RESEARCH ARTICLE

Dental Caries and Dental Anomalies in Children Undergoing Chemotherapy for Malignant Diseases

Abhinav Liladhar Talekar[1], Prasad K Musale[2], Sneha Sunil Kothare[3]

Abstract

Purpose: The study aims to evaluate the prevalence of dental caries and anomalies in pediatric patients undergoing chemotherapy or those who have completed chemotherapy.

Methods: A total of 250 pediatric patients within the age group of 6 months to 17 years, either admitted to hospitals for chemotherapy or on follow-up, were included as a part of the study. Complete oral examination inclusive of the diet history, oral hygiene methods, past dental history, the decayed, missing, and filled teeth (DMFT), def score, and any dental anomaly was diagnosed clinically and radiographically using an orthopantomogram. The samples were further categorized under type of malignancies and duration of chemotherapeutic drug usage groups (from 6 months to 10 years and more than 10 years) to establish a correlation of these variables with the prevalence of dental caries and dental anomalies.

Results: Among all patients, 108 (43.2%) had completed the treatment (chemotherapy), while 142 (56.8%) were undergoing the treatment. Forty-three (17.2%) patients showed positive findings for dental anomalies.

Conclusion: The present study confirms the strong positive correlation between long-term exposure to chemotherapeutic agents and the prevalence of dental anomalies and dental caries in children.

Keywords: Chemotherapy, Prevalence, Tooth abnormality.

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Introduction

The total sum of new pediatric malignancy cases exceeds 200,000 all around the globe, and more than 80% of these are from developing countries.[1] The incidence of cancer in children ranges from 75 to 150 per million per year.[2,3] In the United States of America, cancer is the second most common cause of death in children after accidental deaths. In England, only 0.5% of all cancer cases are seen in children below 15 years of age.[4] In India, however, this count seems to be higher (1.6–4.8%) and is the ninth most prevalent cause of death among children between 5 and 14 years of age. The proportion of cancer in children when compared to cancers in all age groups, as reported in the most recent 3-year report of 27 population-based cancer registries, varied between 0.7 and 4.4% for the year 2012–2014.[5]

In developed countries, central nervous system (CNS) tumors are the second most common cancer (22–25%) and lymphomas a distant third (10%) in children. In contrast, the statistics of India show lymphomas often exceed CNS tumors, particularly in the male gender. Also, in India, the number of Hodgkin's lymphoma (HL) exceeds non-Hodgkin's lymphoma (NHL), a pattern opposite to that seen in developed countries.[4,6] Further, the reported incidence of cancer in children has increased over the last 25 years, the increase being much larger in females (44–76% increase) than in males (12–27% increase).[6]

Early detection and treatment such as chemotherapy, radiotherapy, bone marrow transplantation, or a combination of any of these have made cancer a curable disease. With the progress in chemotherapeutic drugs, there has been a decline seen in the mortality rate in children suffering from malignancies. However, chemotherapeutic drugs are nonspecific and act on all cells in the dividing stage. Mucositis, parotitis, taste changes, xerostomia, opportunistic infections, pain, and bleeding are commonly occurring acute oral complications seen in patients receiving chemotherapy and radiation therapy.[7]

The lack of specificity of chemotherapeutic agents and radiation therapy for differentiating rapidly dividing neoplastic cells from metabolically active normal cells might lead to abnormalities in dental and facial development. An additional indirect effect might also occur due to altered hypothalamic-pituitary function, leading to diminished growth hormone production that may adversely affect odontogenesis and craniofacial development.[8]

The primary and permanent teeth develop over a span of years and could be affected by chemotherapeutic agents given to treat cancer. Postoperative defects with radiotherapy in adults and children have been widely discussed before, but the

[1]Department of Pediatric and Preventive Dentistry, M. A. Rangoonwala College of Dental Sciences & Research Centre, Pune, Maharashtra, India

[2]Department of Pedodontics and Preventive Dentistry, SMBT Institute of Dental Sciences and Research, Nashik, Maharashtra, India

[3]Pediatric Dentist, Private Practitioner, Mumbai, Maharashtra, India

Corresponding Author: Abhinav Liladhar Talekar, Department of Pediatric and Preventive Dentistry, M. A. Rangoonwala College of Dental Sciences & Research Centre, Pune, Maharashtra, India, Phone: 02048604777, e-mail: drabhinavtalekar@gmail.com

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effects of chemotherapy are unfocused in the pediatric group as compared to the effects of radiotherapy. The postoperative effects of chemotherapy on soft tissues are well documented, but its long-term effects on developing teeth are scarce in the literature.

This study assessed the side effects of chemotherapeutic drugs in pediatric patients belonging to the age group ranging from 6 months to 17 years undergoing chemotherapy or those who have completed chemotherapy.

Methods

The samples considered in this study were either admitted to the pediatric oncology department of Deenanath Mangeshkar Hospital & Research Center, Pune and Tata Memorial Cancer Hospital & Research Centre, Mumbai for chemotherapy or were on post-treatment follow-up. The inclusion criteria were patients suffering from various malignant diseases and undergoing chemotherapy only for more than 6 months; pediatric oncologist's consent; patient's consent.

The patients undergoing radiation therapy for malignancies of the head and neck region were excluded from the study. The oral health examination of each sample was carried out at the dental department of the same hospital. The diet history, oral hygiene methods, and previous dental history were also noted. Any dental anomalies such as enamel hypoplasia, hypodontia, oligodontia, and microdontia were diagnosed clinically and duly noted in the patient information sheet. All patients were further investigated for type of malignancies, duration of chemotherapeutic drugs (completed, on follow-up, and undergoing), age groups (from 6 months to 10 years and more than 10 years).

The patients who had completed either one session of chemotherapy or those who were on follow-up were considered in the "completed group."

Statistical Analysis

Continuous data were summarized as mean ± standard deviation (SD) during discrete (categorical) percentages. Categorical groups were compared using the Chi-squared (χ^2) test. A two-sided ($\alpha = 2$) $p < 0.05$ was considered statistically significant. Analysis was performed on GraphPad Prism (Windows version 3.1) software.

Results

A total of 250 children were included in the study. Forty-one patients (50.6%) were ≤10 years and 40 (49.4%) were >10 years. The mean age of all malignant children was 10.23 years (SD = ±3.58 years), ranging from 4 to 17 years. Among the 81 malignant children, 49 (60.5%) were males and the remaining were females. The distribution of type malignancy in these children is given in Figure 1. Of these, 37 (45.7%) had completed the treatment (chemotherapy), while 44 (54.3%) were undergoing the treatment.

Among the dental anomalies, hypodontia (eight cases) was the most common, followed by delayed tooth development (five cases). The least common anomalies were root thinning, dilaceration, exfoliation, and false anodontia, with one case each (Table 1). The prevalence of developmental dental anomalies was more in the >10 years age group than the ≤10 years age group (Table 2). It was found that dental anomalies were more prevalent in males (58.8%) than females (41.2%). Furthermore, completed cases (85.3%) had a higher prevalence of dental anomalies than undergoing cases (14.7%) (Table 3). However, there was no statistical difference in the prevalence of the type of dental anomalies according to age ($p = 0.217$), gender ($p = 0.098$), and case type ($p = 0.472$).

The prevalence of dental anomalies based on the type of malignancy for which the child is undergoing chemotherapy is summarized in Table 4.

Discussion

Chemotherapy has been widely used for the treatment of malignancy and has adverse effects on the oral cavity.[8–11] Various studies have indicated the relationship between the prevalence of dental caries, dental anomalies, and chemotherapy treatment.[12–15] Oral mucositis, xerostomia, gingival bleeding, and dental abnormalities have also been frequently noted.[16–19] Therefore, children undergoing chemotherapy are considered to be a high-risk group for dental care.[16] The present study confirms the correlation between long-term exposure to chemotherapeutic agents and the prevalence of dental anomalies and dental caries seen in children, which depends upon the age of a child, type of malignancy, and duration of exposure to chemotherapeutic drugs.

Hong et al. found that the overall prevalence of dental caries was 28.1% in patients undergoing chemotherapy for malignant diseases from 19 observational studies. The overall DMFT/dmft for patients who had undergone chemotherapy was 5.63

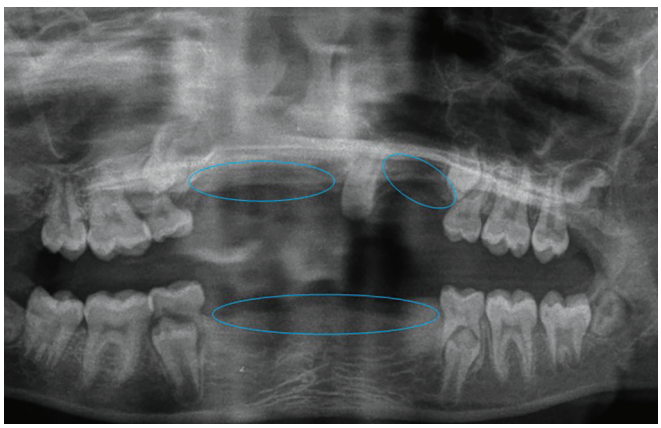

Fig. 1: Frequency distribution of type of malignancy in malignant children

Table 1: Prevalence of type of dental anomalies in malignant children

Dental anomalies	*No. of malignant children (n = 34) (%)*
Hypodontia	8 (23.5%)
Delayed tooth development	5 (14.7%)
Enamel hypoplasia	5 (14.7%)
Affected crown root ratio	4 (11.8%)
Oligodontia	2 (5.9%)
Fusion	1 (2.9%)
Dentin dysplasia	1 (2.9%)
Taurodontism	2 (5.9%)
Mesiodens	2 (5.9%)
Thinning of root	1 (2.9%)
Dilacerated root	1 (2.9%)
Exfoliation	1 (2.9%)
False anodontia	1 (2.9%)

Table 2: Age-wise prevalence of the type of dental anomalies

Dental anomalies	*Dental anomalies (n)*	*Age ≤10 years (n = 13)*	*Age >10 years (n = 21)*	*χ^2 value (DF = 12)*	*p-value*
Hypodontia	8	3 (37.5%)	5 (62.5%)	15.47	0.217
Delayed tooth development	5	2 (40.0%)	3 (60.0%)		
Oligodontia	2	1 (50.0%)	1 (50.0%)		
Fusion	1	1 (100.0%)	0 (0.0%)		
Affected crown root ratio	4	0 (0.0%)	4 (100.0%)		
Dentin dysplasia	1	1 (100.0%)	0 (0.0%)		
Enamel hypoplasia	5	1 (20.0%)	4 (80.0%)		
Taurodontism	2	2 (100.0%)	0 (0.0%)		
Mesiodens	2	0 (0.0%)	2 (100.0%)		
Thinning of root	1	1 (100.0%)	0 (0.0%)		
Dilacerated root	1	0 (0.0%)	1 (100.0%)		
Exfoliation	1	1 (100.0%)	0 (0.0%)		
False anodontia	1	0 (0.0%)	1 (100.0%)		

Table 3: Case-wise prevalence of the type of dental anomalies

Dental anomalies	*Dental anomalies (n)*	*Completed (n = 29)*	*Undergoing (n = 5)*	*χ^2 value (DF = 12)*	*p-value*
Hypodontia	8	6 (75.0%)	2 (25.0%)	11.68	0.472
Delayed tooth development	5	5 (100.0%)	0 (0.0%)		
Oligodontia	2	2 (100.0%)	0 (0.0%)		
Fusion	1	1 (100.0%)	0 (0.0%)		
Affected crown root ratio	4	4 (100.0%)	0 (0.0%)		
Dentin dysplasia	1	1 (100.0%)	0 (0.0%)		
Enamel hypoplasia	5	4 (80.0%)	1 (20.0%)		
Taurodontism	2	1 (50.0%)	1 (50.0%)		
Mesiodens	2	2 (100.0%)	0 (0.0%)		
Thinning of root	1	1 (100.0%)	0 (0.0%)		
Dilacerated root	1	1 (100.0%)	0 (0.0%)		
Exfoliation	1	1 (100.0%)	0 (0.0%)		
False anodontia	1	0 (0.0%)	1 (100.0%)		

Table 4: Malignancies-wise prevalence of dental anomalies

Dental anomalies	*Dental anomalies (n)*	*ALL (n = 16)*	*AML (n = 7)*	*HL (n = 2)*	*NHL (n = 1)*	*Neuroblastoma (n = 5)*	*Rhabdomyosarcoma (n = 3)*	*χ^2 value (DF = 60)*	*p-value*
Hypodontia	8	3 (37.5%)	2 (25.0%)	2 (25.0%)	0 (0.0%)	1 (12.5.0%)	0 (0.0%)	67.67	0.232
Delayed tooth development	5	3 (60.0%)	1 (20.0%)	0 (0.0%)	1 (20.0%)	0 (0.0%)	0 (0.0%)		
Oligodontia	2	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (100.0%)	0 (0.0%)		
Fusion	1	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Affected crown root ratio	4	1 (25.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (50.0%)	1 (25.0%)		
Dentin dysplasia	1	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Enamel hypoplasia	5	4 (80.0%)	1 (20.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Taurodontism	2	1 (50.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Mesiodens	2	2 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Thinning of root	1	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Dilacerated root	1	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Exfoliation	1	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)		
False anodontia	1	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)		

ALL, acute lymphoblastic leukaemia; AML, acute myeloid leukaemia

(SD, 0.88; *n* = 66). The prevalence of dental caries was the highest in patients who received only chemotherapy compared to those who received radiotherapy or chemoradiotherapy.[16] The mean DMFT and def scores in the present study were 1.09 and 3.37, respectively, while the weighted mean DMFT for 5, 12, and 15 years age group for the past 15 years in healthy Indian children was 2.49 ± 7.78, 1.48 ± 3.292, and 2.56 ± 6.508, respectively. This is similar to Nunn et al. who reported no differences in the dental caries experience between 52 postchemotherapy children and their healthy siblings. The dental caries prevalence could be attributed to diet limitations and the inability to maintain proper oral health care due to mucositis, which is seen in the initial phase of chemotherapy.[20–23]

The American Academy of Pediatric Dentistry (2015–16) recommendations stress on the importance of patient and parent education regarding optimal oral care in order to minimize possible acute and long-term effects of chemotherapy on the oral cavity.[24] The patients from one of these hospitals had poor oral health status and higher caries prevalence as compared to the other. The difference between patients' and parents' awareness about dental health, parents' education, and economic status from both hospitals might have been the reason for the same. This substantiated the fact that dental caries is a multifactorial disease, and chemotherapy alone could not be the contributory factor.

The prevalence of dental anomalies in healthy population in India was 2.27%.[25] However, the prevalence of dental anomalies in children undergoing chemotherapy in this study was much higher at 42%, which is similar to Nunn et al.[16] There are several studies that show a relationship between chemotherapy and dental anomalies but the sample size considered was not sufficient to draw conclusive results.[10–15,23,26–29]

The prevalence of dental anomalies was found to be higher in older children (>10 years) than in younger children (≤10 years) (Table 2). These results are similar to Krasuska-Sławińska et al. who found a correlation between time elapsed since chemotherapy and manifestation of dental anomalies.[30] Alpaslan et al. suggested that children treated with chemotherapy/radiotherapy in the early years of their lives had more severe dental defects, suggesting that immature teeth are at a greater risk of developing disturbances than fully developed teeth.[31]

Proc et al. observed a significantly higher number ($p = 0.04$) of dental anomalies in males as compared to females suffering from cancer.[32] The prevalence of dental anomalies in the present study was higher in males (58.8%) than in females (41.2%). However, this was not significant ($p = 0.098$). If we compare the anomalies and treatment status, it differs significantly in both groups. Patients who had completed at least one session of chemotherapy or more showed a prevalence of 78.4%, while patients who were still undergoing treatment showed a prevalence of 11.4%. This clearly indicates that the etiological factor for the presence of anomalies is long-term chemotherapeutic exposure and not malignancy itself. This is similar to several other studies which state that the presence of dental anomalies is influenced by the duration of exposure and dosage of the chemotherapeutic agent.[30,32]

The prevalence of anomalies differed as per the type of malignancies. Neuroblastoma (Fig. 2) and rhabdomyosarcoma (Fig. 3) showed a 100% prevalence of anomalies, followed by lymphomas and then leukemia. When we discussed with pediatric oncologists, they suggested that the severity of chemotherapeutic drugs used during the treatment decreases in the same order. The chemotherapeutic drugs and their administration and exposure schedule vary depending upon the type of malignancies and stage at which the patient reported for chemotherapy.

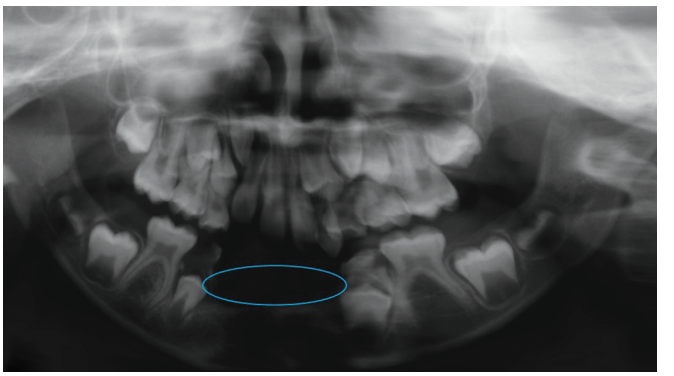

Fig. 2: Orthopantomogram showing oligodontia in a 14-year-old male patient suffering from neuroblastoma

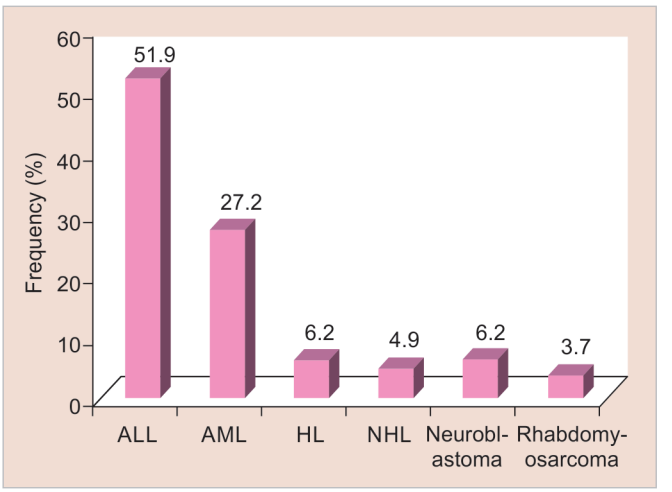

Fig. 3: Orthopantomogram showing hypodontia seen with lower incisors and canines in a 9-year-old female patient suffering from rhabdomyosarcoma

Conclusion

Dental caries is multifactorial in origin. Side effects of chemotherapeutic drugs could be one of the contributing factors for the increased prevalence of dental caries. The mean DMFT and def scores of children included in this study were 1.09 and 3.37, respectively. Dental anomalies are associated with long-term exposure to chemotherapeutic drugs. The severity of dental anomalies varies with the individual, type of malignancies, duration of chemotherapy, and age at which the child was exposed to chemotherapy. Furthermore, if the child is exposed to chemotherapeutic drugs at a younger age, an increased prevalence of dental anomalies is observed. The teeth which are in the developing stage at the time of chemotherapy are more prone to developmental dental defects.

Further studies with a larger population under study are necessary to substantiate the results of this study.

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