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CASE REPORT

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Generalized root agenesis in permanent dentition of a young adolescent patient with rhabdomyosarcoma: a case report

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Abstract

Background Parameningeal rhabdomyosarcoma (PM-RMS) is a rare and aggressive soft tissue malignancy that primarily occurs in the head and neck region. The standard treatment approach for RMS involves a multimodal therapy regimen, which includes surgery, chemotherapy, and radiotherapy. However, the routine use of radiotherapy and chemotherapy in young patients with RMS in the head and neck region can lead to adverse effects on dental development and thereby, pose a challenge in planning dental intervention.

Case presentation This case report outlines the dental and facial developmental consequences in a 13-year-old child, who received chemo-radiotherapeutic intervention at the age of 7 years for the management of PM-RMS. Following treatment, the child exhibited significant dental complications, including arrested root growth and restricted mouth opening.

Conclusions This case highlights the necessity for interdisciplinary collaboration between oncologists, dentists, and other healthcare professionals to mitigate the adverse effects on dental health and overall quality of life in patients undergoing chemo-radiotherapy for rhabdomyosarcoma.

Keywords Chemotherapy, Craniofacial abnormalities, Head and neck cancer, Late effects, Rhabdomyosarcoma

Introduction

Rhabdomyosarcoma (RMS) is a malignant soft tissue tumour most commonly occuring in young adolescents. It originates from mesenchymal tissues [1], and currently exhibits a 5-year survival rate exceeding 70% [2]. The 2013 World Health Organization (WHO) classification of bone and soft tissue tumors recognizes four subtypes of RMS: Embryonal rhabdomyosarcoma, alveolar rhabdomyosarcoma, pleomorphic rhabdomyosarcoma, spindle cell/sclerosing rhabdomyosarcoma [3]. Parameningeal rhabdomyosarcoma (PM-RMS, subtype of embryonal rhabdomyosarcoma) is a rare and aggressive soft tissue malignancy that primarily occurs in the head and neck region [4]. This tumor, although rare, represents a significant diagnostic and therapeutic challenges due to its location and proximity to vital anatomical structures [5]. The standard treatment approach for RMS involves a multimodal therapy regimen, which includes surgery, chemotherapy, and radiotherapy [6]. However, the routine use of radiotherapy and chemotherapy in young patients with RMS in the head and neck region can lead to adverse effects on dental development [7]. Furthermore, radiotherapy can result in limited mouth opening

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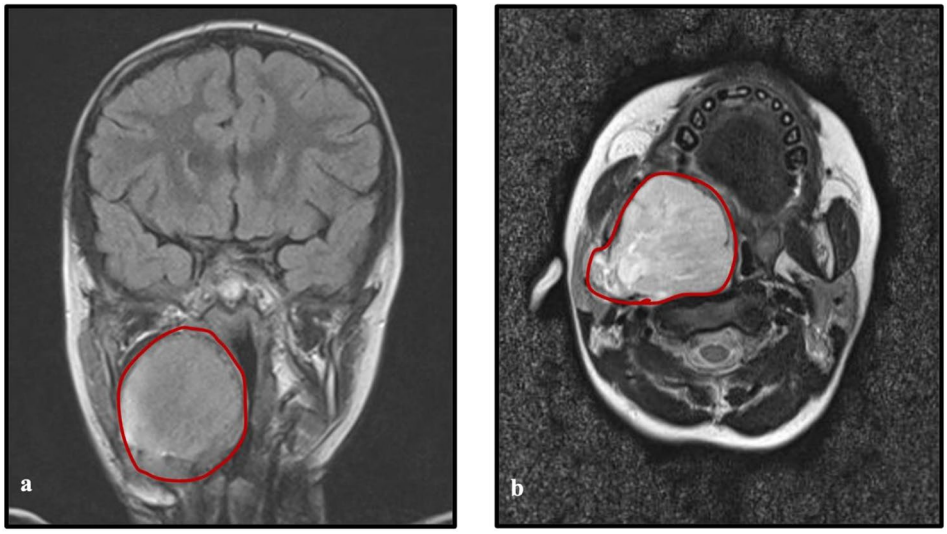

Fig. 1 (**a** & **b**). MRI image of the patient at 7 years of age showing well circumscribed heterogeneously enhancing soft tissue mass, measuring approximately 4.6 × 5.0 × 4.9 cm in AP x T x CC (anteroposterior x transverse x craniocaudal) dimensions in the right parameningeal region (outlined by red color)

due to radiation-induced fibrosis of muscles of mastication and temporomandibular joint [8, 9].

In this case report, the authors reported the unique aspects of PM-RMS, including its clinical presentation and the impact of therapeutic interventions. Through the exploration of a specific case, we intend to provide insights into long-term consequences of the therapeutic intervention of this condition, particularly in relation to its effects on dentofacial development. This report emphasizes the importance of a multidisciplinary approach to treatment and the need for ongoing care and surveillance for patients who have undergone therapy for PM-RMS.

Case presentation

A 13-year-old male patient presented to the dental clinics of Aga Khan University Hospital, Karachi in August 2021, with the complaint of swollen gums and bleeding on his right lower side for the past three weeks. Upon asking, the patient revealed that he was diagnosed with PM-RMS at the age of 7 years, for which he was treated successfully with chem-radiotherapy at 8 years of age. The patient underwent 30 cycles of chemotherapy using VAC (vincristine sulfate, dactinomycin, and cyclophosphamide) along with external-beam radiation therapy. The total radiation dose administered was 50.40 Gy, targeting the right upper and lower molar teeth, the right half of the mandible, the right side of the oropharynx and hypopharynx, extending from the base of the skull to the level of the right lobe of the thyroid gland.

The pre-operative MRI image of the patient is presented in Fig. 1. Computed Tomography (CT) scan of the chest and whole-body skeletal scintigraphy were also done which were negative for pulmonary and bony metastasis respectively.

Fig. 2 Frontal view of patient's face at the age of 13 years

On presentation, clinical examination revealed normal facial symmetry (Fig. 2), with limited mouth opening (20 mm). Oral hygiene was poor with associated plaque and calculus deposits, as well as inflamed gums. The patient had a secondary dentition with retained tooth #85 and clinically missing tooth #45. Moreover, both the maxillary and mandibular anterior teeth were misaligned with significant crowding. (Fig. 3).

Fig. 3 Dental photographs of a patient with parameningeal rhabdomyosarcoma showing different dental views. **a**, Right buccal view; **b**, Frontal view; **c**, Left buccal view; **d**, Maxillary occlusal view; **e** & **f**, Mandibular right and left occlusal views

Fig. 4 Panoramic radiograph at the age of 13 years shows dental abnormalities, such as fore-shortening and blunting of roots, are seen as a combined result of chemo-radiotherapeutic intervention

An orthopantomogram [OPG] (Fig. 4) was done to evaluate the existing dentition and surprisingly, it showed arrested root development of all the teeth except for mandibular central and lateral incisors. Maxillary central incisors and all the first permanent molars were less affected than other teeth, but they still showed some degree of arrested root development. The rest of the dentition showed complete root agenesis with the premolars

and second molars being severely affected than the other teeth.

Owing to the misaligned teeth, an orthodontic specialist was taken on board, however, due to the arrested root development, orthodontic treatment poses a significant challenge. Therefore, no active dental treatment was provided to the patient except for restoration of his carious teeth and non-surgical periodontal therapy. Furthermore, preventive treatment regimen in the form of oral hygiene reinforcement (brushing and flossing), fluoride therapy, dietary modification, sealants, and regular dental follow up visits were advised to improve patient's oral health.

Discussion

RMS is a rapidly progressing and highly aggressive tumor commonly found in children. Its highest incidence in the head and neck area typically occurs between the ages of two and six [10]. The adoption of modern combination of chemotherapy, radiotherapy, and surgical interventions has enabled management of the disease, leading to a considerable enhancement in the overall survival rate from 25% to 71% in recent years [11]. However, multimodal therapy has been linked with dental and/or craniofacial complications, along with developmental abnormalities among survivors of childhood cancer [12, 13].

The present case shows the effects of combined chemo-radiotherapeutic intervention for the management of PM-RMS and its late-effects on dental development. The patient at the time of presentation to our clinic had already finished his course of cancer treatment and his orthopantomogram showed arrested root development of most of the permanent teeth. The mandibular central and lateral incisors are the first teeth to erupt in the oral cavity at the age of six years and the root development completes three years post-eruption. It was intriguing to observe that despite undergoing chemo-radiotherapy at the age of seven, the mandibular central and lateral incisors had completed their root development. This could be due to the fact that patients irradiated for head and neck cancer do not receive significant doses of radiation to the anterior mandible [14]. The maxillary central incisors and all the first permanent molars also showed some degree of arrested root growth, but less severe than the other teeth. The most likely explanation for this could be that at the age of 7 years the patient received chemo-radiotherapy, the maxillary incisors and molars have been erupted into the oral cavity with 2/3rd of their roots being formed but following the intervention the roots development was arrested. The rest of the dentition showed complete root agenesis with the premolars and second molars being severely affected than the other teeth. By the age of 7 years, at which the patient received the therapy, the crowns of premolars and second molars might have just completed their calcification, so the likely etiology of the arrested root development could be the phase of the therapy. Despite the arrested root development, none of the affected teeth exhibited any mobility. Furthermore, the formation of roots on both sides was adversely affected and the condyle of the right side appeared hypoplastic. This outcome may be associated with chemotherapy, as the effects are symmetrical on both sides, whereas the radiation therapy specifically targeted the area behind the right-side dentition. The chemotherapeutic drugs received by the patient were vincristine (alkaloid), dactinomycin, and cyclophosphamide (alkylating agent). All these drugs interfere with DNA synthesis and cell division, leading to cytotoxicity and apoptosis in rapidly dividing cells such as those in the developing tooth buds. This results in reduced cellular proliferation, differentiation and impaired function of odontoblasts and ameloblasts, the cells responsible for dentin and enamel formation, respectively and normal root development [15].

Literature has documented instances of facial bone growth impairment in children undergoing radiation therapy for head and neck tumors [16]. This effect appears to be more pronounced during phases of heightened growth, such as from infancy to six years old and during puberty, suggesting a heightened sensitivity of tissues during these developmental stages [17]. In the present case, the patient's lower facial third appeared to be smaller and V-shaped as compared to the rest of the face (Fig. 2) and the orthopantomogram showed that the right mandibular angle was not well developed as compared to the left side (Fig. 4). However, this could not be confirmed due to the lack of pre-treatment facial photographs and lateral skull cephalometric radiographs to make direct comparisons and measurements of facial proportions. Also, the patient had developed hearing loss of the right ear and hypothyroidism one year following chemo-radiotherapy. Several studies have reported hearing loss as a complication following chemo-radiotherapy for head and neck malignancies with young age children being more severely affected than the older ones [18–20]. Radiotherapy of the head and neck tumors might be associated with increased risk of hypothyroidism with the effect being more prevalent by increasing the dose of radiation and volume (small) of the thyroid gland [21, 22]. Chemotherapy appears to be less related with the incidence of hypothyroidism and currently, there is no definitive conclusion regarding the contribution of chemotherapy to the development of hypothyroidism alongside radiation therapy [21].

Orthodontic treatment may present a challenge in patients with history of radiation therapy for head and neck tumors and can lead to several complications affecting the treatment. Short root length poses a significant risk during orthodontic treatment because the

application of orthodontic forces can lead to further root resorption, increasing the likelihood of tooth mobility or even tooth loss [23]. The shortened roots are less capable of withstanding the mechanical forces applied during orthodontic movements, which may compromise the stability and longevity of the teeth. The reduced bone healing capacity because of radiation therapy increases the risk of bone necrosis during or after treatment, and the reduced salivary flow increases the risk of dental caries and periodontal disease, which further complicates orthodontic treatment. Teeth and surrounding tissues may be more sensitive due to radiation-induced damage, making orthodontic treatment more uncomfortable [23, 24]. Following chemo-radiotherapy, the tissues in the head and neck region, including bone, soft tissue, and teeth, undergo significant changes and stress. An immediate recovery period is necessary for healing and stabilization. A waiting period of at least 6–12 months post-therapy is commonly recommended [24, 25]. This allows for the resolution of acute side effects, assessment of late effects, and stabilization of the patient's overall health and oral environment [25]. Several non-orthodontic options might be available to address malocclusion for this individual with generalized root agenesis transitioning into adulthood. These include prosthetic solutions like crowns, bridges, and partial dentures, cosmetic dentistry options such as veneers and composite bonding, and limited orthodontic treatments like removable appliances and clear aligners.

To improve the dental prognosis as the patient transitions from pediatric to adult care, establishing a clear transition plan with coordinated care between pediatric and adult dental providers, ensuring access to specialized care, and implementing preventive measures (fluoride treatments, regular cleanings) are crucial. Regular monitoring and education on maintaining oral hygiene can also significantly enhance his dental health outcomes.

Cancer therapies can have profound and long-lasting effects on oral health and dental development. Incorporating dental professionals into the multidisciplinary team from the outset of cancer treatment offers numerous benefits for pediatric patients. It ensures early intervention to prevent complications, optimizes treatment planning for potential dental anomalies such as root agenesis, thereby facilitating timely interventions that can preserve oral function and aesthetics. It provides ongoing dental health management for treatment-related side effects such as xerostomia and mucositis, enhancing overall health outcomes and quality of life for children undergoing cancer treatment, supports patient education, and facilitates effective team collaboration.

Conclusions

In conclusion, this case highlights the complex interplay between cancer treatment and dental/maxillofacial development in pediatric patients with rhabdomyosarcoma. While aggressive multimodal therapy is necessary for disease control, it is essential to recognize and manage potential long-term sequelae, including dental abnormalities and maxillofacial growth disturbances. Close collaboration between oncologists, pediatric dentists, and maxillofacial surgeons is crucial in providing comprehensive care and optimizing outcomes for these patients. Long-term follow-up and monitoring are also essential to identify and address late effects of treatment, ensuring the overall health and well-being of childhood cancer survivors.

Author contributions

Author 1 - Saqib Habib: Conceptualization of the case report, data collection, interpretation of clinical findings. Author 2 - Bibi Fatima: Acquisition and analysis of radiographic data, drafting the manuscript, critical revision of the manuscript for important intellectual content. Author 3 - Farhan Raza Khan: Critical analysis and revision of the manuscript for important intellectual content, and final approval of the version to be published. All authors reviewed the manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent

Ethical approval was granted by the Aga Khan University Hospital's ethical review committee. Written and informed consent was obtained from the patient's parents.

Consent for publication

The patient's parents provided written informed consent for the publication of identifiable information in an open-access journal.

Competing interests

The authors declare no competing interests.

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