compromised medical history. The prophylaxis and fluoride treatment as well as three dental restorations were performed on two separate visits with behavior management techniques such as tell-show-do and positive reinforcement and without any restrictions imposed by the oncologists.

The patient was put in a 3-month recall program but due to medical complications he re-visited the office again a year later. At this time the clinical exam revealed severe caries on all primary teeth, and fistula on the right maxillary first primary molar (Figs. 1,2). At that point radiographs were taken and showed a radiolucency on the right first maxillary molar, and extensive caries close to the pulp on lower first and second primary molars.

FIGURE 1. Clinical presentation of the maxillary teeth prior to restoration.

FIGURE 2. Clinical presentation of the mandibular teeth prior to restoration.

The treatment plan, after consultation with the oncologist, included the same preventive protocol highlighting to the parents its implementation. The canines, the upper primary molars, and the lower second molars were decided to be restored with composite resin as they presented adequate tooth structure to retain the restorative material. The treatment plan included vital pulp therapy and restoration with zirconia crowns for the lower first primary molars (NuSmile ZR) as they presented extensive loss of tooth structure, with pulp involvement and required a full-coverage restoration. Finally, extraction of the incisors and the right maxillary first molar was decided followed by space maintenance as they presented with abscesses.

Patient was cooperative and all the restorations were performed at the dental operatory without any restrictions imposed by the medical doctors (Fig. 3). Mandibular first primary

molars were prepared for the zirconia crowns according to the manufacturer's recommendations. Thus, occlusal surface was reduced by 1–1.5 mm, caries was removed, pulp treatment was performed as necessary, followed by further preparation of the lingual, buccal and interproximal surfaces by 1–1.5 mm. A gingival preparation finish line was created, try-in crowns were tested and the final prefabricated zirconia crowns were adhesively cemented with composite resin cement.

FIGURE 3. Frontal clinical picture post-restoration.

A panoramic radiograph (Fig. 4) was requested after treatment completion to evaluate the development of permanent teeth.

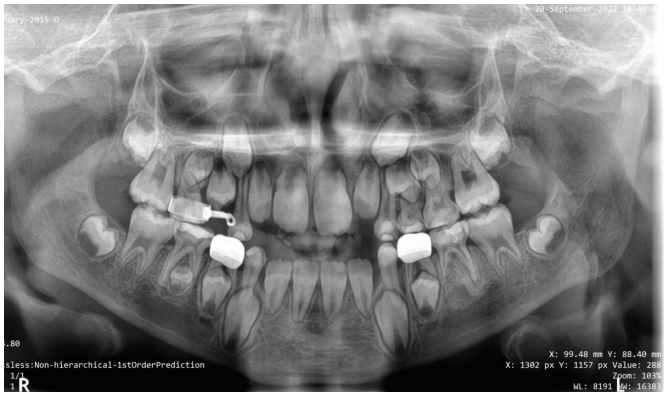

FIGURE 4. Panoramic xray at the age of 7 year after the completion of the restorative treatment.

The patient has been attending the clinic for follow up visits without presenting any new carious lesions or complications. Sealants were placed at the 2-year follow-up visit to the first permanent molars that had erupted.

3. Discussion

Patients requiring frequent MRI imaging often need to have metal parts removed prior to the MRI. For those patients, composite resin restorations, zirconia crowns or computer-aided design and manufacturing (CAD/CAM) materials are the materials of choice.

Oncology patients are often at higher caries risk and develop cavities for multiple reasons. During chemotherapy, they are often advised not to brush for certain periods of time due to low platelets and white blood cells counts [2]. Also, during antineoplastic treatment most patients present with acute oral mucositis, microbial and fungal infections, xerostomia and taste alterations that may change their oral hygiene habits [7]. In addition, chemotherapy and radiotherapy have been associated with higher risk for dental defects at the teeth that are developing during the treatments' period [3]. As a result, cancer survivors often require extensive dental treatment to restore their severely damaged dentition and to prevent further deterioration, while preserving function and aesthetics. Also, due to the fact that most of them undergo multiple treatments for long time periods and at a very young age they often become uncooperative making dental treatment even more challenging.

For all of these reasons, oral health prevention is of utmost importance to these patients. When a strict preventive protocol is not followed, the dentition can deteriorate rapidly as shown in the presented case. In addition, when extensive restorative treatment is required a treatment plan should be developed after consulting the oncology physician.

SSCs are considered the treatment of choice at high caries risk children and for teeth with severe caries, developmental defects, or when other restorative materials are likely to fail [4, 8]. However, SSCs are made of base metal and are not indicated in patients that need to undergo MRI imaging frequently for follow-ups due to distortion of the image that limits the diagnostic value of the exam. The alternatives in those cases are composite resin restorations, zirconia crowns or CAD/CAM hybrid composite materials.

In the present case, direct composite resin restorations were chosen for the restoration of the majority of the teeth, as they could adequately restore the teeth, they could be placed at the same visit, and were less costly than crowns. However, for the restoration of the lower first primary molars, zirconia crowns were chosen due to the extensive loss of tooth structure and the need for pulp therapy. CAD/CAM hybrid composite materials were not chosen in the present case as they often require two visits for their placement and it was important to keep the number of appointments to a minimum.

Composite resins are widely used in restorative dentistry and have been significantly improved in the last decade [9], with low annual failure rates for Class I and Class II restorations [4]. Advantages of direct composite restorations are the esthetic result, and the option to restore the tooth in one visit. However, composite resin restorations are more technique sensitive, require several steps and thus longer time for their completion, and cannot be used in cases of extensive loss of tooth structure [4, 8]. Also, clinician's experience, gingival inflammation and degree of caries removal can influence the longevity of the restoration [10], with marginal microleakage and secondary caries being the most common reason for failure [8, 11].

Prefabricated zirconia crowns were introduced to pediatric dentistry in the last decade [12], as a more aesthetic alternative to the SSCs [13, 14]. They have good retention, they are resistant to wear and show reduced risk for recurrent decay [12, 13]. Also, improved gingival health has been reported around zirconia crowns in comparison to SSCs [15]. However, zirconia crowns require extensive preparation of the tooth to achieve passive fit around the tooth and their inability to be crimped to allow good adaptation to the tooth like the SSCs [12]. As a result, in most cases pulp treatment is also required [14]. Finally, their higher cost compared to SSCs and

composite resin restorations and the need for decontamination protocols prior to cementation limits the frequency of their use mainly in cases where they are considered necessary [14, 16].

Use of CAD/CAM technology has increased significantly in the last years with the advancement of intraoral dental scanning [17, 18]. CAD/CAM technology allows minimal preparation compared to preformed crowns as the restorative material is customized [17]. In addition, CAD/CAM hybrid/reinforced composite resin materials are durable and esthetic [18, 19]. However, they require two visits for their fabrication, they need a technique sensitive adhesive protocol, and their longevity in primary full-coverage restoration has not been tested extensively [19, 20]. They also have a relatively higher cost which should be taken into account in developing countries and under-resourced settings.

In regards to MRI, the most compatible materials are composite resin and glass-ionomer cement [6, 21], whereas, non-precious metals, titanium and stainless steel seem to produce high image distortion and are considered to have high magnetic susceptibility [6, 21]. High noble metal restorations, amalgam fillings, ceramic, zirconia and hybrid CAD/CAM materials seem to be acceptable in cases of MRI. Although they might produce some image distortion [21], any artifacts tend to be minimal and do not interfere significantly with the diagnostic value of the image [6].

Cancer survivors are at greater risk for developing dental problems. The type of cancer treatment received, the socioeconomic background and access to dental care are considered the factors mostly influencing the type and severity of dental problems [22]. Thus, as other special needs patients, they should be monitored closely with recall visits every three months, radiographs every six months and reinforcement of their strict preventive protocol with fluoride supplements, oral hygiene, diet counseling and sealants or restorations when necessary [23].

4. Conclusions

Maintaining adequate oral health and having frequent recall visits are important in oncology patients to detect any defects early and adopt required treatment. Although, there are no restrictions regarding the dental treatment of cancer survivors, materials that are compatible with their medical follow-ups should be chosen. Composite resin, zirconia crowns or CAD/CAM hybrid composite materials that are compatible with MRI imaging can be used as an alternative in patient with oncology history and should be integrated in the restorative guidelines as indications of these materials. Material choice should be based on the cooperation of the patient, caries risk and the available time and means to treat the patient.

AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article. Additional x-rays and photographs are available upon reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

MVA—conceived the idea for the paper and treated the patient. KS and IIA—wrote part of the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Informed consent for publication was provided by the mother MK. This is a case report and was exempted from requiring ethics approval from the ethics committee of the National & Kapodisitrian University of Athens, School of Dentistry.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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